WEBM005700

SHOP MANUAL

WH609-1 WH613-1 WH713-1 WH714-1 WH714H-1 WH716-1

TELESCOPIC HANDLER

MODEL	SERIAL NUMBER
WH609-1	395F60001 and up
WH613-1	395F60003 and up
WH713-1	395F70001 and up
WH714-1	395F70002 and up
WH714H-1	395F70003 and up
WH716-1	395F70004 and up

KOMATSU

Utility

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REVISED PAGES

The affected pages are indicated by the use of the following marks. It is requested that necessary actions be taken to these pages according to table below.

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●	Page to be replaced	Replace
( )	Page to be delete	Discard

Pages having no marks are those previously revised or made additions.

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IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for the safe operation of your machine.
The service and repair techniques recommended by Komatsu Utility and describe in this manual are both effective and safe methods of operation. Some of these operations require the use of tools specially designed by Komatsu Utility for the purpose.

To prevent injury to workers, the symbol ⚠ is used to mark safety precautions in this manual. The cautions accompanying these symbols should always be carefully followed. If any danger arises or may possibly arise, first consider safety, and take necessary steps to face.

SAFETY

GENERAL PRECAUTIONS

Mistakes in operation extremely dangerous.
Read all the Operation and Maintenance Manual carefully BEFORE operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions written on the decals which are suck on the machine.
2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
   - Always wear safety glasses when hitting parts with a hammer.
   - Always wear safety glasses when grinding parts with a grinder, etc.
3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, glasses, cap and other clothes suited for welding work.
4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator's compartment.
5. Keep all tools in good condition and learn the correct way to use them.
6. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

PREPARATIONS FOR WORK

7. Before adding or making any repairs, park the machine on hard, level ground, and block the wheels to prevent the machine from moving.
8. Before starting work, lower outrigger, bucket or any other work equipment to the ground. If this is not possible, use blocks to prevent the work equipment from falling down. In addition, be sure to lock all the control levers and hang warning sign on them.
9. When disassembling or assembling, support the machine with blocks, jacks or stands before starting work.
10. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine.
    Never jump on or off the machine.
    If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filler cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out.
    Before disconnecting or removing components of the hydraulic circuit and engine cooling circuit, first remove the pressure completely from the circuit.
12. The water and oil in the circuits are not hot when the engine in stopped, so be careful not to get burned.
    Wait for the oil water to cool before carrying out any work on the cooling water circuits.
13. Before starting work, remove the leads from the battery. Always remove the lead from the negative (–) terminal first.

14. When raising heavy components, use a hoist or crane. Check that the wire rope, chains and hooks are free from damage.
    Always use lifting equipment which has ample capacity. Install the lifting equipment at the correct places.
    Use a hoist or crane and operate slowly to prevent the component from hitting any other part.
    Do not work with any part still raised by the hoist or crane.
15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure, then slowly loosen the bolts to remove.
16. When removing components, be careful not to break or damage the wiring.
    Damage wiring may cause electrical fires.
17. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips on to the floor, wipe it up immediately.
    Fuel or oil on the floor can cause you to slip, or can even start fires.
18. As a general rule, do not use gasoline to wash parts. In particular, use only the minimum of gasoline when washing electrical parts.
19. Be sure to assemble all parts again in their original places. Replace any damage parts with new parts. When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.
20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also, check that connecting parts are correctly tightened.
21. When assembling or installing parts, always use specified tightening torques.
    When installing the parts which vibrate violently or rotate at high speed, be particulary careful to check that they are correctly installed.
22. When aligning two holes, never insert your fingers or hand.
23. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurement.
24. Take sure when removing or installing wheels.

FOREWORD

This shop manual has been prepared as an aid to improve the quality of repairs by giving the operator an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop.

The manual is divided into chapters on each main group of components; these chapters are further divided into the following sections.

STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

TESTING AND ADJUSTING

This sections explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Troubleshooting charts correlating «Problems» to «Causes» are also included in this section.

DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

NOTE

The specifications contained in this shop manual are subject to change at any time and without any notice.
Contact your Komatsu Utility distributor for the latest information.

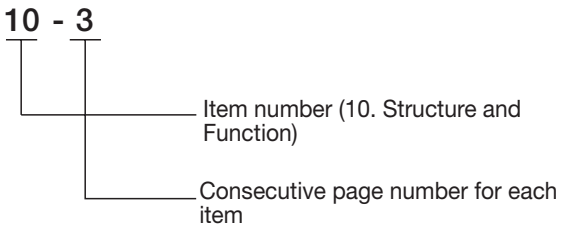
HOW TO READ THE SHOP MANUAL

VOLUMES
Shop manual are issued as a guide to carry out repairs. These various volumes are designed to avoid duplicating the same information.

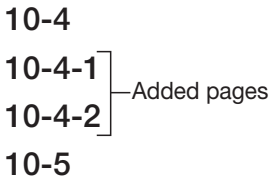
DISTRIBUTION AND UPDATING
Any additions, amendments or other changes will be sent to Komatsu Utility distributors.
Get the most up-to-date information before you start any work.

FILING METHOD

1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show you how to read the page number.
   Example:



3. Additional pages: additional pages are indicated by a hyphen (–) and number after the page number. Fle as in the example.
   Example:



REVISED EDITION MARK
When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

REVISIONS
Revised pages are shown on the LIST OF REVISED PAGES between the title page and SAFETY page.

SYMBOLS
In order to make the shop manual greatly chelpful, important points about safety and quality are marked with the following symbols.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
★	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
	Weight	Weight of parts or systems. Caution necessary when selecting hoisting wire, or when working posture is important, etc.
	Tightening torque	Parts that require special attention for the tightening torque during assembly.
	Coat	Parts to be coated with adhesives and lubricants etc.
	Oil, water	Places where oil, water or fuel must be added, and their quantity.
	Drain	Places where oil or water must be drained, and quantity to be drained.

HOISTING INSTRUCTIONS

⚠ Heavy parts (25 kg or more) must be lifted with a hoist etc. In the Disassembly and Assembly section, every part weighing 25 kg or more is clearly indicated with the symbol

1. If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
   - Check for removal of all bolts fastening the part to the relative parts.
   - Check for any part causing interference with the part to be removed.

2. Wire ropes

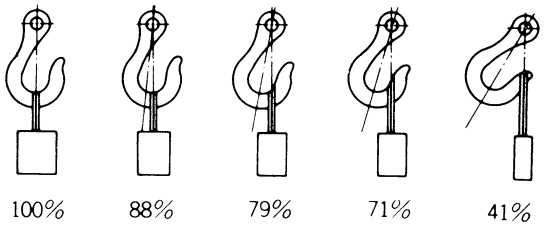
1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

WIRE ROPES (Standard «S» or «Z» twist ropes without galvanizing)	
Rope diameter (mm)	Allowable load (tons)
10.0	1.0
11.2	1.4
12.5	1.6
14.0	2.2
16.0	2.8
18.0	3.6
20.0	4.4
22.4	5.6
30.0	10.0
40.0	18.0
50.0	28.0
60.0	40.0

The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

2) Sling wire ropes from the middle portion of the hook. Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result.

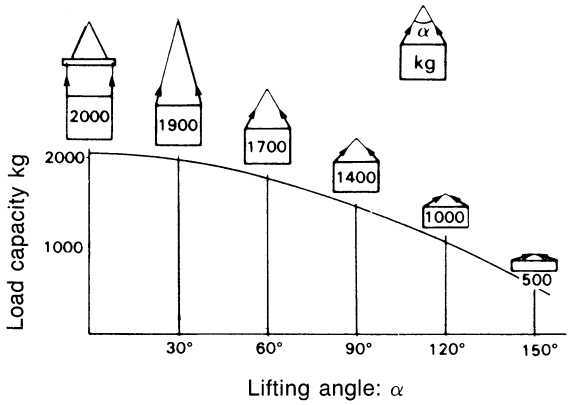
Hooks have maximum strength at the middle portion.



3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound on to the load.

⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can cause dangerous accidents.

4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook.
When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles.
The table below shows the variation of allowable load (kg) when hoisting is made with two ropes, each of which is allowed to sling up to 1000 kg vertically, at various handing angles.
When two ropes sling a load vertically, up to 2000 kg of total weight can be suspended.
This weight becomes 1000 kg when two ropes make a 120° hanging angle.
On the other hand, two ropes are subjected to an excessive force as large as 4000 kg if they sling a 2000 kg load at a lifting angle of 150°.



STANDARD TIGHTENING TORQUE

The following charts give the standard tightening torques of bolts and nuts.
Exceptions are given in section of «Disassembly and Assembly».

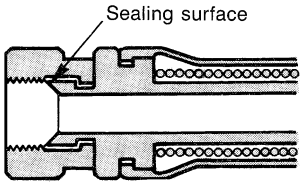
1. STANDARD TIGHTENING TORQUE OF BOLTS AND NUT

Thread diameter of bolts (mm)	Pitch of bolts (mm)	Width across flat (mm)		8.8		10.9	
				kgm	Nm	kgm	Nm
6	1	10	8	0.96±0.1	9.5±1	1.3±0.15	13.5±1.5
8	1.25	13	6	2.3±0.2	23±2	3.2±0.3	32.2±3.5
10	1.5	17	8	4.6±0.5	45±4.9	6.5±0.6	63±6.5
12	1.75	19	10	7.8±0.8	77±8	11±1	108±11
14	2	22	12	12.5±1	122±13	17.5±2	172±18
16	2	24	14	19.5±2	191±21	27±3	268±29
18	2.5	27	14	27±3	262±28	37±4	366±36
20	2.5	30	17	38±4	372±40	53±6	524±57
22	2.5	32	17	52±6	511±57	73±8	719±80
24	3	36	19	66±7	644±70	92±10	905±98
27	3	41	19	96±10	945±100	135±15	1329±140
30	3.5	46	22	131±14	1287±140	184±20	1810±190
33	3.5	50	24	177±20	1740±200	250±27	2455±270
36	4	55	27	230±25	2250±250	320±35	3150±350
39	4	60	—	295±33	2900±330	410±45	4050±450

This torque table does not apply to bolts or nuts which have to fasten nylon or other parts non-ferrous metal washer.

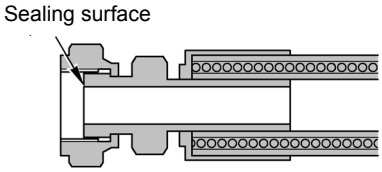
★ **Nm (newton meter): 1 Nm = 0.102 kgm**

2. TIGHTENING TORQUE FOR NUTS OF FLARED

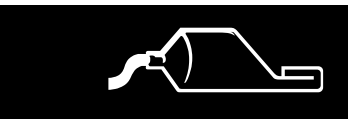


Use these torques for nut part of flared.

Thread diameter of nut part (mm)	Width across flats of nut part (mm)	TIGHTENING TORQUE	
		kgm	Nm
1/2” - 20	17	2.6±0.5	25.5±4.9
9/16” - 18	17	4±0.5	39.2±4.9
3/4” - 16	22	6.7±2	65.7±19.6
7/8” - 14	27	8±2	78.5±19.6
1.1/16 - 12	32	9.7±3	95.15±29.4
1.5/16 - 12	38	17±3	166.7±29.4
1.5/8 - 12	50	20±5	196.2±49
22	27	8±2	78.5±19.6
33	41	20±5	196.2±49



Thread diameter of nut part (mm)	Width across flats of nut part (mm)	TIGHTENING TORQUE	
		kgm	Nm
9/16” - 18	17	2.3–2.5	23–25
11/16” - 16	22	3.4–3.9	33–38
13/16” - 16	24	5.2–5.8	51–57
1” - 14	30	8.2–9.2	80–90
1.3/16 - 12	36	12.2–13.3	120–130
1.7/16 - 12	41	15.3–17.3	150–170
1.11/16 - 12	50	18.4–20.4	180–200
2” - 12	57	20.4–24.4	200–240



COATING MATERIALS

The recommended coating materials prescribed in Komatsu Utility Shop Manuals are listed below:

Nomenclature	Code	Applications
Adhesives	ASL800010	Used to apply rubber pads, rubber gaskets and cork plugs.
	ASL800020	Used to apply resin, rubber, metallic and non-metallic parts when a fast, strong seal is needed.
	Loctite 222	Used for low resistance locking of screws, check nuts and adjustment nuts.
	Loctite 242	To prevent the loosening of bolts, nuts and plugs and the leakage of oil. Used for medium resistance locking of screws and nuts of every type, and for locking keys and bearings.
	Loctite 262	Used for high resistant of threaded parts that can be removed with normal tools.
	Loctite 270	Used for high resistant locking and for sealing threaded parts, bolts and stud bolts.
	Loctite 542	Used for sealing the union threads for hydraulic tubes.
	Loctite 573	Used for sealing rather exact plane surfaces when the option of possible future dismantling is required.
	Loctite 601	Used for high resistant locking of mechanical components that can be removed only after heating
	Loctite 675	Used to lock cylindrical couplings and for the permanent locking of threaded parts, and also to lock shafts to bearings, gears, pulleys, pins, bushings, etc.
Gasket sealant	ASL800060	Used by itself to seal grease fittings, tapered screw fittings and tapered screw fittings in hydraulic circuits of less than 50 mm in diameter.
	Loctite 510	Used by itself on mounting flat surface (Clearance between surfaces within 0.2 mm)
	Loctite 518	Used by itself on mounting flat surface (Clearance between surfaces within 0.5 mm
Antifriction compound (Lubricant including Molybdenum disulfide)	ASL800040	Applied to bearings and taper shaft to facilitate press-fitting and to prevent sticking, burning or rusting.
Grease (Lithium grease)	ASL800050	Applied to bearings, sliding parts and oil seals for lubrication, rust prevention and facilitation of assembling work.
Vaseline	—	Used for protecting battery electrode terminals from corrosion

ELECTRIC

ELECTRIC

In the wiring diagrams various colour and symbols are employed to indicate the thickness of wires.
This wire code table will help you understand WIRING DIAGRAMS.
Example: R–N 1.5 indicates a cable having a nominal number 1.5 and red coating with black stripe.

CLASSIFICATION BY THICKNESS

Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)
	Number strands	Ø of strands (mm)	Cross section (mm)		
0.5	16	0.20	0.35	1.55	3.5
1	14	0.30	0.99	2.80	11
1.5	21	0.30	1.48	3.35	14
2.5	35	0.30	2.47	3.80	20
4	56	0.30	3.95	4.60	28
6	84	0.30	5.93	5.20	37
10	84	0.40	10.55	7.10	53
50	399	0.40	50.11	14	160

CLASSIFICATION BY COLOUR AND CODE

	Primary	Auxiliary									
Code	A	A–B	A/B	A–G	–	A–N	A/N	A–R	A/R	A–V	A/V
Colour	Light Blue	Light Blue – White		Light Blue–Yellow		Light Blue–Black		Light Blue–Red		Light Blue–Green	
Code	B	B–G	–	B–N	B/N	B–R	B/R	–	B/V	–	–
Colour	White	White–Yellow		White–Black		White–Red		White–Green		–	
Code	C	C–B	C/B	C–L	–	C–N	–	–	–	–	–
Colour	Orange	Orange–White		Orange–Blue		Orange–Black		–		–	
Code	G	G–N	G/N	G–R	–	G–V	–	–	–	–	–
Colour	Yellow	Yellow–Black		Yellow–Red		Yellow–Green		–		–	
Code	H	H–L	–	H–N	H/N	–	–	–	–	–	–
Colour	Grey	Grey–Blue		Grey–Black		–		–		–	
Code	L	L–B	L/B	L–G	–	–	L/N	–	–	–	–
Colour	Blue	Blue–White		Blue–Yellow		Blue–Black		–		–	
Code	M	M–B	–	M–N	M/N	M–V	–	–	–	–	–
Colour	Brown	Brown–White		Brown–Black		Brown–Green		–		–	
Code	N	–	–	–	–	–	–	–	–	–	–
Colour	Black	–		–		–		–		–	
Code	R	R–G	–	R–N	R/N	R–V	–	–	–	–	–
Colour	Red	Red–Yellow		Red–Black		Red–Green		–		–	
Code	S	S–G	–	S–N	–	–	–	–	–	–	–
Colour	Pink	Pink–Yellow		Pink–Black		–		–		–	
Code	V	V–B	–	V–N	V/N	–	–	–	–	–	–
Colour	Green	Green–White		Green–Black		–		–		–	
Code	Z	Z–B	Z/B	Z–N	Z/N	–	–	–	–	–	–
Colour	Violet	Violet–White		Violet–Black		–		–		–	

COMPOSITION OF THE COLOURS

The coloration of two-colour wires is indicated by the composition of the symbol listed.
Example: G–V = Yellow-Green with longitudinal colouring
G/V = Yellow-Green with transversal colouring

WEIGHT TABLE

⚠ This weight table is a guide for use when transporting or handling components.

Unit: kg

Machine model	WH609	WH613	WH713	WH714	WH716
Engine assembly	390.0	390.0	390.0	390.0	390.0
Radiator - exchanger	36.0	36.0	36.0	36.0	36.0
Hydraulic oil tank (empty)	70.0	70.0	86.6	70.0	70.0
Fuel tank (empty)	10.0	10.0	10.0	10.0	10.0
Engine hood	45.0	45.0	45.0	45.0	45.0
Cabin (with seat)	476.0	476.0	476.0	476.0	476.0
Seat	34.0	34.0	34.0	34.0	34.0
Engine-gear box-pump group	672	672	672	672	672
Piston pump	21.6	21.6	21.6	21.6	21.6
Transmission	260.0	260.0	260.0	260.0	260.0
Front axle	436.5	436.5	436.5	436.5	436.5
Rear axle	435.0	435.0	435.0	435.0	435.0
Front wheel Rear wheel	140.0	140.0	140.0	140.0	140.0
Control valve	30.0	30.0	30.0	30.0	30.0
Telescopic arm assembly (2-section boom) • Basic boom • Top boom	1382.0 523.0 510.0	– – –	– – –	– – –	– – –
Telescopic arm assembly (3-section boom) • Basic boom • Intermediate boom • Top boom	– – – –	2112.0 627.0 400.0 510.0	2288.0 690.0 430.0 540.0	2318.0 690.0 430.0 540.0	2588.0 762.0 494.0 567.0
Outrigger	638.0	638.0	638.0	638.0	638.0
Boom lift cylinder	280.0	280.0	292.0	292.0	292.0
Boom extension cylinder	141.0	217.0	217.0	247.0	370.0
Frame levelling cylinder	–	28.7	28.7	28.7	28.7
Outrigger cylinder	65.2	65.2	65.2	65.2	65.2
Locking axle cylinder	–	35.0	35.0	35.0	35.0
Offset cylinder	32.0	32.0	32.0	32.0	32.0
Bucket cylinder	90.0	90.0	90.0	90.0	90.0

TABLE OF OIL AND COOLANT QUANTITIES

TANK/ RESERVOIR	FLUID	AMBIENT TEMPERATURE -30 -20 -10 0 10 20 30 40 50 °C	CAPACITY (l)	
			1st filling	Change
Engine oil pan	In cold climates OIL ACEA E5 - E4	SAE 5W-30	12.8	12.8
	OIL API CH-4 / CI-4 ACEA E5 - E3	SAE 15W-40		
Chains lubrication	ENGINE OIL	SAE 15W-40	as required	as required
Hydraulic system	OIL CF - CF2 - CD	SAE 10W-30	117	95
Hydraulic system with biodegradable oil	see «4.3.1»		117	95
Front axle: Differential	OIL UTTO FLUID		7.1	7.1
Final reduction gear (ea.)			0.7	0.7
Rear axle: Differential			7.1	7.1
Final reduction gear (ea.)			0.7	0.7
Hydraulic transmission	OIL ATF GM DEXRON® II D (DEXRON® is a registered trademark of General Motors Corporation)		12.2	10.4
Transmission reduction gear			0.25	0.25
Braking system			0.65	0.65
Fuel tank	DIESEL OIL	* ASTM D975 N. 2	130	130
Engine cooling system	PERMANENT COOLANT		20	–

*** ASTM D975 N. 1**

ASTM: America Society of Testing and Materials
SAE: Society of Automotive Engineers
API: American Petroleum Institute
MIL: Military Specification
CCMC: Common Market Constructors Committe

First filling quantity:
total quantity of oil, including the oil for the components and pipes.

Oil change quantity:
quantity of oil necessary to fill the system or unit during the normal inspection and maintenance operations.

NOTE:

(1) When the diesel oil sulphur content is less then 0.5%, change the engine oil according to the periodic maintenance intervals indicated in the operation and maintenance manual. In the diesel oil sulphur content exceeds 0.5% change the engine oil according to the following table:

Sulphur content	Engine oil change interval
from 0.5 to 1.0%	1/2 of regular interval
over 1.0%	1/4 of regular interval

(2) When starting the engine at temperatures below 0 °C, use engine oil SAE 10W, 20W-20, even if during the day the temperature increases by 10 °C.

(3) Use engine oil with CD classification; if oil with CC classification is used, reduce the engine oil change interval by a half.

(4) Use original products, which have characteristics specifically formulated and approved for the engine, the hydraulic circuit of equipment and for reductions.

CONVERSION TABLE

METHOD OF USING THE CONVERSION TABLE

The conversion table in this section is provided to enable simple conversion of figures.
For details of the method of using the conversion table, see the example given below.

EXAMPLE

- Method of using the conversion table to convert from millimeters to inches.

1. Convert 55 mm into inches.

1 - Locate the number 50 in the vertical column at the left side, take this as Ⓐ, then drow a horizontal line from Ⓐ.

2 - Locate the number 5 in the row across the top, take this as , then draw a perpendicular line down from Ⓑ.

3 - Take the point where the two lines cross as Ⓒ. This point Ⓒ gives the value when converting from millimeters to inches. Therefore, 55 mm =2.165 in.

2. Convert 550 mm into inches

1 - The number 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.

2 - Carry out the same procedure as above to convert 55 mm to 2.165 in.

3 - The original value (550 mm) was divided by 10, so multiply 2.165 in. by 10 (move the decimal point one place to the right) to return to the original value. This gives 550 mm = 21.65 in.

From millimeters to inches

1 mm = 0.03937 in.

	0	1	2	3	4	5 (Ⓑ)	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50 (Ⓐ)	1.969	2.008	2.047	2.087	2.126	2.165 (Ⓒ)	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

From mm to in.

1 mm = 0.03937 in.

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

From kg to lb.

1 kg = 2.2046 lb.

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.24	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

From liter to U.S. Gall.

1 ℓ = 0.2642 U.S. Gall.

	0	1	2	3	4	5	6	7	8	9
0	0	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.361	25.625	25.889	26.153

From liter to U.K. Gall.

1 ℓ = 0.21997 U.K. Gall.

	0	1	2	3	4	5	6	7	8	9
0	0	0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	12.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

From Nm to lb.ft.

1 Nm = 0.737 lb.ft.

	0	1	2	3	4	5	6	7	8	9
0	0	0.737	1.474	2.211	2.948	3.685	4.422	5.159	5.896	6.633
10	7.370	8.107	8.844	9.581	10.318	11.055	11.792	12.529	13.266	14.003
20	14.740	15.477	16.214	16.951	17.688	18.425	19.162	19.899	20.636	21.373
30	22.110	22.847	23.584	24.321	25.058	25.795	26.532	27.269	28.006	28.743
40	29.480	30.217	30.954	31.691	32.428	33.165	33.902	34.639	35.376	36.113
50	36.850	37.587	38.324	39.061	39.798	40.535	41.272	42.009	42.746	43.483
60	44.220	44.957	45.694	46.431	47.168	47.905	48.642	49.379	50.116	50.853
70	51.590	52.327	53.064	53.801	54.538	55.275	56.012	56.749	57.486	58.223
80	58.960	59.697	60.434	61.171	61.908	82.645	63.382	64.119	64.856	65.593
90	66.330	67.067	67.804	68.541	69.278	70.015	70.752	71.489	72.226	72.963
100	73.700	74.437	75.174	75.911	76.648	77.385	78.122	78.859	79.596	80.333
110	81.070	81.807	82.544	83.281	84.018	84.755	85.492	86.229	86.966	87.703
120	88.440	89.177	89.914	90.651	91.388	92.125	92.862	93.599	94.336	95.073
130	95.810	96.547	97.284	98.021	98.758	99.495	100.232	100.969	101.706	102.443
140	103.180	103.917	104.654	105.391	106.128	106.865	107.602	108.339	109.076	109.813
150	110.550	111.287	112.024	112.761	113.498	114.235	114.972	115.709	116.446	117.183
160	117.920	118.657	119.394	120.131	120.868	121.605	122.342	123.079	123.816	124.553
170	125.290	126.027	126.764	127.501	128.238	128.975	129.712	130.449	131.186	131.923
180	132.660	133.397	134.134	134.871	135.608	136.345	137.082	137.819	138.556	139.293
190	140.030	140.767	141.504	142.241	142.978	143.715	144.452	145.189	145.926	146.663

From Nm to kgm

1 Nm = 0.102 kgm

	0	1	2	3	4	5	6	7	8	9
0	0	0.102	0.204	0.306	0.408	0.510	0.612	0.714	0.816	0.918
10	1.020	1.222	1.224	1.326	1.428	1.530	1.632	1.734	1.836	1.938
20	2.040	2.142	2.244	2.346	2.448	2.550	2.652	2.754	2.856	2.958
30	3.060	3.162	3.264	3.366	3.468	3.570	3.672	3.774	3.876	3.978
40	4.080	4.182	4.284	4.386	4.488	4.590	4.692	4.794	4.896	4.998
50	5.100	5.202	5.304	5.406	5.508	5.610	5.712	5.814	5.916	6.018
60	6.120	6.222	6.324	6.426	6.528	6.630	6.732	6.834	6.936	7.038
70	7.140	7.242	7.344	7.446	7.548	7.650	7.752	7.854	7.956	8.058
80	8.160	8.262	8.364	8.466	8.568	8.670	8.772	8.874	8.976	9.078
90	9.180	9.282	9.384	9.486	9.588	9.690	9.792	9.894	9.996	10.098
100	10.200	10.302	10.404	10.506	10.608	10.710	10.812	10.914	11.016	11.118
110	11.220	11.322	11.424	11.526	11.628	11.730	11.832	11.934	12.036	12.138
120	12.240	12.342	12.444	12.546	12.648	12.750	12.852	12.954	13.056	13.158
130	13.260	13.362	13.464	13.566	13.668	13.770	13.872	13.974	14.076	14.178
140	14.280	14.382	14.484	14.586	14.688	14.790	14.892	14.994	15.096	15.198
150	15.300	15.402	15.504	15.606	15.708	15.810	15.912	16.014	16.116	16.218
160	16.320	16.422	16.524	16.626	16.728	16.830	16.932	17.034	17.136	17.238
170	17.340	17.442	17.544	17.646	17.748	17.850	17.952	18.054	18.156	18.258
180	18.360	18.462	18.564	18.666	18.768	18.870	18.972	19.074	19.176	19.278
190	19.380	19.482	19.584	19.686	19.788	19.890	19.992	20.094	20.196	20.298

From kgm to lb.ft.

1 kgm = 7.233 lb.ft.

	0	1	2	3	4	5	6	7	8	9
0	0	7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.2	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	876.5	983.7	990.9	998.2	1005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

From bar to psi (lb/in^2)

1 bar = 14.503 psi

	0	1	2	3	4	5	6	7	8	9
0	0	14.5	29.0	43.5	58.0	72.5	87.0	101.5	116.0	130.5
10	145.0	159.5	174.0	188.5	203.0	217.5	232.0	246.5	261.0	275.6
20	290.0	304.6	319.1	333.6	348.1	362.6	377.1	391.6	406.1	420.6
30	435.1	449.6	464.1	478.6	493.1	507.6	522.1	536.6	551.1	565.6
40	580.1	594.6	609.1	623.6	638.1	652.6	667.1	681.6	696.1	710.6
50	725.1	739.6	754.1	768.6	783.2	797.7	812.2	826.7	841.2	855.7
60	870.2	884.7	899.2	913.7	928.2	942.7	957.2	971.7	986.2	1000.7
70	1015.2	1029.7	1044.2	1058.7	1073.2	1087.7	1102.2	1116.7	1131.2	1145.7
80	1160.2	1174.7	1189.2	1203.7	1218.2	1232.7	1247.2	1261.8	1276.3	1290.8
90	1305.3	1319.8	1334.3	1348.8	1363.3	1377.8	1392.3	1406.8	1421.3	1435.8
100	1450.3	1464.8	1479.3	1493.8	1508.3	1522.8	1537.3	1551.8	1566.3	1580.8
110	1595.3	1609.8	1624.3	1638.8	1653.3	1667.8	1682.3	1696.8	1711.3	1725.8
120	1740.4	1754.9	1769.4	1783.9	1798.4	1812.9	1827.4	1841.9	1856.4	1870.8
130	1885.4	1899.9	1914.4	1928.9	1943.4	1957.9	1972.4	1986.9	2001.4	2015.9
140	2030.4	2044.9	2059.4	2073.9	2088.4	2102.9	1217.4	2131.9	2146.4	2160.9
150	2175.4	2189.9	2204.4	2218.9	2233.5	2248.0	2262.5	2277.0	2291.5	2306.0
160	2320.5	2335.0	2349.5	2364.0	2378.5	2393.0	2407.5	2422.0	2436.5	2451.0
170	2465.5	2480.0	2494.5	2509.0	2523.5	2538.0	2552.5	2567.0	2581.5	2596.0
180	2610.5	2625.0	2639.5	2654.0	2668.5	2683.0	2697.7	2712.1	2726.6	2641.1
190	2755.6	2770.0	2784.6	2799.1	2813.6	2828.1	2842.6	2857.1	2871.6	2886.1
200	2900.6	2915.1	2929.6	2944.1	2958.6	2973.1	2987.6	3002.1	3016.6	3031.1
210	3045.6	3060.1	3074.6	3089.1	3103.6	3118.1	3132.6	3147.1	3161.6	3176.1
220	3190.7	3205.2	3219.7	3234.2	3248.7	3263.2	3277.7	3192.2	3306.7	3321.2
230	3335.7	3350.2	3364.7	3379.2	3393.7	3408.2	3422.7	3437.2	3451.7	3466.2
240	3480.7	3495.2	3509.7	3524.2	3538.7	3553.2	3567.7	3582.2	3596.7	3611.2

TEMPERATURE

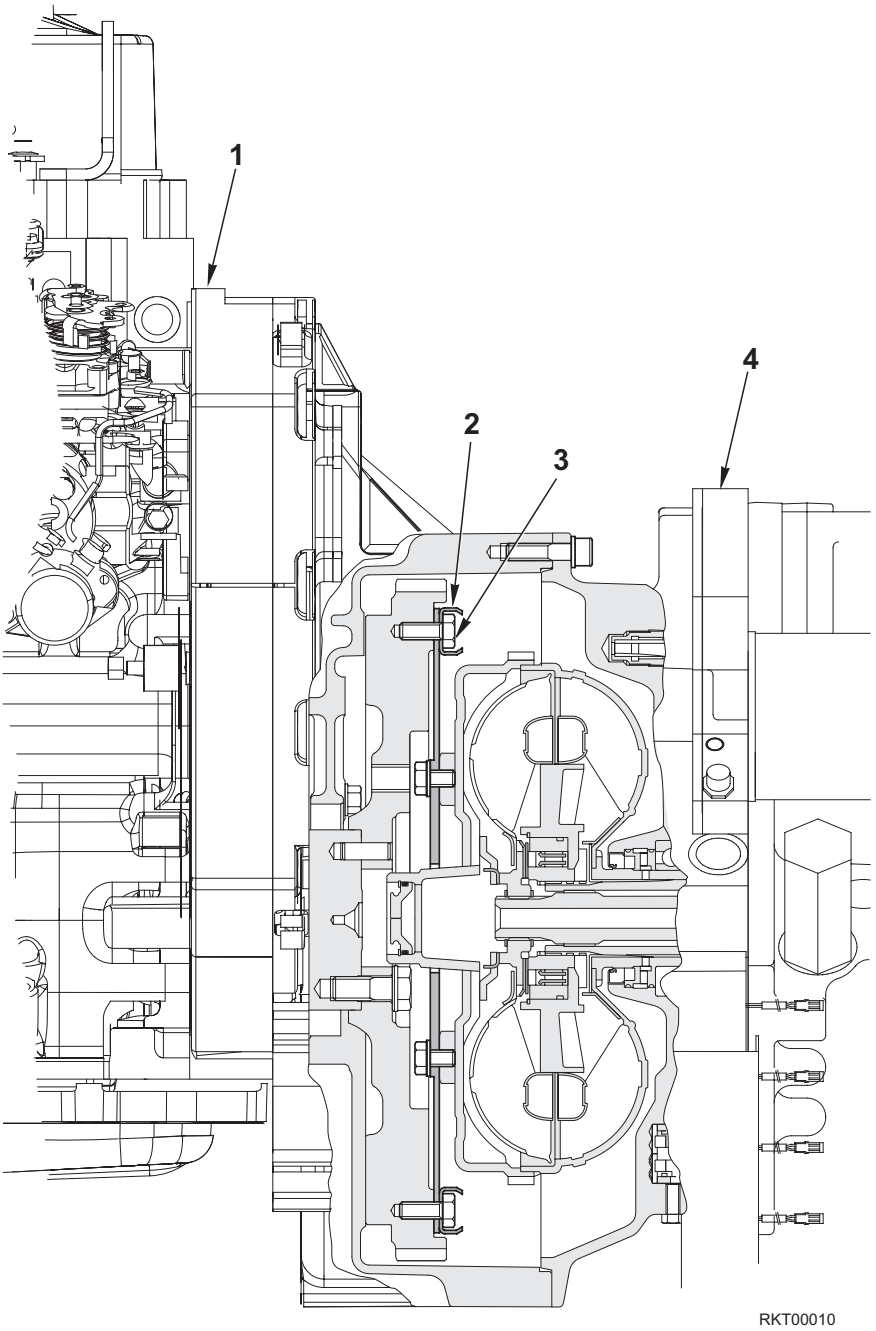
Fahrenheit-Centigrade conversion; a simple way to convert a Fahrenheit temperature reading into a Centigrade temperature reading or vice versa is to enter the accompanying table in the center or boldface column of figures.
These figures refer to the temperature in either Fahrenheit or Centigrade degrees.
If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values and read the corresponding Fahrenheit temperature on the right.

1 °C = 33.8°F

°C		°F	°C		°F	°C		°F	°C		°F
–40.4	**–40**	–40.0	–11.7	**11**	51.8	7.8	**46**	144.8	27.2	**81**	117.8
–37.2	**–35**	–31.0	–11.1	**12**	53.6	8.3	**47**	116.6	27.8	**82**	179.6
–34.4	**–30**	–22.0	–10.6	**13**	55.4	8.9	**48**	118.4	28.3	**83**	181.4
–31.7	**–25**	–13.0	–10.0	**14**	57.2	9.4	**49**	120.2	28.9	**84**	183.2
–28.9	**–20**	–4.0	–9.4	**15**	59.0	10.0	**50**	122.0	29.4	**85**	185.0
–28.3	**–19**	–2.2	–8.9	**16**	60.8	10.6	**51**	123.8	30.0	**86**	186.8
–27.8	**–18**	–0.4	–8.3	**17**	62.6	11.1	**52**	125.6	30.6	**87**	188.6
–27.2	**–17**	1.4	–7.8	**18**	64.4	11.7	**53**	127.4	31.1	**88**	190.4
–26.7	**–16**	3.2	–7.2	**19**	66.2	12.2	**54**	129.2	31.7	**89**	192.2
–26.1	**–15**	5.0	–6.7	**20**	68.0	12.8	**55**	131.0	32.2	**90**	194.0
–25.6	**–14**	6.8	–6.1	**21**	69.8	13.3	**56**	132.8	32.8	**91**	195.8
–25.0	**–13**	8.6	–5.6	**22**	71.6	13.9	**57**	134.6	33.3	**92**	197.6
–24.4	**–12**	10.4	–5.0	**23**	73.4	14.4	**58**	136.4	33.9	**93**	199.4
–23.9	**–11**	12.2	–4.4	**24**	75.2	15.0	**59**	138.2	34.4	**94**	201.2
–23.3	**–10**	14.0	–3.9	**25**	77.0	15.6	**60**	140.0	35.0	**95**	203.0
–22.8	**–9**	15.8	–3.3	**26**	78.8	16.1	**61**	141.8	35.6	**96**	204.8
–22.2	**–8**	17.6	–2.8	**27**	80.6	16.7	**62**	143.6	36.1	**97**	206.6
–21.7	**–7**	19.4	–2.2	**28**	72.4	17.2	**63**	145.4	36.7	**98**	208.4
–21.1	**–6**	21.2	–1.7	**29**	84.2	17.8	**64**	147.2	37.2	**99**	210.2
–20.6	**–5**	23.0	–1.1	**30**	86.0	18.3	**65**	149.0	37.8	**100**	212.0
–20.0	**–4**	24.8	–0.6	**31**	87.8	18.9	**66**	150.8	40.6	**105**	221.0
–19.4	**–3**	26.6	0.0	**32**	89.6	19.4	**67**	152.6	43.3	**110**	230.0
–18.9	**–2**	28.4	0.6	**33**	91.4	20.0	**68**	154.4	46.1	**115**	239.0
–18.3	**–1**	30.2	1.1	**34**	93.2	20.6	**69**	156.2	48.9	**120**	248.0
–17.8	**0**	32.0	1.7	**35**	95.0	21.1	**70**	158.0	51.7	**125**	257.0
–17.2	**1**	33.8	2.2	**36**	96.8	21.7	**71**	159.8	54.4	**130**	266.0
–16.7	**2**	35.6	2.8	**37**	98.6	22.2	**72**	161.6	57.2	**135**	275.0
–16.1	**3**	37.4	3.3	**38**	100.4	22.8	**73**	163.4	60.0	**140**	284.0
–15.6	**4**	39.2	3.9	**39**	102.2	23.3	**74**	165.2	62.7	**145**	2930
–15.0	**5**	41.0	4.4	**40**	104.0	23.9	**75**	167.0	65.6	**150**	302.0
–14.4	**6**	42.8	5.0	**41**	105.8	24.4	**76**	168.8	68.3	**155**	311.0
–13.9	**7**	44.6	5.6	**42**	107.6	25.0	**77**	170.6	71.1	**160**	320.0
–13.3	**8**	46.4	6.1	**43**	109.4	25.6	**78**	172.4	73.9	**165**	329.0
–12.8	**9**	48.2	6.7	**44**	111.2	26.1	**79**	174.2	76.7	**170**	338.0
–12.2	**10**	50.0	7.2	**45**	113.0	26.7	**80**	176.0	79.4	**175**	347.0

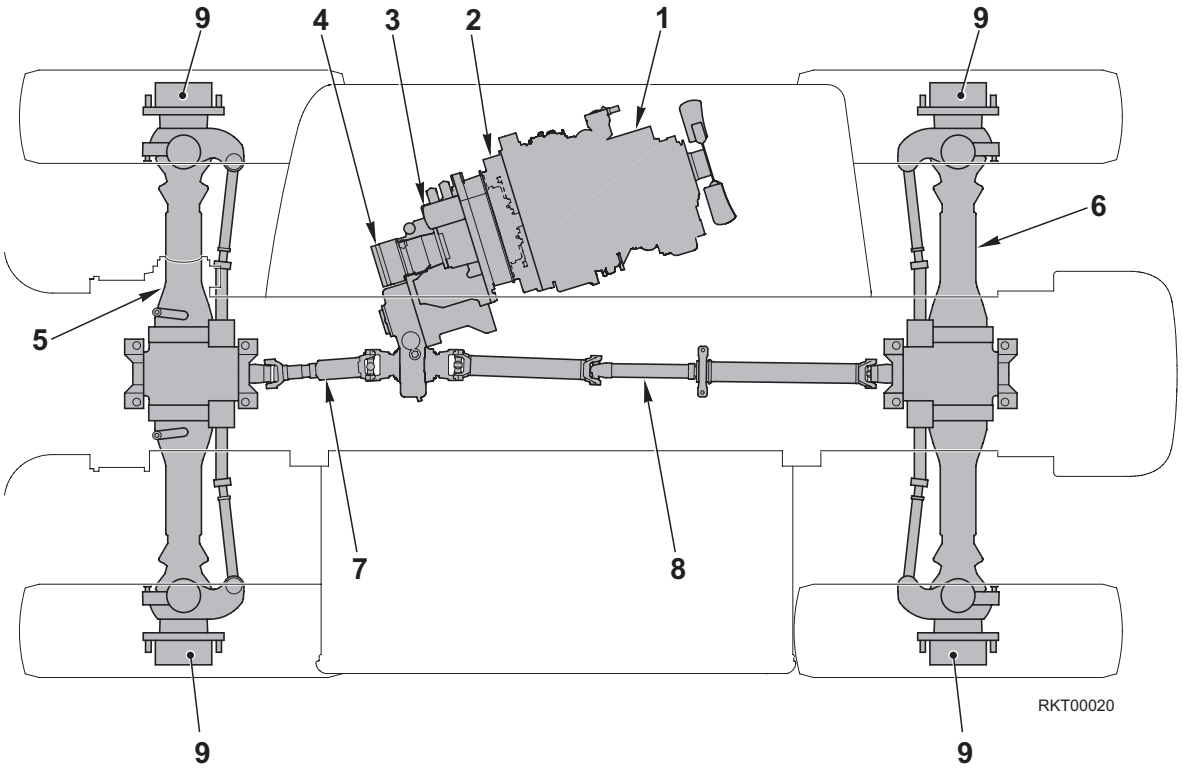
10 STRUCTURE AND FUNCTION

ENGINE-TRANSMISSION COUPLING



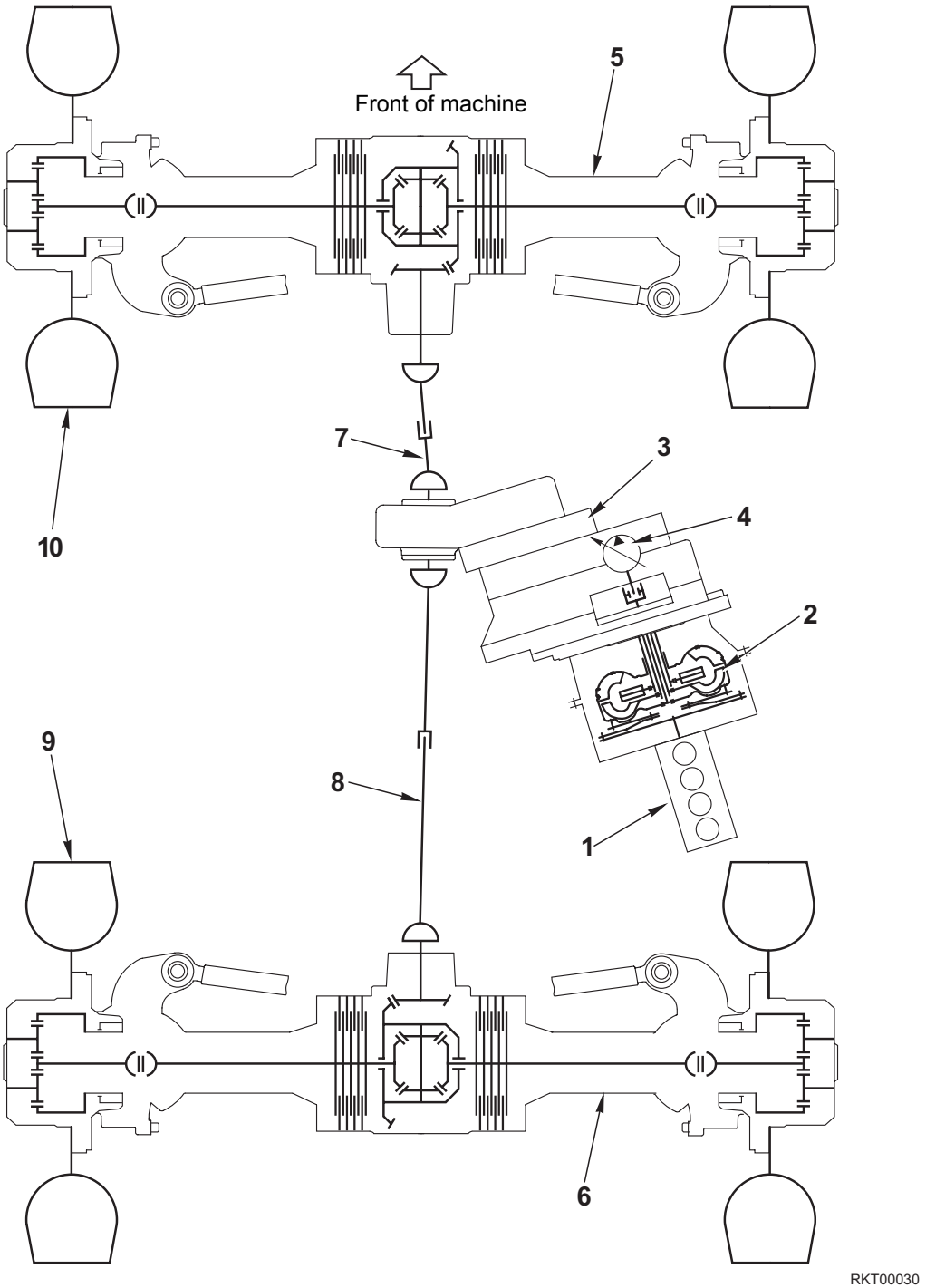
1. Engine
2. Flange
3. Screw
4. Transmission

POWER TRAIN



DESCRIPTION

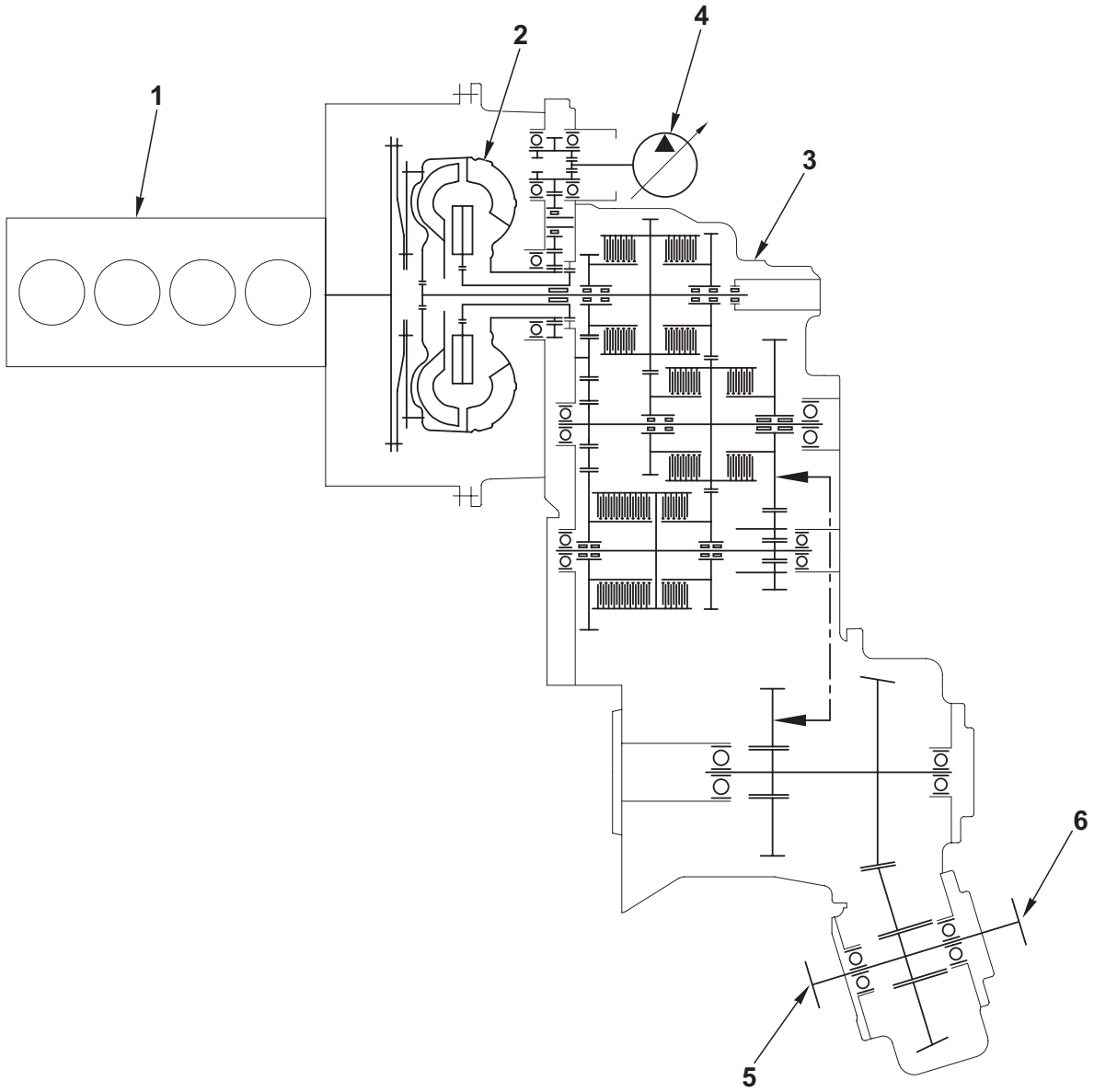
- The driving power generated by the engine (1) is transmitted through the flywheel to the converter (2). The converter uses hydraulic oil to convert the torque transmitted by the engine (1) into driving power. The converter (2) transmits motion to the drive shaft of the transmission (3) and to the drive shaft of the hydraulic pump (4).
- The transmission (3) has two hydraulically-activated clutches that can be selected by an electrically-controlled gear selector.
- The driving power is transmitted from the transmission flanges (3) to the front (5) and rear (6) axles through the cardan drive shafts (7 and 8).
- The driving power transmitted to the front (5) and rear (6) axles is reduced by the differentials and then transmitted to the final drives (9) through the drive shafts.



1. Diesel engine
2. Converter
3. Transmission
4. Hydraulic pump
5. Front axle
6. Rear axle
7. Front cardan shaft
8. Rear cardan shaft
9. Rear wheels
10. Front wheels

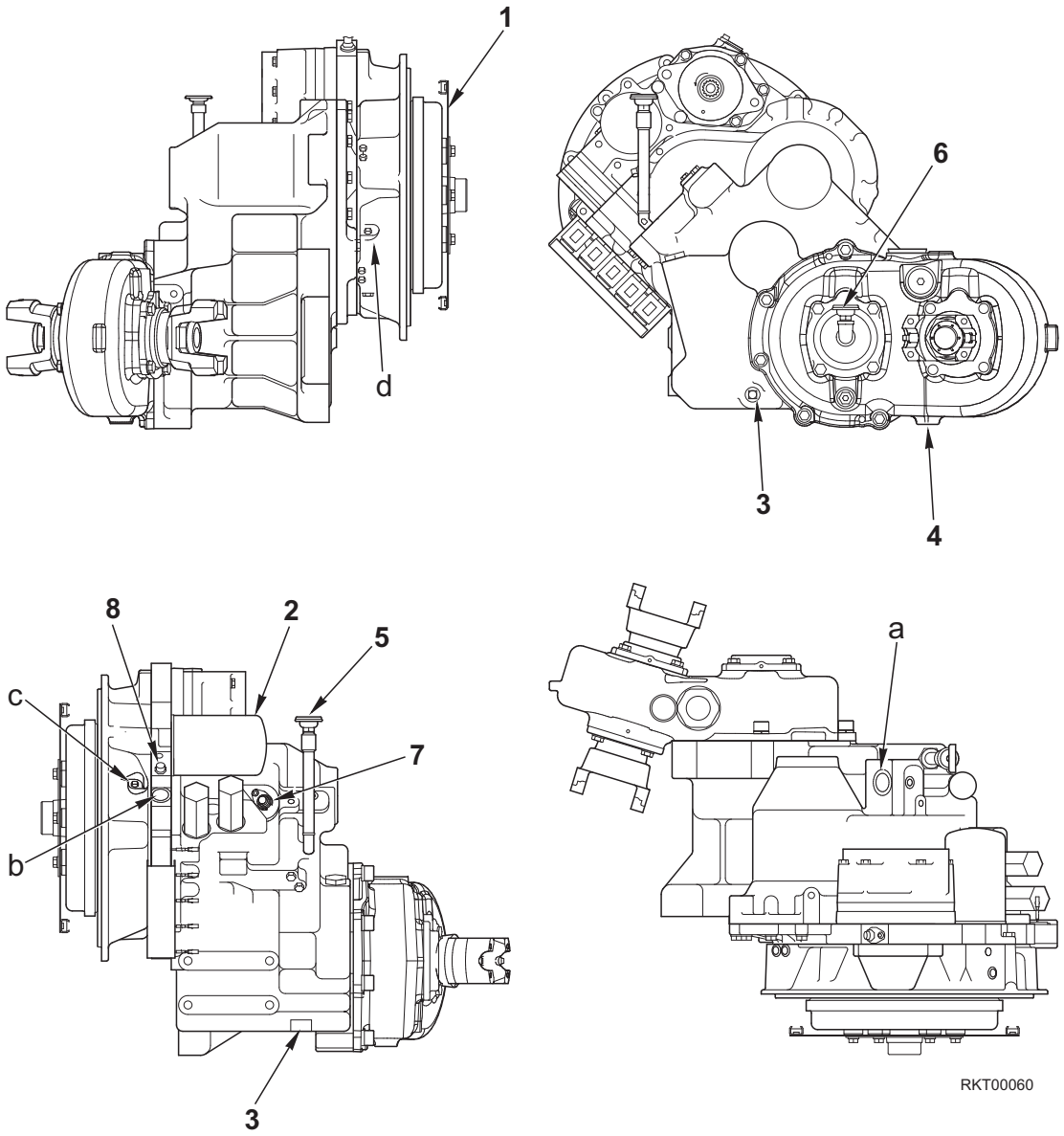
TRANSMISSION

DIAGRAM OF THE POWER TRAIN



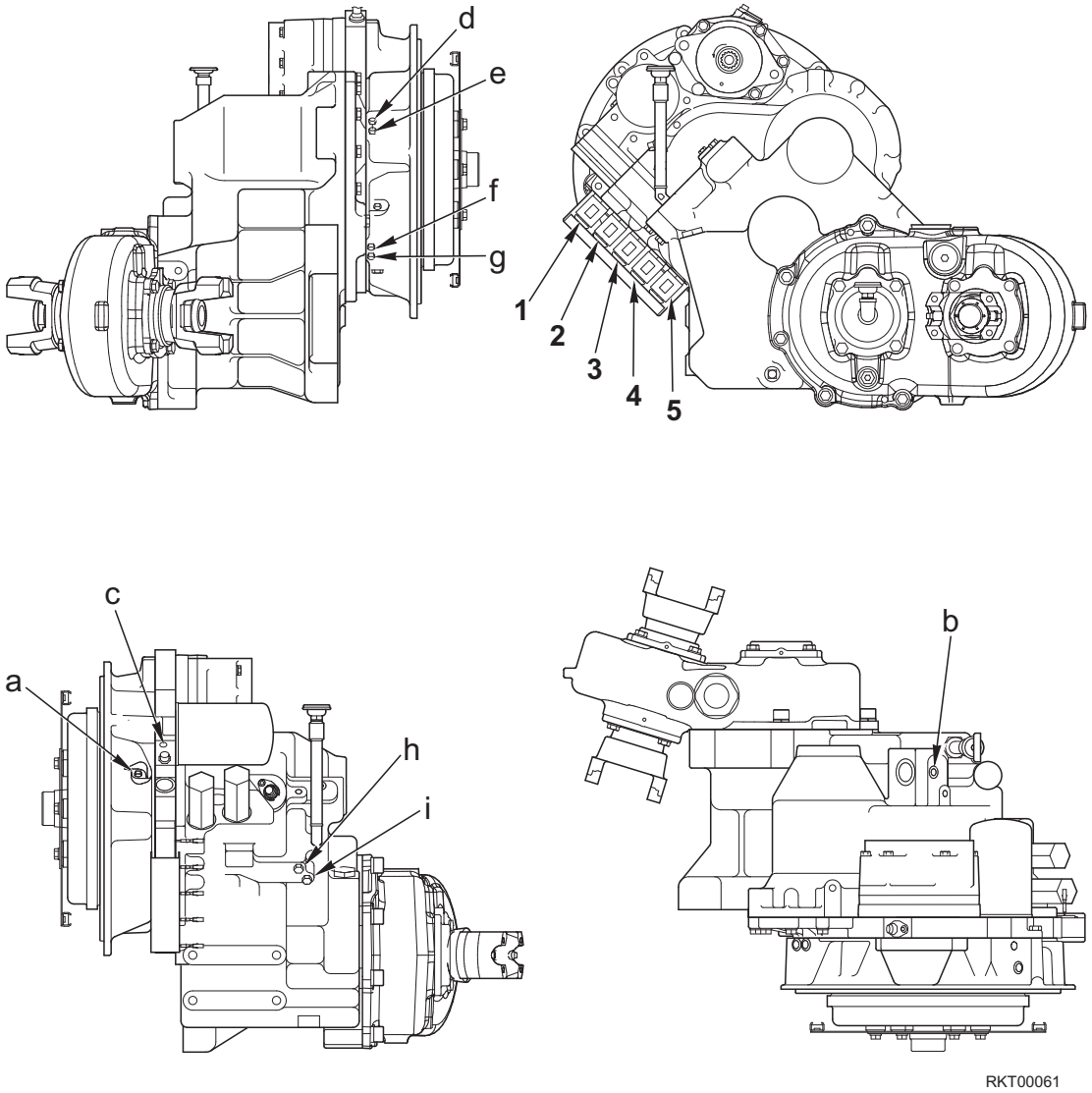
RKT00040

1. Engine
2. Converter
3. Transmission
4. Hydraulic pump
5. Rear flange
6. Front flange



a. Port 12 - from the oil cooler
b. Port 11 - to the oil cooler
c. Port 31 - from the brake pump (P Port)
d. Port 71 - from the brake pump (S Port)

1. Converter
2. Filter
3. Transmission oil drain plug
4. Drop box oil drain plug
5. Transmission plug vent
6. Drop box plug vent
7. Rotational speed sensor (YV)
8. Oil temperature sensor (X56)

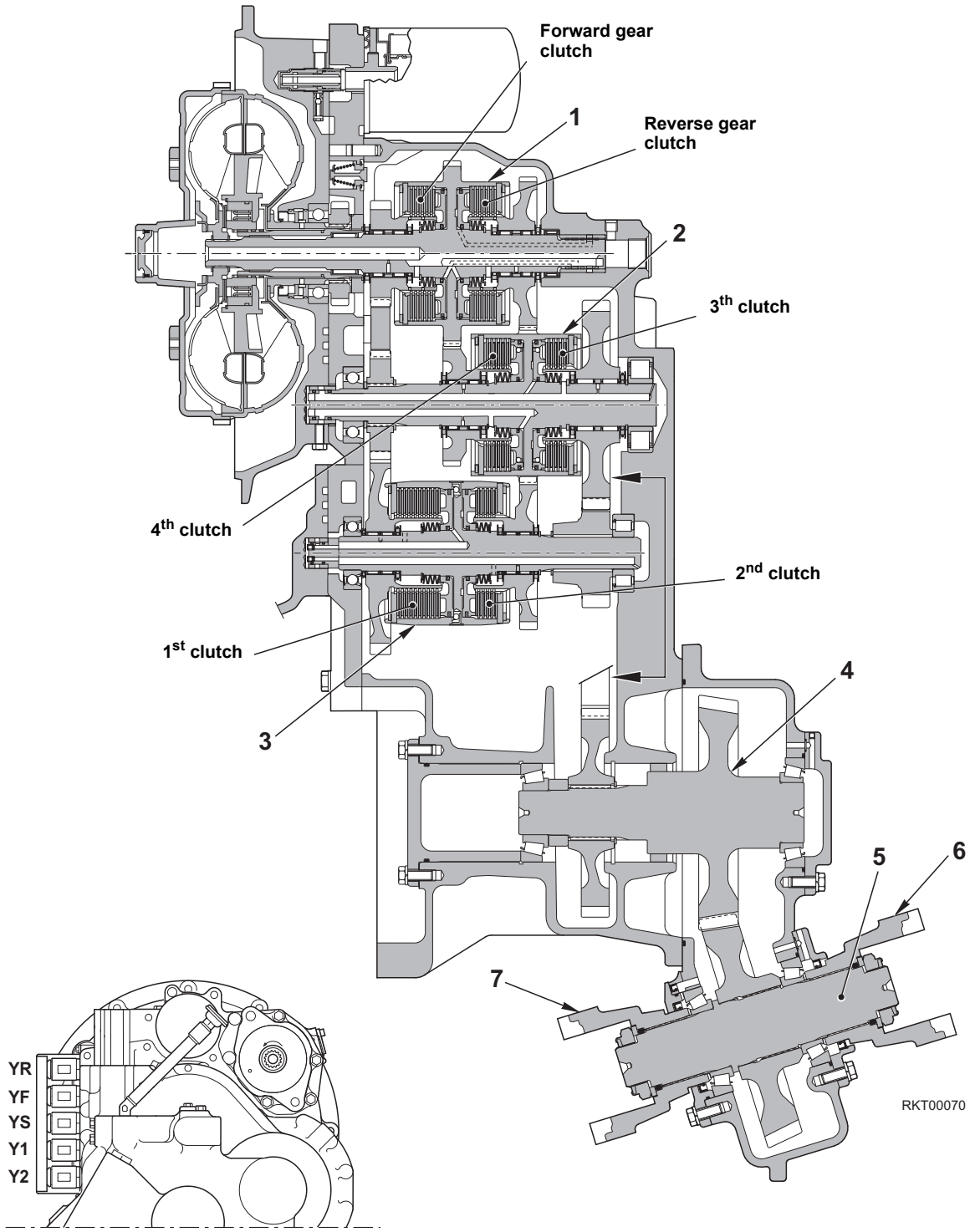


ELECTRICAL COMPONENTS

1. YR - Reverse clutch solenoid valve
2. YF - Forward clutch solenoid valve
3. YS - Gear selector solenoid valve
4. Y1 - 1st clutch solenoid valve
5. Y2 - 2nd clutch solenoid valve

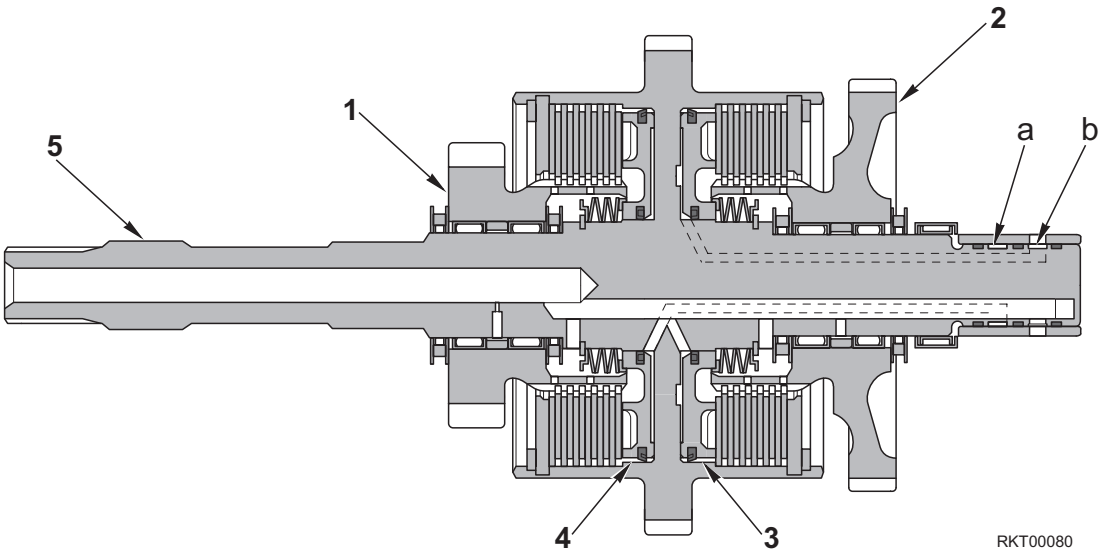
CHECK POINTS

a. 31 Port - Clutch pressure
b. 33 Port - Delivery pressure to intercooler
c. 32 Port - Pressione mandata all'intercooler
d. 41 Port - 1st clutch pressure
e. 42 Port - 2nd clutch pressure
f. 43 Port - 3rd clutch pressure
g. 44 Port - 4th clutch pressure
h. 45 Port - Forward gear pressure
i. 46 Port - Reverse gear pressure



1. Direction selection clutch shaft
2. 3rd and 4th clutch shaft
3. 1st and 2nd clutch shaft
4. Transmission output shaft
5. Drop box output shaft
6. Front cardan flange
7. Rear flange

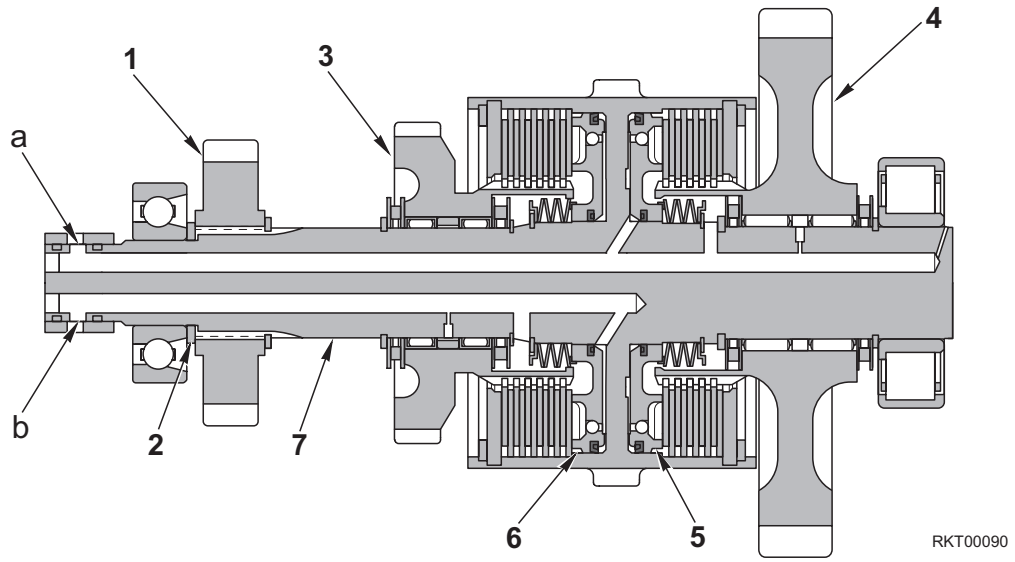
FORWARD AND REVERSE GEAR DRIVE SHAFT



a. Reverse gear port
b. Forward gear port

1. Reverse gear gears
2. Forward gear gears
3. Forward gear piston
4. Reverse gear piston
5. Drive shaft

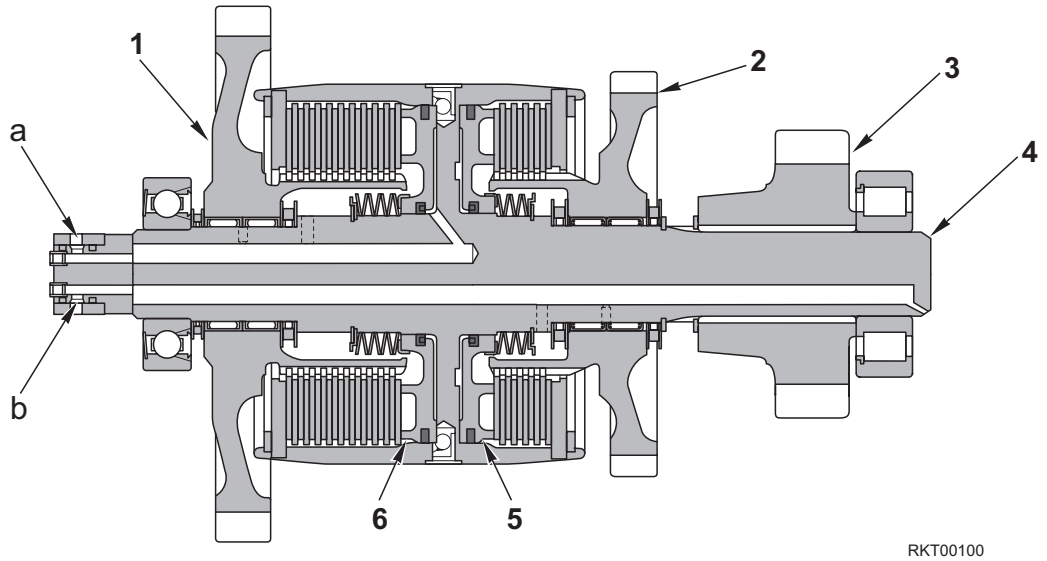
3rd AND 4th GEAR DRIVE SHAFT



a. 3rd gear port
b. 4th gear port

1. 4th gear driven gear
2. Backing ring
3. 4th gear drive gear
4. 3rd gear drive gear
5. 3rd gear piston
6. 4th gear piston
7. Drive shaft

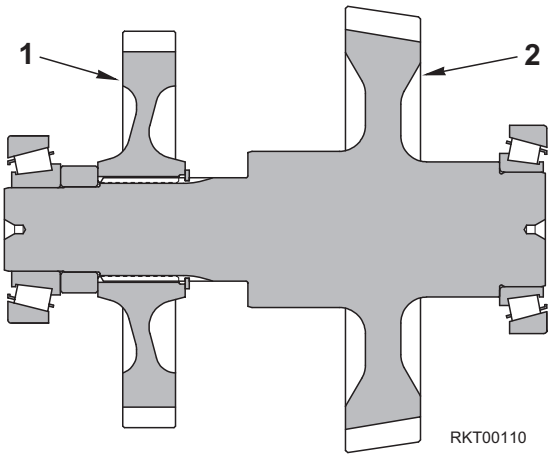
1st AND 2nd GEAR DRIVE SHAFT



a. 1st gear port
b. 2nd gear port

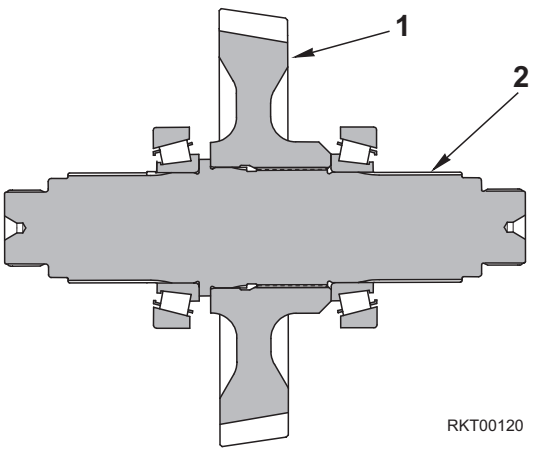
1. 1st gear drive gear
2. 2nd gear drive gear
3. 3rd gear drive gear
4. Drive shaft
5. 2nd gear piston
6. 1st gear piston

DROP BOX INPUT SHAFT



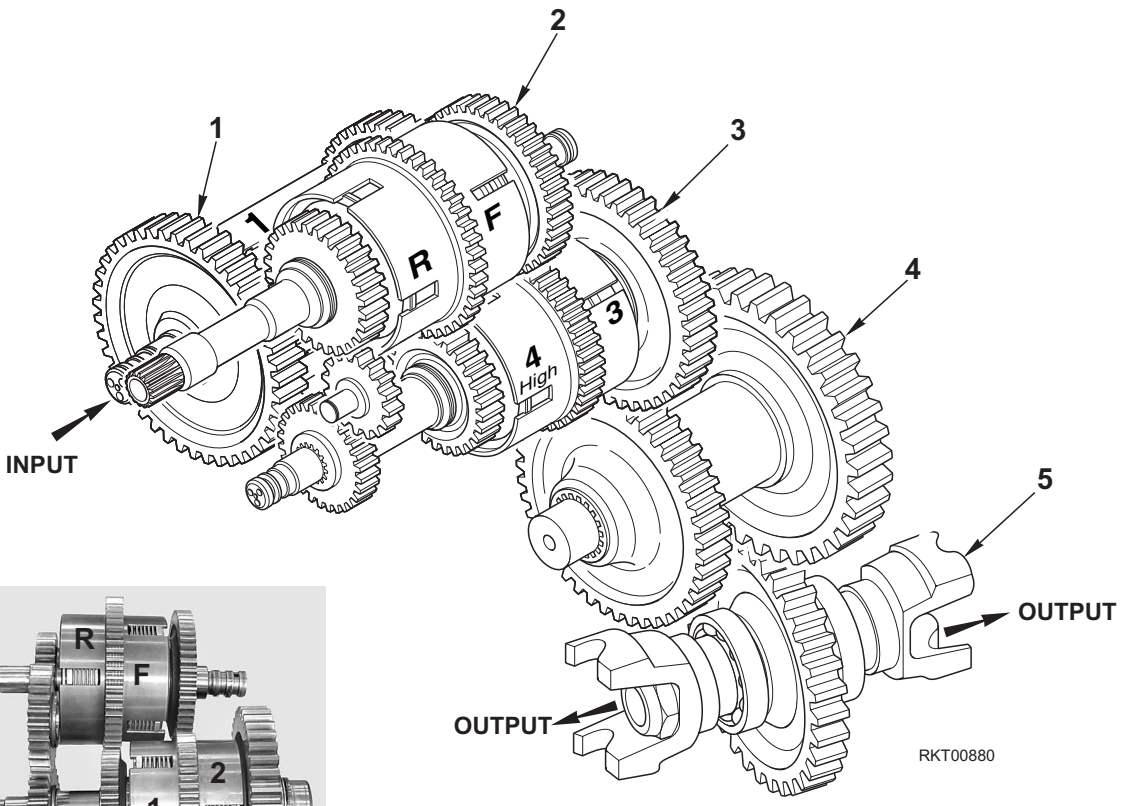
1. Output drive gear
2. Input shaft

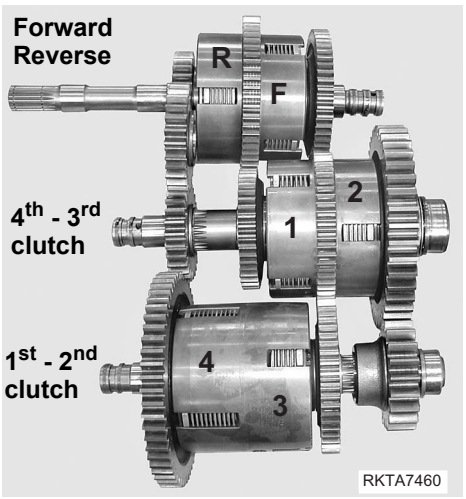
DROP BOX OUTPUT SHAFT



1. Output driven gear
2. Output shaft

GEAR AND CLUTCH LAY-OUT





NOTE

1 - The following information describes the mechanic and hydraulic operation of the entire transmission, without considering the electronic programme for machine operation.

2 - The diagrams refer to all combinations (i.e. speeds) that are possible for the type of transmission, even if the solenoid valve energising programme does not cover the mechanical and hydraulic selection of all available gears.

TRANSMISSION GEAR	ACTIVATED SOLENOID VALVES ACTIVATED	CLUTCHES
5th forward	YF - YS	4th – 3rd
4th forward	YF	Forward - 3rd
3rd forward	YF - YS - Y2	4th – 2nd
2nd forward	YF - Y2	Forward – 2nd
1st forward	YF - Y1 - Y2	Forward – 1st
Neutral	–	3rd
3rd reverse	YR	Reverse – 3rd
2nd reverse	YR - Y2	Reverse – 2nd
1st reverse	YR - Y1 - Y2	Reverse – 1st

1. OPERATION OF THE TRANSMISSION

The transmission is composed of 5 main assemblies:

1 - Converter, pump drive section and pressure regulating valve.

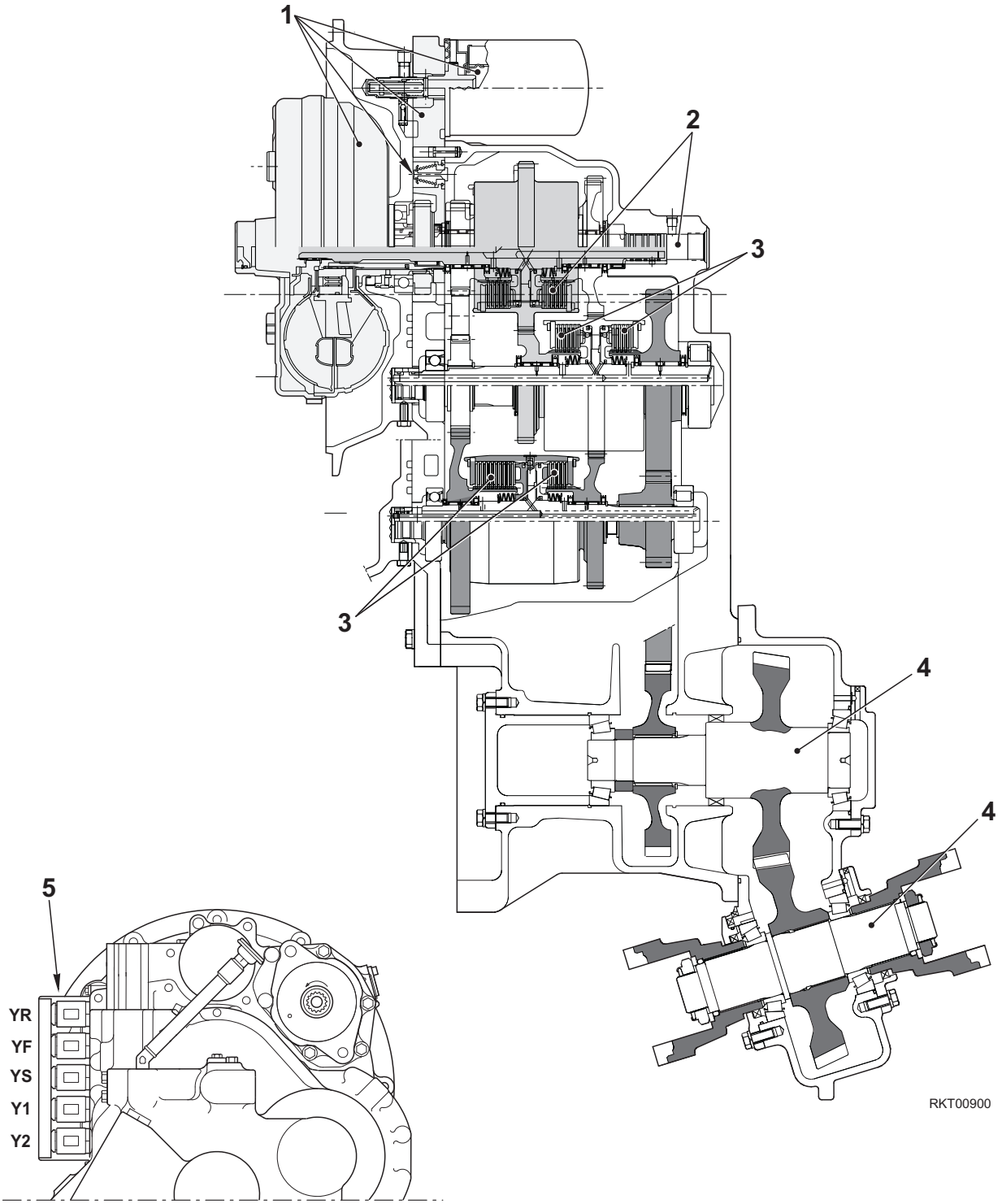
2 - Input shaft and directional clutches.

3 - Range clutches.

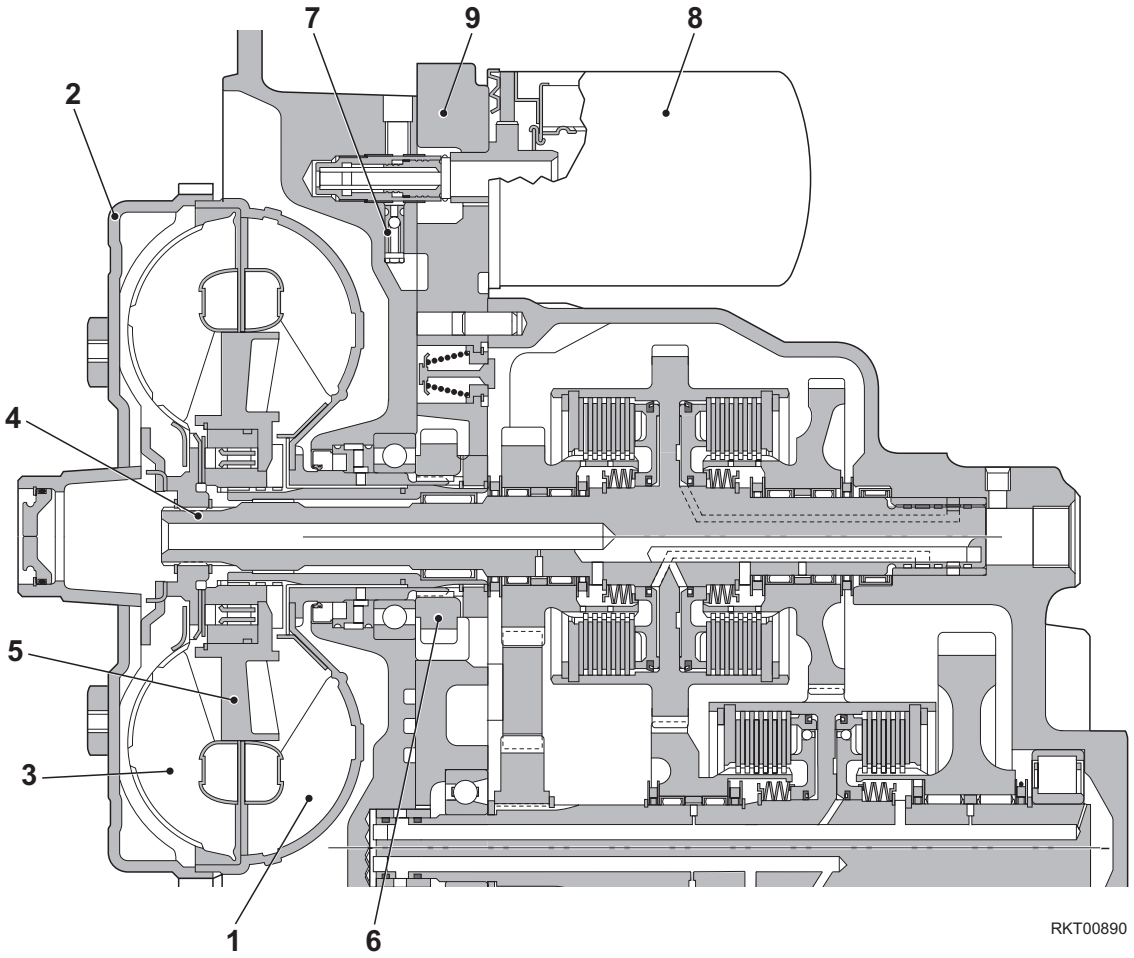
4 - Output section.

5 - Solenoid valve group.

A total of 5 forward speeds and 3 reverse speeds is achieved by combining the different clutches.



1.1 Converter, pump drive section and pressure regulating valve.

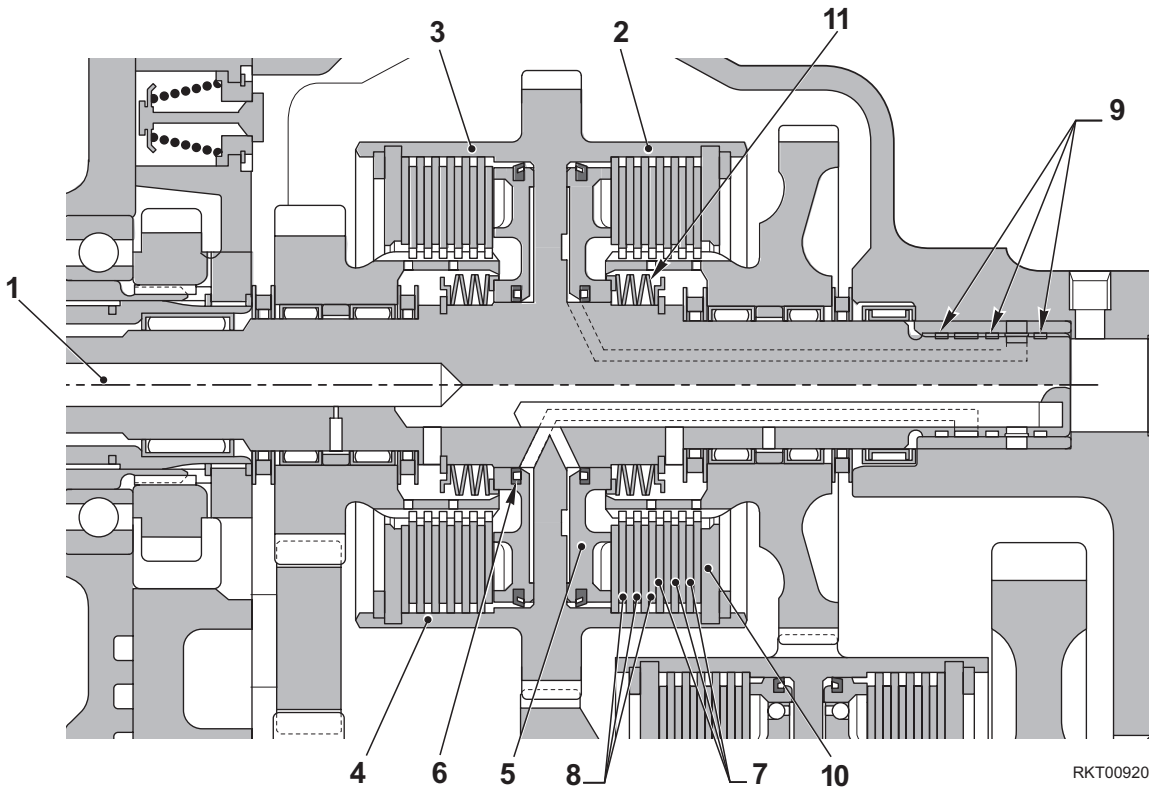


- Engine power is transmitted from the flywheel to the impeller (1), which coalesces with the housing (2) of the converter.
- This impeller (1) is the pump portion of the hydraulic torque converter and is the primary component which starts the oil flowing to the other components which results in torque multiplication.
  The impeller (1) can be compared to a centrifugal pump that picks up fluid at its centre and discharges it at the outer diameter.
- The torque converter turbine (3) is mounted opposite the impeller (1) and is connected to the converter shaft (4). This element receives fluid at its outer diameter and discharges it at its centre.
- The reaction member (5) of the torque converter is located between and at the centre of the inner diameters of the impeller (1) and turbine (3).
  Its function is to take the fluid which is exhausting from the inner portion of the impeller and change its direction to allow correct entry for recirculation into the turbine element.
- The torque multiplication is function of the blading (impeller, turbine and reaction member) and of the converter output speed (turbine speed).
  The converter will multiply engine torque to its designed maximum multiplication ratio when the turbine shaft is at zero RPM (stall).
- Therefore we can say that as the turbine shaft is decreasing in speed, the torque multiplication is increasing.
- The hydraulic pump is connected with the pump drive gear. This pump drive gear is driven by the impeller hub gear (6). Since the impeller hub gear is connected with the impeller housing, the pump speed is in direct relation with the engine speed.

NOTE

The operating pressure regulator valve (7) is mounted behind the filter (8), in the filter adapter housing (9).

1.2 Input shaft and directional clutchesi

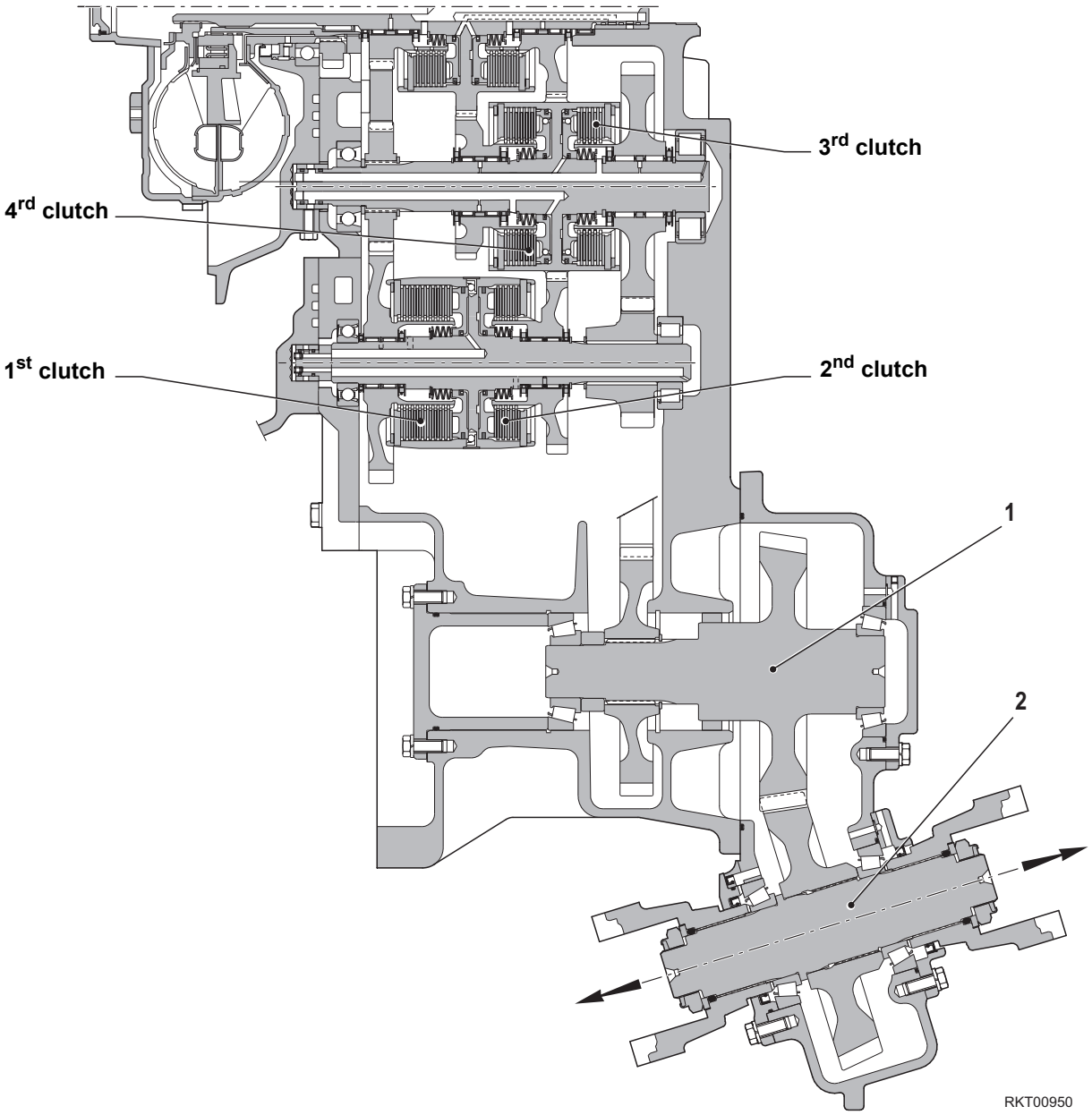


- The turbine shaft (1) driven by the turbine transmits power to the forward clutch (2) (4th High) or to the reverse clutches (3).
- These clutches consist of a drum with internal splines (4) and a bore to receive a hydraulic actuated piston (5).
- The piston (5) is oil tight by the use of sealing rings (6).The steel discs (7) with external splines, and friction discs (8) with internal splines, are alternated until the required total is achieved.
- The friction discs that are engaged on the hub are free to increase in speed or rotate in the opposite direction as long as that specific clutch is not activated.
- To engage the clutch, the solenoid will direct oil under pressure through tubes and passages to the selected clutch.
- Oil sealing rings (9) are located on the clutch shafts. These rings delimit the drilled passage in the shaft to the desired clutch.
- Pressure of the oil forces the piston (5) and discs (7 and 8) against the back-up plate (10). The steel discs clamping against friction discs enables the drum and hub to be locked together and allows them to drive as one unit.
- When the hydraulic pressure is released, some return springs (11) will push the piston (5) back and oil will drain back into a return circuit and from here into the transmission sump.
- The engagement of the directional clutches (forward and reverse) is modulated. This means that clutch pressure is built up gradually. This will enable the unit to make forward, reverse shifts while the vehicle is still moving and will allow smooth engagement of drive. The modulation is done hydraulically.

1.3 Clutches

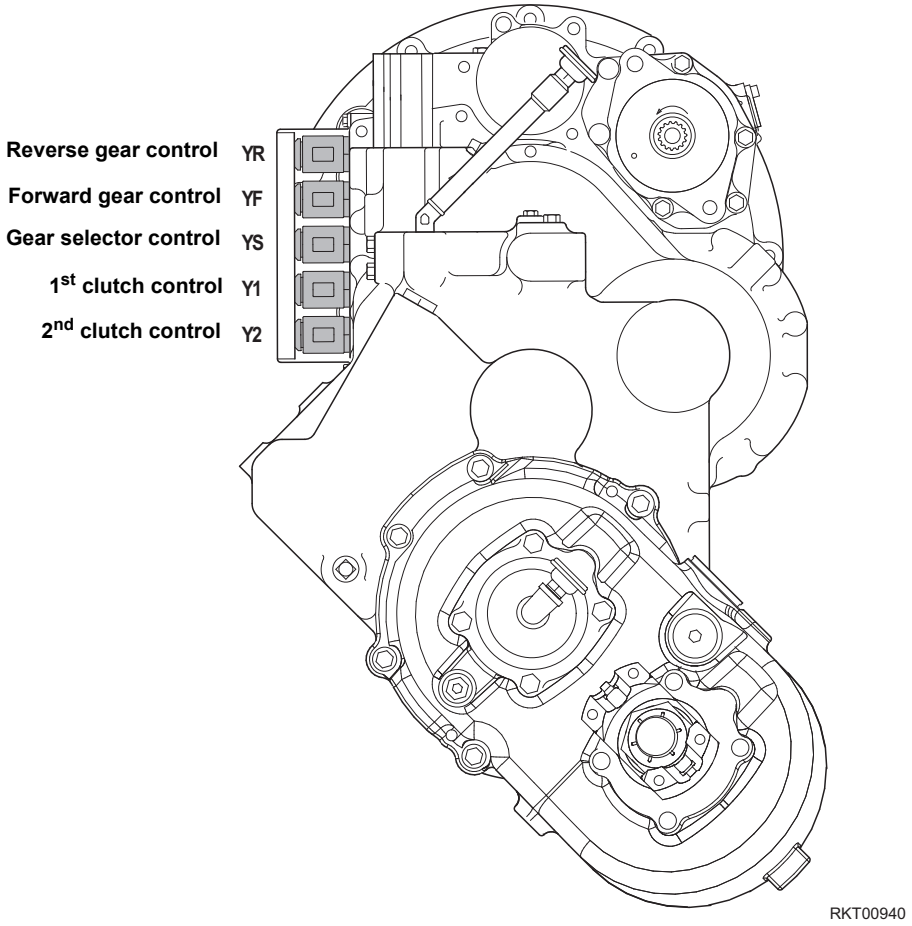
- Once a directional clutch is engaged, power is transmitted to the range clutches (1st,2nd, 3rd or 4th High).
- Operation and actuation of the range clutches is similar to the directional clutches.
- The engagement of the range clutches is not modulated.

1.4 Output section



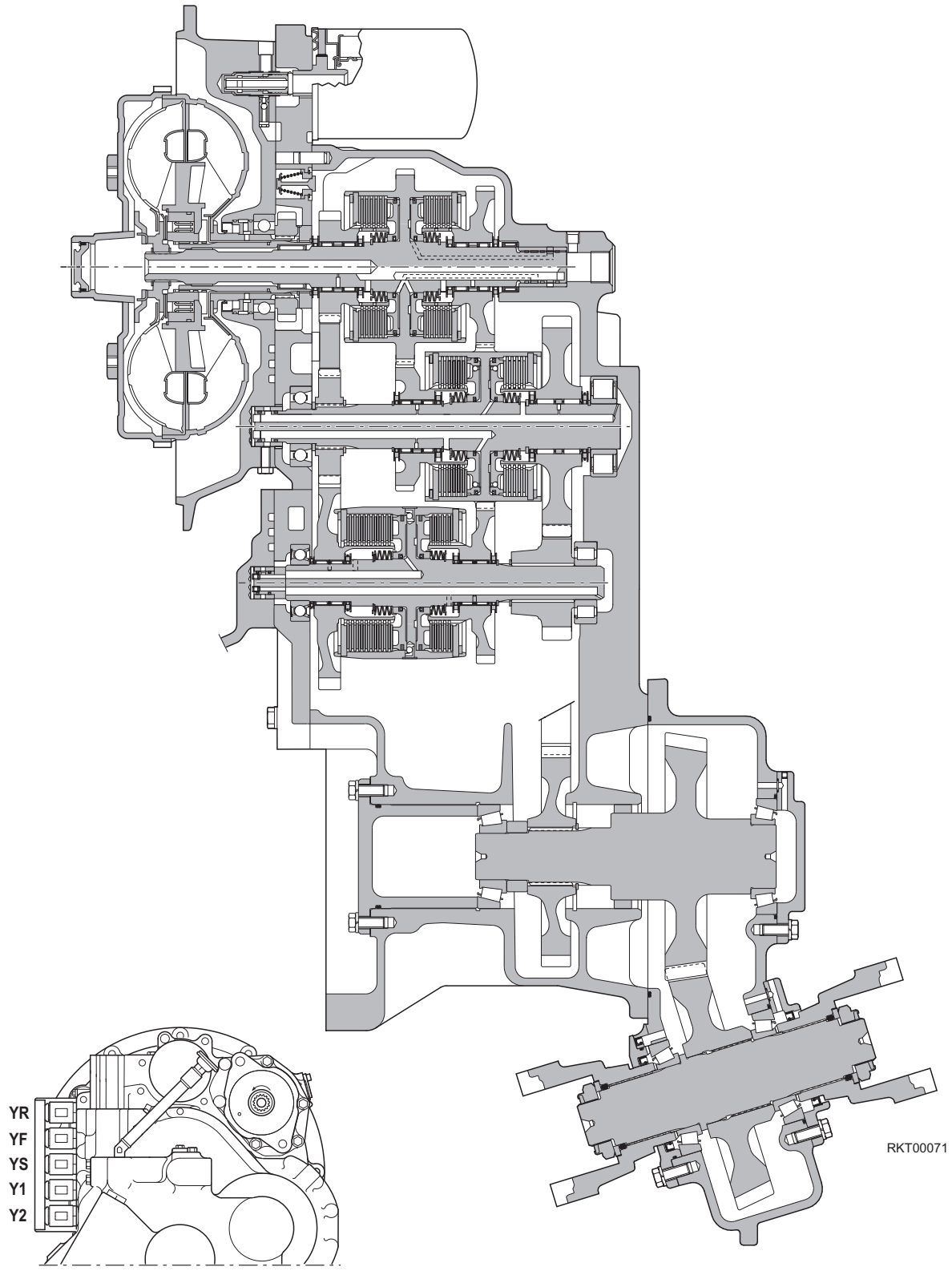
- Once a range clutch is engaged, power is transmitted to the output shaft.
  Output rotation is the same as engine rotation.
- The output shaft transmits motion to the drop box gears (1) and (2) which in turn transmit motion to the transmission shafts connected to the axles.

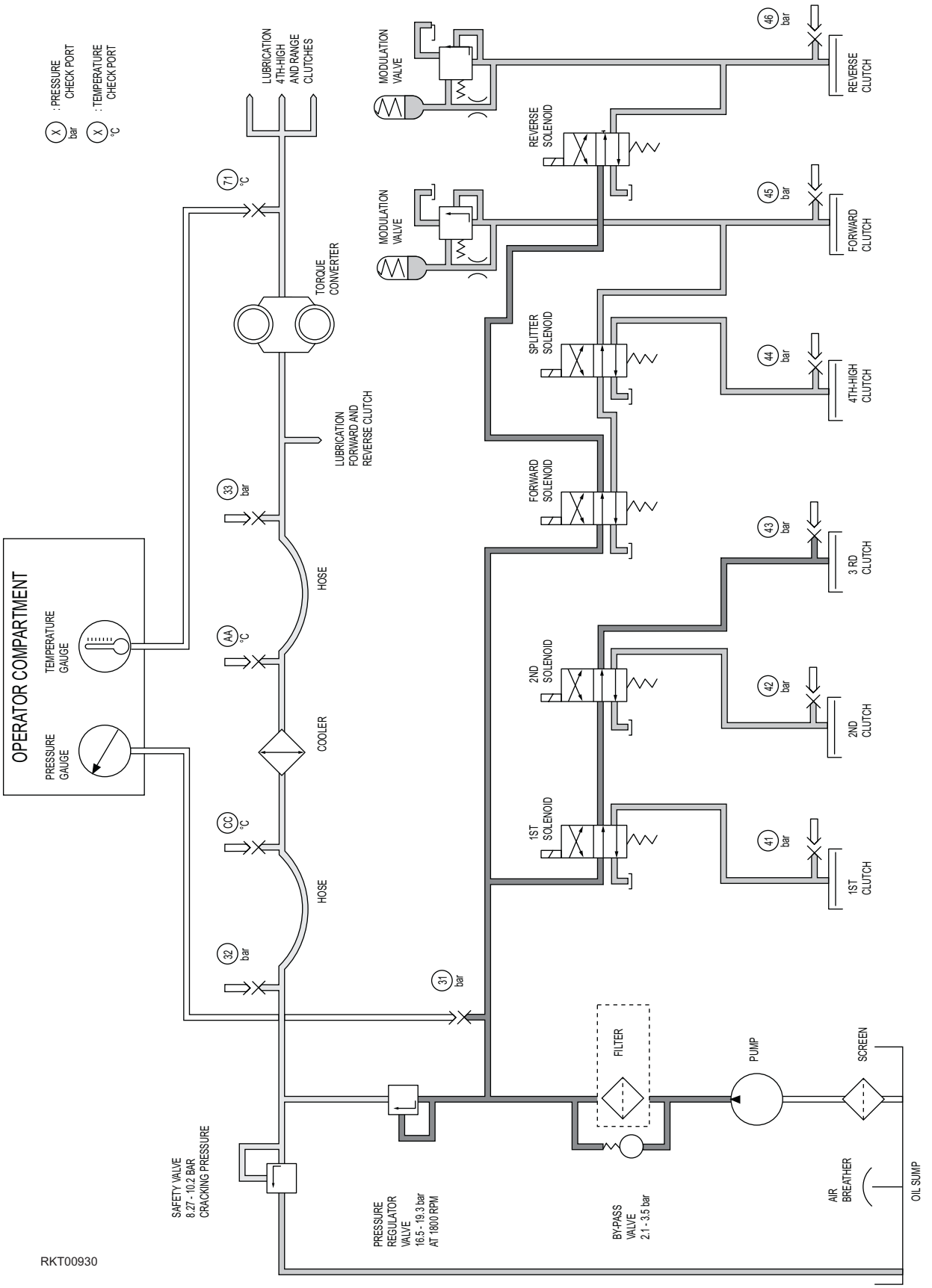
2. TRANSMISSION CONTROLS (also refer to hydraulic diagram)



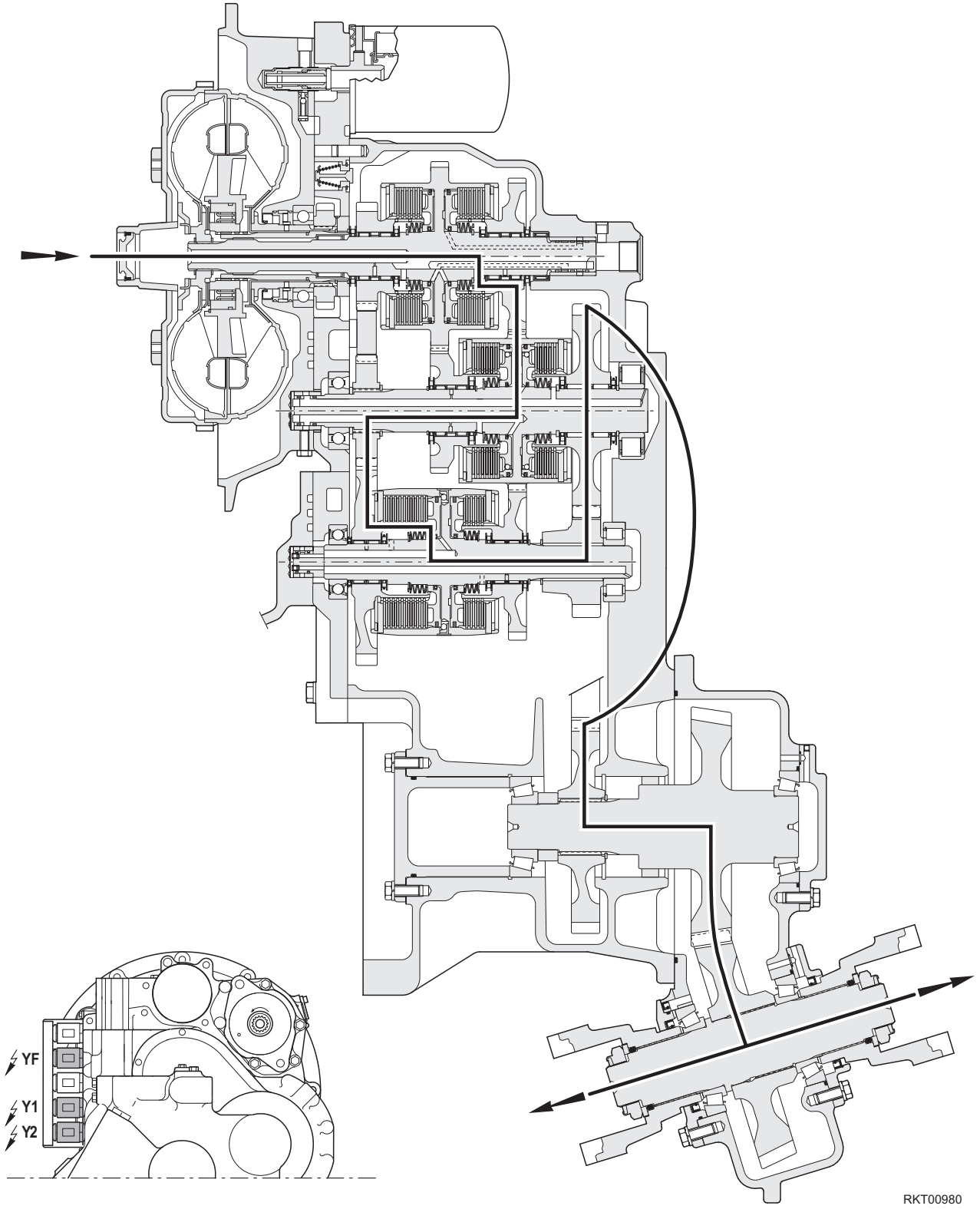
- The transmission is controlled by the direction and range solenoid valves.
- The solenoid valves are mounted on the left side of the transmission case.
- When selected direction and range solenoid valves are energised, oil under pressure will flow through tubes and passages to the selected clutch shafts.
- Oil sealing rings are located on the clutch shafts. These rings direct oil under pressure through a drilled passage way in the shaft to the desired clutch.

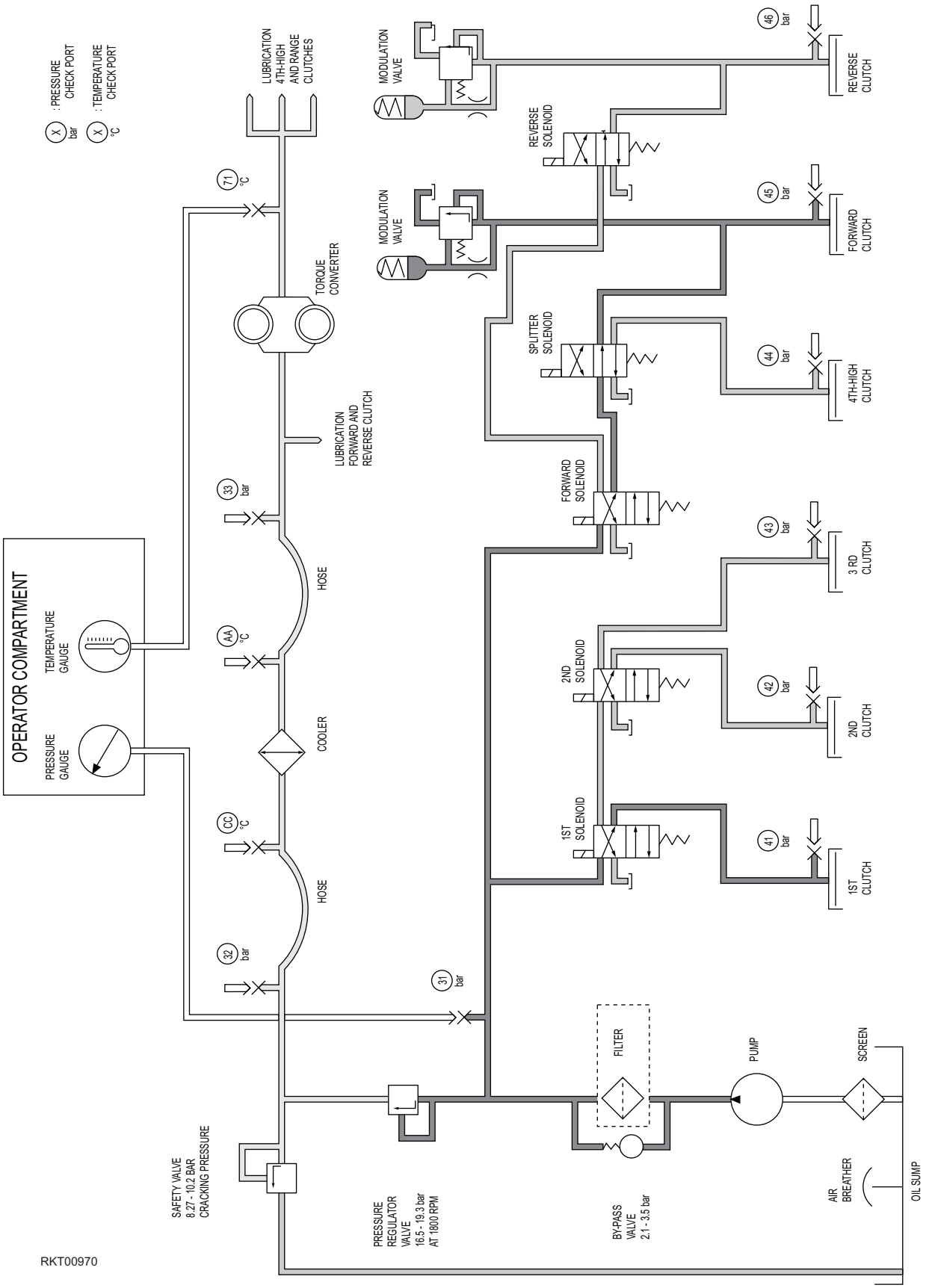
- **TRANSMISSION IN NEUTRAL**



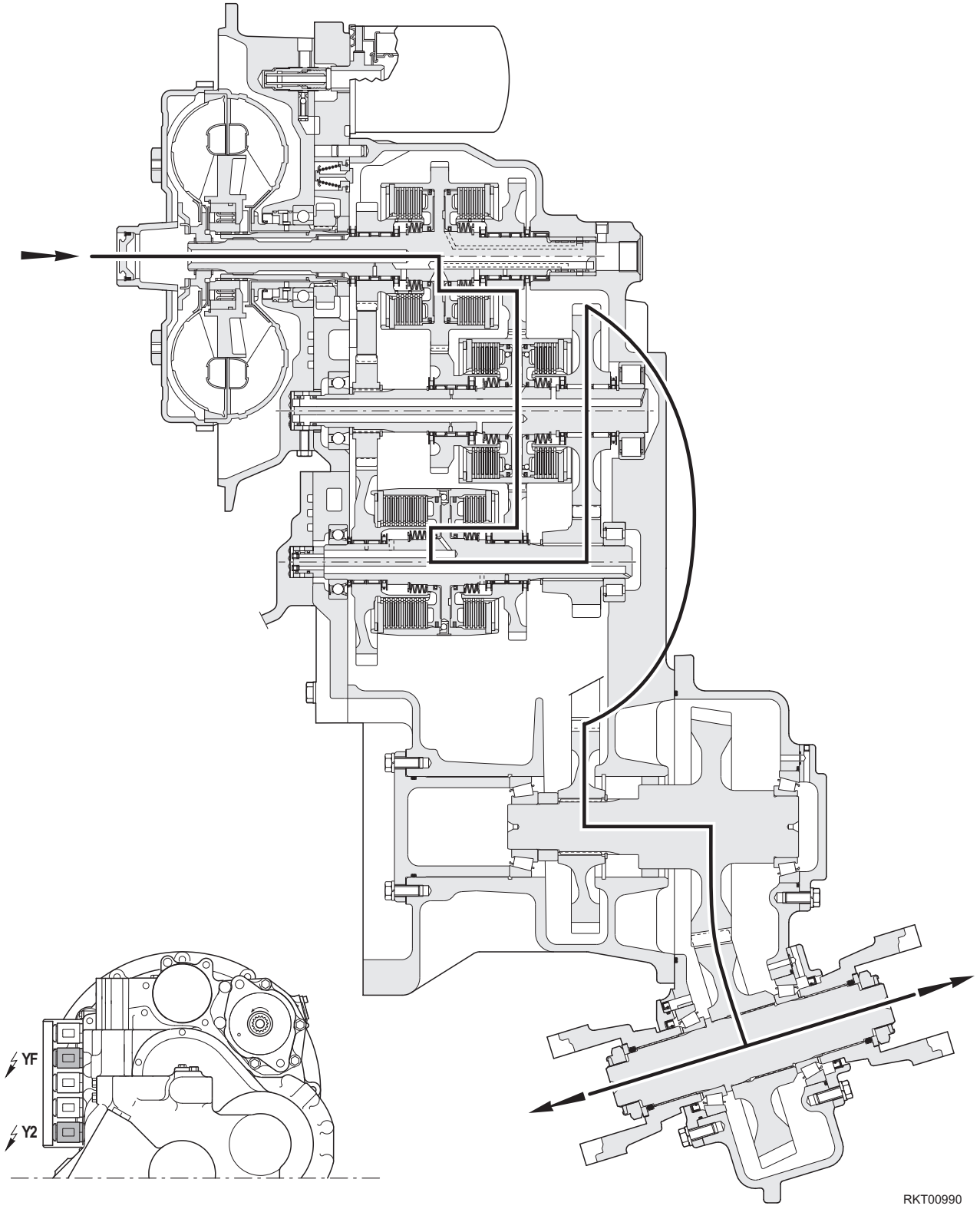

: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
SPLITTER SOLENOID
4TH-HIGH CLUTCH
TORQUE CONVERTER
LUBRICATION FORWARD AND REVERSE CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
HOSE
2ND SOLENOID
2ND CLUTCH
COOLER
1ST SOLENOID
1ST CLUTCH
FILTER
PUMP
SCREEN
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
AIR BREATHER
OIL SUMP
RKT00930

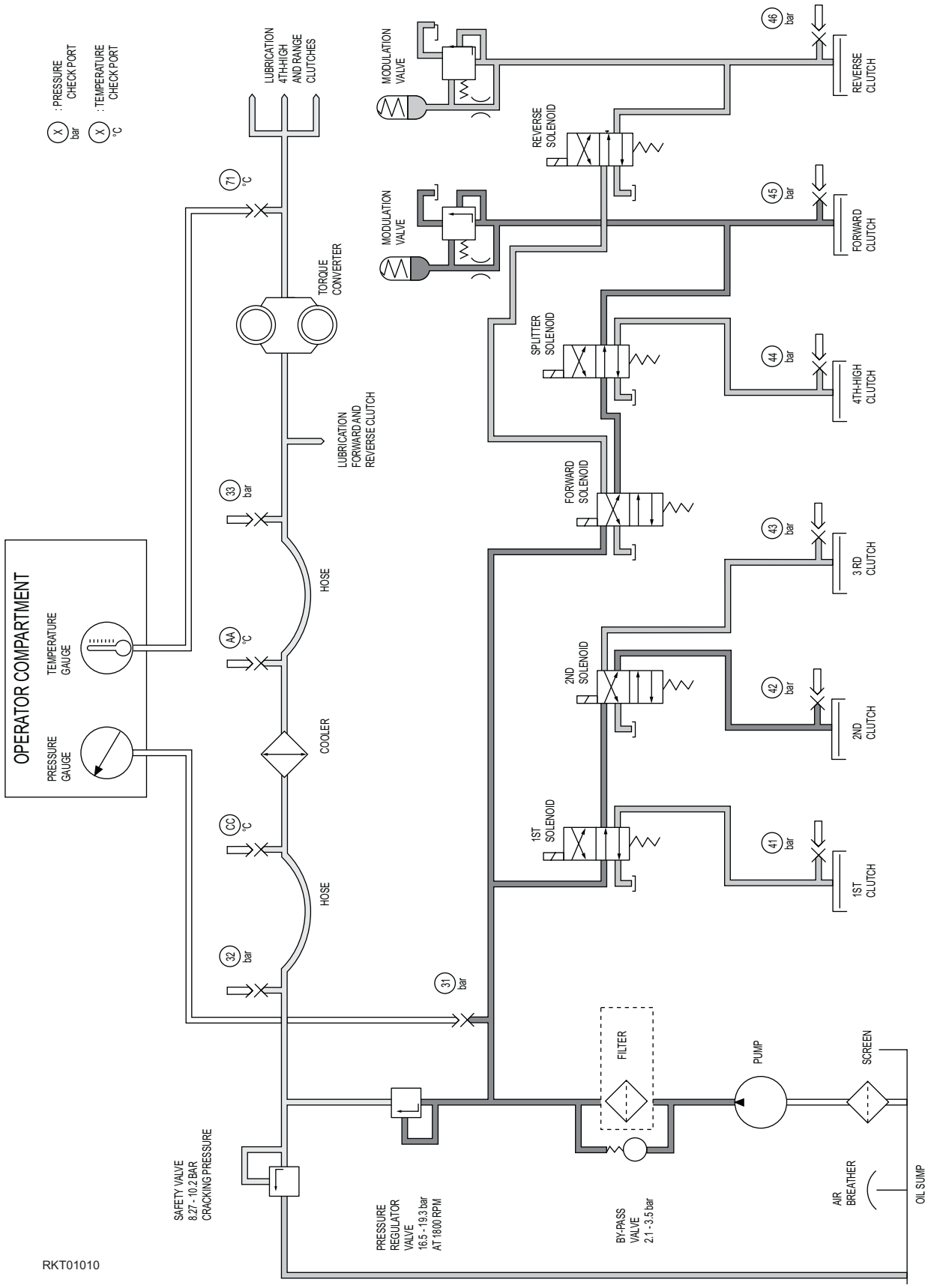
- **FORWARD 1st SPEED**



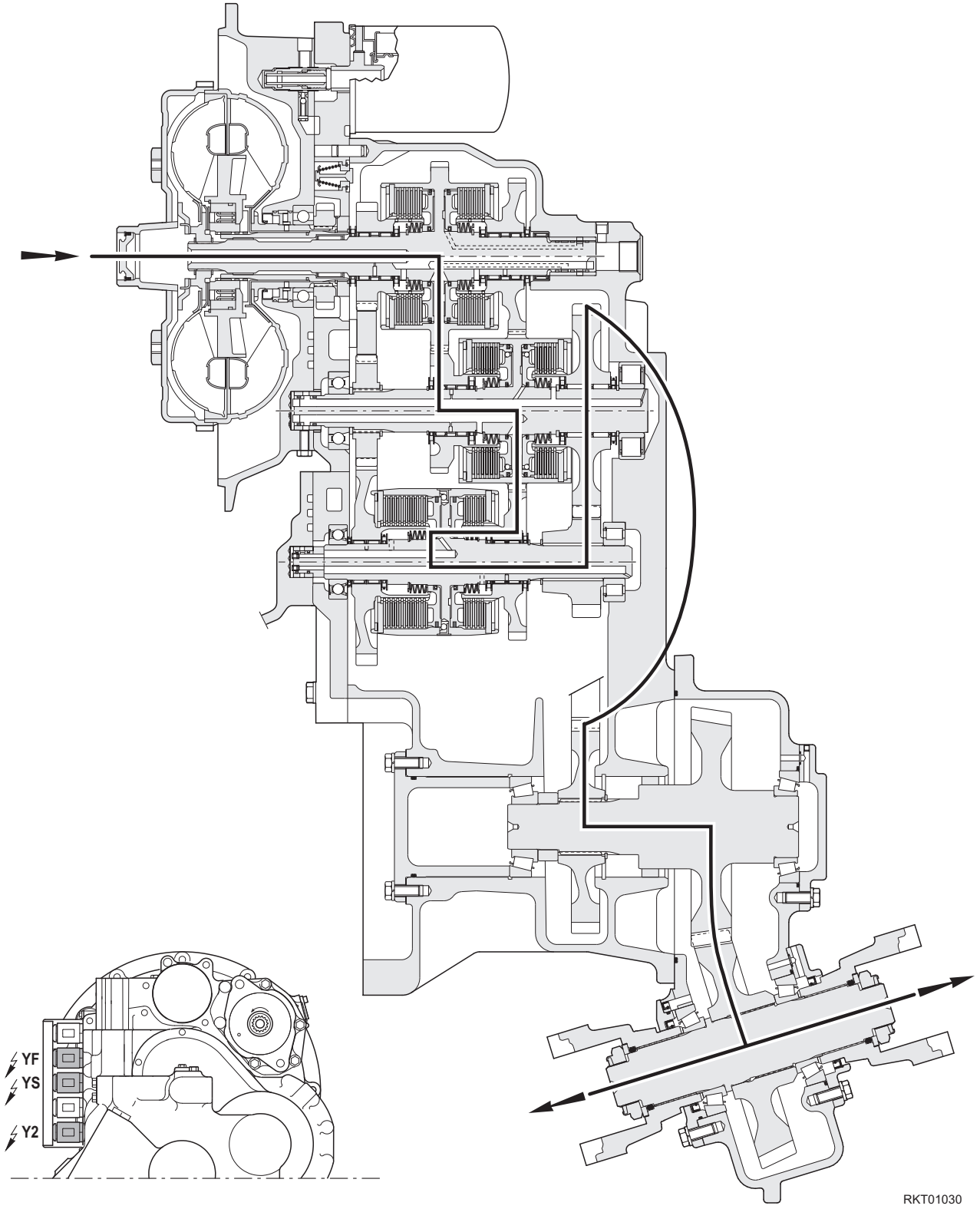

: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
SPLITTER SOLENOID
4TH-HIGH CLUTCH
TORQUE CONVERTER
LUBRICATION FORWARD AND REVERSE CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
HOSE
COOLER
2ND SOLENOID
2ND CLUTCH
1ST SOLENOID
1ST CLUTCH
FILTER
PUMP
SCREEN
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
AIR BREATHER
OIL SUMP
RKT00970

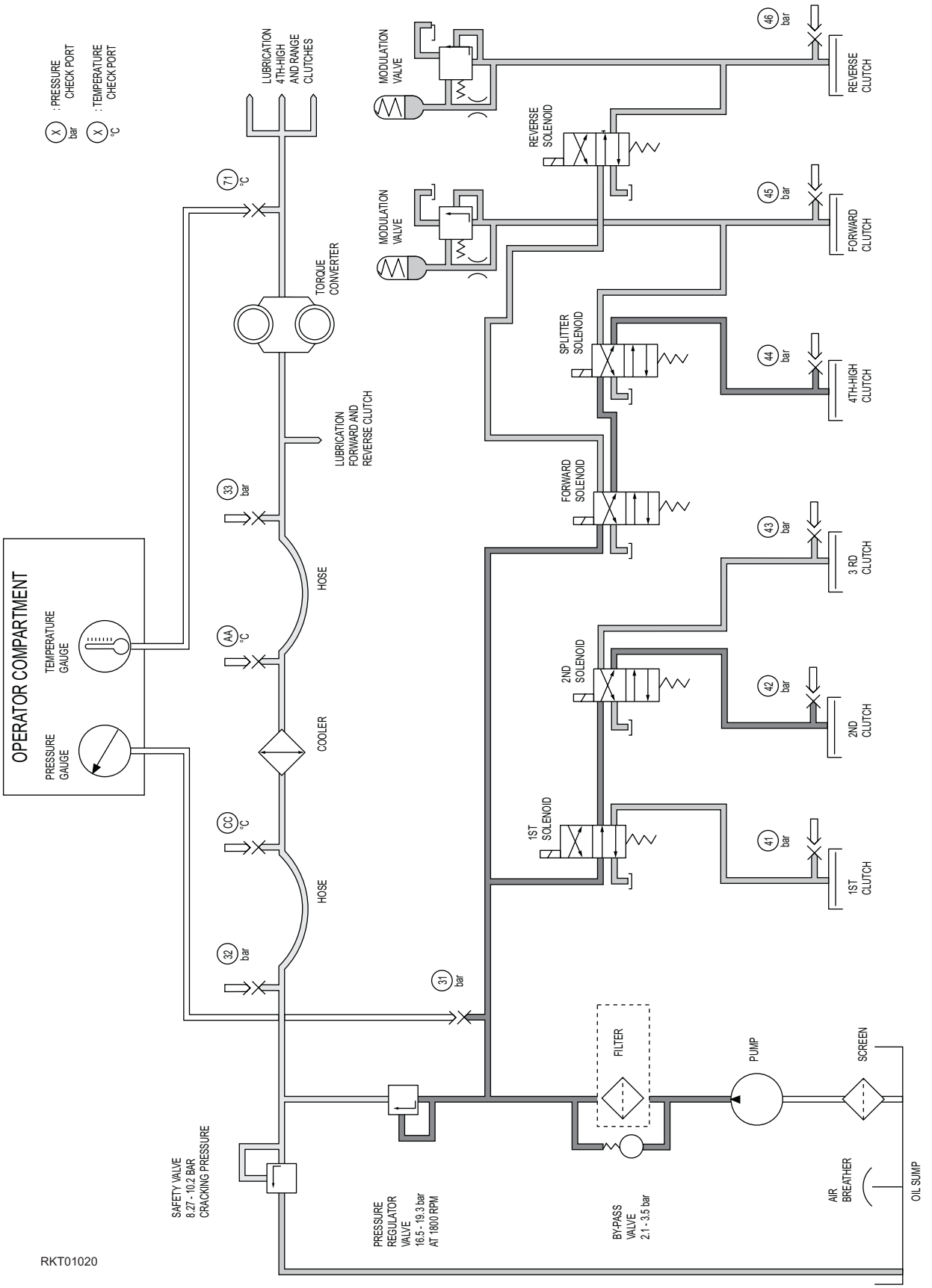
- **FORWARD 2nd SPEED**



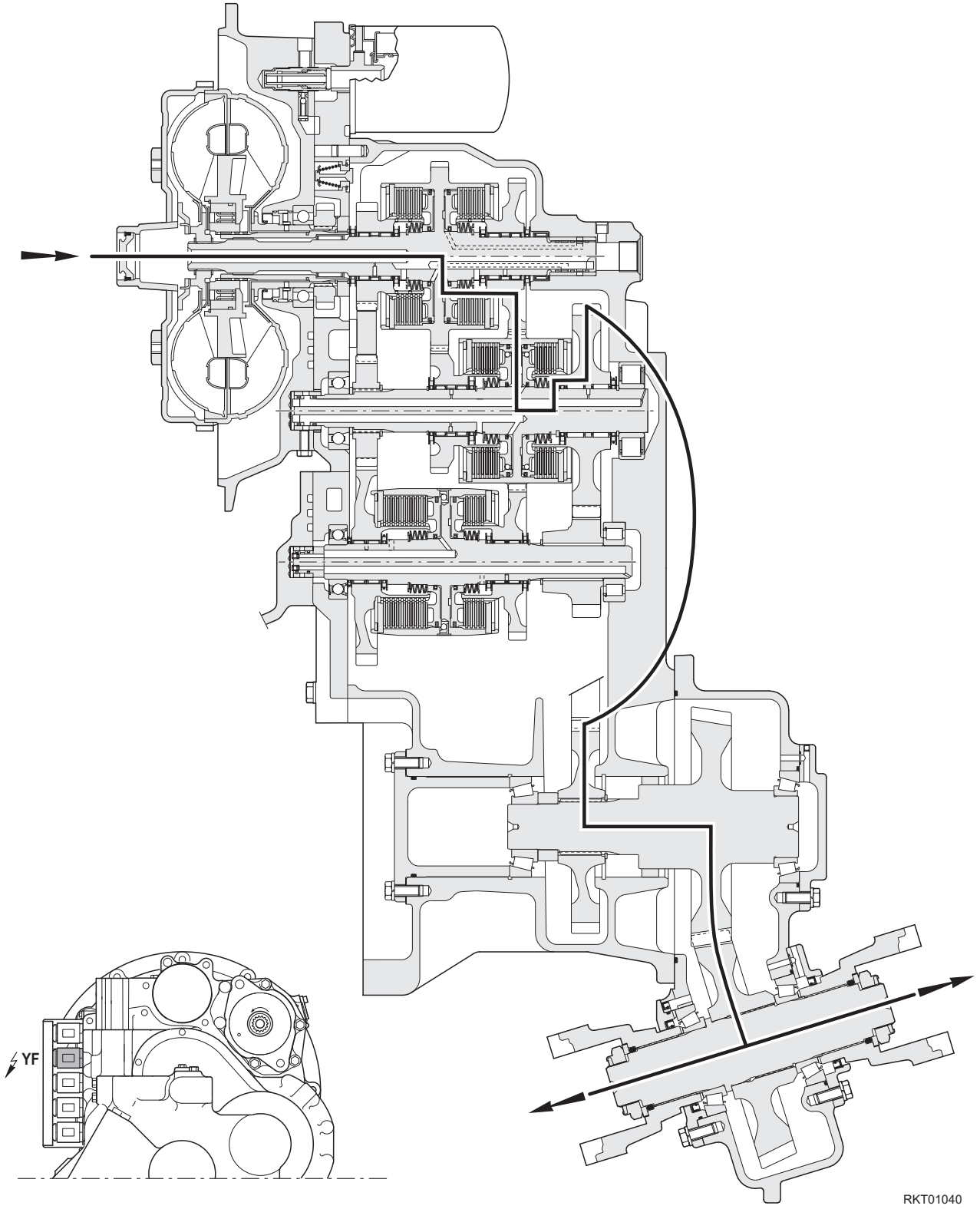

: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
TORQUE CONVERTER
SPLITTER SOLENOID
4TH-HIGH CLUTCH
LUBRICATION FORWARD AND REVERSE CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
HOSE
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
2ND SOLENOID
2ND CLUTCH
COOLER
1ST SOLENOID
1ST CLUTCH
HOSE
FILTER
PUMP
SCREEN
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
AIR BREATHER
OIL SUMP
RKT01010

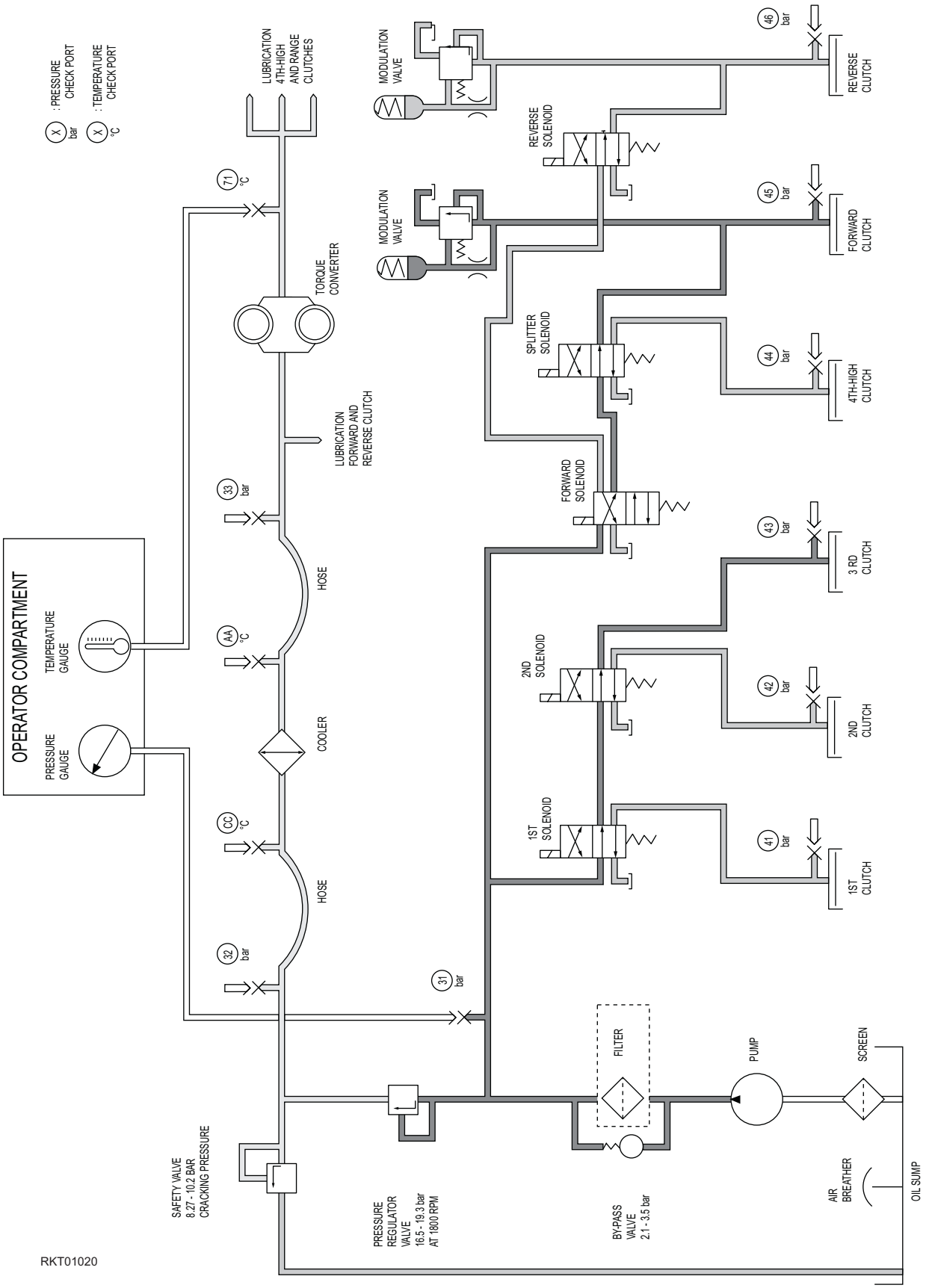
- **FORWARD 3rd SPEED**



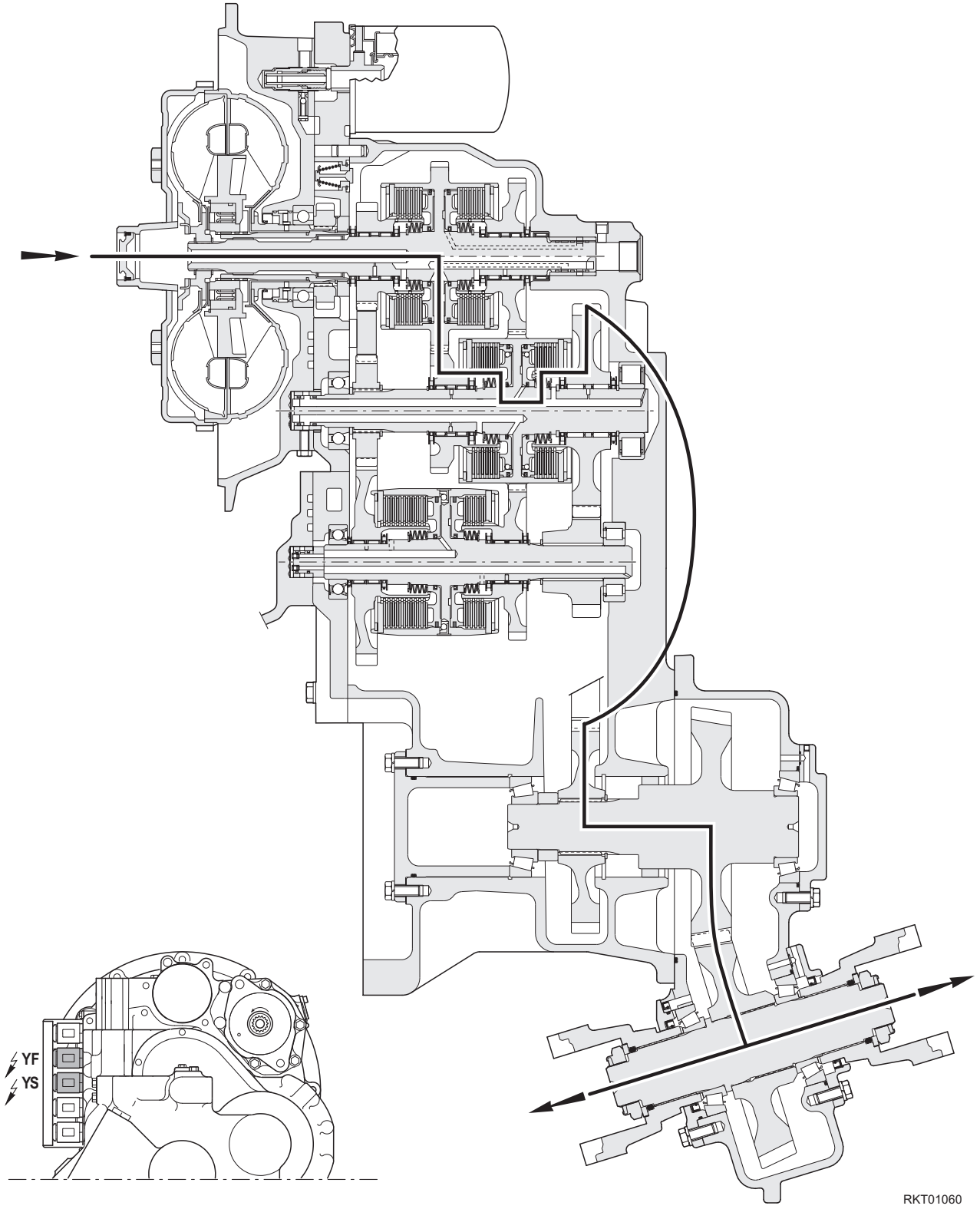

: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
SPLITTER SOLENOID
4TH-HIGH CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
2ND SOLENOID
2ND CLUTCH
1ST SOLENOID
1ST CLUTCH
TORQUE CONVERTER
LUBRICATION FORWARD AND REVERSE CLUTCH
HOSE
COOLER
FILTER
PUMP
SCREEN
AIR BREATHER
OIL SUMP
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
RKT01020

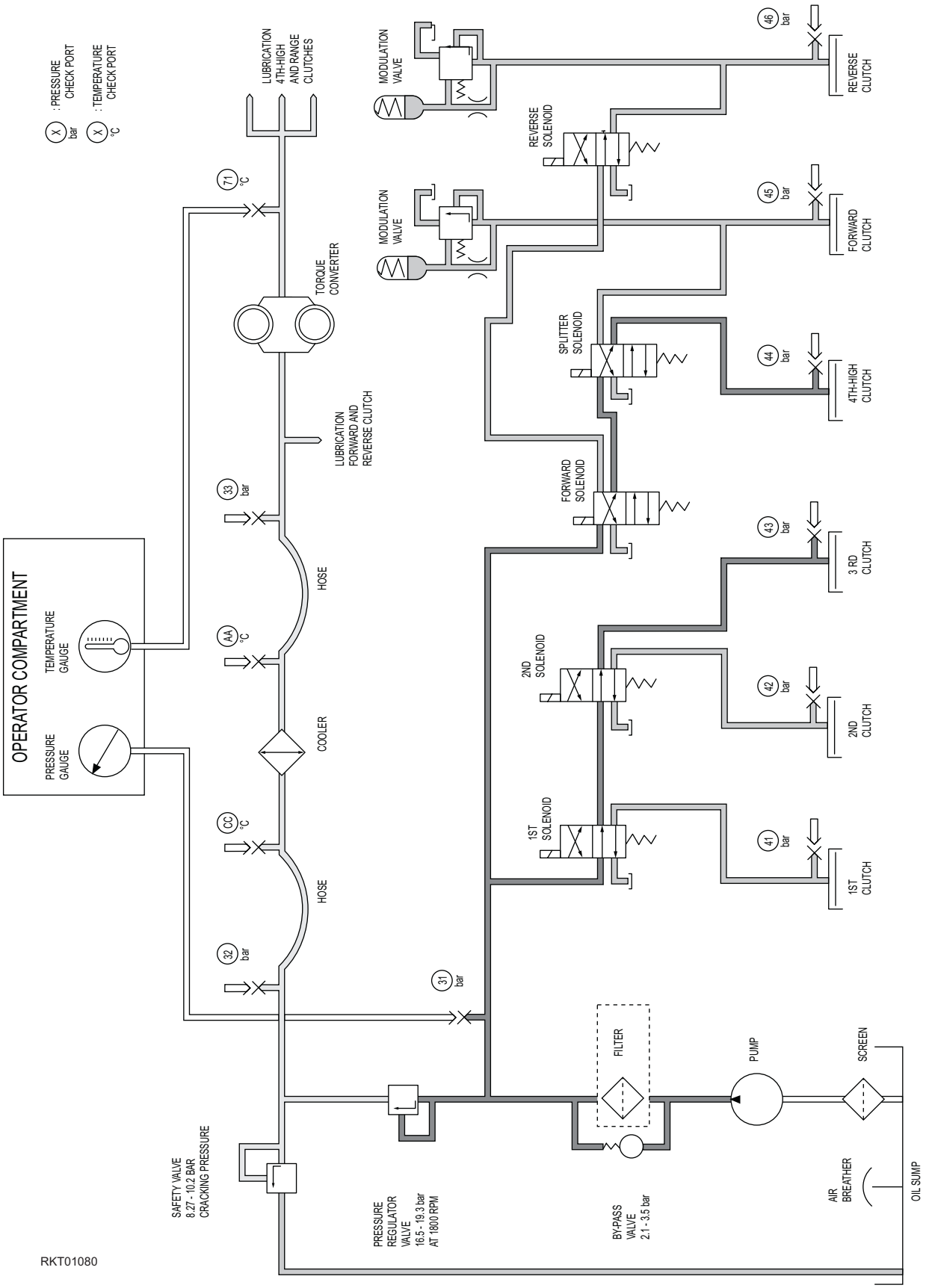
- **FORWARD 4th SPEED**



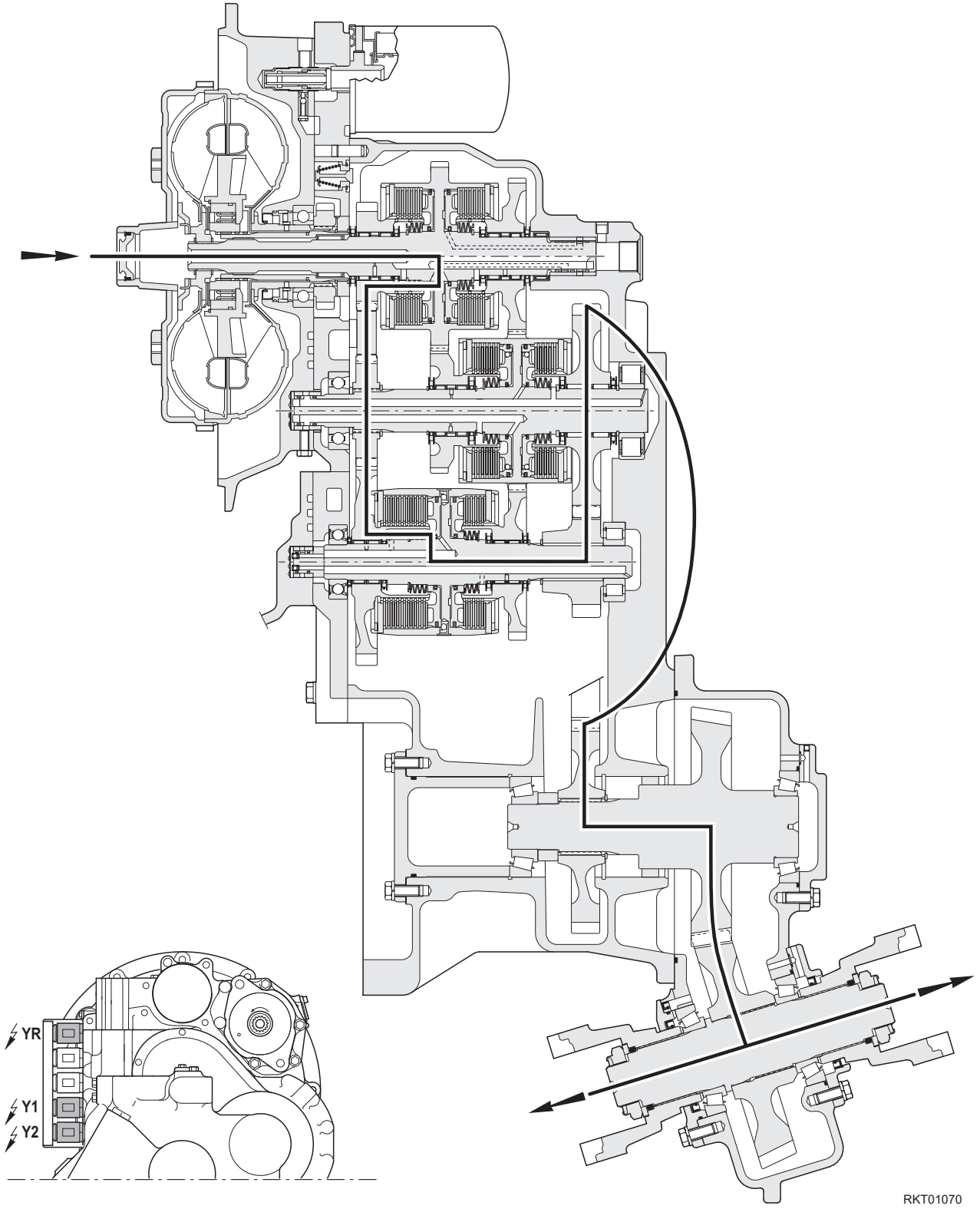

: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
TORQUE CONVERTER
SPLITTER SOLENOID
4TH-HIGH CLUTCH
LUBRICATION FORWARD AND REVERSE CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
HOSE
COOLER
2ND SOLENOID
2ND CLUTCH
1ST SOLENOID
1ST CLUTCH
FILTER
PUMP
SCREEN
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
AIR BREATHER
OIL SUMP
RKT01020

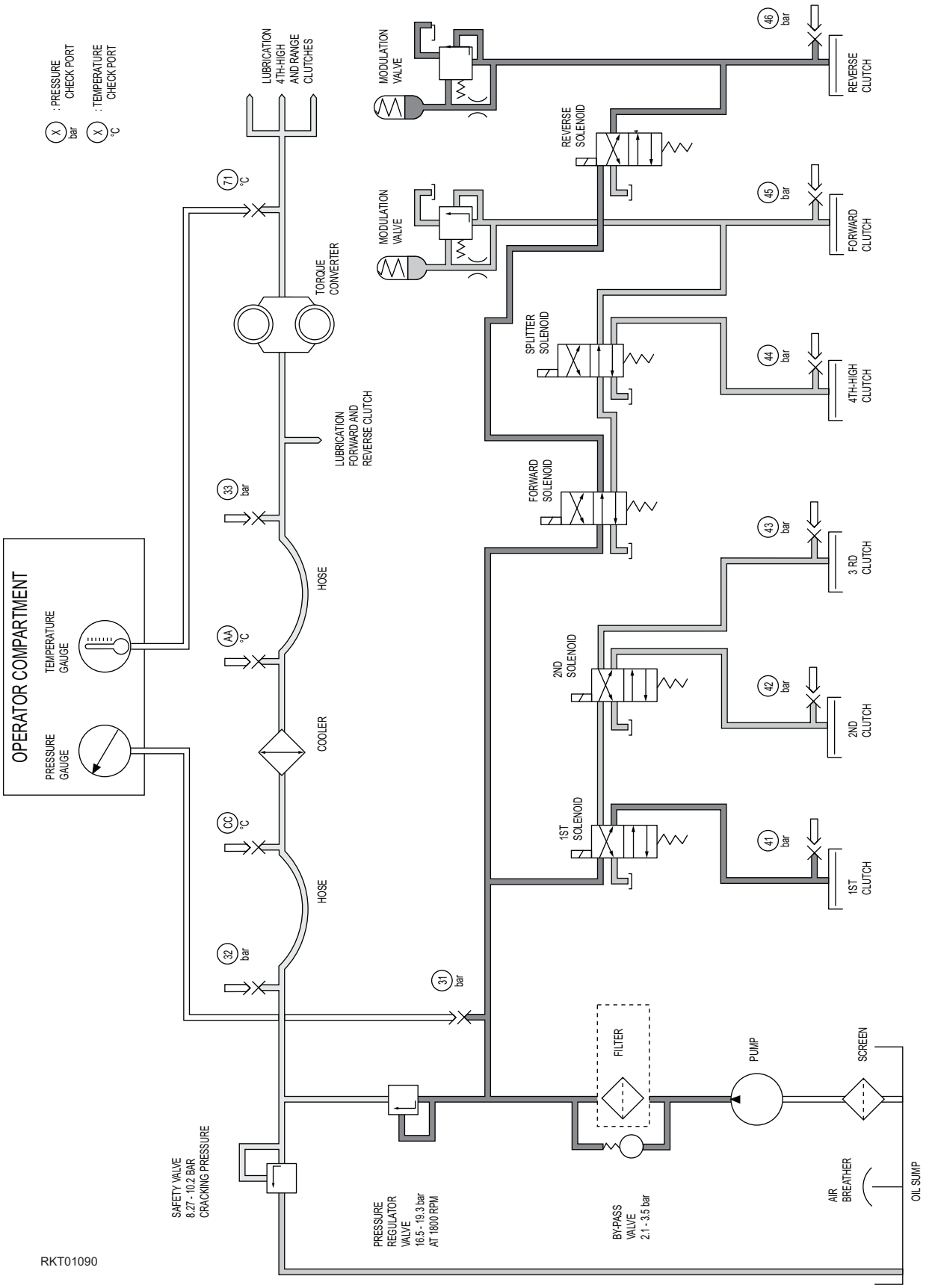
- **FORWARD 5th SPEED**




: PRESSURE CHECK PORT
: TEMPERATURE CHECK PORT
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
MODULATION VALVE
REVERSE SOLENOID
REVERSE CLUTCH
FORWARD CLUTCH
SPLITTER SOLENOID
4TH-HIGH CLUTCH
FORWARD SOLENOID
3 RD CLUTCH
2ND SOLENOID
2ND CLUTCH
1ST SOLENOID
1ST CLUTCH
TORQUE CONVERTER
LUBRICATION FORWARD AND REVERSE CLUTCH
HOSE
COOLER
FILTER
PUMP
SCREEN
AIR BREATHER
OIL SUMP
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
RKT01080

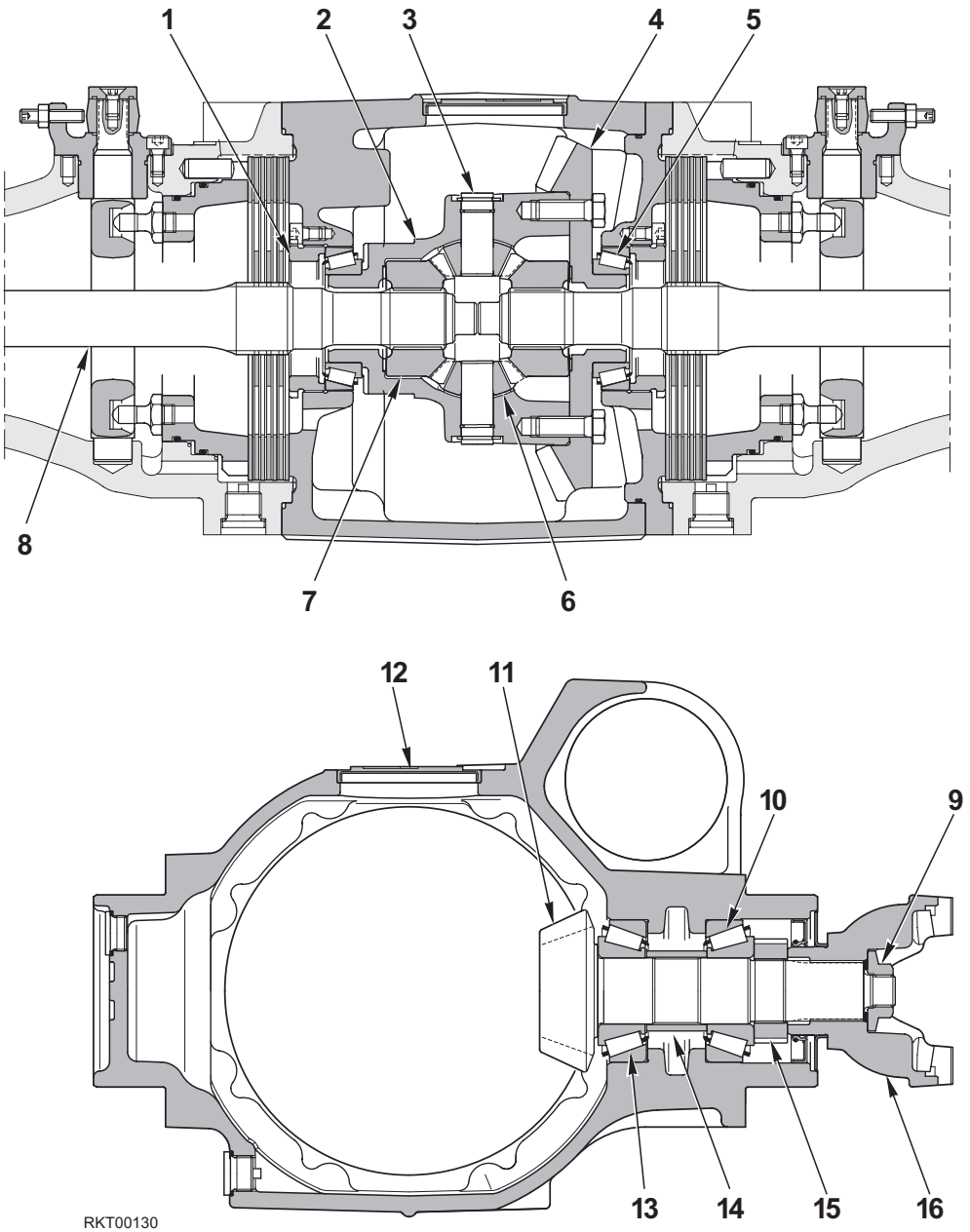
- **REVERSE 1st SPEED**




: PRESSURE CHECK PORT
(X) bar
: TEMPERATURE CHECK PORT
(X) °C
OPERATOR COMPARTMENT
TEMPERATURE GAUGE
PRESSURE GAUGE
LUBRICATION 4TH-HIGH AND RANGE CLUTCHES
(71) °C
TORQUE CONVERTER
LUBRICATION FORWARD AND REVERSE CLUTCH
(33) bar
HOSE
(AA) °C
COOLER
(CC) °C
HOSE
(32) bar
(31) bar
SAFETY VALVE 8.27 - 10.2 BAR CRACKING PRESSURE
PRESSURE REGULATOR VALVE 16.5 - 19.3 bar AT 1800 RPM
BY-PASS VALVE 2.1 - 3.5 bar
FILTER
PUMP
SCREEN
AIR BREATHER
OIL SUMP
MODULATION VALVE
REVERSE SOLENOID
(46) bar
REVERSE CLUTCH
MODULATION VALVE
(45) bar
FORWARD CLUTCH
SPLITTER SOLENOID
(44) bar
4TH-HIGH CLUTCH
FORWARD SOLENOID
(43) bar
3 RD CLUTCH
2ND SOLENOID
(42) bar
2ND CLUTCH
1ST SOLENOID
(41) bar
1ST CLUTCH
RKT01090

FRONT AXLE

CENTRE BODY

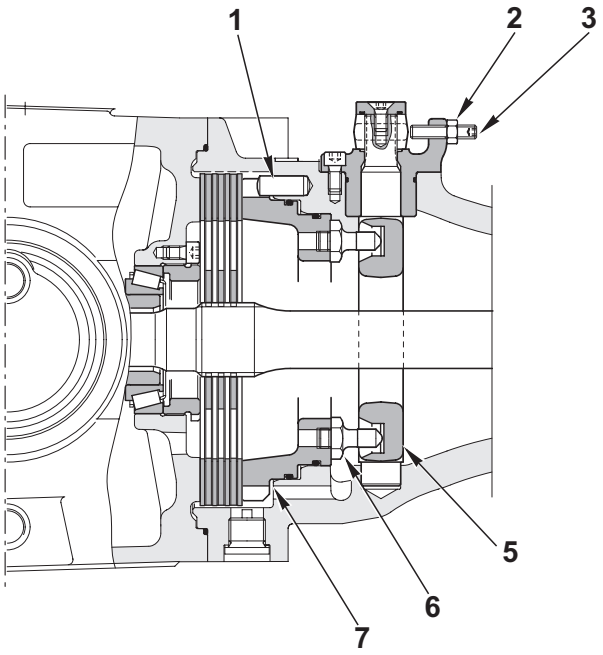


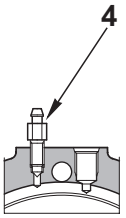
1. Ring nut
2. Differential housing
3. Pin
4. Ring gear
5. Bearing
6. Planetary gear
7. Side gear
8. Drive shaft
9. Nut
10. Bearing
11. Pinion
12. Plug
13. Bearing
14. Spacer
15. Ring nut
16. Flange

CHARACTERISTICS:

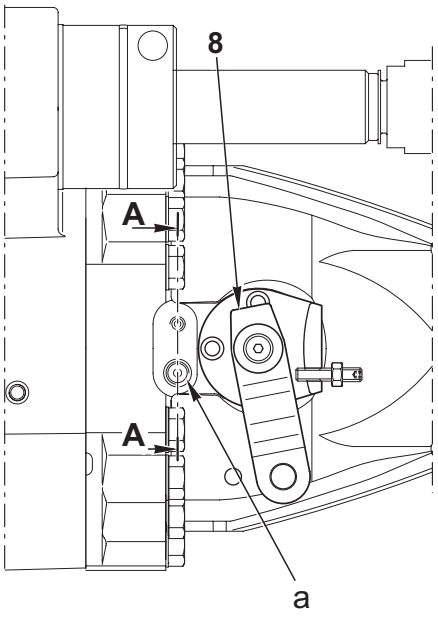
- Version with aspirated engine
  Amount of oil: 7.1 ℓ
  Reduction ratio: 8:31
- Version with turbo engine
  Amount of oil: 7.0 ℓ
  Reduction ratio: 9:31

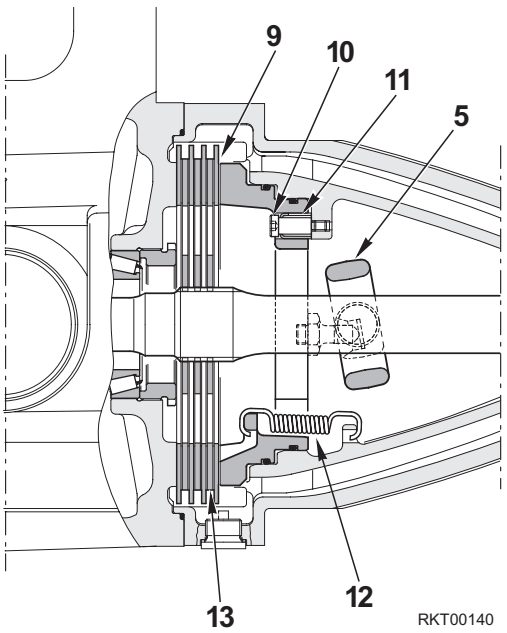
BRAKES AND PARKING BRAKE





Section A - A

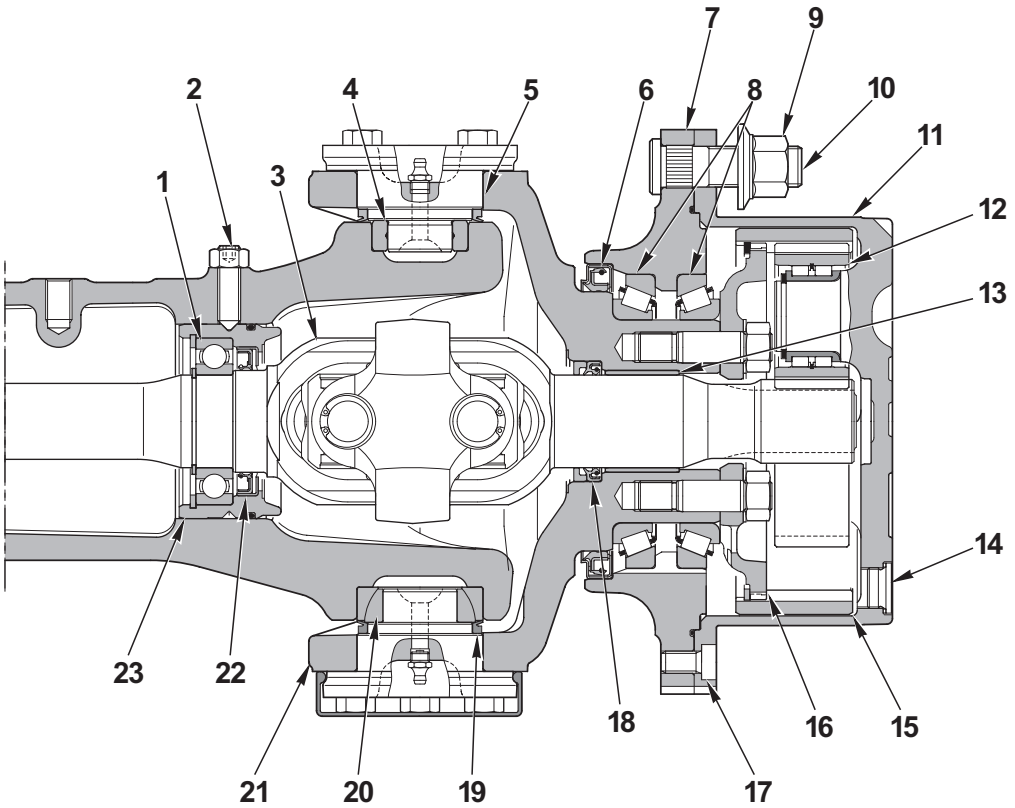




1. Pin
2. Nut
3. Dowel
4. Brake bleed screw
5. Thrust lever
6. Push rod
7. Pressure disc
8. Fulcrum lever
9. Intermediate braking disc
10. Screw
11. Bushing
12. Spring
13. Braking disc

a. From brake pump (B2 Port)

FINAL REDUCTION



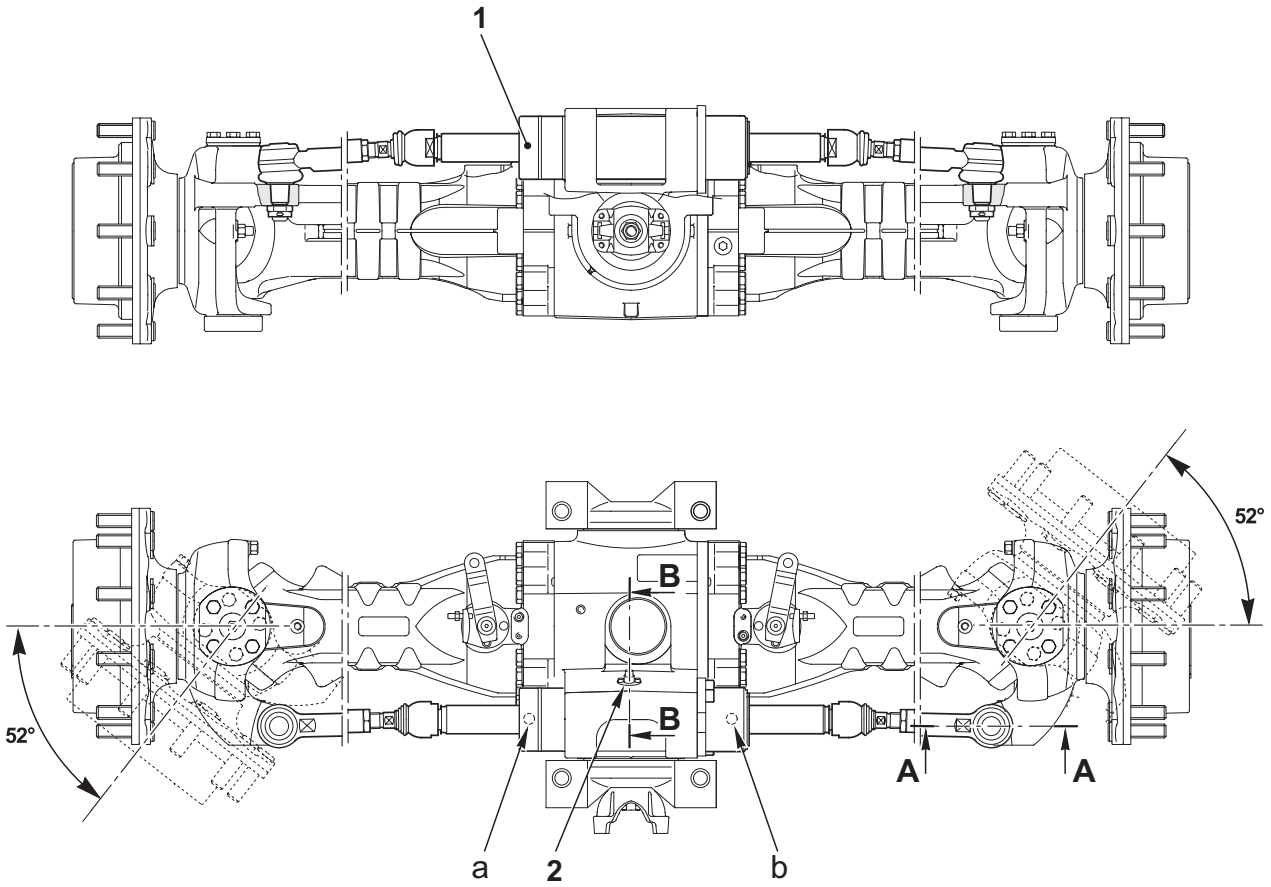
RKT00150

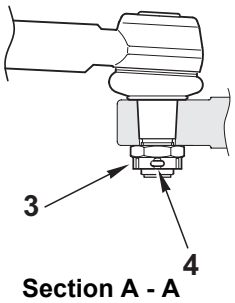
1. Bearing
2. Dowel
3. Double cardan shaft
4. Bushing
5. Pin
6. Sealing ring
7. Wheel hub
8. Bearing
9. Nut
10. Stud bolt
11. Planetary carrier
12. Planetary gears
13. Bushing
14. Plug
15. Ring gear
16. Ring gear carrier
17. Screw
18. Sealing ring
19. Sealing ring
20. Ball bushing
21. Housing
22. Sealing ring
23. Bushing

CHARACTERISTICS

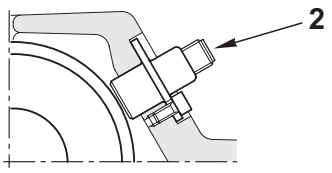
Amount of oil: 0.7 ℓ
Reduction ratio: 1:6

STEERING CYLINDER





Section A - A



Section B - B

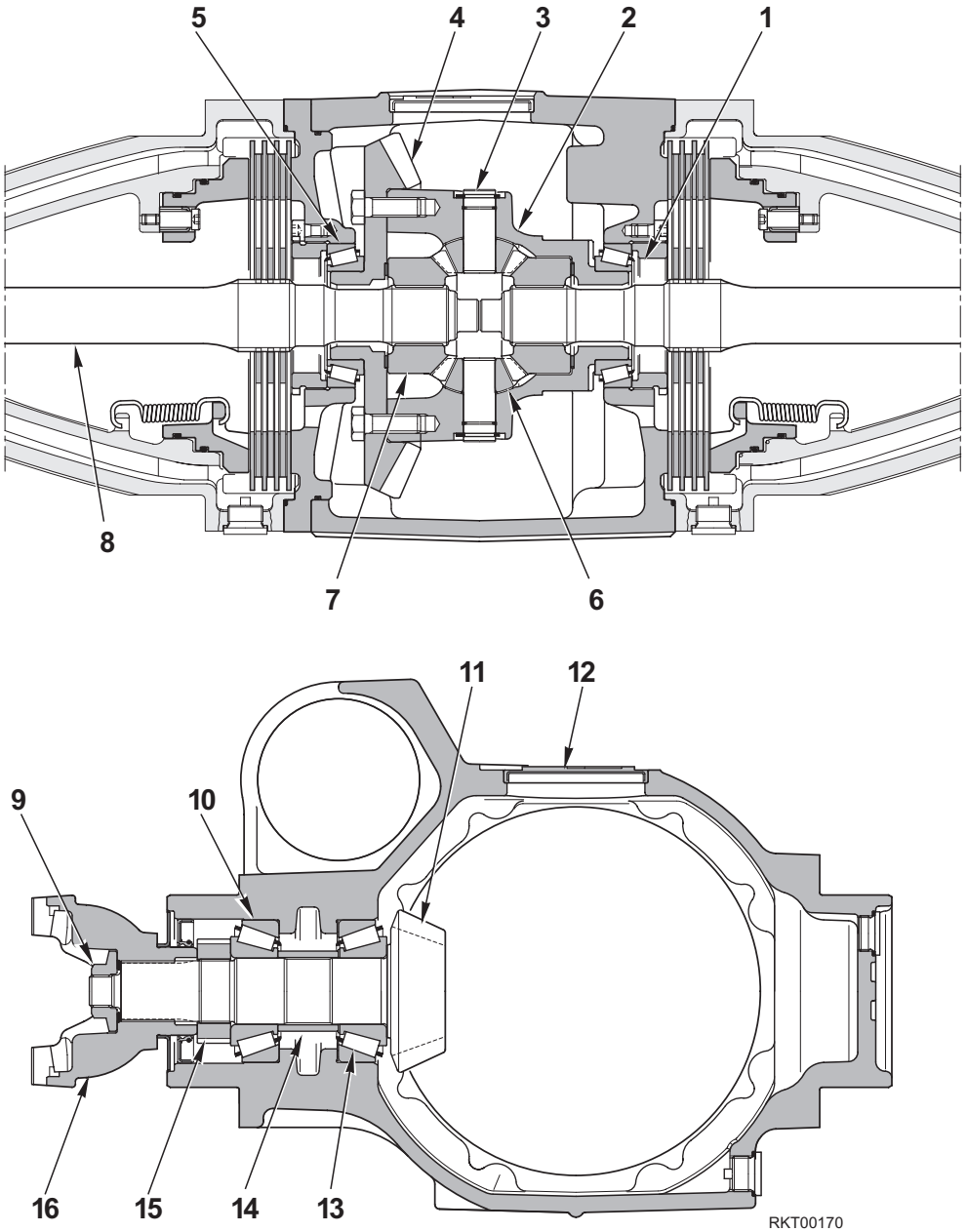
RKT00160

1. Steering cylinder
2. Centering sensor
3. Nut
4. Cotter pin

a. b Port - From ST1 solenoid valve group (T Port)
b. a Port - From steering unit (R Port)

REAR AXLE

CENTRE BODY

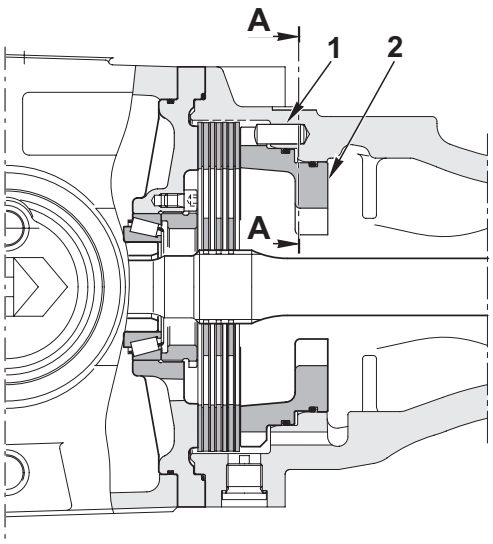


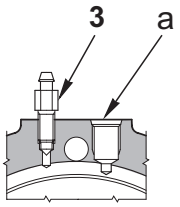
1. Ring nut
2. Differential housing
3. Pin
4. Ring gear
5. Bearing
6. Planetary gear
7. Side gear
8. Drive shaft
9. Nut
10. Bearing
11. Pinion
12. Plug
13. Bearing
14. Spacer
15. Ring nut
16. Flange

CHARACTERISTICS:

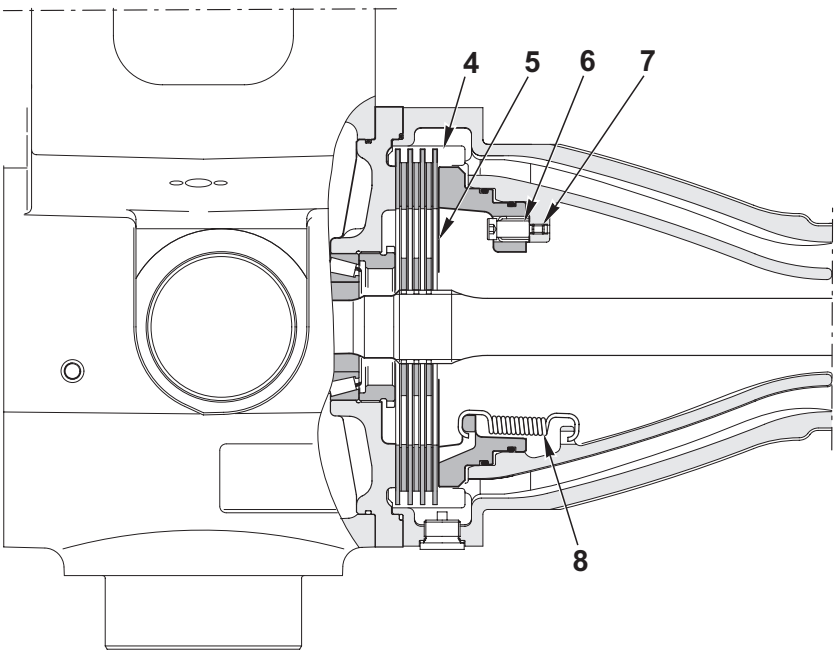
- **Version with aspirated engine**
  Amount of oil: 7.0 ℓ
  Reduction ratio: 8:31
- **Version with turbo engine**
  Amount of oil: 7.1 ℓ
  Reduction ratio: 9:31

BRAKES





Section A - A

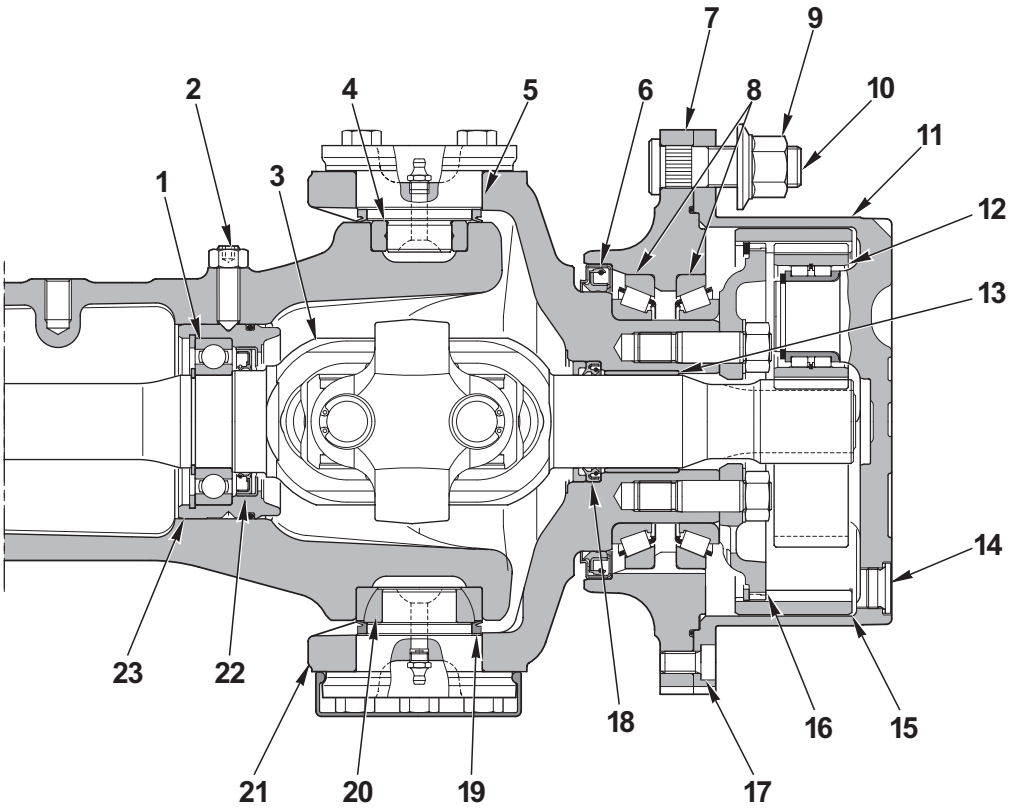


RKT00180

1 Pin
2. Pressure disc
3. Brake bleed screw
4. Disc
5. Braking disc
6. Bushing
7. Screw
8. Spring

a. From brake pump (B2 Port)

FINAL REDUCTION



RKT00150

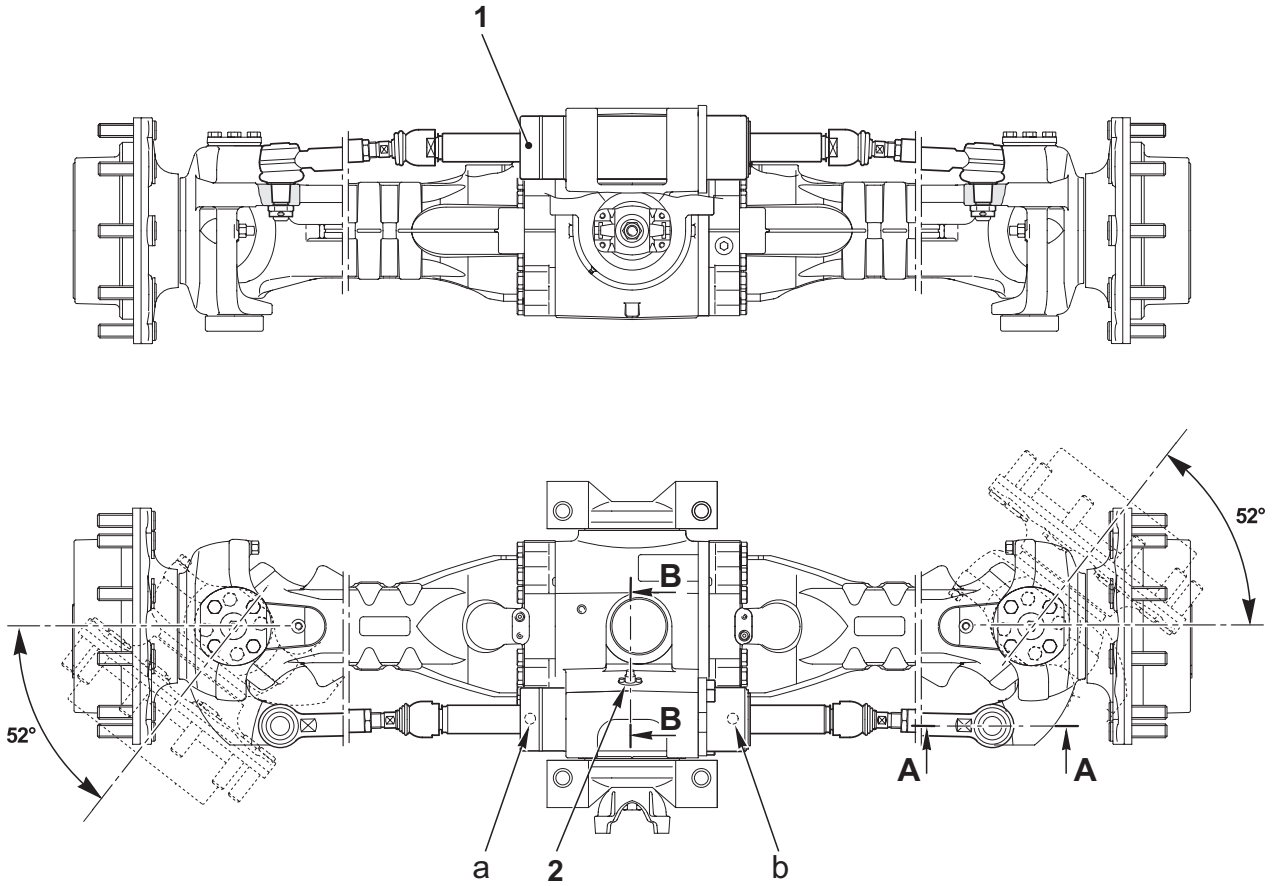
1. Bearing
2. Dowel
3. Double cardan shaft
4. Bushing
5. Pin
6. Sealing ring
7. Wheel hub
8. Bearing
9. Nut
10. Stud bolt
11. Planetary carrier
12. Planetary gears
13. Bushing
14. Plug
15. Ring gear
16. Ring gear carrier
17. Screw
18. Sealing ring
19. Sealing ring
20. Ball bushing
21. Housing
22. Sealing ring
23. Bushing

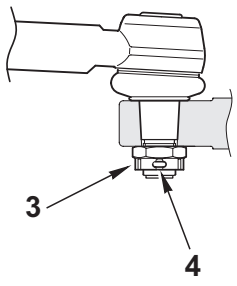
CHARACTERISTICS:

Amount of oil: 0.7 ℓ

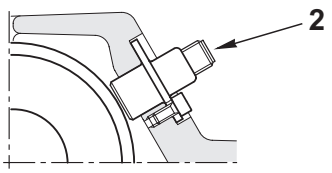
Reduction ratio: 1:6

STEERING CYLINDER





Section A - A



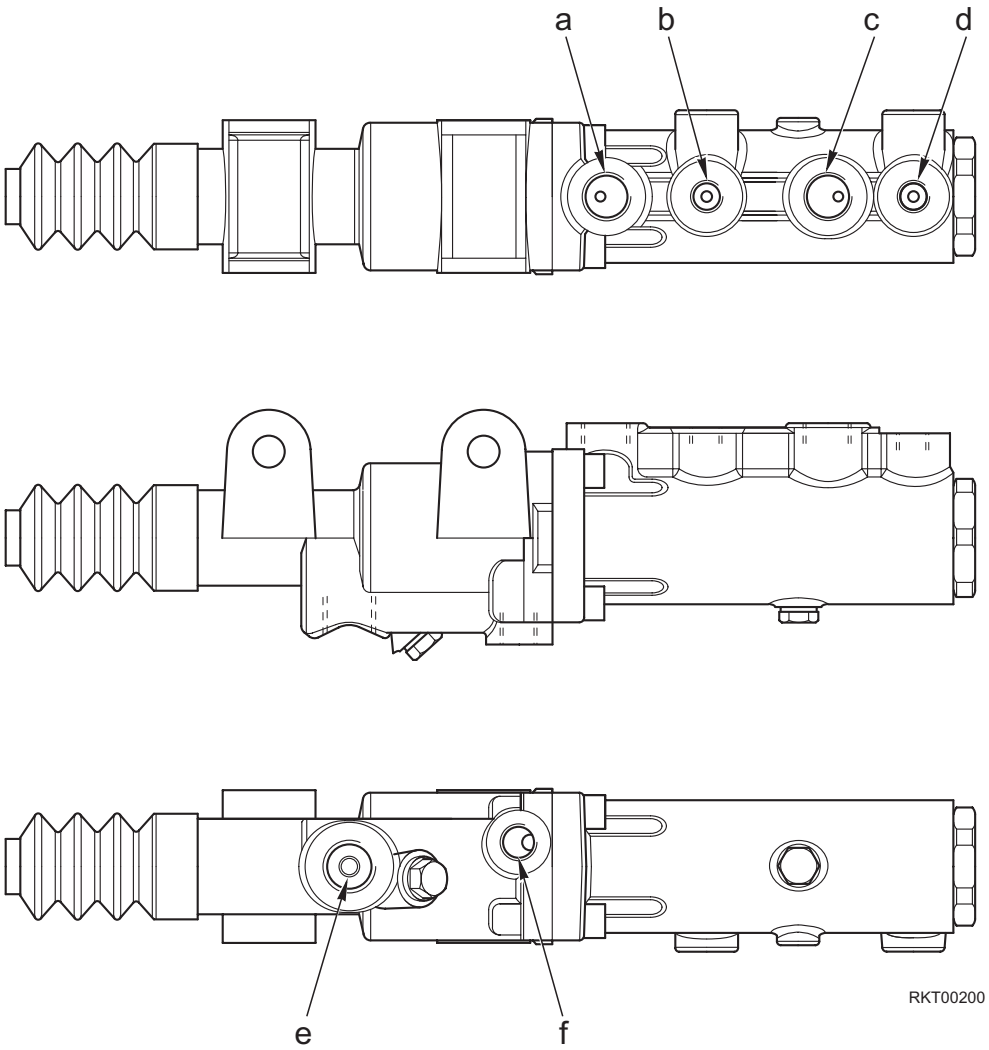
RKT00190

Section B - B

1. Steering cylinder
2. Centering sensor
3. Nut
4. Cotter pin

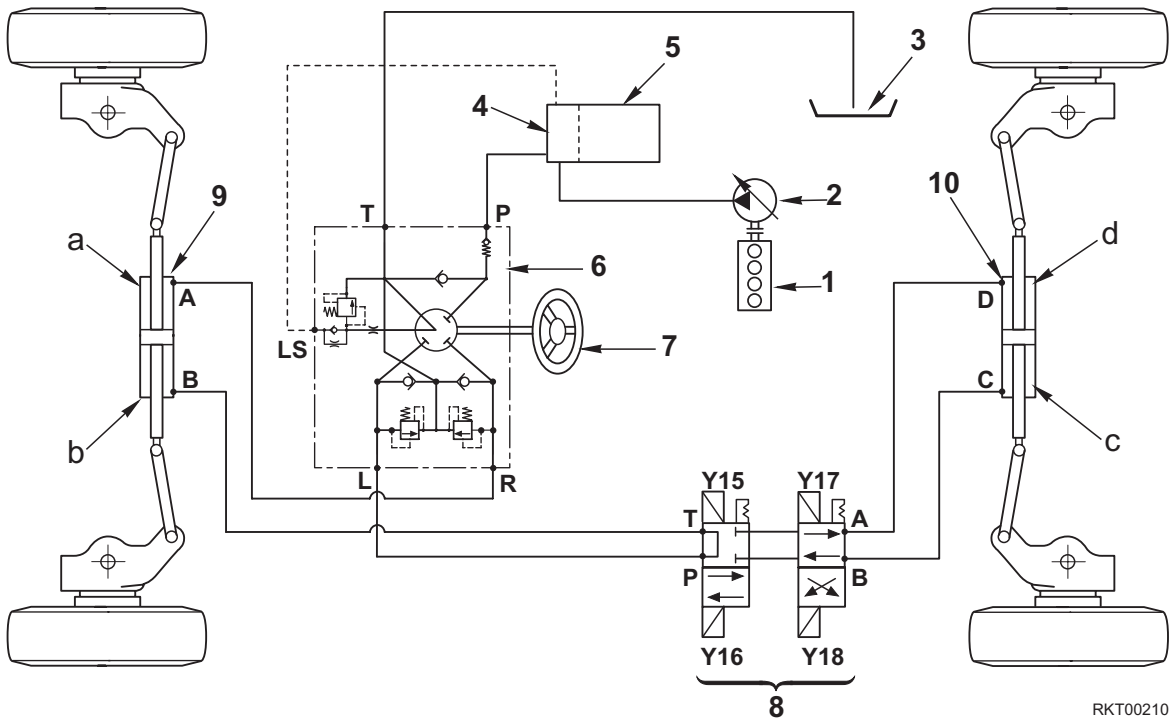
a. Port d - From ST1 solenoid valve group (A Port)
b. Port c - From ST1 solenoid valve assembly (B Port)

BRAKE PUMPS



a. Port R1 - To oil brake tank
b. Port B1 - To rear axle
c. Port R2 - To oil brake tank
d. Port B2 - To front axle
e. Port P - From the transmission pump (31 Port)
f. Port S - To transmission (Port 71)

STEERING SYSTEM (4WS)



1. Engine
2. Hydraulic pump
3. Tank
4 Priority valve
5. Control valve
6. Steering unit
7. Steering wheel
8. ST1 solenoid valve group:
   – Y15: rear steering cut out
   – Y16: front/rear steering
   – Y17: phase coincidence steering
   – Y18: crab steering
9. Front axle steering cylinder
10. Rear axle steering cylinder

DESCRIPTION

- The steering system is completely hydraulic. The oil required, supplied by the pump (2) driven by the motor (1), is sent to the priority valve (4), which is incorporated in the control valve (5). The priority valve functions by Load Sensing, and sends the necessary quantity of oil to the steering system (6), even when other oleodynamic components supplied by the same circuit are in operation. The oil passes from this assembly (6) into the steering cylinders (9 and 10). The solenoid valve group (8) can switch the oil flow to provide three types of steering:

  1 - 2 wheels steering
  Steering condition in which the rear axle is excluded.

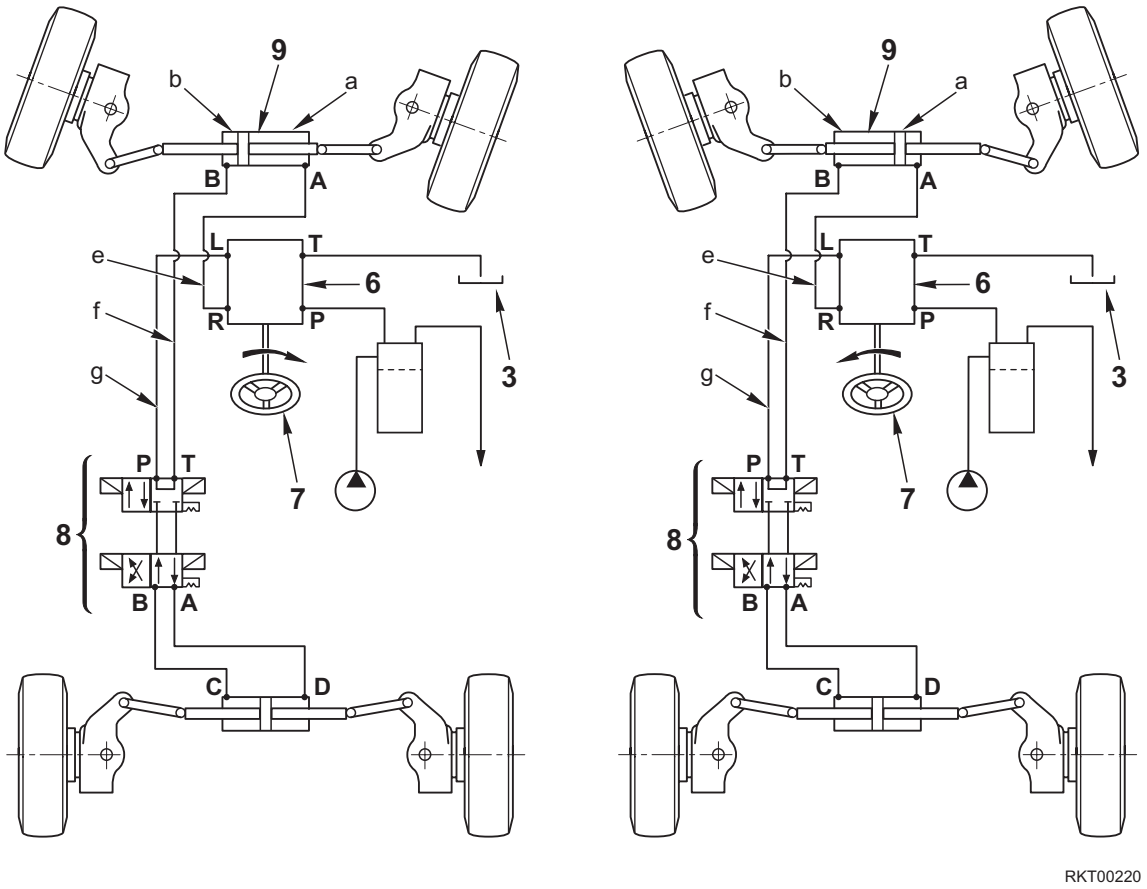
  2 - 2 wheels steering and 2 wheels counter-steering (coordinated steering).
  Steering condition in which rear steering is activated and the direction of the rear wheels is contrary to that of the front wheels.

  3 - 4 wheels steering in the same direction (crab steering).
  Steering condition in which rear steering is activated and the direction of the rear wheels agrees with that of the front wheels.

- The hydraulic power supplied by the pump (2) is transferred to cylinders (9 and 10) and transformed into mechanical steering power.

OPERATION

1 - Steering with front wheels only.



STEERING TO THE RIGHT

Turning the steering wheel (7) clockwise causes rotation of the steering metering unit (6) and prepares the control valve (port **R**) to send oil through line **e** directly into chamber **a** of the cylinder (9); the pressurized oil moves the piston which then steers the wheels.

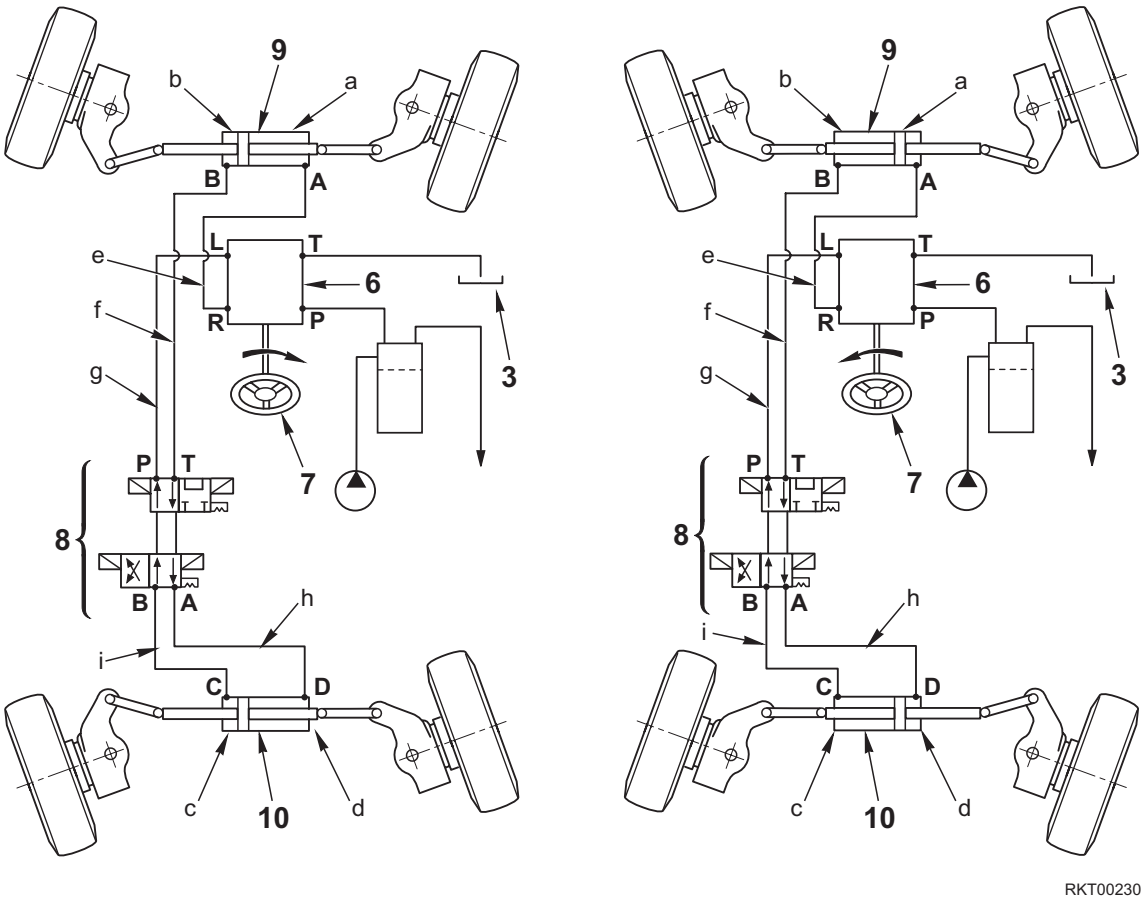
The oil in chamber **b** of cylinder (9) is impelled through line **f** to the solenoid valve group (8) and thence into line **g** which is coupled to the control valve of the steering group (6) (port **L**); from the oil control valve the oil passes out of Port **T** and drains into the tank (3).

STEERING TO THE LEFT

Turning the steering wheel (7) anti-clockwise causes rotation of the steering metering group (6) and prepares the control valve (port **L**) to send oil through line **g** to the solenoid valve group (8) and thence through line **f** into chamber **b** of the cylinder (9); the pressurized oil moves the piston which then steers the wheels.

The oil in chamber **a** of cylinder (9) is impelled into line **e** which is coupled to the control valve of the steering assembly (port **R**); from the control valve, the oil passes out of Port **T** and drains into the tank (3).

2 - Steering with 2 wheels steering and 2 wheels counter-steering (coordinated steering).



STEERING TO THE RIGHT

Turning the steering wheel (7) clockwise causes rotation of the steering metering group (6) and prepares the control valve (port **R**) to send oil through line **e** directly into chamber **a** of the cylinder (9).

The pressurized oil moves the piston of the cylinder (9) that steers the wheels while simultaneously impelling the oil in chamber **c** (at the same pressure as chamber a) through lines **f** and **h** into chamber **d** of the cylinder (10).

The oil in chamber **c** of cylinder (10) is sent through lines **i** and **g** to the control valve of the steering assembly (port **L**) from which the oil passes out (port **T**) to drain into the tank (3).

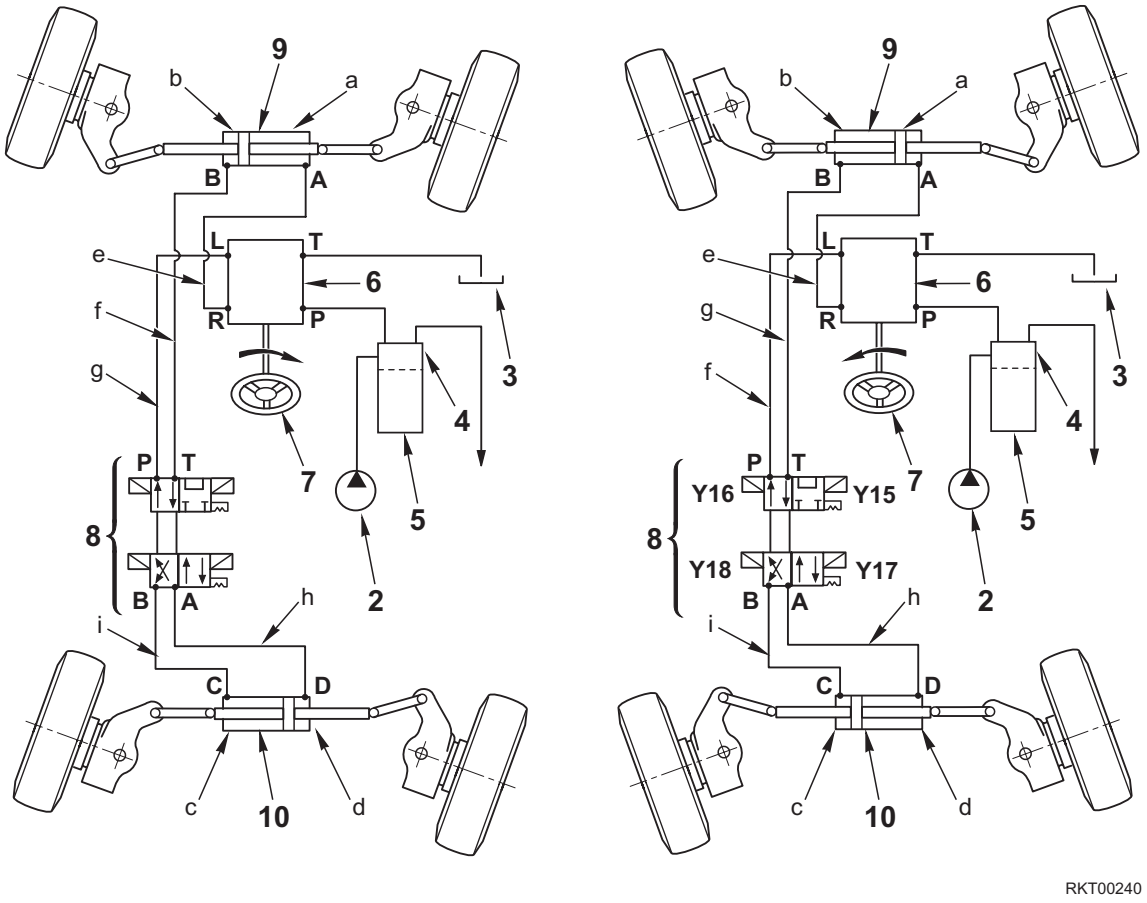
STEERING TO THE LEFT

Turning the steering wheel (7) anti-clockwise causes rotation of the steering metering group (6) and prepares the control valve (port **L**) to send oil through line **g** to the solenoid valve group (8) and thence through line **i** to chamber **c** of cylinder (10).

The pressurized oil moves the piston of the cylinder (10) that steers the wheels while simultaneously impelling the oil in chamber **d** (at the same pressure as chamber **c**) through lines **h** and **f** into chamber **b** of the cylinder (9).

The oil in chamber **a** of cylinder (9) is sent through line **e** to the control valve of the steering group (port **R**) from which the oil passes out (port **T**) to drain into the tank (3).

3 - Steering with 4 wheels steering in the same direction (crab steering).



STEERING TO THE RIGHT

Turning the steering wheel (7) clockwise causes rotation of the steering metering unit (6) and prepares the control valve (port **R**) to send oil (through line **e**) into chamber **a** of the cylinder (9).

The pressurized oil moves the piston of the cylinder (9) that steers the wheels while simultaneously impelling the oil into chamber **b** (at the same pressure as chamber **a**) through lines **f** and **i** into chamber **c** of cylinder (10).

The oil in chamber **d** of cylinder (10) is sent through lines **h** and **g** to the control valve of the steering assembly (port **L**) from which the oil passes out (port **T**) to drain into the tank (3).

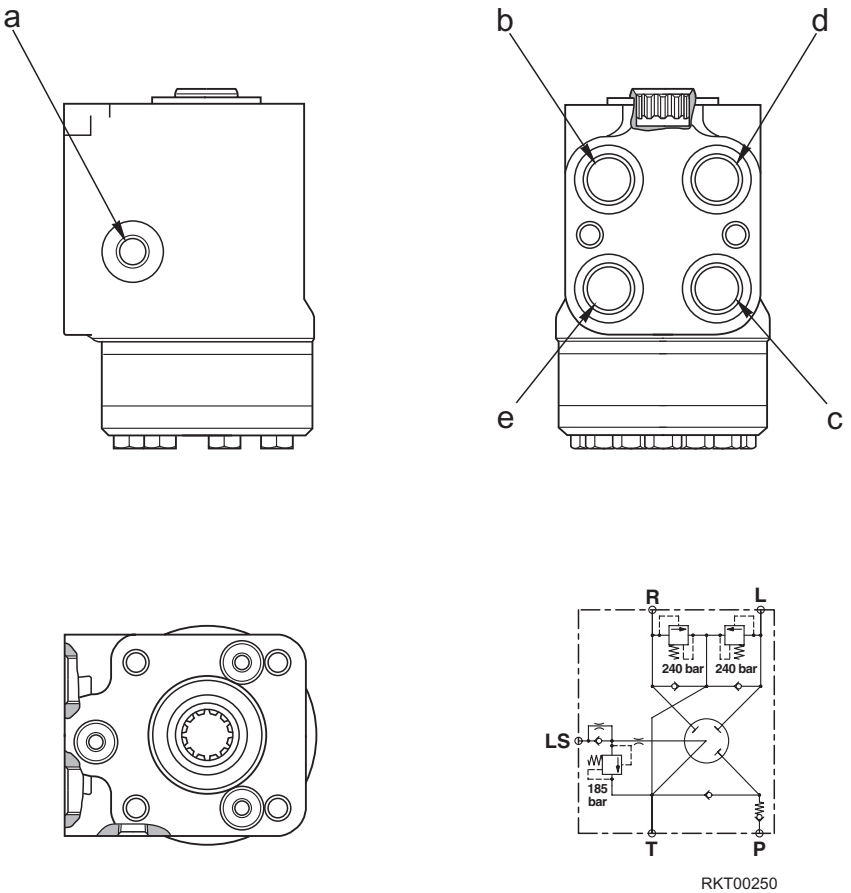
STEERING TO THE LEFT

Turning the steering wheel (7) anti-clockwise causes rotation of the steering metering group (6) and prepares the control valve (port **L**) to send oil (through line **g**) to the solenoid valve group (8) and thence through line **h** to chamber **d** of cylinder (10).

The pressurized oil moves the piston of the cylinder (10) that steers the wheels while simultaneously impelling the oil in chamber **c** (at the same pressure as chamber **d**) through lines **i** and **f** into chamber **b** of steering cylinder (9).

The oil in chamber **a** of cylinder (9) is sent through line **e** to the control valve of the steering assembly (port **R**) from which the oil passes out (port **T**) to drain into the tank (3).

STEERING UNIT



a. Port LS - From control valve (DLS port)
b. Port T - To hydraulic oil tank
c. Port R - To front axle steering cylinder (a Port)
d. Port L - To ST2 solenoid valve group (T Port)
e. Port P - From control valve (D Port)

SPECIFICATIONS

Steering unit type: LAGU 250/125-13LD240
185M40-415S

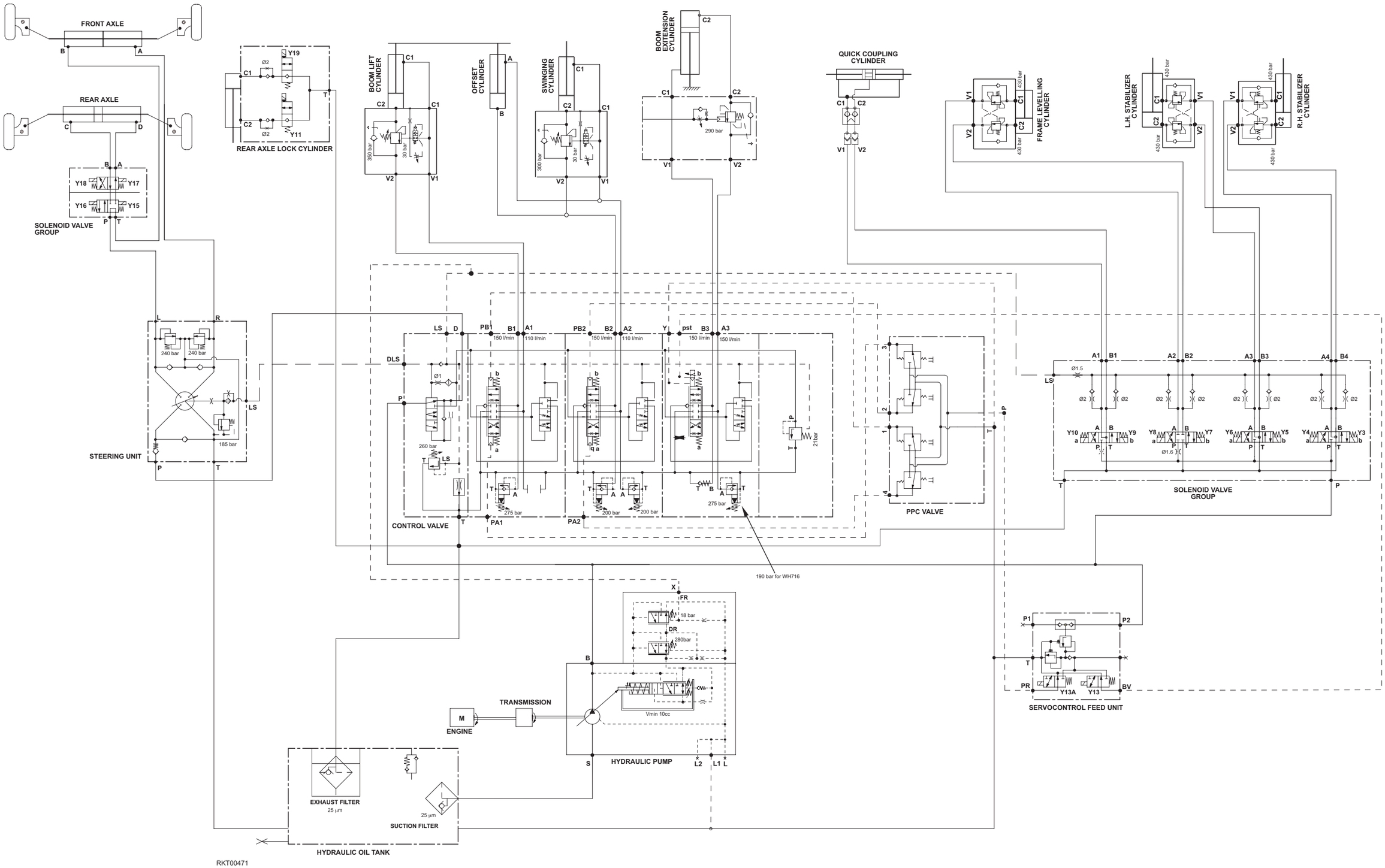
Displacement with servocontrol: 250 cc/rev

Displacement in emergency: 125 cc/rev

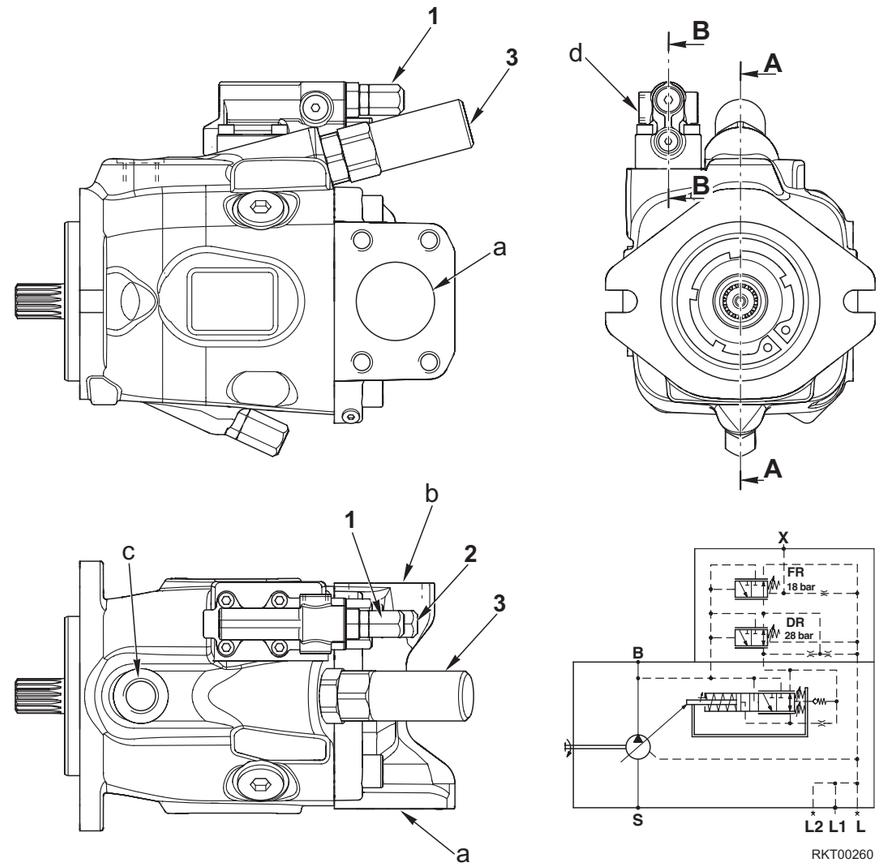
OPERATION

- The steering unit consists of a control valve and a rotating oil dispenser. These units function hydrostatically.
- When the steering wheel is moved, the control valve sends oil from the hydraulic pump (through the rotating oil dispenser) to one or other end of the steering cylinder.
  The rotating oil dispenser ensures that the amount of oil supplied to the cylinder is proportional to the rotation angle of the steering wheel.
- If the steering unit pump malfunctions, the oil dispenser functions automatically like a hand-pump to ensure emergency steering.

HYDRAULIC DIAGRAM

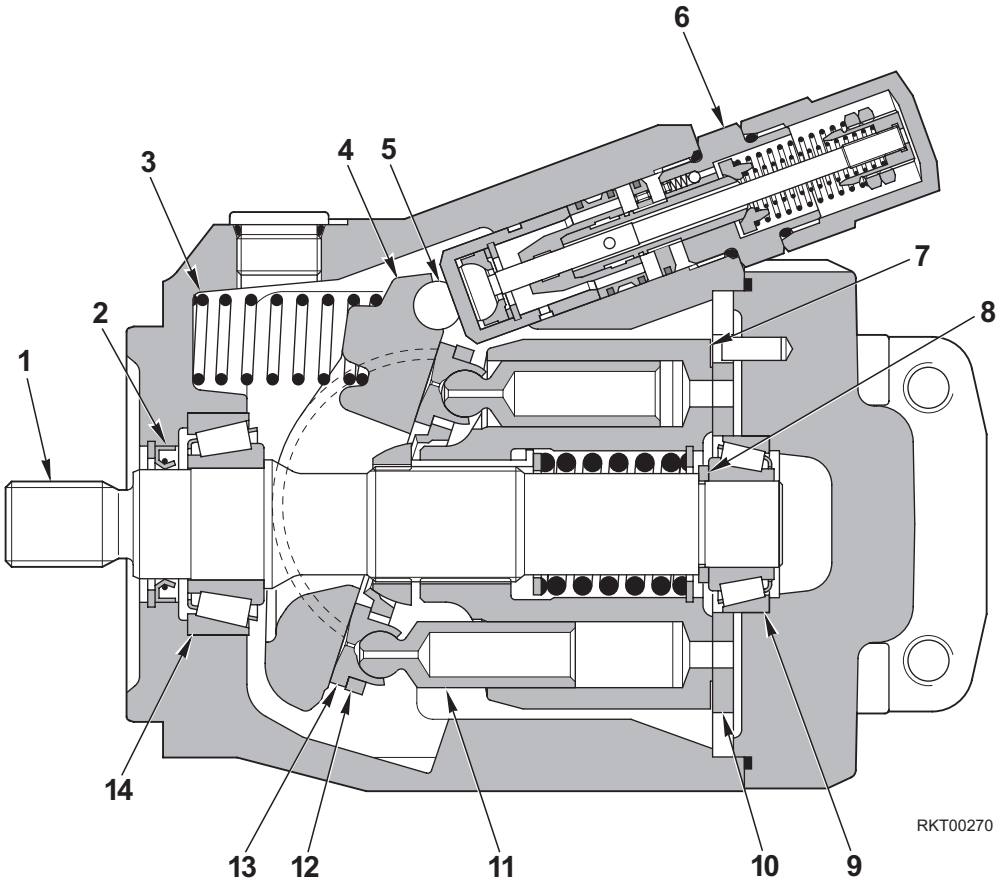


HYDRAULIC PUMP



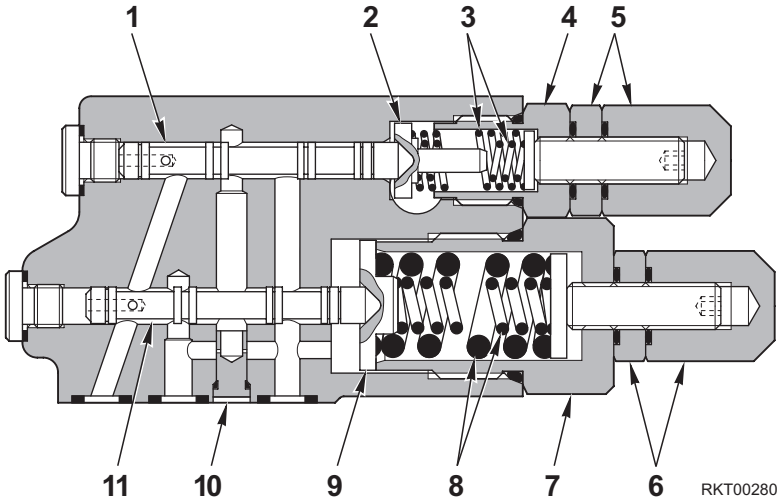
1. LS valve
2. PC valve
3. TVC valves

a. S Port - From hydraulic oil tank
b. B Port - To control valve (P Port)
c. L1 Port - To hydraulic oil tank
d. X Port - To control valve (LS Port)



Section A - A

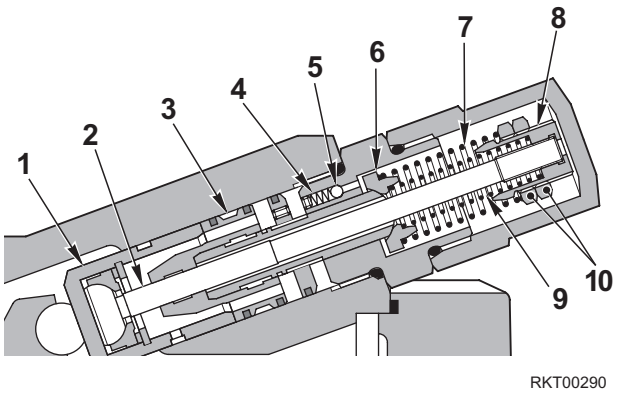
1. Drive shaft
2. Sealing ring
3. Swashplate return spring
4. Swashplate
5. Ball
6. TVC valve
7. Cylinder block
8. Spacer
9. Bearing
10. Valve plate
11. Piston (no. 9)
12. Flexplate
13. Guide shoe
14. Bearing



Section B - B

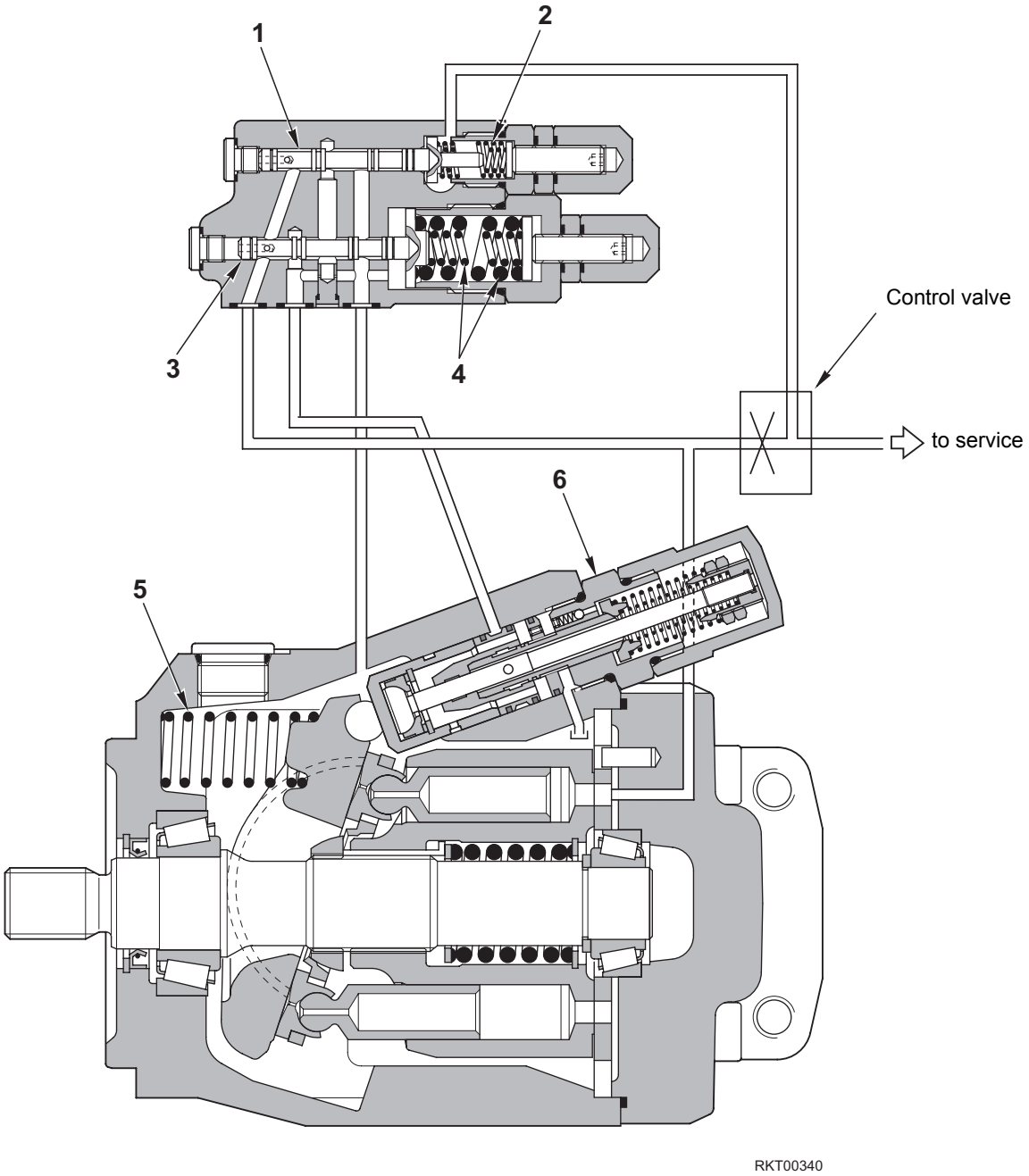
1. Load Sensing valve spool
2. Collar
3. Load Sensing valve springs
4. Spring cover
5. Adjusting nuts
6. Adjusting nuts
7. Spring cover
8. Cut-off valve springs
9. Collar
10. Restrictor
11. Cut-off valve spool

TVC VALVE



1. Piston
2. Stem
3. Bushing
4. Spring
5. Ball
6. Swashplate
7. Spring
8. Calibration screw
9. Spring
10. Adjusting nut

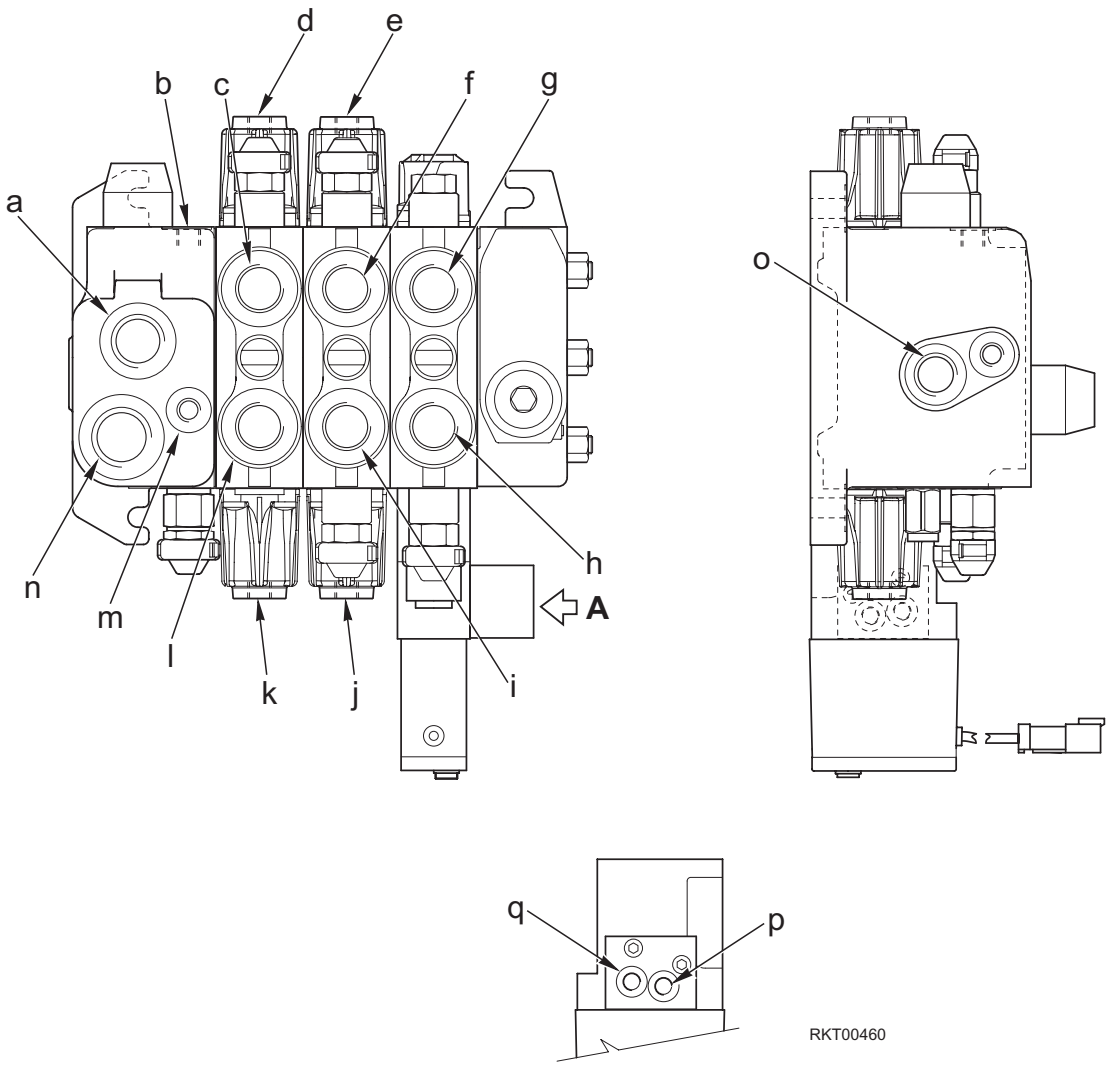
PC VALVE, LS VALVE, POSITIONING PISTON



COMPONENTS

1. LS valve spool
2. LS valve spring
3. PC valve spool
4. PC valve springs
5. Swashplate return spring
6. TVC valve

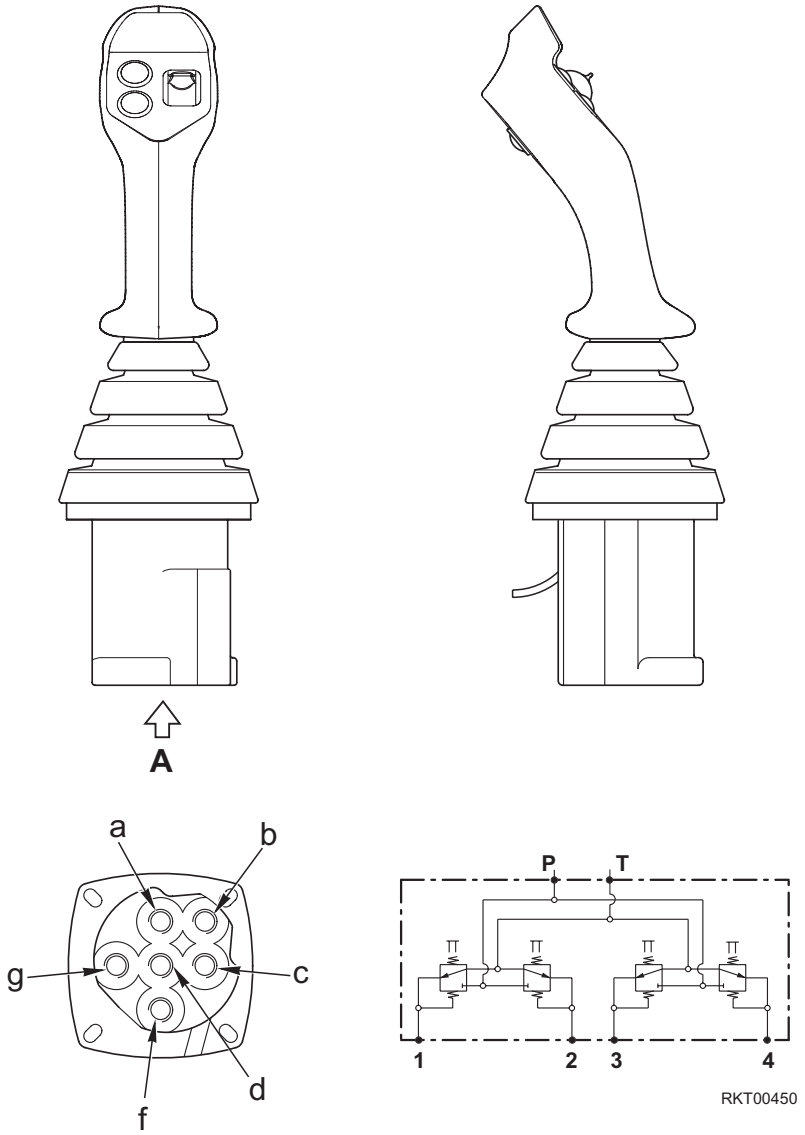
CONTROL VALVE



View "A"

a.	P Port	-	From hydraulic pump (B Port)
b.	DLS Port	-	To steering unit (LS Port)
c.	B1 Port	-	To boom lift cylinder (V2 Port)
d.	PB1 Port	-	From PPC valve (Port 1)
e.	PB2 Port	-	From PPC valve (Port 2)
f.	B2 Port	-	To swing cylinder (V2 Port) and offset cylinder (B Port)
g.	B3 Port	-	To boom extension cylinder (V1 Port)
h.	A3 Port	-	To boom extension cylinder (V2 Port)
i.	A2 Port	-	To swing cylinder (V1 Port) and offset cylinder (A Port)
j.	PA2 Port	-	From PPC valve (Port 4)
k.	PA1 Port	-	From PPC valve (Port 3)
l.	A1 Port	-	From boom lift cylinder (V1 Port)
m.	LS Port	-	From hydraulic pump (X Port)
n.	T Port	-	To hydraulic oil tank
o.	D Port	-	To steering unit (P Port)
p.	PST Port	-	From supply unity (BV Port)
q.	Y Port	-	To hydraulic oil tank

PPC VALVE



View "A"

a. 1 Port - To control valve (PB1 Port)
b. T Port - To hydraulic oil tank
c. 4 Port - To control valve (PA2 Port)
d. P Port - From supply unity (PR Port)
f. 3 Port - To control valve (PA1 Port)
g. 2 Port - To control valve (PB2 Port)

OPERATION OF THE PPC VALVES

1. Control lever in neutral position

Ports **A** and **B** of the control valve and lines **P1** and **P2** of the PPC valve are connected to drain chamber **D** through fine control hole **f** in stem (1). (Fig. 1 1).

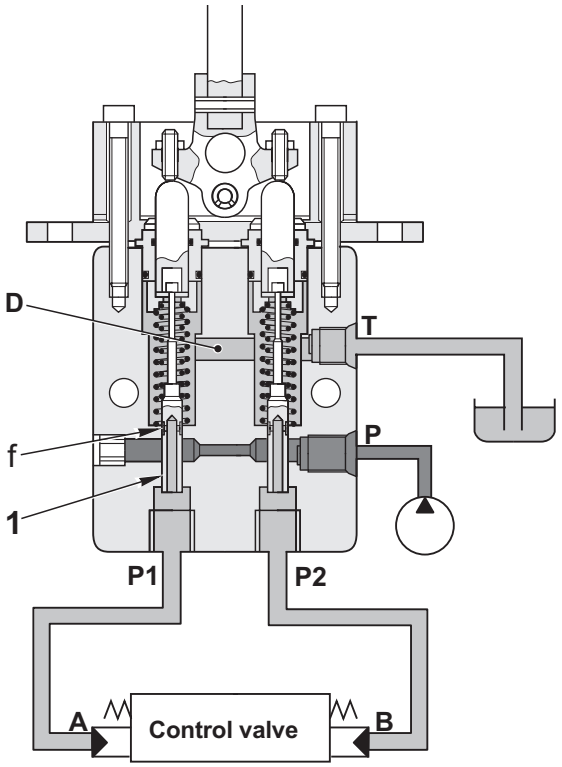


Fig. 1 RKT01101

2. Control lever moved to partial stroke (NEUTRAL to operation)

When push rod (4) starts to be pushed downwards by lever (5), retainer (7) is pushed; stem (1) is also pushed by the spring (2), and moves down.
When this happens, fine control hole **f** is shut off from drain chamber **D**, and at almost the same time, it is connected to pump pressure chamber **PP**, which is directly linked to the servocontrol circuit.
Servocontrol circuit pressure passes through fine control hole **f,** into the circuit and increases pressure in line **P1-A**.
When pressure at **P1** becomes higher, stem (1) is pushed upwards and fine control hole **f** is re-connected to chamber **D**, compressing spring (2).
The position of the stem (1) keeps changing until the fine control hole **f** is at a point between drain chamber **D** and pressure chamber **PP**, i.e. until pressure in line **P1** impacting the stem portion (1) counterbalances the force applied by the spring (2).
The spring (2) is compressed proportionally to the amount of movement of the lever (5), so the pressure at **P1** also rises in proportion to the travel of the lever (5).
The balanced position remains until the position of the push rod (4) changes, i.e.:

a) until pressures at **A** and **P1** ports are perfectly balanced;
b) pressure in the **A-P1 '**arm' impacting the stem (1) reaches the value required to counter the force of the spring (2).

This way the proportionality between travel of the control lever, pressure in the **A-P1** circuit, and displacement of the main control valve stem is guaranteed (Fig. 2).

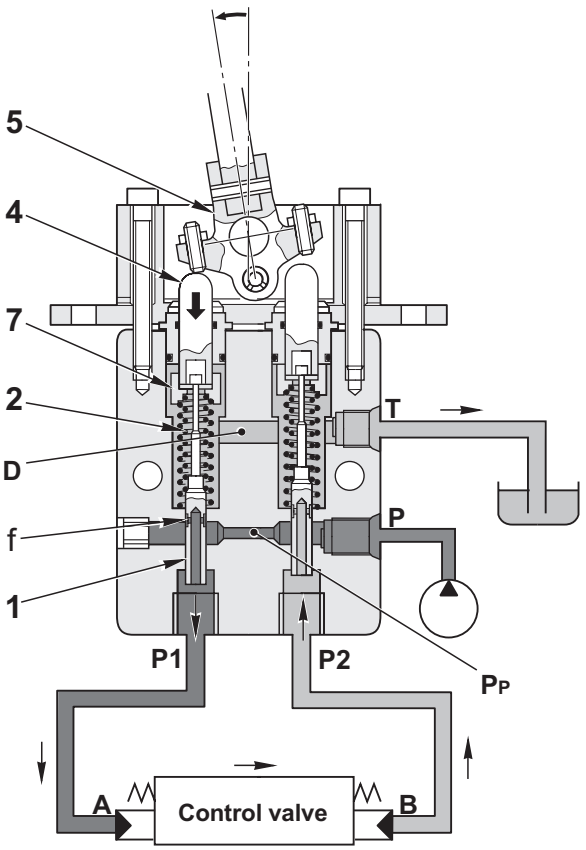


Fig. 2 RKT01111

3. Control lever returned to neutral position (Operation to NEUTRAL)

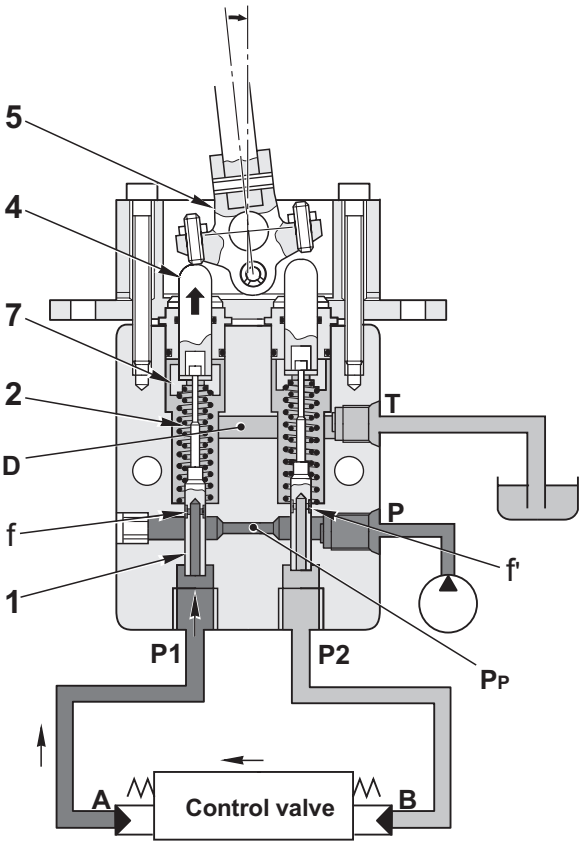
When control lever (5) is released and returned to neutral position, push rod (4) is pushed up by spring (3) which operates the retainer (7), and stem (1) is pushed up by both the force of the spring (2) and the force applied to the stem by pressure in the **A-P1** 'arm'.

When this happens, fine control hole **f** of stem (1) is connected to drain chamber **D** thus allowing pressure in **A-P1** to be released.

If the pressure at **P1** drops too quickly, stem (1) is pushed down by spring (2), and fine control hole **f** is shut off from drain chamber **D**. At almost the same time, fine control hole **f** is connected to pump pressure chamber **PP**, and the pump pressure is supplied to **P1** 'arm' until the pressure at Port P1 recovers to a pressure that corresponds to the lever position.

When the spool of the control valve returns, oil returns to chamber **D** and flows from fine control hole **f'** into chamber **B** of the control valve spool that is not working.

The oil passes through Port **P2** and enters chamber **B** to fill the chamber with oil. (Fig. 3).



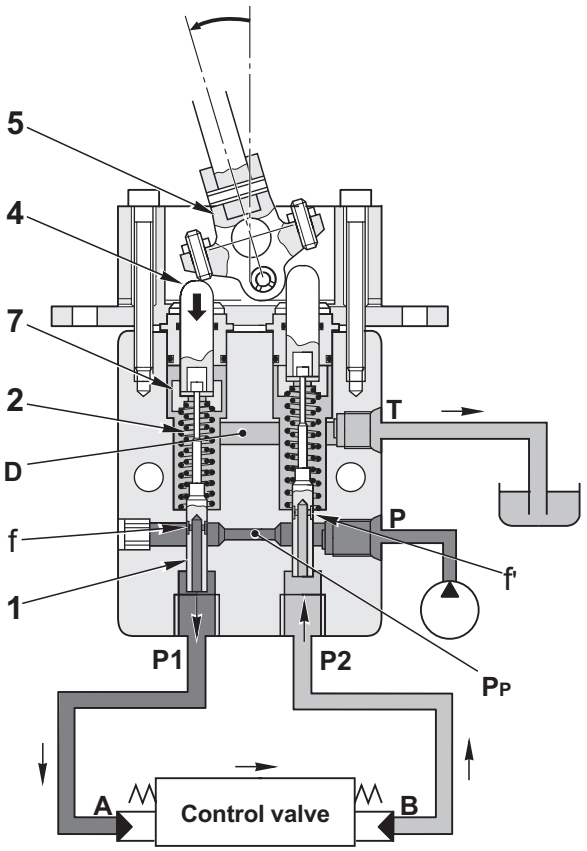
RKT01121

Fig. 3

4. Control lever at full stroke (NEUTRAL to full stroke)

When lever (5) pushes down push rod (4), and retainer (7) pushes down stem (1), fine control hole **f** is connected to pump pressure chamber **PP** which is connected with a constantly pressurized servocontrol circuit.

Therefore, the oil flows directly to the **A-P1** 'arm', and pushes the main control valve stem to the end of its stroke. In turn, the stem sends the oil in chamber **B** towards **P2** input and through fine control hole **f'** into drain chamber **D**. (Fig. 4).

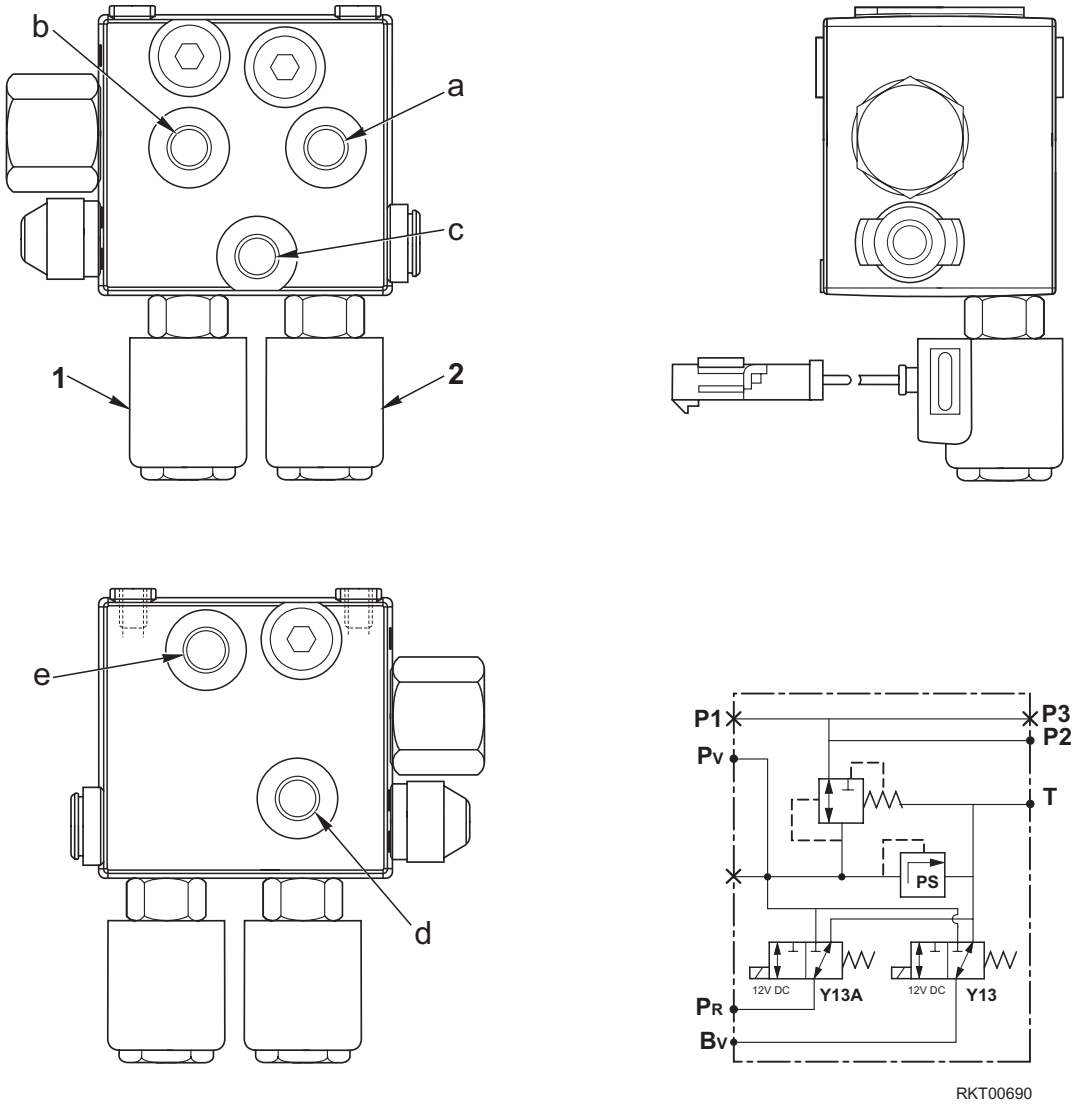


RKT01131

Fig. 4

SOLENOID VALVES

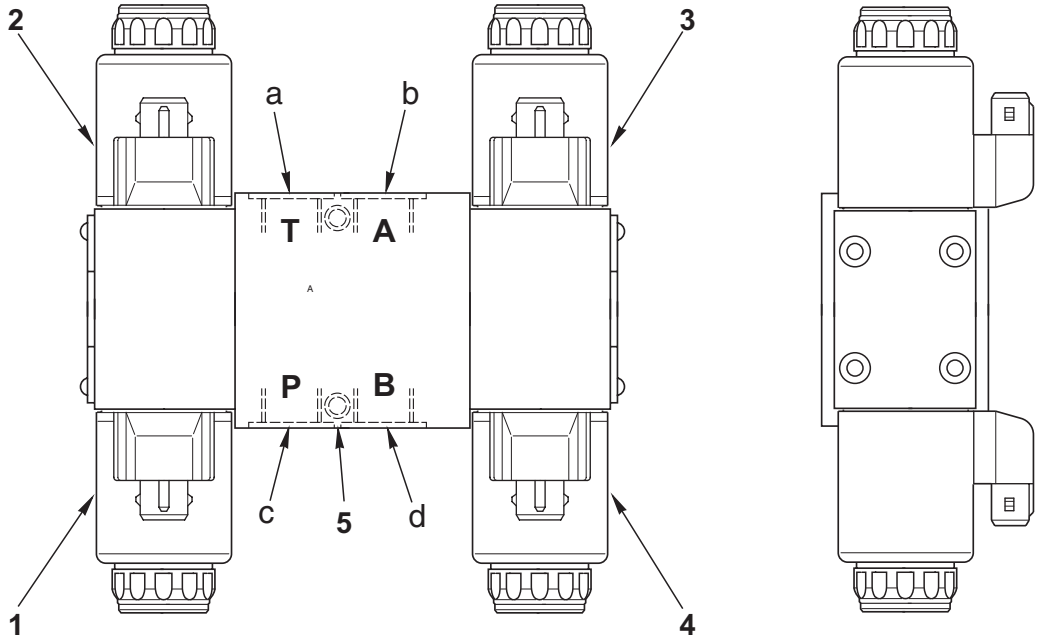
SERVOCONTROL SUPPLY UNIT



2. Y13 - Extension/retraction control supply solenoid valve
1. Y13A - PPC supply solenoid valve

a. PR Port - To PPC valve (P Port)
b. BV Port - To control valve (PST Port)
c. PV Port - Not used
d. T Port - To hydraulic oil tank
e. PZ Port - From hydraulic pump (B Port)

ST1 STEERING SOLENOID VALVE GROUP (Y15 - Y16 - Y17 - Y18)

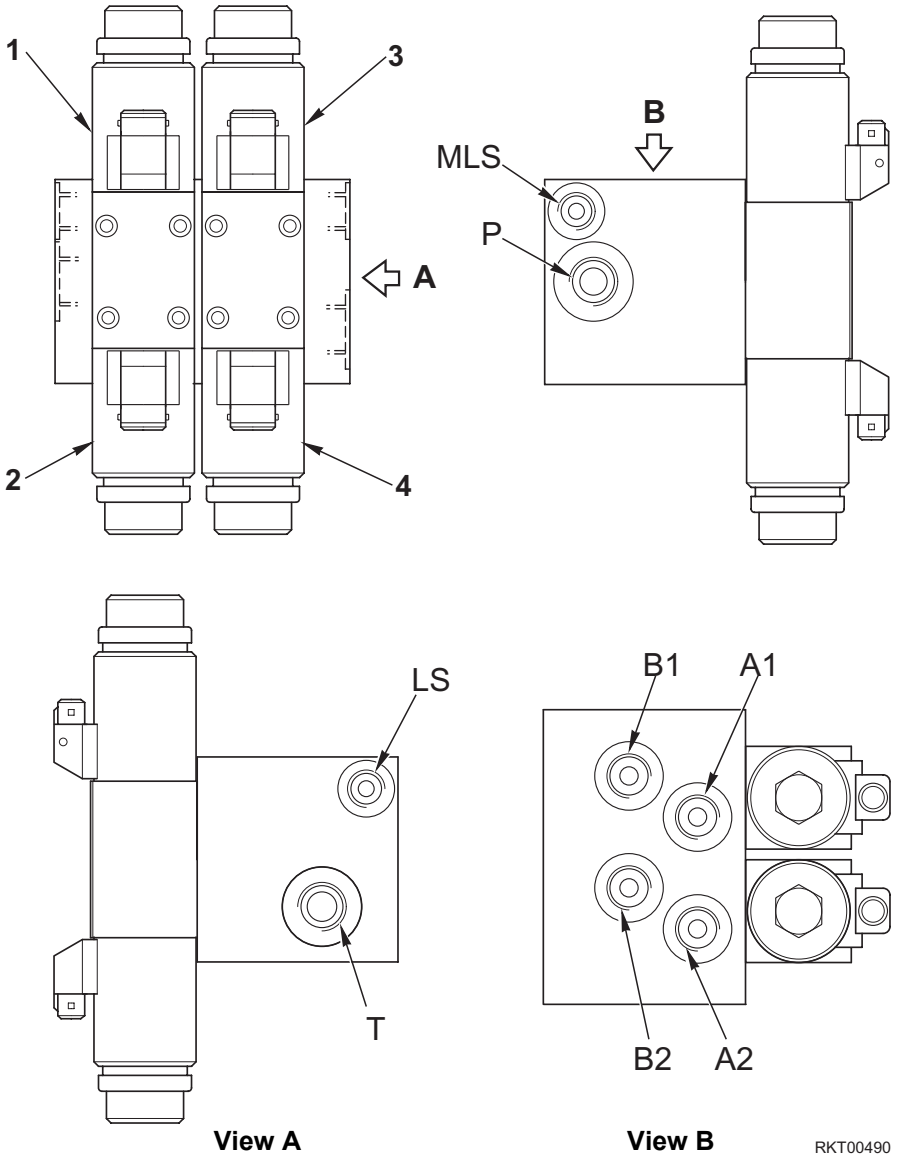


RKT00480

1. Y15 - Rear steering cut out
2. Y16 - Front/rear steering
3. Y17 - Phase coincidence steering
4. Y18 - Crab steering
5. Port block

a. T Port - To front axle steering cylinder (B Port)
b. A Port - To rear axle steering cylinder (D Port)
c. P Port - From steering unit (L Port)
d. B Port - To rear axle steering cylinder (C Port)

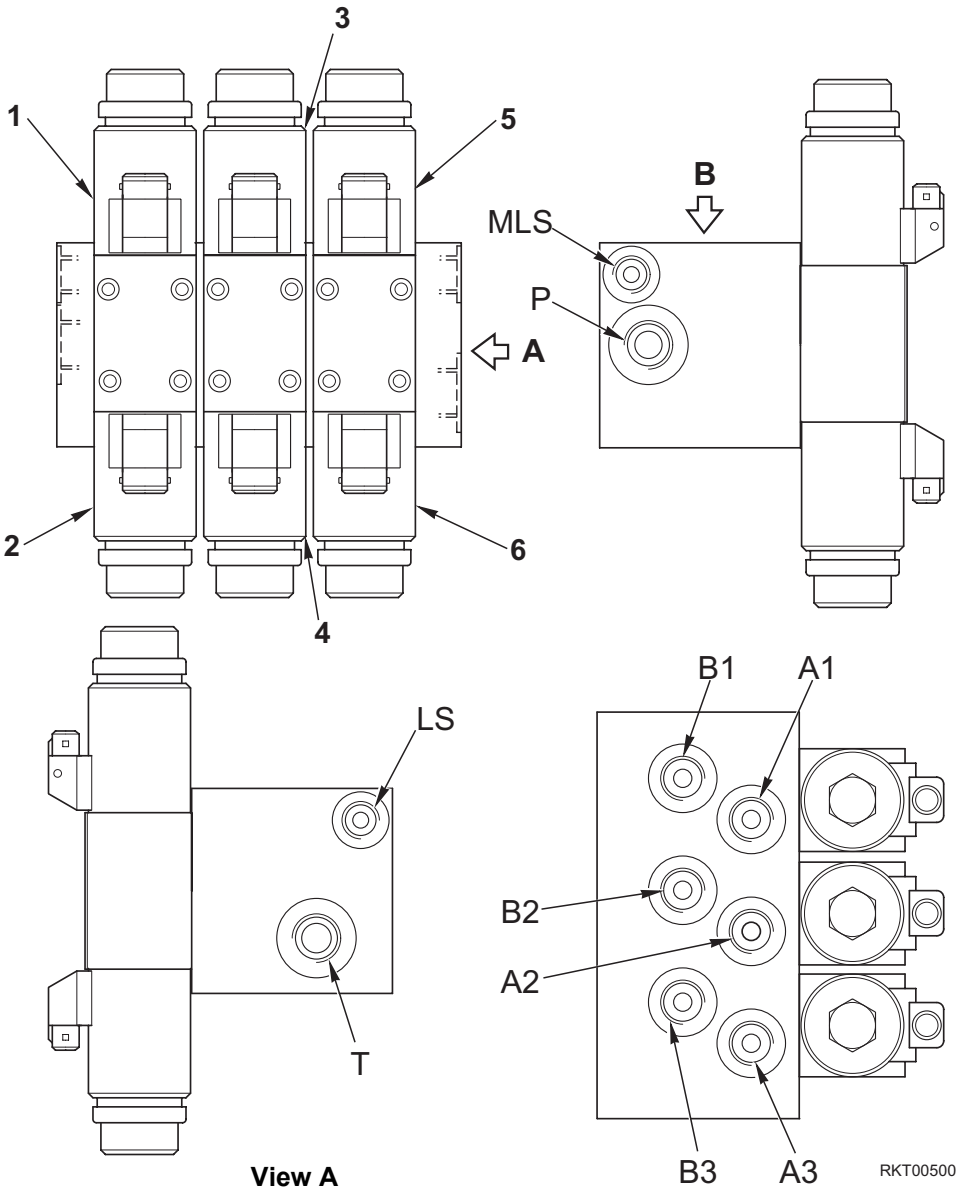
FRAME LEVELLING AND OP2 QUICK COUPLING SOLENOID VALVE GROUP (Y7 - Y8 - Y9 - Y10)



1. Y7 - Left frame rotation solenoid valve
2. Y8 - Right frame rotation solenoid valve
3. Y9 - Quick-coupling solenoid valve
4. Y10 - Quick coupling solenoid valve

MLS Port - not used
P Port - From hydraulic pump (B Port)
A2 Port - To frame levelling cylinder (V1 Port)
B2 Port - To frame levelling cylinder (V2 Port)
A1 Port - To quick coupling cylinder (V1 Port)
B1 Port - To quick coupling cylinder (V2 Port)
LS Port - From hydraulic pump (X Port)
T Port - To hydraulic oil tank

STABILIZER AND OP3 QUICK COUPLING SOLENOID VALVE GROUP (Y3 - Y4 - Y5 - Y6 - Y9 - Y10)



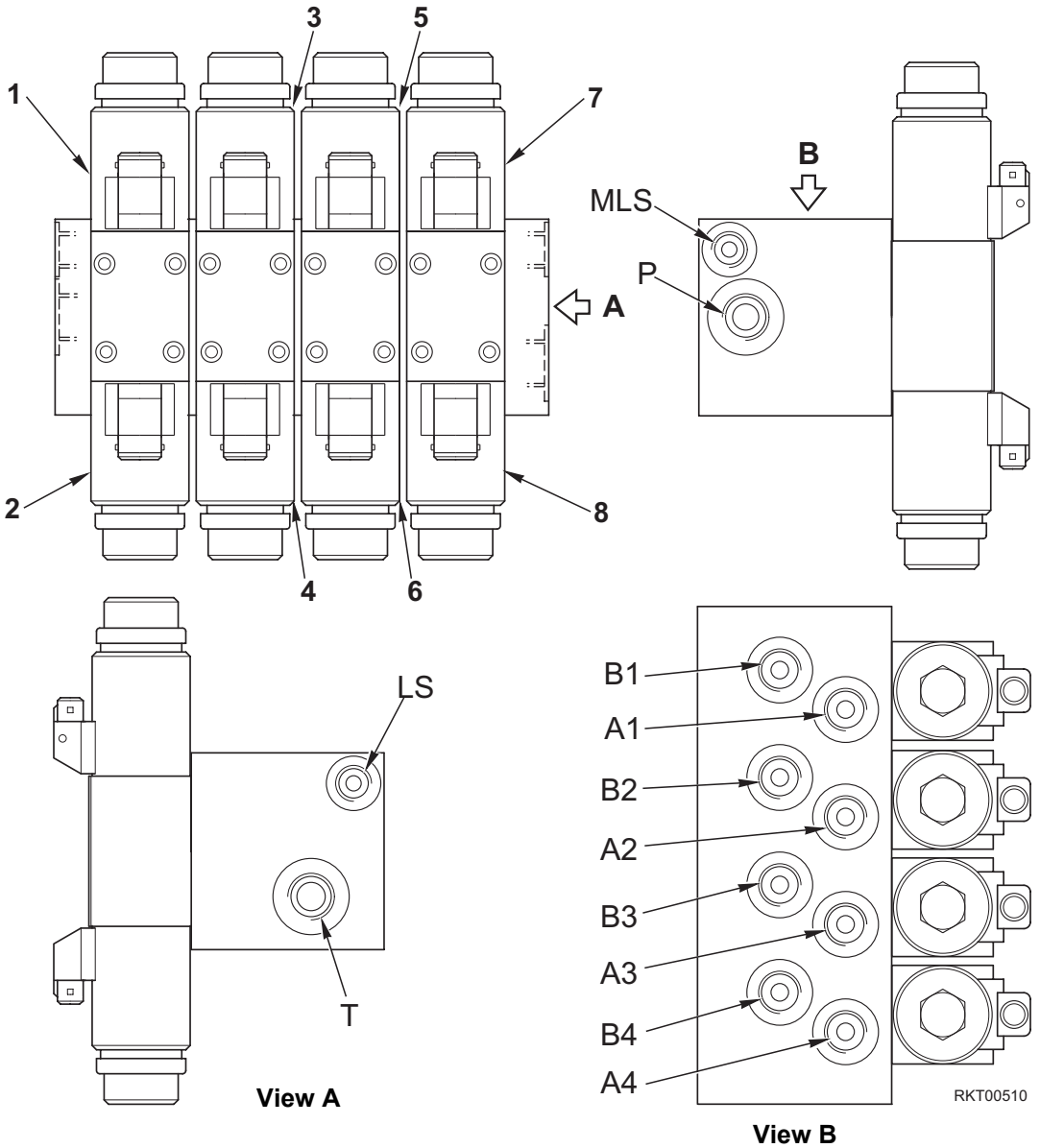
View A

View B

1. Y3 - RH stabilizer up solenoid valve
2. Y4 - RH stabilizer down solenoid valve
3. Y5 - LH stabilizer up solenoid valve
4. Y6 - LH stabilizer down solenoid valve
5. Y9 - Quick coupling solenoid valve
6. Y10 - Quick coupling solenoid valve

MLS Port - not used
P Port - From hydraulic pump (B Port)
A3 Port - To RH stabilizer cylinder (V1 Port)
B3 Port - To RH stabilizer cylinder (V2 Port)
A2 Port - To LH stabilizer cylinder (V1 Port)
B2 Port - To LH stabilizer cylinder (V2 Port)
A1 Port - To quick coupling cylinder (V1 Port)
B1 Port - To quick coupling cylinder (V2 Port)
LS Port - From hydraulic pump (X Port)
T Port - To hydraulic oil tank

FRAME LEVELLING, STABILIZER, AND ST4 QUICK COUPLING SOLENOID VALVE GROUP (Y3 - Y4 - Y5 - Y6 - Y7 - Y8 - Y9 - Y10)

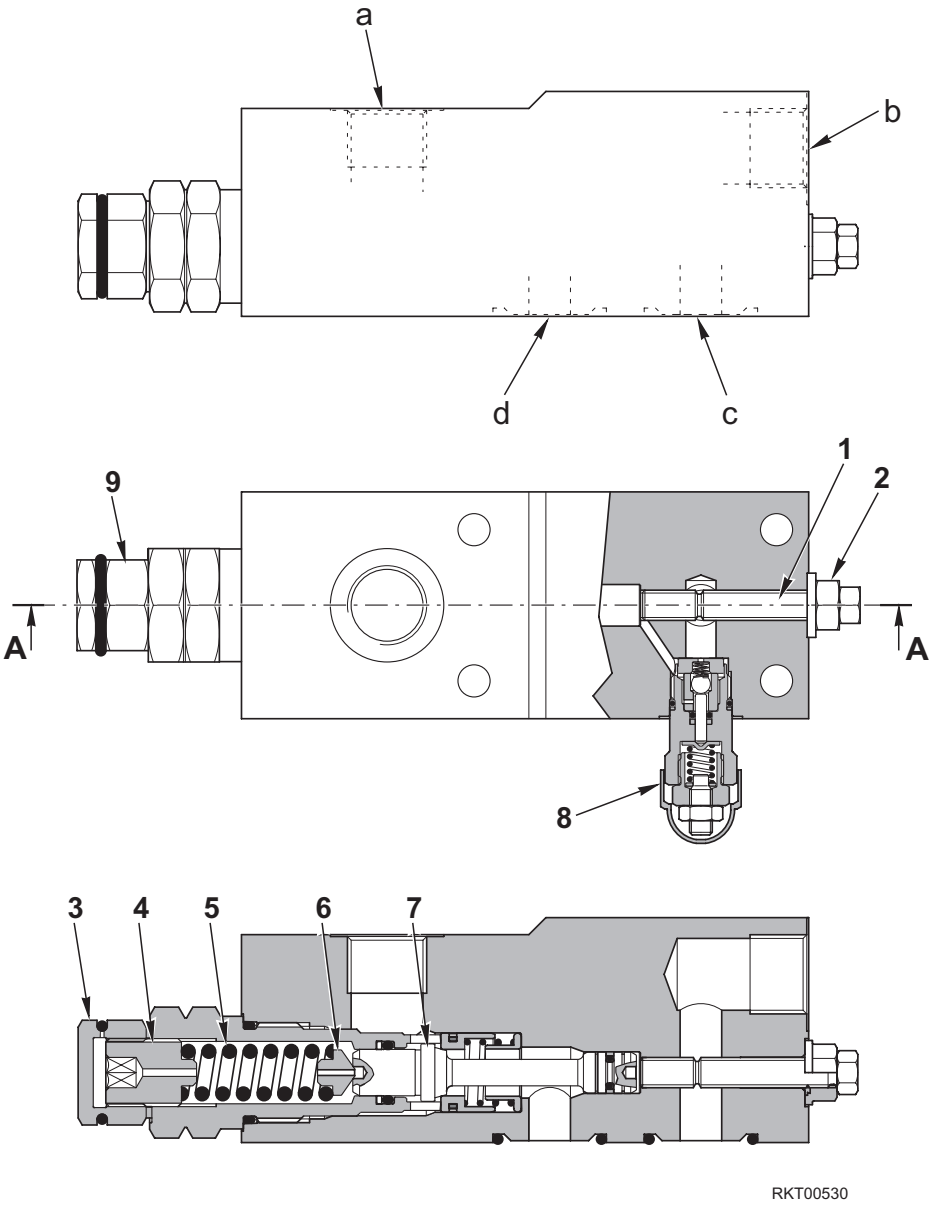


1. Y3 - RH stabilizer up solenoid valve
2. Y4 - RH stabilizer down solenoid valve
3. Y5 - LH stabilizer up solenoid valve
4. Y6 - LH stabilizer down solenoid valve
5. Y7 - Left frame rotation solenoid valve
6. Y8 - Right frame rotation solenoid valve
7. Y9 - Boom equipment solenoid valve
8. Y10 - Boom equipment solenoid valve

MLS Port - not used
P Port - From hydraulic pump (B Port)
A4 Port - To RH stabilizer cylinder (V1 Port)
B4 Port - To RH stabilizer cylinder (V2 Port)
A3 Port - To LH stabilizer cylinder (V1 Port)
B3 Port - To LH stabilizer cylinder (V2 Port)
A2 Port - To frame levelling cylinder (V1 Port)
B2 Port - To frame levelling cylinder (V2 Port)
A1 Port - To quick coupling cylinder (V1 Port)
B1 Port - To quick coupling cylinder (V2 Port)
LS Port - From hydraulic pump (X Port)
T Port - To hydraulic oil tank

SAFETY VALVES

BOOM LIFT



Section A - A

1. Release screw
2. Nut
3. Nut
4. Adjusting screw
5. Spring
6. Valve
7. Spool
8. Control safety valve
9. Safety valve

a. V2 Port - From control valve (B1 Port)
b. V1 Port - From control valve (A1 Port)
c. C1 Port - To boom lift cylinder (head side)
d. C2 Port - To boom lift cylinder (base side)

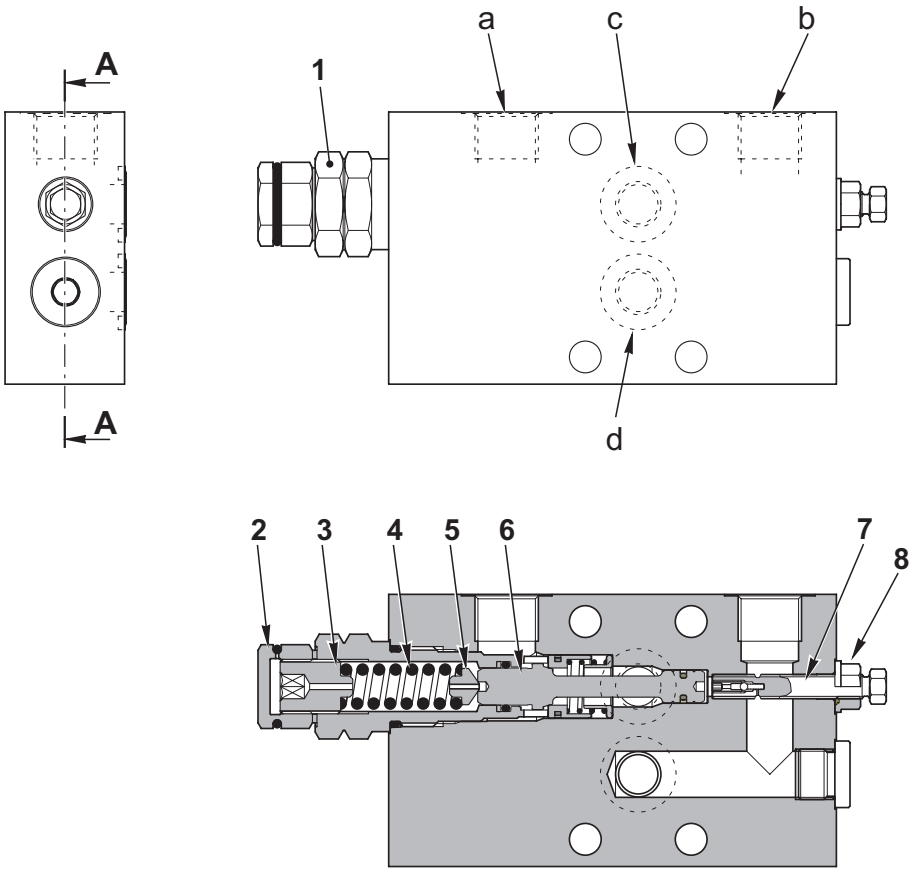
CHARACTERISTICS

Control ratio: 4:1

Control safety valve calibration: 30 bar

Safety valve calibration: 350 bar

BOOM EXTENSION



Section A - A

RKT00540

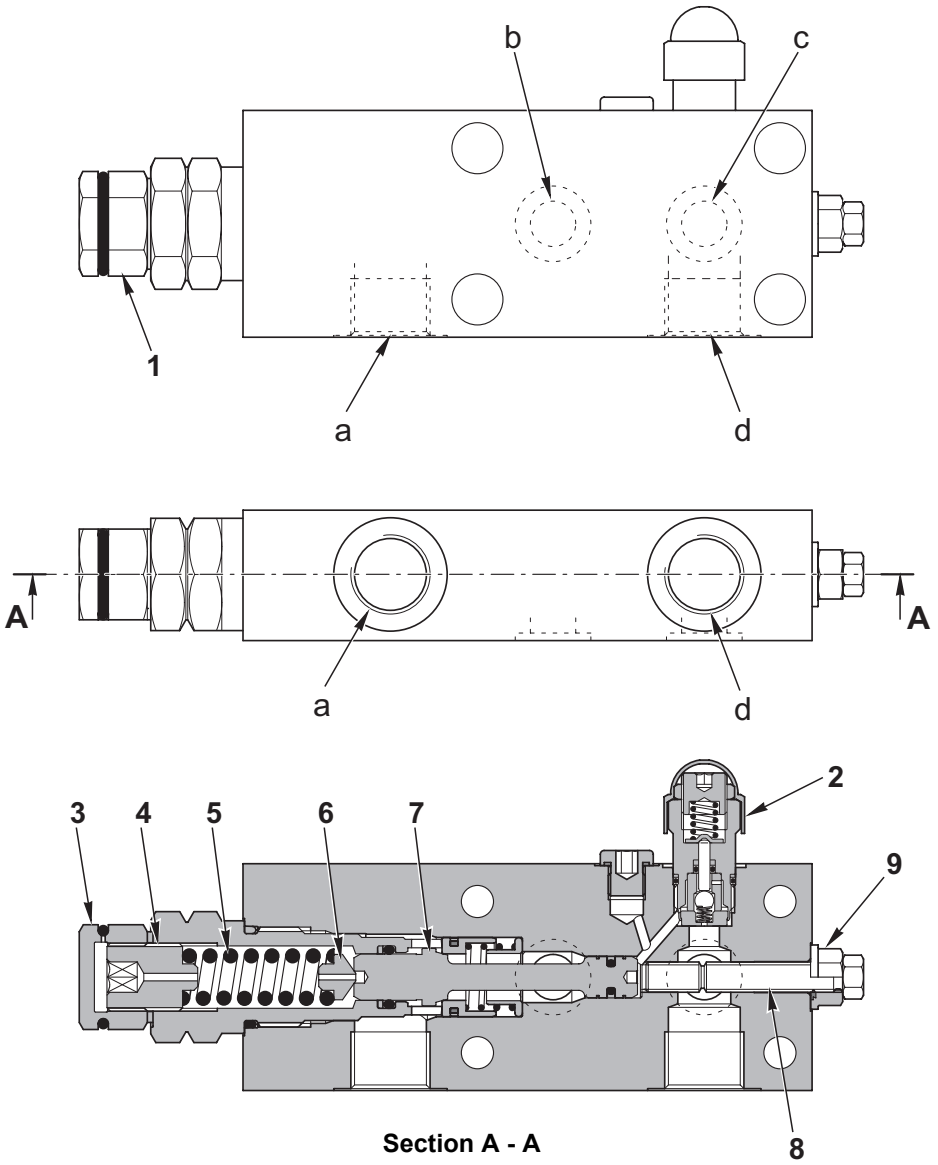
1. Safety valve
2. Nut
3. Adjusting screw
4. Spring
5. Valve
6. Spool
7. Release screw
8. Nut

a. V2 Port - From control valve (A3 Port)
b. V1 Port - From control valve (B3 Port)
c. C2 Port - To extension cylinder (base side)
d. C1 Port - To extension cylinder (head side)

CHARACTERISTICS

Safety valve calibration: 290 bar

SWINGING



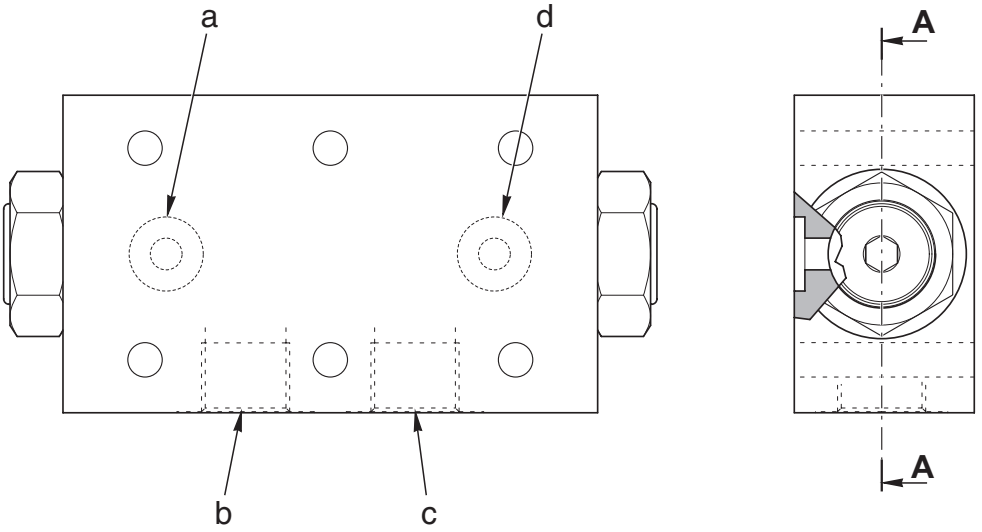
1. Safety valve
2. Control safety valve
3. Nut
4. Adjusting screw
5. Spring
6. Valve
7. Spool
8. Release screw
9. Nut

a. V2 Port - From control valve (B2 Port)
b. C2 Port - To swing cylinder (base side)
c. C1 Port - Al cilindro brandeggio (lato testa)
d. V1 Port - To control valve (A2 Port)

CHARACTERISTICS

Safety valve calibration: 300 bar
Control safety valve calibration: 30 bar
Control ratio: 4:1

QUICK COUPLING



Section A - A

RKT00550

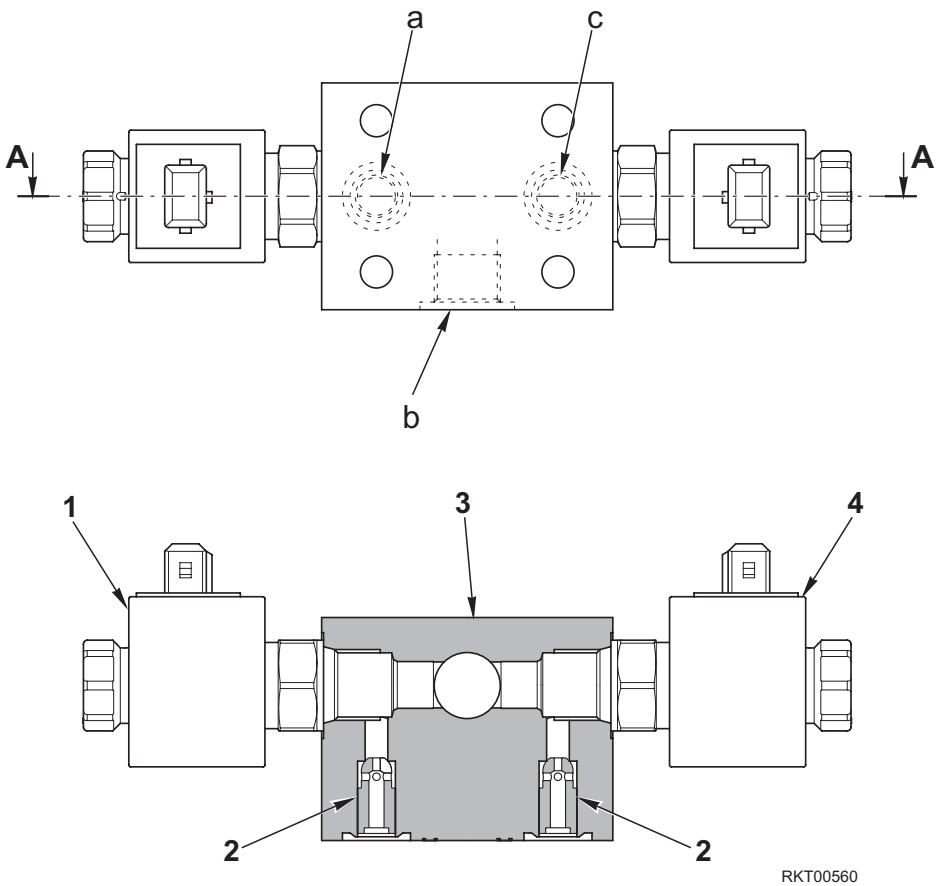
1. Spring
2. Valve
3. Spool

a. C1 Port - To quick coupling cylinder (head side)
b. V2 Port - From solenoid valve group OP2 - OP3 - OP4 (B1 Port)
c. V1 Port - From solenoid valve group OP2 - OP3 - OP4 (A1 Port)
d. C2 Port - To quick coupling cylinder (base side)

CHARACTERISTICS

Safety valve calibration: 350 bar
Control ratio: 7:1

REAR AXLE LOCKING

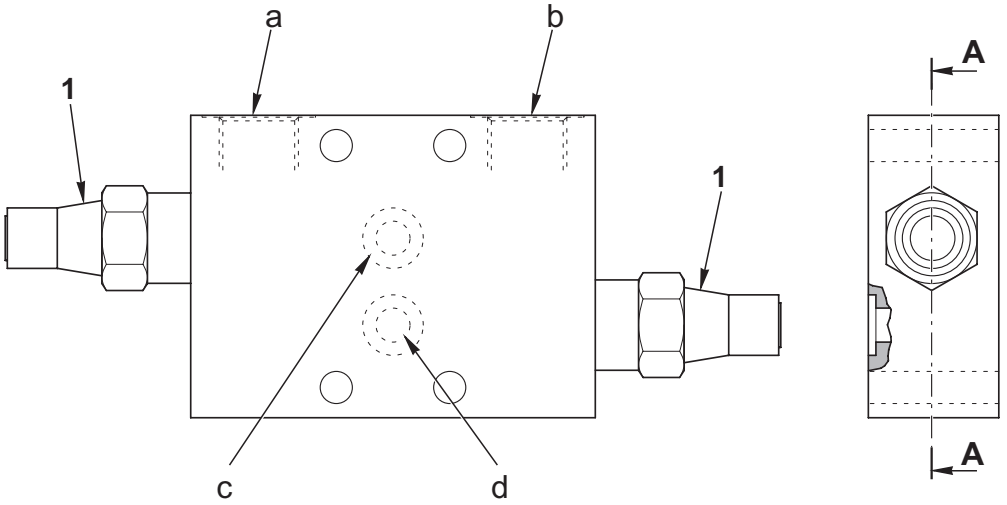


Section A - A

1. Y11 solenoid valve
2. Piston
3. Block
4. Y19 solenoid valve

a. C2 Port - To rear axle locking cylinder (head side)
b. T Port - To hydraulic oil tank
c. C1 Port - To rear axle locking cylinder (base side)

FRAME LEVELLING



Section A - A

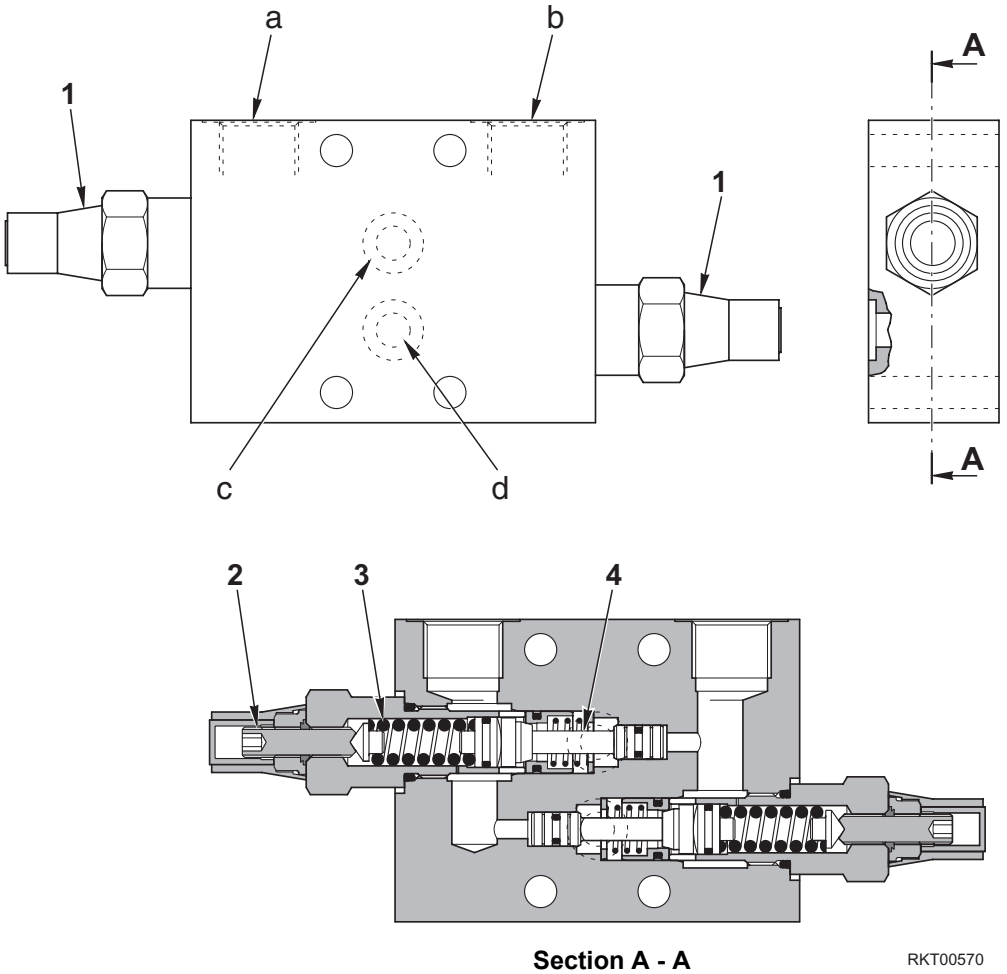
1. Safety valve
2. Adjusting screws
3. Spring
4. Valve

a. V2 Port - From OP2 OP4 solenoid valve group (B2 Port)
b. V1 Port - From OP2 OP4 solenoid valve group (A2 Port)
c. C2 Port - To frame levelling cylinder (base side)
d. C1Port - To frame levelling cylinder (head side)

CHARACTERISTICS

Safety valve calibration: 430 bar

STABILIZERSI



Section A - A RKT00570

1. Safety valve
2. Adjusting screw
3. Spring
4. Valve

a. Port V2 - V2 Port-From OP3 solenoid valve group (B2 Port) (B3 Port)
From OP4 solenoid valve group (B3 Port) (B4 Port)

b. V1 Port - From OP3 solenoid valve group (A2 Port) (A3 Port)
From OP4 solenoid valve group (A3 Port) (A4 Port)

c. C2 Port - To stabilizer cylinder (base side)

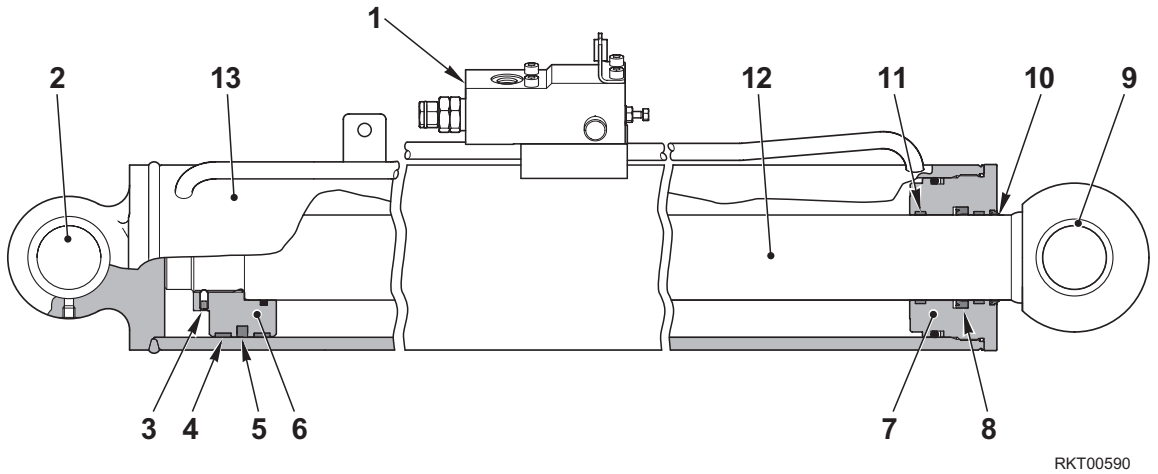
d. C1 Port - To stabilizer cylinder (head side)

CHARACTERISTICS

Safety valve calibration: 430 bar

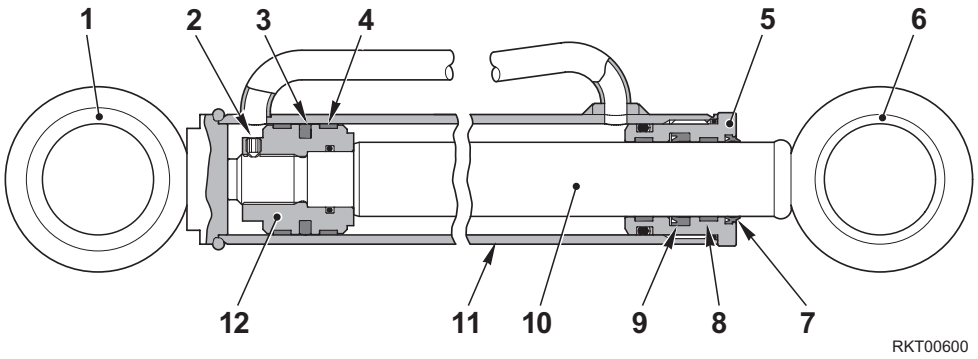
CYLINDERS

BOOM LIFT



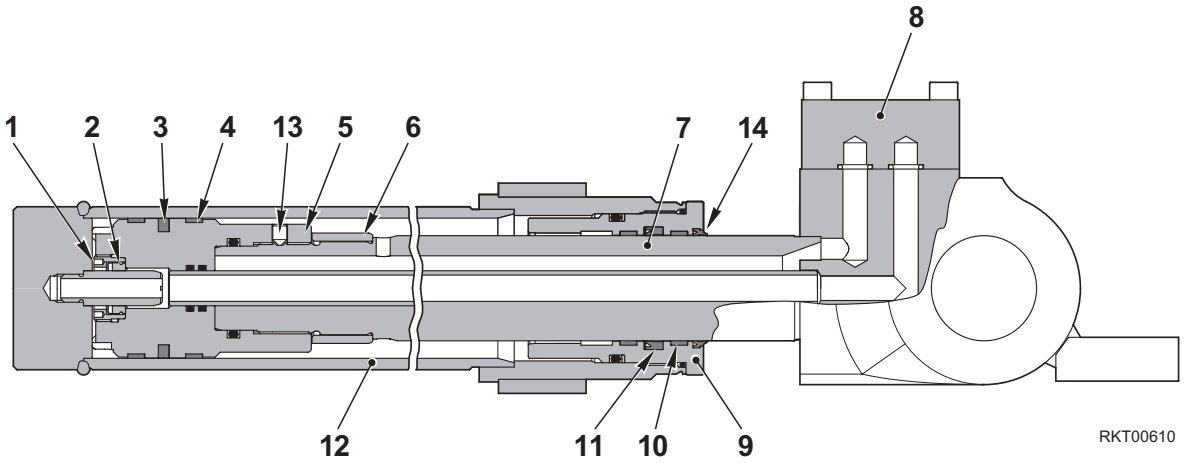
1. Safety valve
2. Bushing base side
3. Dowel
4. Guide ring
5. Piston seal
6. Piston
7. Cylinder head
8. Cylinder head gasket
9. Bushing head side
10. Scraper
11. Guide ring
12. Stem
13. Cylinder

OFFSET



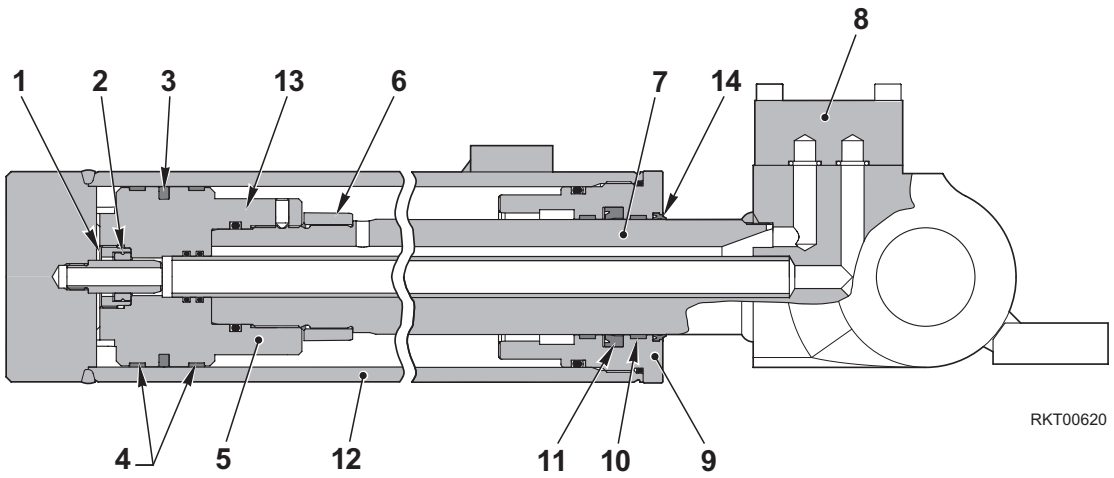
1. Bushing base side
2. Dowel
3. Piston seal
4. Guide ring
5. Cylinder head
6. Bushing head side
7. Scraper
8. Guide ring
9. Cylinder head gasket
10. Stem
11. Cylinder
12. Piston

BOOM EXTENSION (WH609)



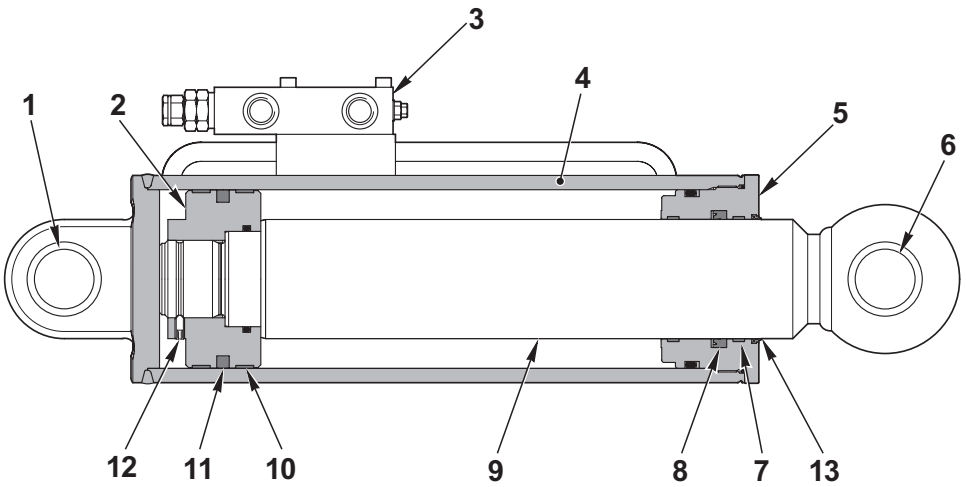
1. Ring
2. Ring
3. Piston seal
4. Guide ring
5. Piston
6. Spacer
7. Stem
8. Safety valve
9. Cylinder head
10. Guide ring
11. Cylinder head gasket
12. Cylinder
13. Dowel
14. Scraper

BOOM EXTENSION (WH613 - WH713 - WH714 - WH714H - WH716)



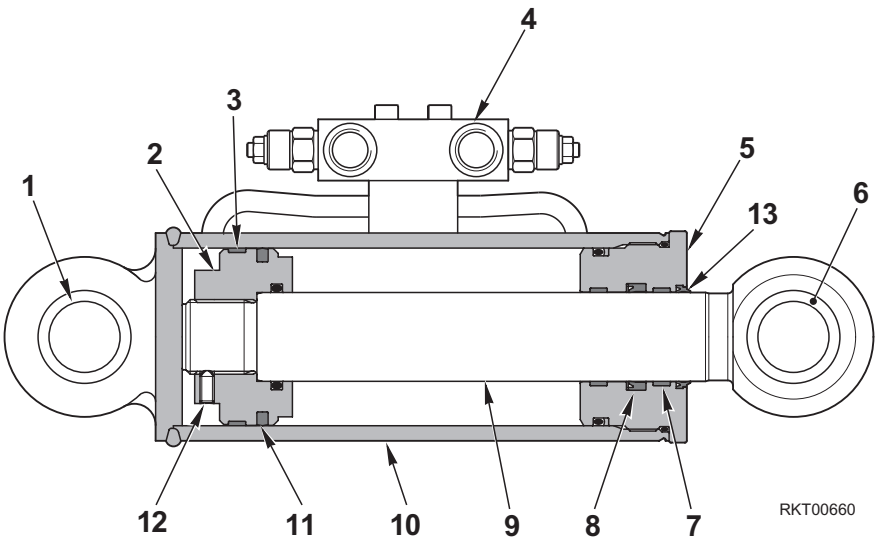
1. Ring
2. Ring
3. Piston seal
4. Guide ring
5. Piston
6. Spacer
7. Stem
8. Safety valve
9. Cylinder head
10. Guide ring
11. Cylinder head gasket
12. Cylinder
13. Dowel
14. Scraper

SWINGING



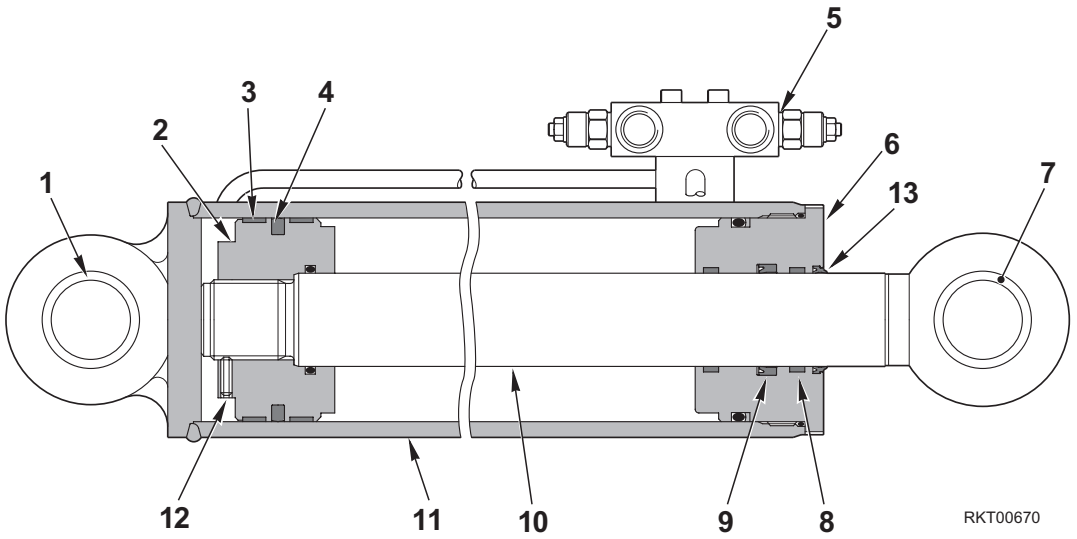
1. Bushing base side
2. Piston
3. Safety valve
4. Cylinder
5. Cylinder head
6. Bushing stem side
7. Guide ring
8. Cylinder head gasket
9. Stem
10. Guide ring
11. Piston seal
12. Dowel
13. Scraper

FRAME LEVELLING



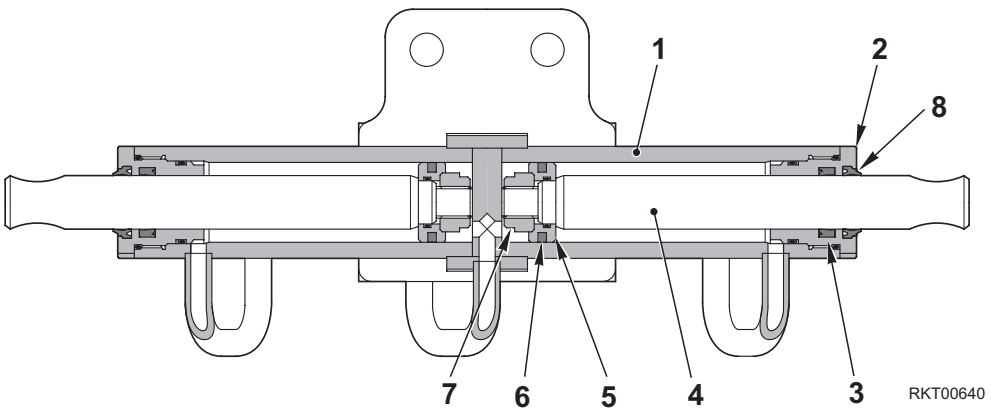
1. Bushing base side
2. Piston
3. Guide ring
4. Safety valve
5. Cylinder head
6. Bushing head side
7. Guide ring
8. Cylinder head gasket
9. Stem
10. Cylinder
11. Piston seal
12. Dowel
13. Scraper

STABILIZERSI



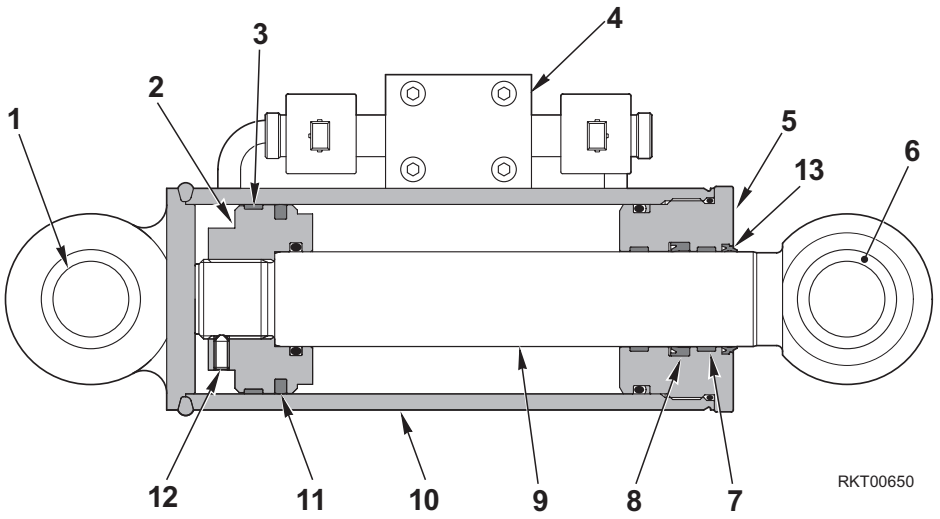
1. Bushing base side
2. Piston
3. Guide ring
4. Piston seal
5. Safety valve
6. Cylinder head
7. Bushing stem side
8. Guide ring
9. Cylinder head gasket
10. Stem
11. Cylinder
12. Dowel
13. Scraper

QUICK COUPLING



1. Cylinder
2. Cylinder head
3. Cylinder head gasket
4. Stem
5. Piston
6. Piston seal
7. Nut
8. Scraper

REAR AXLE LOCKING (WH613 - WH713 - WH714 - WH714H - WH716)



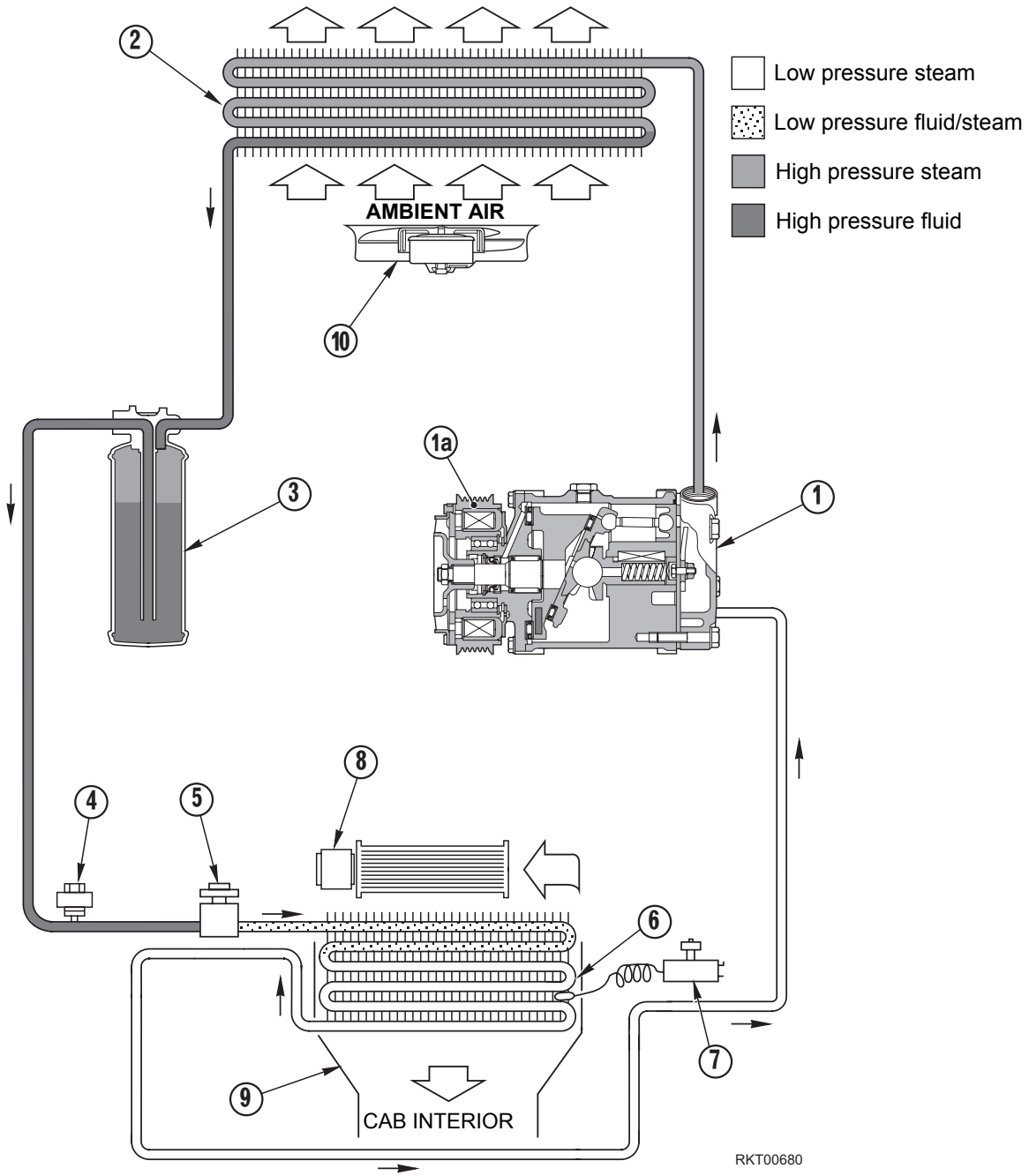
1. Bushing base side
2. Piston
3. Guide ring
4. Safety valve
5. Cylinder head
6. Bushing head side
7. Guide ring
8. Cylinder head gasket
9. Stem
10. Cylinder
11. Piston seal
12. Dowel
13. Scraper

CHARACTERISTICS

	WH609	WH613	WH713	WH714	WH714H	WH716
Boom lift cylinder						
Stem diameter	80	90	100	100	100	100
Cylinder inner diameter	150	160	180	180	180	180
Piston travel	1190	1190	1350	1350	1350	1350
Cylinder max length	2730	2730	3050	3050	3050	3050
Cylinder min length	1540	1540	1700	1700	1700	1700
Offset cylinder						
Stem diameter	40	40	40	40	40	40
Cylinder inner diameter	60	60	60	60	60	60
Piston travel	1223	1223	1383	1383	1383	1383
Cylinder max length	2753	2753	3073	3073	3073	3073
Cylinder min length	1530	1530	1690	1690	1690	1690
Boom extension cylinder						
Stem diameter	60	70	70	80	80	80
Cylinder inner diameter	80	110	110	120	120	120
Piston travel	3559	3500	3500	3978	3978	3675
Cylinder max length	7548	7440	7440	8396	8396	9790
Cylinder min length	3989	3940	3940	4418	4418	5115
Frame levelling cylinder						
Stem diameter	–	50	50	50	50	50
Cylinder inner diameter	–	100	100	100	100	100
Piston travel	–	162	162	162	162	162
Cylinder max length	–	561	561	561	561	561
Cylinder min length	–	399	399	399	399	399
Stabilizer cylinder						
Stem diameter	60	60	60	60	60	60
Cylinder inner diameter	130	130	130	130	130	130
Piston travel	394.5	394.5	394.5	394.5	394.5	394.5
Cylinder max length	1128.5	1128.5	1128.5	1128.5	1128.5	1128.5
Cylinder min length	734	734	734	734	734	734
Swing cylinder						
Stem diameter	100	100	100	100	100	100
Cylinder inner diameter	150	150	150	150	150	150
Piston travel	336	336	336	336	336	336
Cylinder max length	1025	1025	1025	1025	1025	1025
Cylinder min length	689	689	689	689	689	689

	WH609	WH613	WH713	WH714	WH714H	WH716
Rear axle locking cylinder						
Stem diameter	50	50	50	50	50	50
Cylinder inner diameter	100	100	100	100	100	100
Piston travel	162	162	162	162	162	162
Cylinder max length	561	561	561	561	561	561
Cylinder min length	399	399	399	399	399	399
Quick coupling cylinder						
Stem diameter	20	20	20	20	20	20
Cylinder inner diameter	30	30	30	30	30	30
Piston travel	80	80	80	80	80	80
Cylinder max length	495	495	495	495	495	495
Cylinder min length	335	335	335	335	335	335
Key size for piston retaining nut	19	19	19	19	19	19

AIR CONDITIONING SYSTEM



1. Compressor
2. Condenser
3. Filer – dehydrator reservoir
4. Safety pressure switch
5. Expansion valve
6. Evaporator
7. Thermostatic clutch control sensor
8. Air circulation blowers in cab
9. Air cowl

SPECIFICATIONS

Circuit operating pressure with engine
at 2500 rpm and ambient temperature at 25/30°C:
Normal pressure: 15 – 17 bar
Low pressure: 1.6 – 1.8 bar
Safety pressure values:
High pressure: 26 bar
Low pressure: 2.5 bar
Coolant fluid: R134a
Amount of coolant: 110 +50/-30 g

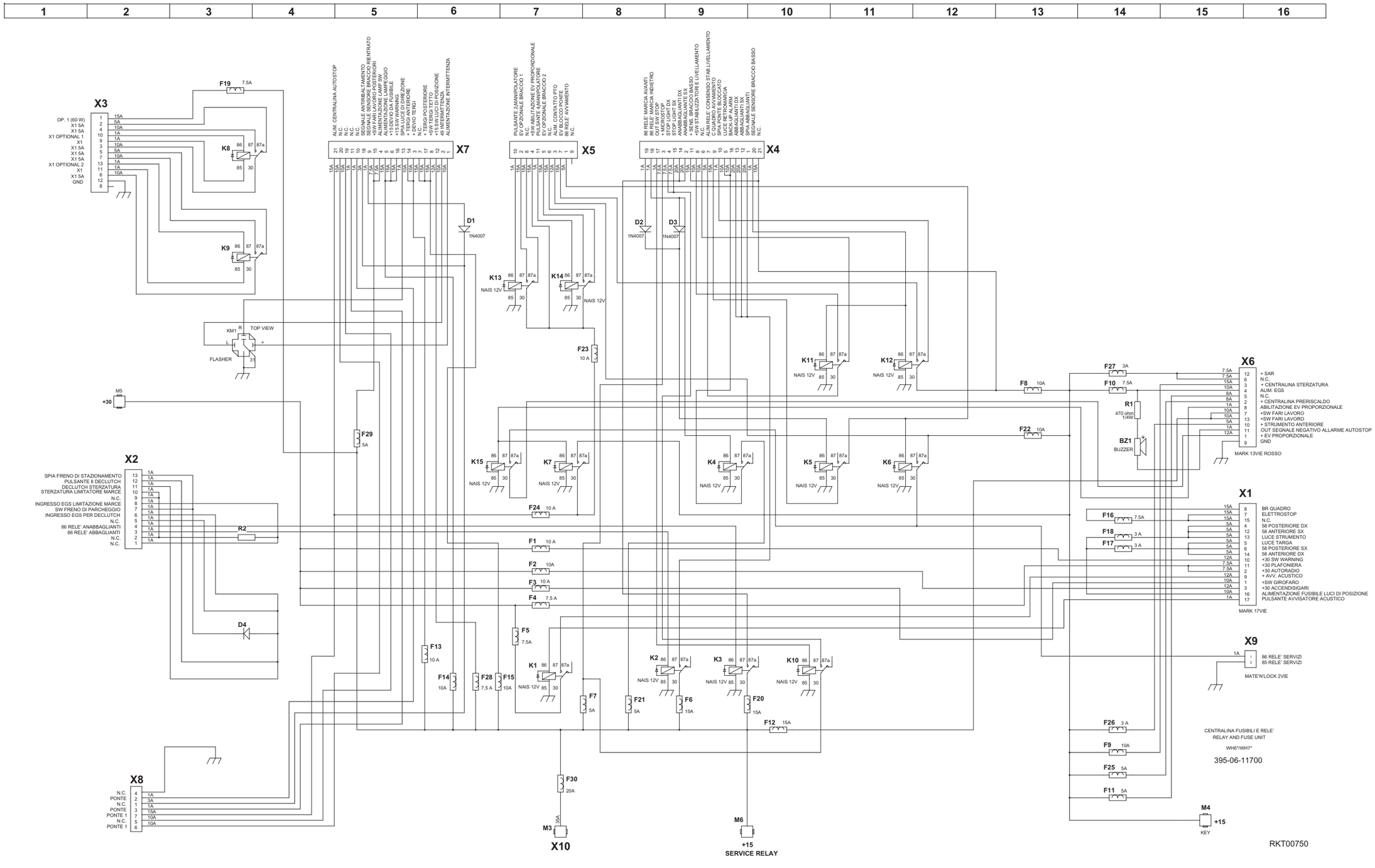
CLIMATE CONTROL SYSTEM OPERATION

The compressor (1) is driven directly by the crankshaft by means of a belt, and is caused to rotate by a pulley fitted with an electromagnetically-engaged clutch (1a).
A thermostatic sensor (7) controls the engagement and disengagement of the clutch. It disengages the clutch when the evaporator reaches the lower temperature limit and engages the clutch when the evaporator reaches the upper temperature limit.
The coolant fluid (in gaseous phase) is drawn into the compressor where it is subjected to compression and an intense heating process. In these conditions the fluid is then sent into the condenser (2) where, due to the heat extracted by ambient temperature air flowing over fins, it reaches condensation temperature, and passes into a high-pressure liquid state.
Subsequently the coolant passes into the drying-filter assembly (3) which performs three functions: it filters out impurities, absorbs any moisture present in the circuit and, finally, also functions as a reserve tank.
The coolant in its liquid state is then transferred to the evaporator (6), first passing through an expansion valve (5). The task of this valve is the constant metering of the quantity of fluid in order to maintain optimum evaporation.
In the evaporator the coolant fluid is subjected to expansion, bringing it up to the critical evaporation point at a temperature of approximately – 8°C.
The flow of air generated by centrifugal fan (8), which passes through the evaporator (6) at ambient temperature is considerably warmer than – 8°C. For this reason it yields heat to the coolant fluid, bringing it up to boiling point and complete evaporation.
On leaving the evaporator (6) the coolant is drawn once more into the compressor (1) and a new cycle commences.
The extraction of heat from the atmosphere in which the evaporator is positioned leads to the condensation of the water suspended in the air, and hence to dehumidification. The condensate is deposited on the evaporator fins where, if a temperature higher than 0°C is not maintained, it freezes and inhibits the functioning of the evaporator.
The task of keeping the temperature of the evaporator above 0°C (and thus within the optimum limits for heat exchange) is entrusted to a thermostatic sensor (7).
The condensate that forms on the evaporator fins (6) also contains dust, pollens and particles suspended in the air. Continual condensation therefore effectively purifies the air, and the droplets of condensate are discharged to the exterior.

A fixed quantity of anti-freeze oil is also introduced into the circuit, with the function of lubricating all the mechanical parts of the A/C system. A percentage of this oil circulates constantly throughout the A/C system in atomised form, lubricating the compressor (pistons and bearings) and the expansion valve.
A pressure switch (4) has been inserted in the electrical control circuit to protect the A/C system in the case of a lack of coolant fluid or if the quantity becomes insufficient due to leakages. This switch will inhibit the engagement of the electromagnetic clutch and hence the functioning of the air-conditioning system.

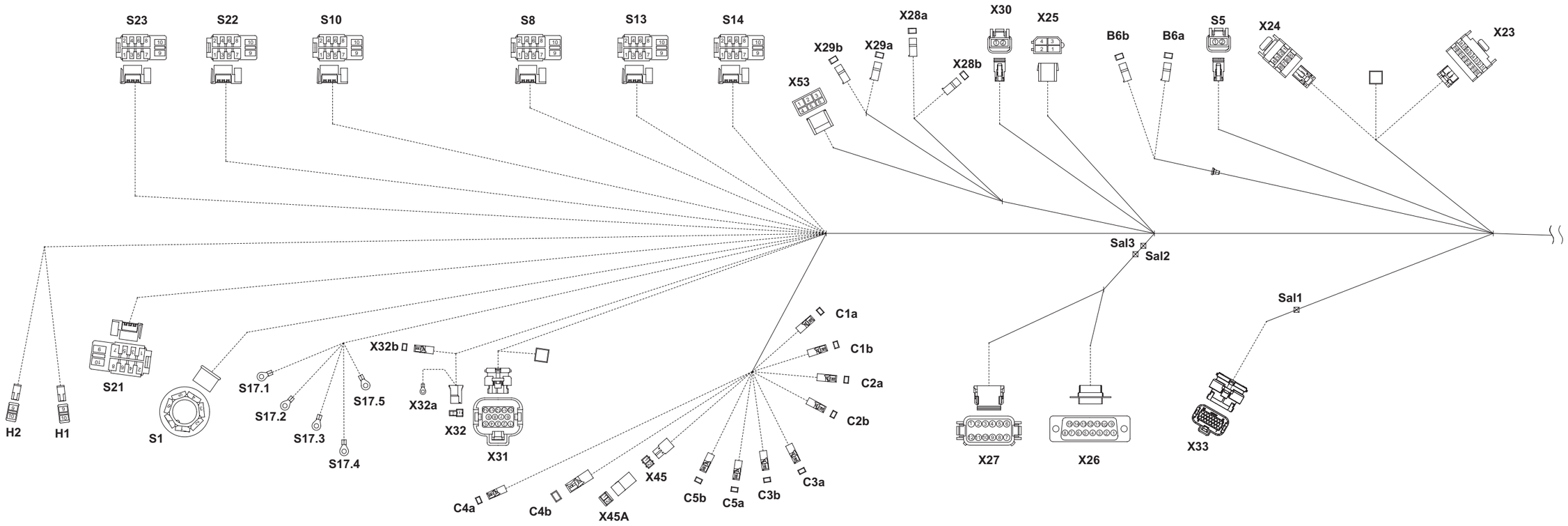
ELECTRICAL DIAGRAMS

FUSE CENTRE



CAB WIRING (1/2)

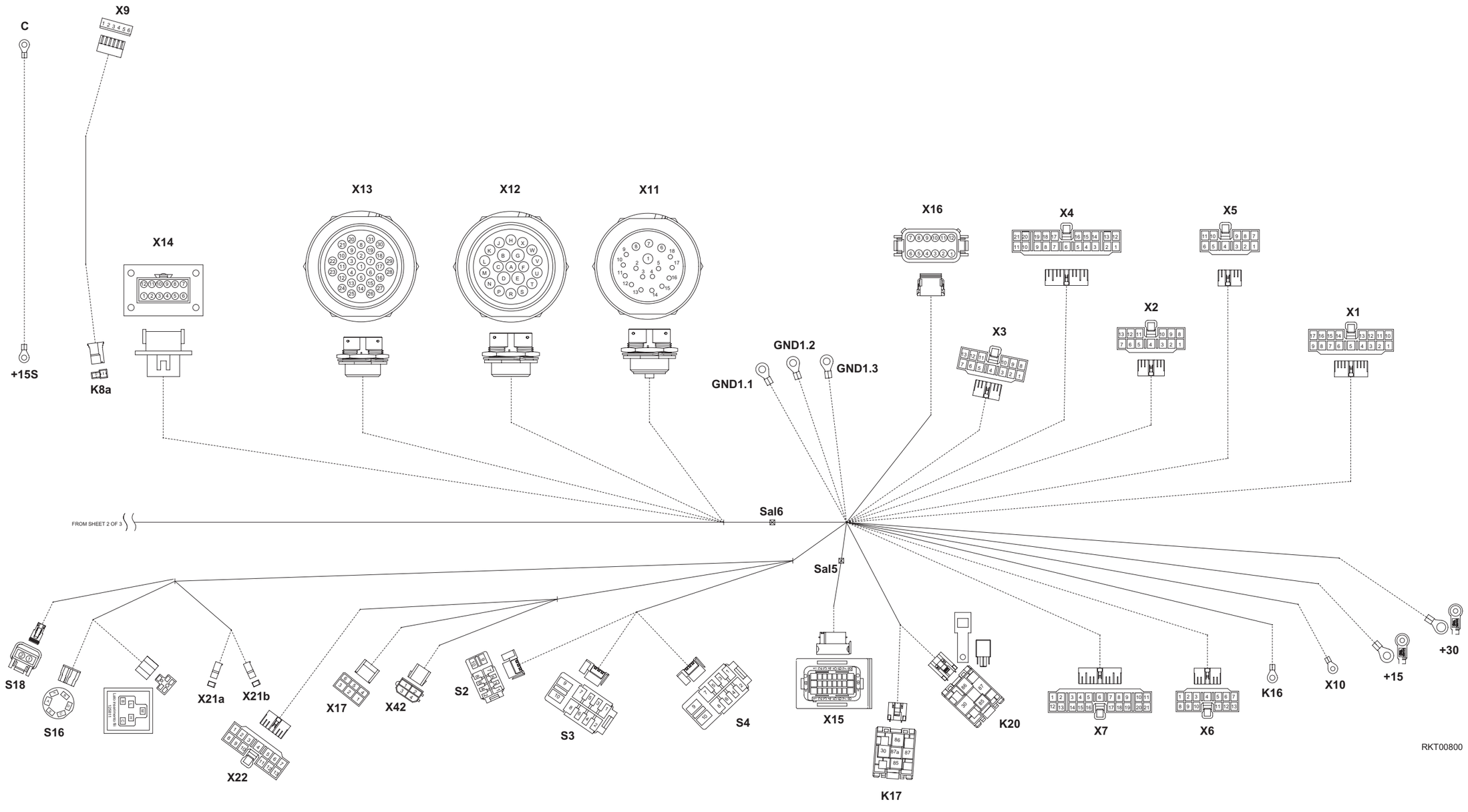
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



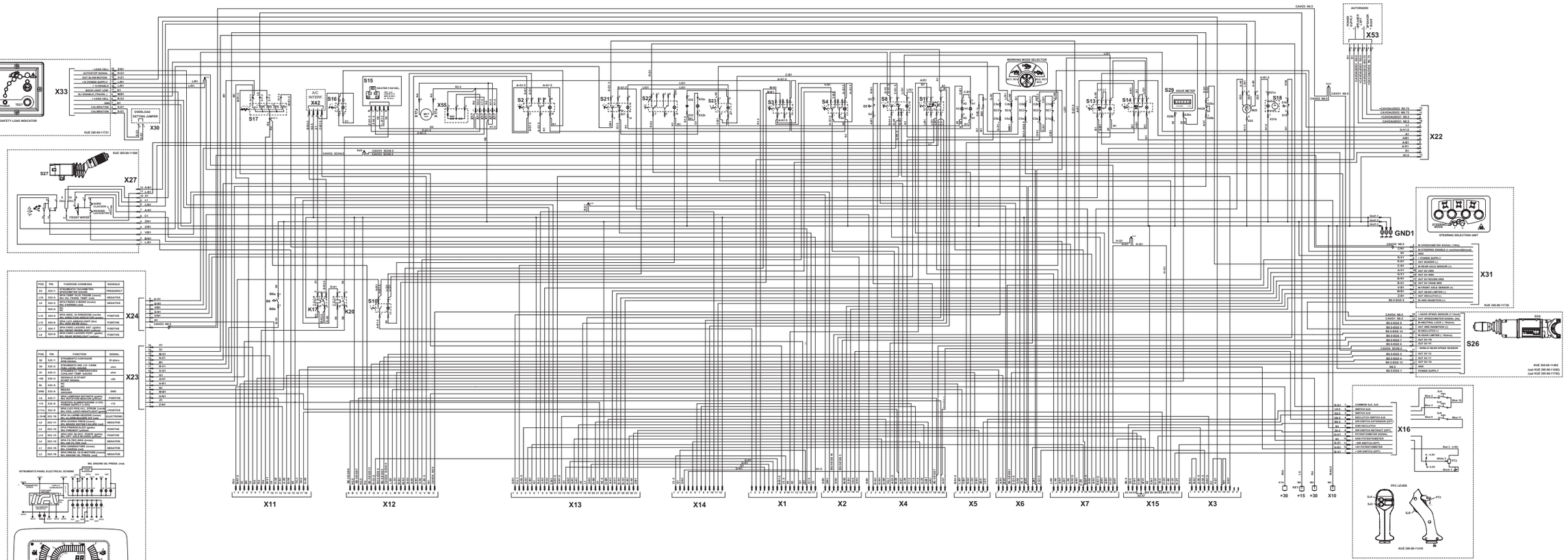
RKT00840

CAB WIRING (2/2)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



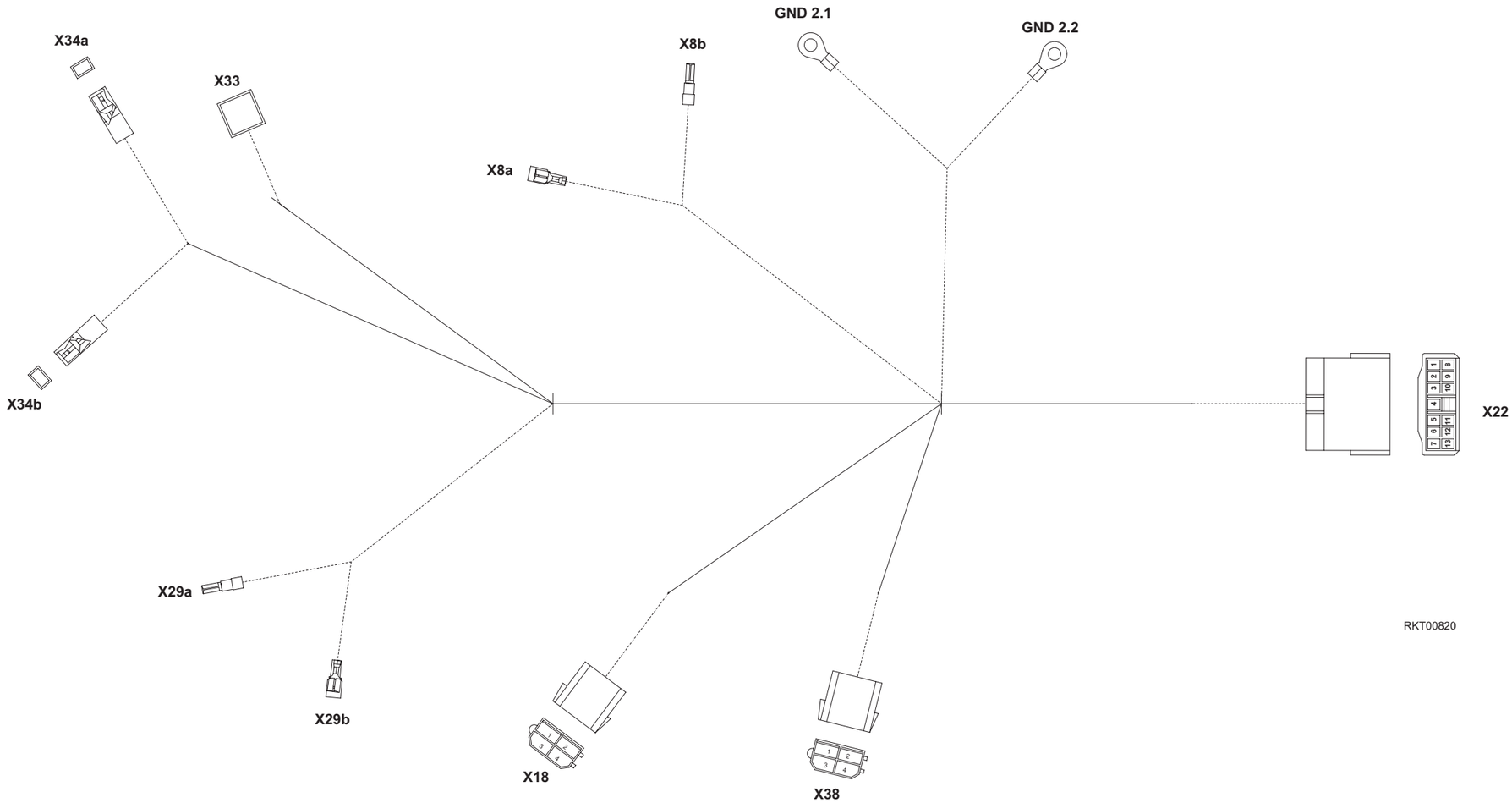
CAB WIRING DIAGRAM (see also Group 90)



RKT00760

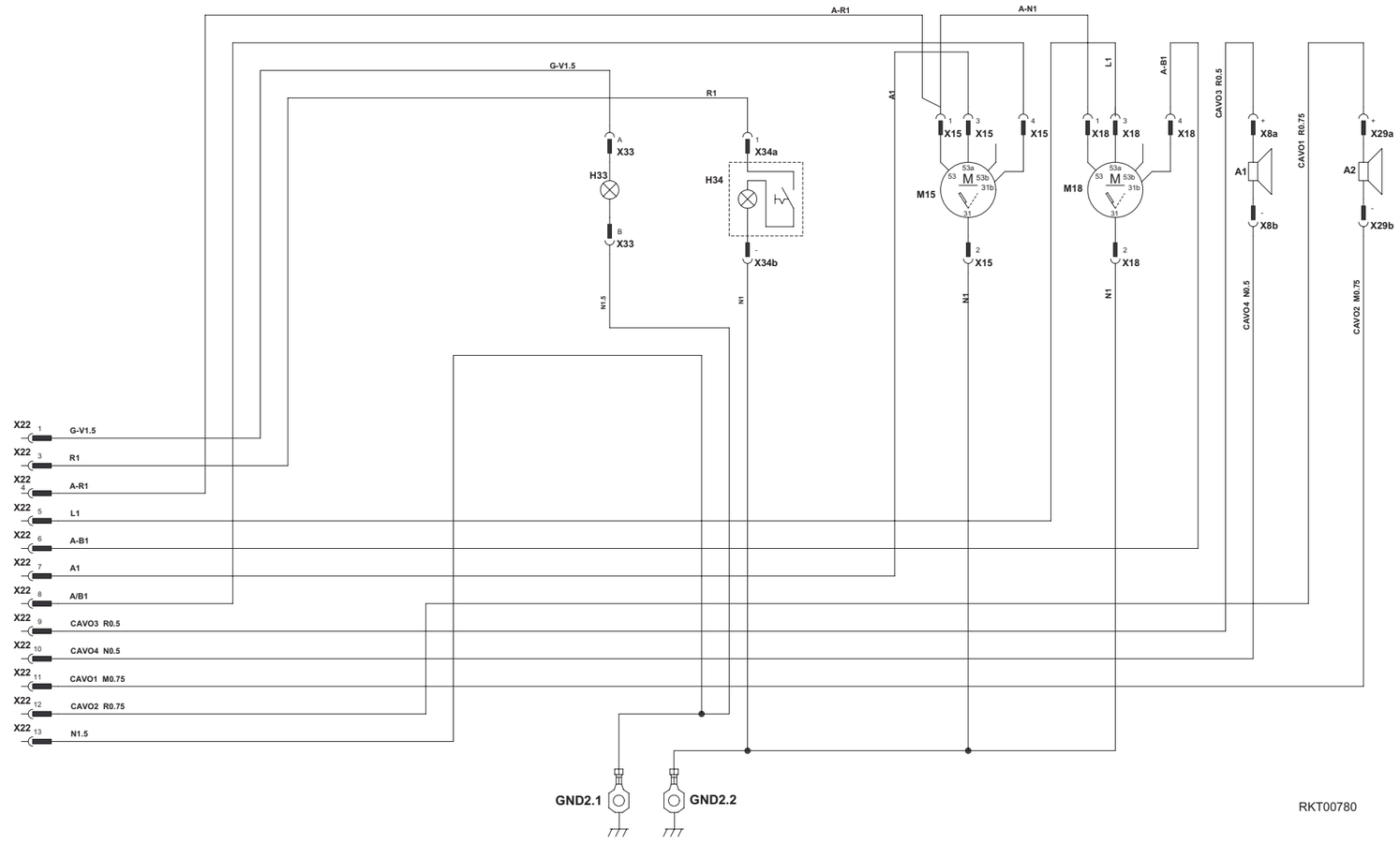
CAB ROOF WIRING

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

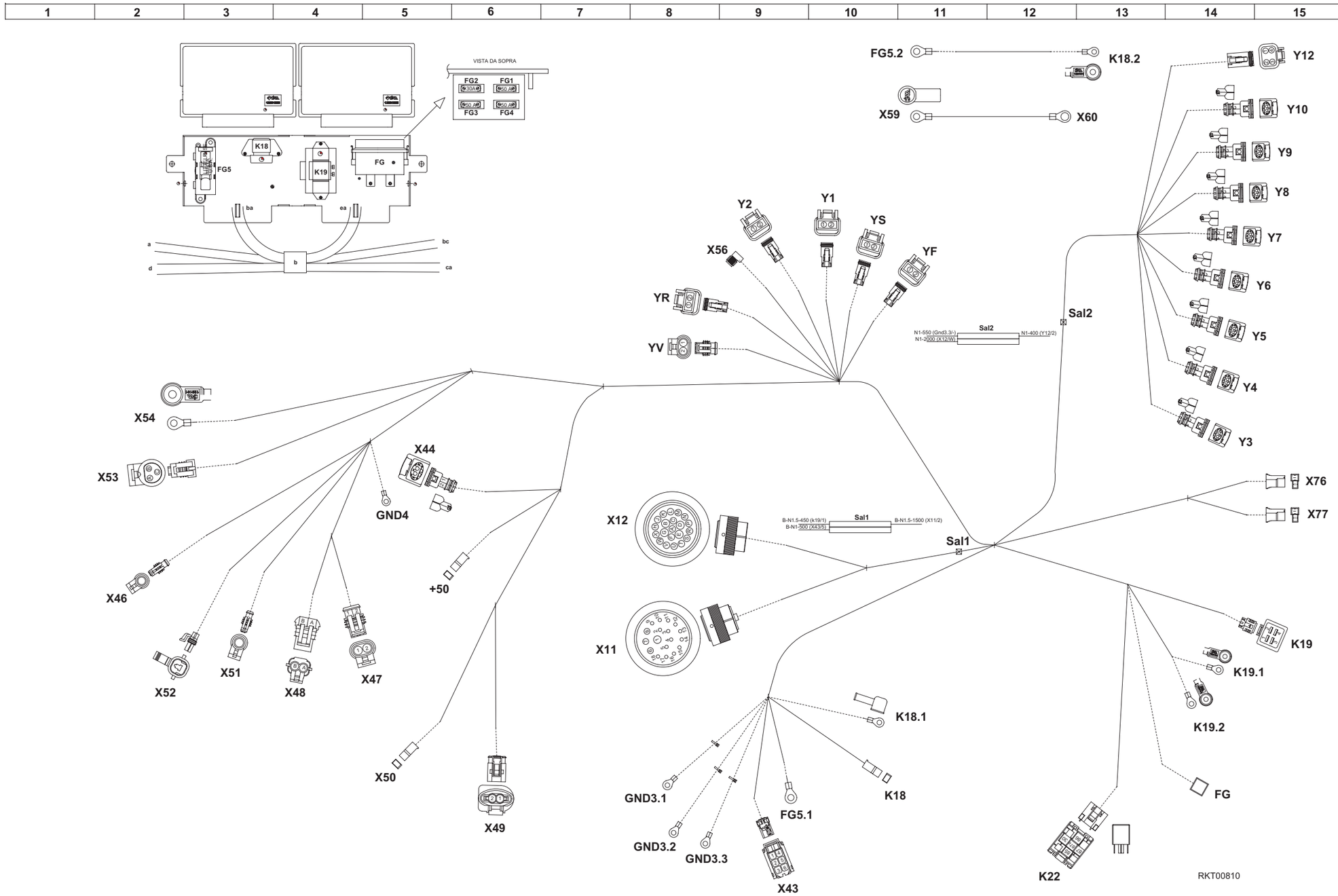


CAB ROOF WIRING DIAGRAM

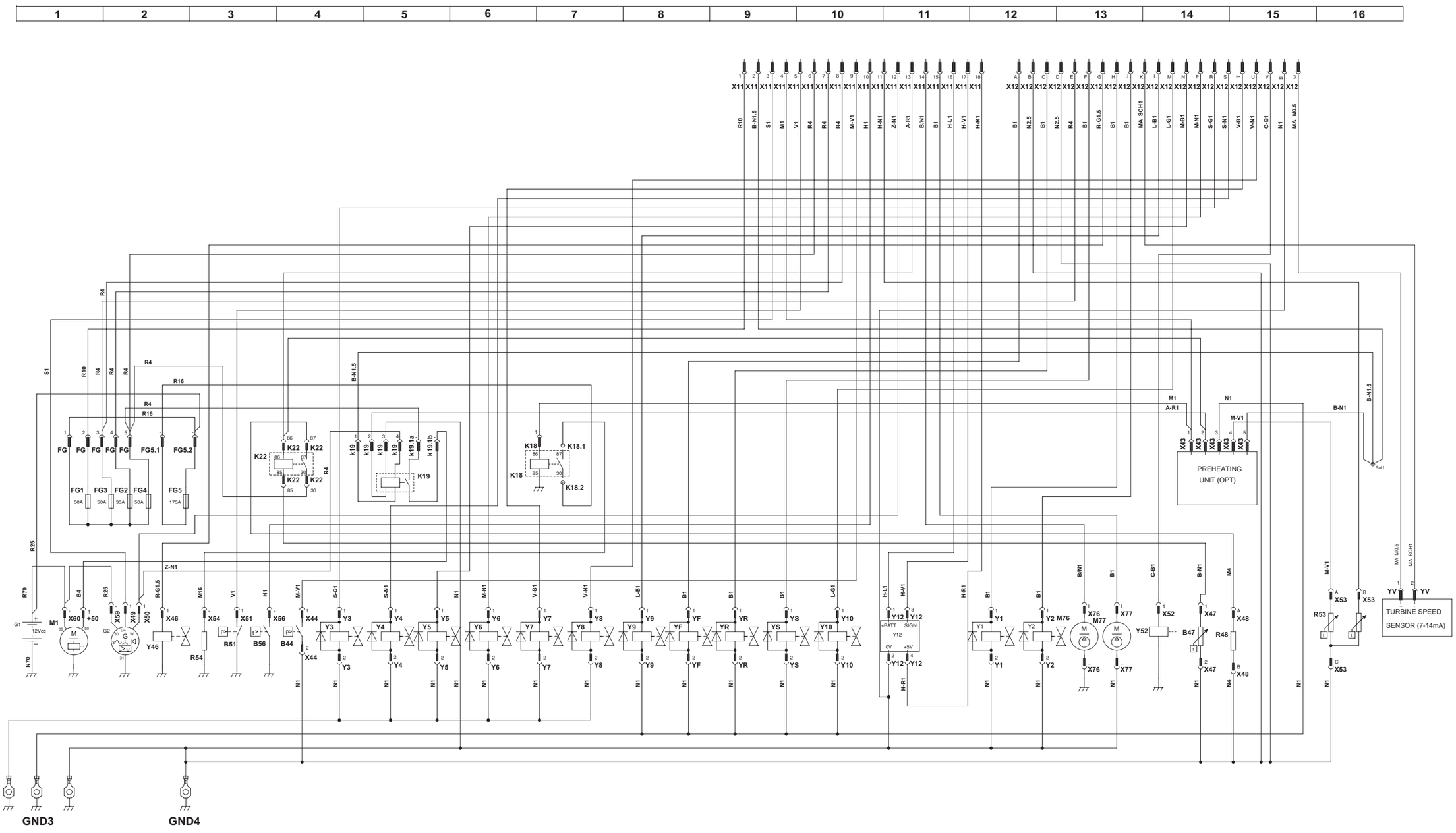
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



ENGINE WIRING



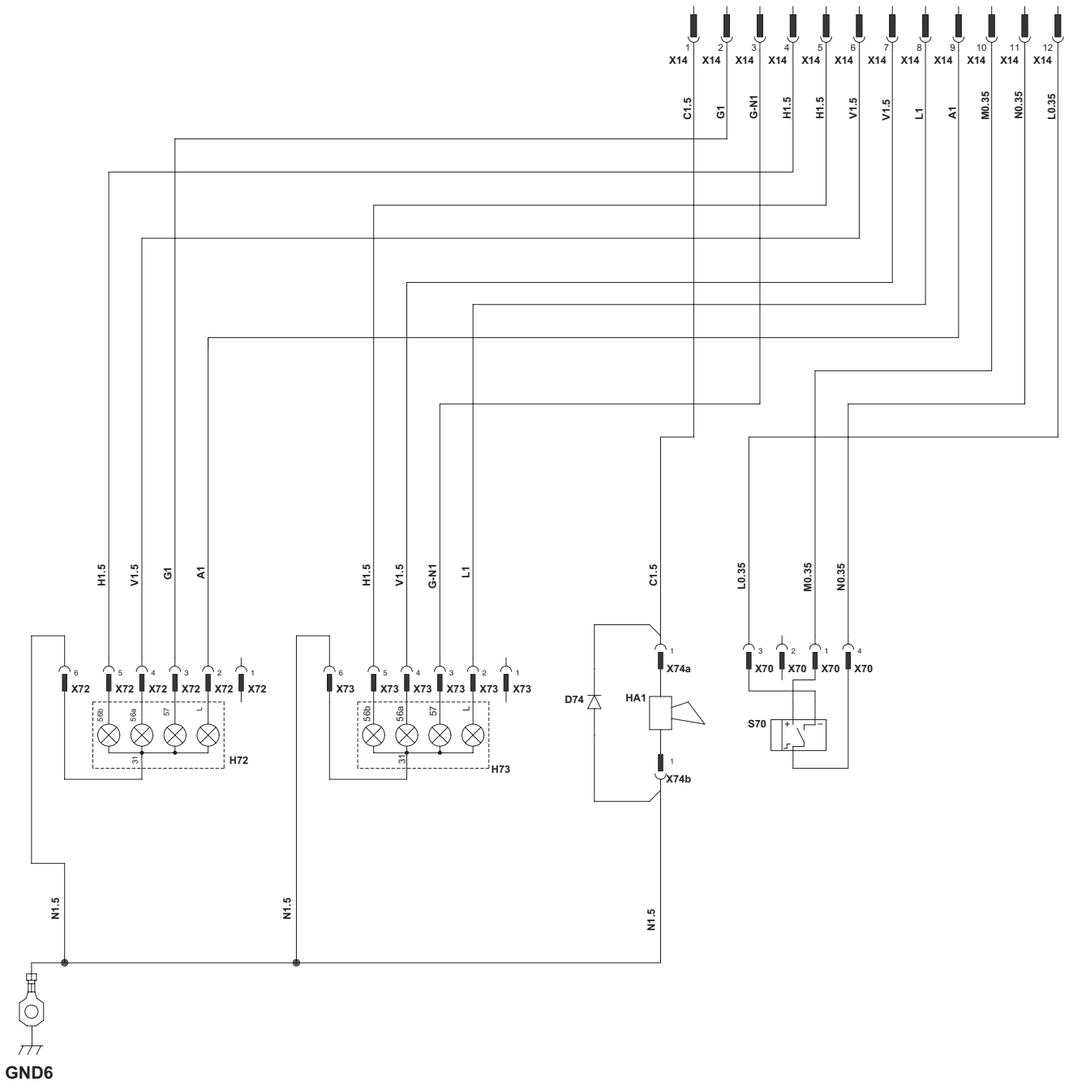
ENGINE WIRING DIAGRAM



RKT00730

FRONT WIRING

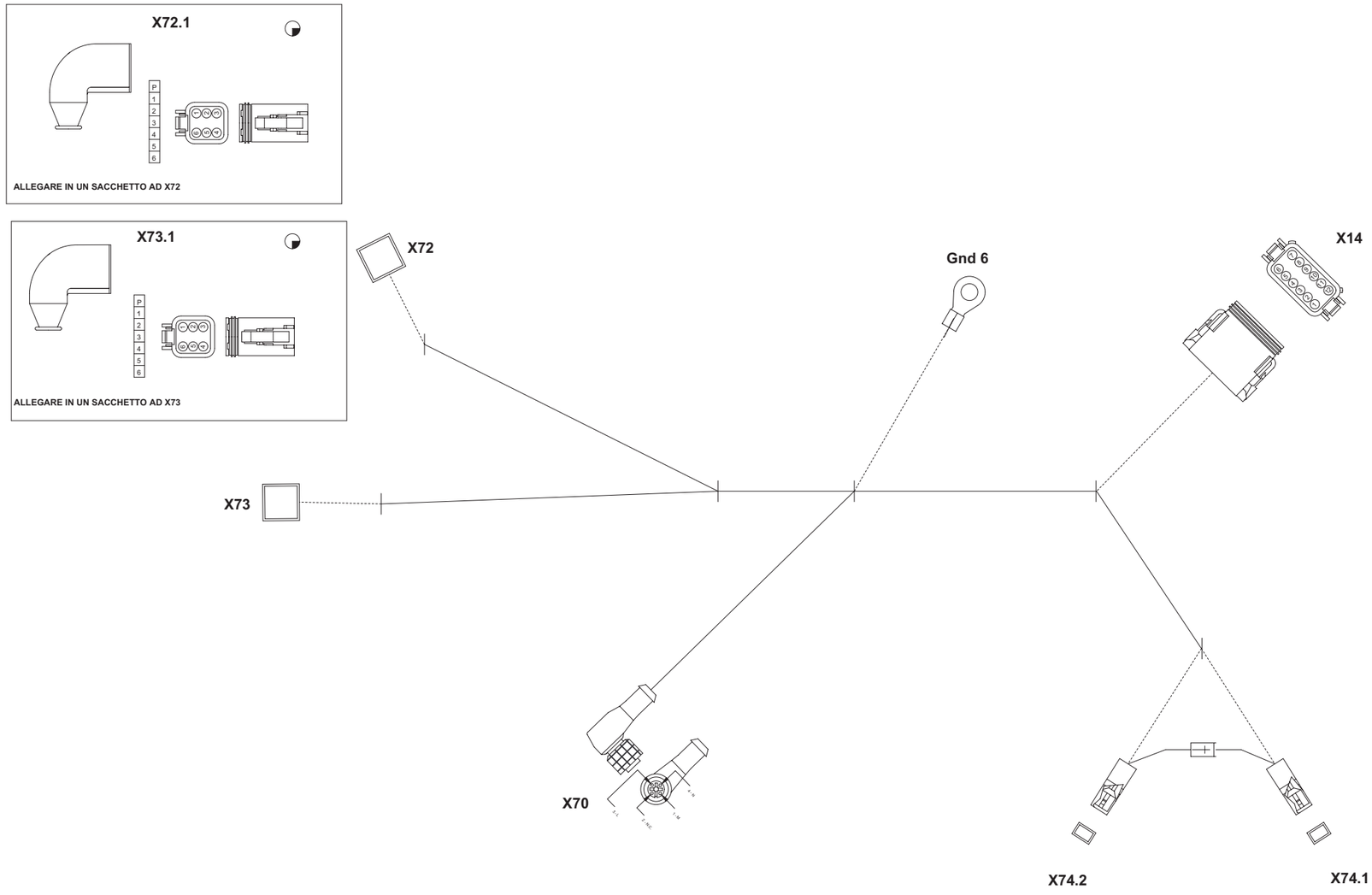
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



RKT00740

FRONT WIRING DIAGRAM

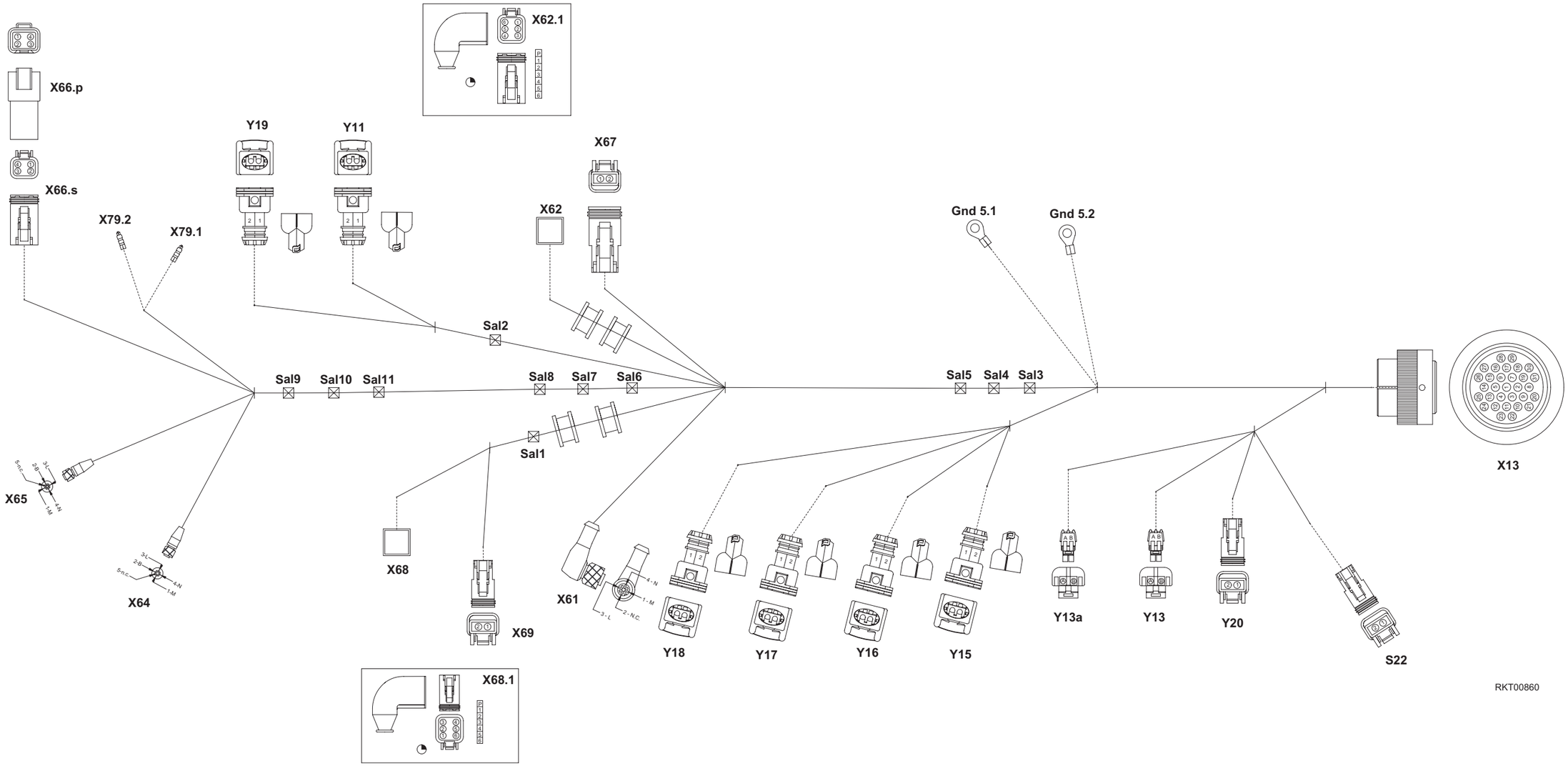
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



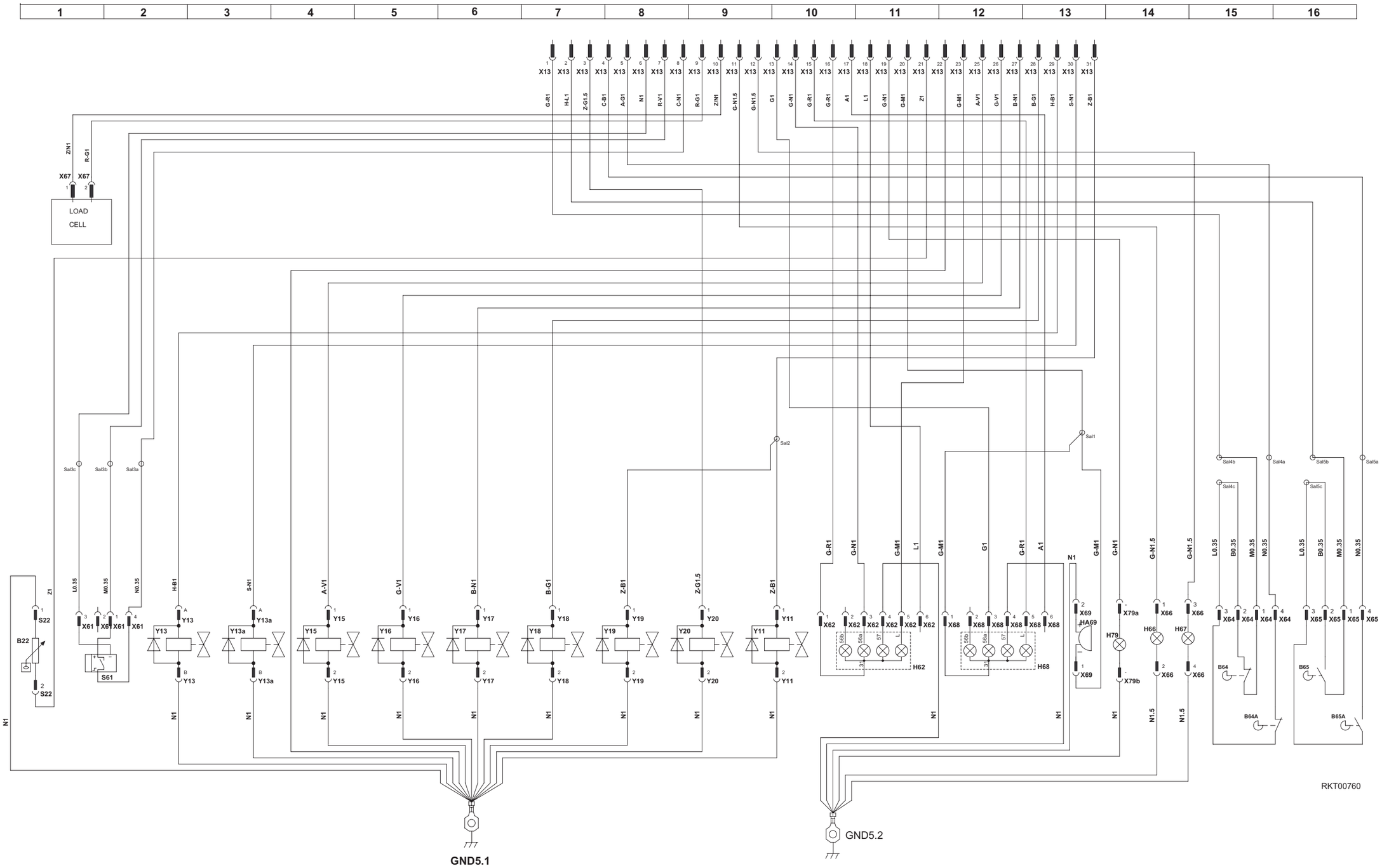
RKT00850

REAR FRAME WIRING

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

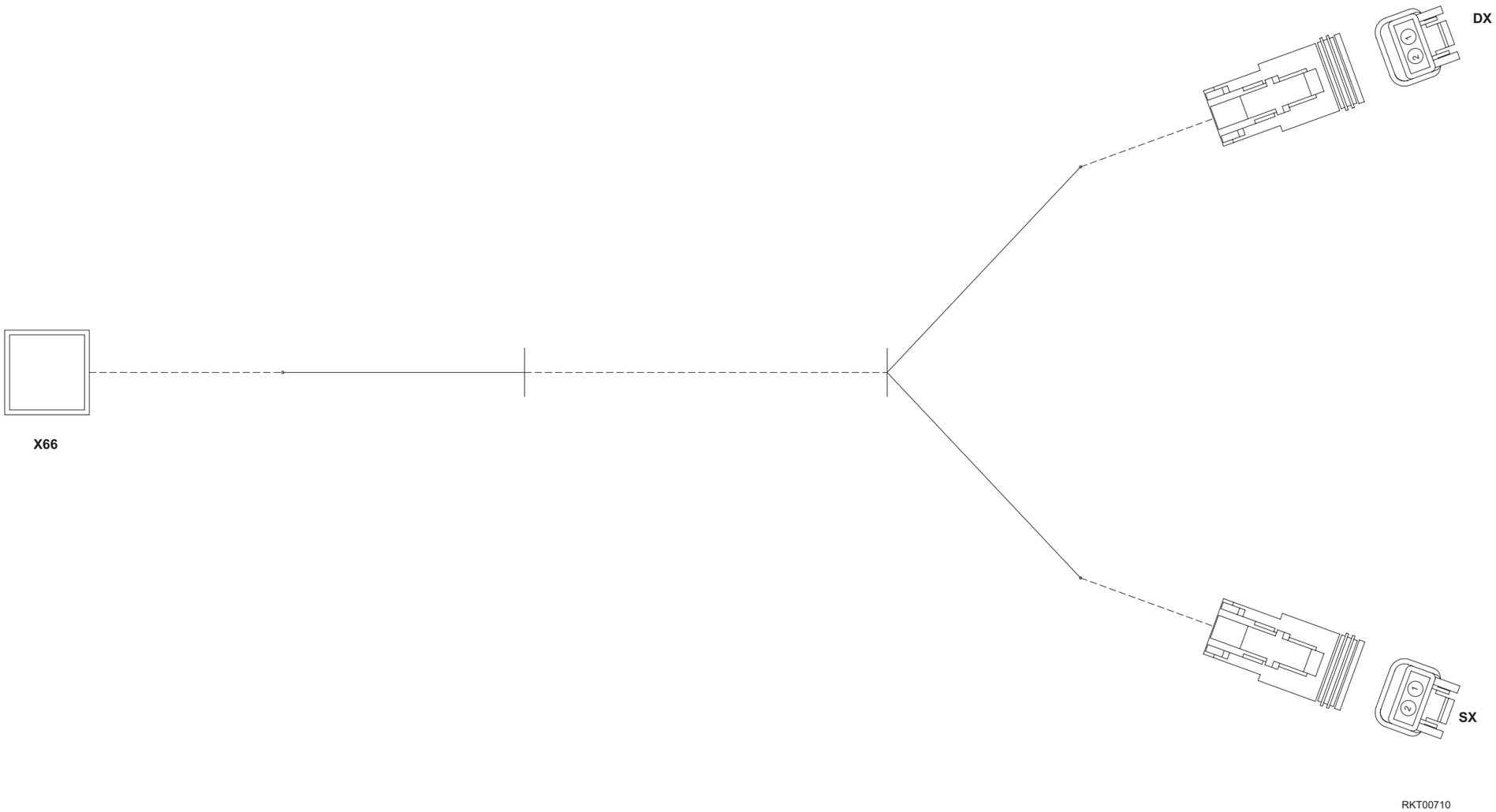


REAR FRAME WIRING DIAGRAM



FRONT SERVICE LIGHTS WIRING

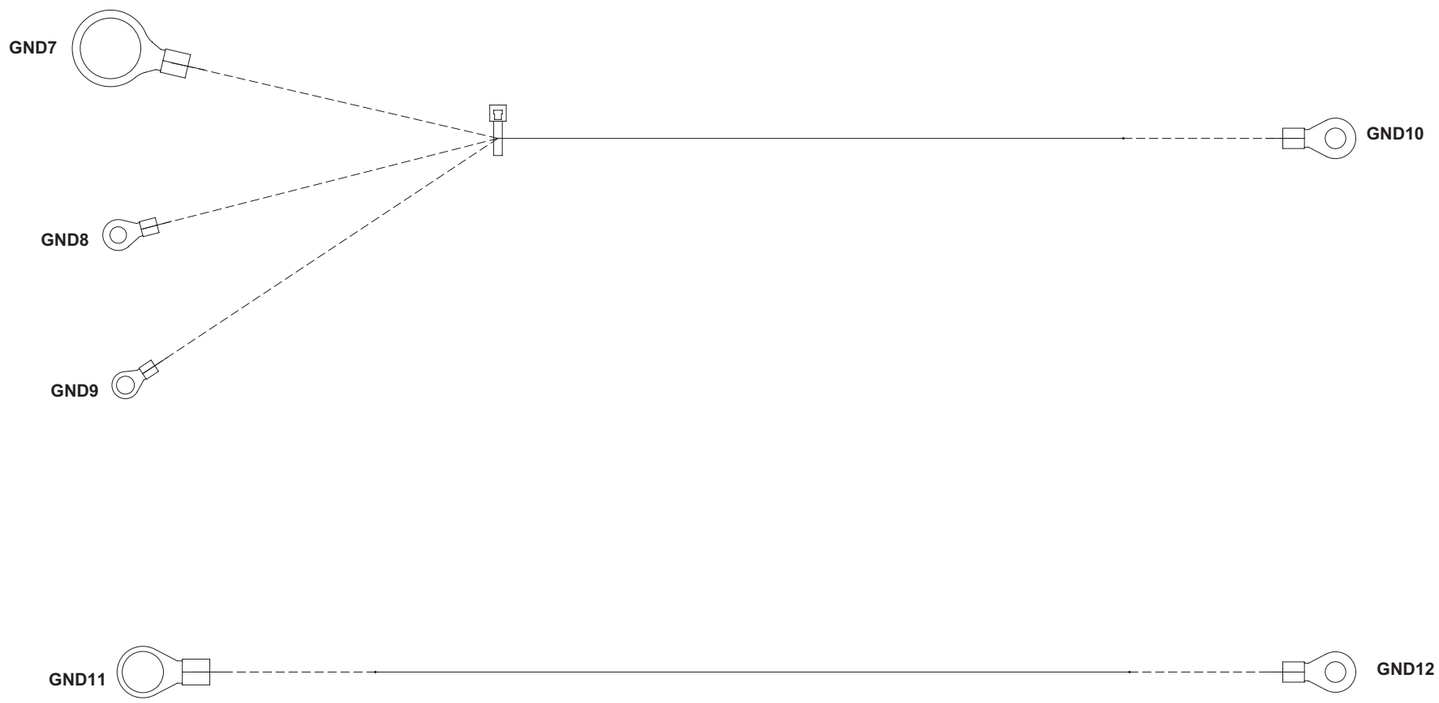
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



RKT00710

GROUND WIRING

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



RKT00720

20 TESTING AND ADJUSTMENTS

STANDARD SPECIFICATIONS

• ASPIRATED ENGINES

Machine model			WH609 - WH613	
Engine			4D104E-1	
Check item	Test conditions	Unit	Standard value	Permissible value
Engine speed (no load condition)	Maximum speed Minimum speed Operating speed	rpm rpm rpm	2500 1050 –	2500±50 1050±50 –
Exhaust gas colour	Abrupt acceleration At maximum speed	Bosch index	<2.5 <2.5	<2.5 <2.5
Valve lash	Intake (20 °C) Exhaust (20 °C)	mm mm	0.30±0.05 0.55±0.05	0.30±0.05 0.55±0.05
Compression pressure (oil SAE30)	Oil temperature 69÷72 °C (Engine speed)	bar (rpm)	–	–
Pressure in housing (oil SAE30)	Water at operating temperature At maximum speed	mm H_2O	5–10 50.0	5–10 50.0
Engine oil pressure	At maximum speed At minimum speed	bar (kPa) bar (kPa)	3.5 (350) 0.7 (70)	–
Engine oil temperature	All speeds	°C	Max. 120	Max. 120
Injection advance	B.T.D.C.	mm	1.35	1.35±0.05

• TURBO ENGINES

Machine model			WH609 - WH613 - WH713 WH714 - WH714H - WH716	
Engine			S4D104E-1	
Check item	Test conditions	Unit	Standard value	Permissible value
Engine speed (no load condition)	Maximum speed Minimum speed Operating speed	rpm rpm rpm	2500 1050 –	2500±50 1050±50 –
Exhaust gas colour	Abrupt acceleration At maximum speed	Bosch index	1.5 1.5	1.5 1.5
Valve lash	Intake (20 °C) Exhaust (20 °C)	mm mm	0.30±0.05 0.55±0.05	0.30±0.05 0.55±0.05
Compression pressure (oil SAE30)	Oil temperature 69÷72 °C (Engine speed)	bar (rpm)	–	–
Pressure in housing (oil SAE30)	Water at operating temperature At maximum speed	mm H_2O	5–10 50.0	5–10 50.0
Engine oil pressure	At maximum speed At minimum speed	bar (kPa) bar (kPa)	3.5 (350) 0.7 (70)	–
Engine oil temperature	All speeds	°C	Max. 120	Max. 120
Injection advance	B.T.D.C.	mm	1.00	1.00±0.05

• MACHINE MODELS WH609 - WH613 WITH ASPIRATED ENGINE

Machine model				WH609 - WH613	
Classification	Check item	Test conditions	Unit	Standard value	Permissible value
Engine speed (load condition)	With stalled converter	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied	rpm	1850	1850–2100
	With stalled converter and hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied • Equipment crate curl at end of travel and steering at end of travel		1350	1350–2100
	With hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Parking brakes: applied • Equipment crate curl at end of travel and steering at end of travel		2450	2450–2550

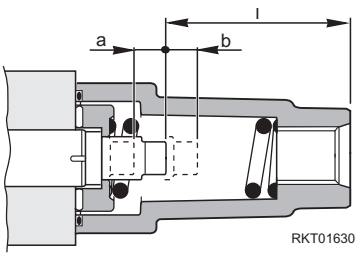
• MACHINE MODELS WH609 - WH613 WITH TURBO ENGINE

Machine model				WH609 - WH613	
Classification	Check item	Test conditions	Unit	Standard value	Permissible value
Engine speed (load condition)	With stalled converter	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied	rpm	2015	2015–2100
	With stalled converter and hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied • Equipment crate curl at end of travel and steering at end of travel		1550	1550–2200
	With hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Parking brakes: applied • Equipment crate curl at end of travel and steering at end of travel		2450	2450–2550

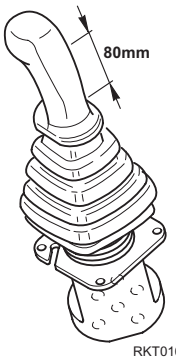
• MACHINE MODELS WH713 - WH714 - WH714H - WH716

Machine model				WH713 - WH714 - WH714H - WH716	
Classification	Check item	Test conditions	Unit	Standard value	Permissible value
Engine speed (load condition)	With stalled converter	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied	rpm	2015	2015–2100
	With stalled converter and hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Machine in 2nd gear • Service brakes: applied • Equipment crate curl at end of travel and steering at end of travel		1610	1610–2200
	With hydraulic system in load condition	• Max. engine speed • Hydraulic oil temperature: 45–55 °C • Converter oil temperature: 80°C • Parking brakes: applied • Equipment crate curl at end of travel and steering at end of travel		2450	2450–2550

• MACHINE MODEL WH609-1

Machine model				WH609-1					
Classification	Check item	Test conditions	Unit	Standard value			Permissible value		
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7		
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 −0		
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1		
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5		
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 −0		
	Boom (extension)			275			275 +5 −0		
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 −0		
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm						
Control valve spool travel	Boom		mm	l	a	b	l	a	b
	Equipment			45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3

• MACHINE MODEL WH609-1

Machine model					WH609-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	• Neutral → Up	mm	–	90±5
	Boom down lever		• Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	• Neutral → Open		–	90±5
	Equipment crate closing lever		• Neutral → Close		–	90±5
	Accelerator control lever		• Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH609-1

Machine model					WH609-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

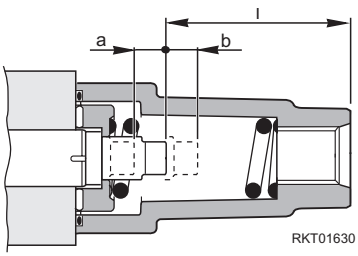
• MACHINE MODEL WH609-1

Machine model					WH609-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1’	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

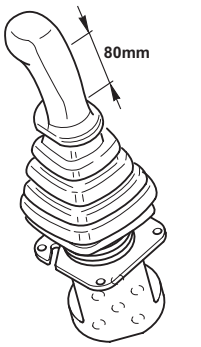
• MACHINE MODEL WH609-1

Machine model					WH609-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Hydraulic drift	Boom angle	• Machine control position: see Figures G and H in this chapter. • Machine levelled • Load P on forks: 3500 kg • Stabilizers: fully lowered. • Boom extension: letter **E** • Boom inclination: 60° in relation to the ground. • Forks: parallel to the ground. ★ Carry out two tests: a. with oil temperature at 40 °C b. a. with oil temperature at 80 °C ★ Measure any variations 10 minutes after engine stop ★ Measure inclination using a magnetic bubble placed on the boom ★ Measurement **A** at the tips of the forks ★ Measurement **B** at the mark between cylinder head and rod attachment	Inclination variation	a°	1.1°	0–2.5°
	Fork tip height		Tips down	mm	37.5	10–75
	Stabilizer cylinder (retraction)		RH		Max. 2	0
			LH		Max. 2	0

• MACHINE MODEL WH613-1

Machine model				WH613-1					
Classification	Check item	Test conditions	Unit	Standard value			Permissible value		
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7		
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 0		
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1		
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5		
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 0		
	Boom (extension)			275			275 +5 0		
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 0		
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm						
Control valve spool travel	Boom		mm	l	a	b	l	a	b
				45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3
	Equipment								

• MACHINE MODEL WH613-1

Machine model					WH613-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	• Neutral → Up	mm	–	90±5
	Boom down lever		• Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	• Neutral → Open		–	90±5
	Equipment crate closing lever		• Neutral → Close		–	90±5
	Accelerator control lever		• Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH613-1

Machine model					WH613-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

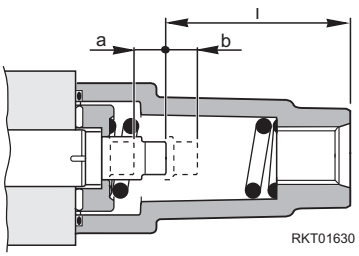
• MACHINE MODEL WH613-1

Machine model					WH613-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1'	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

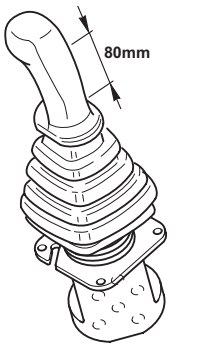
• MACHINE MODEL WH613-1

Machine model					WH613-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Hydraulic drift	Boom angle	• Machine control position: see Figures G and H in this chapter. • Machine levelled • Load P on forks: 3500 kg • Stabilizers: fully lowered. • Boom extension: letter **E** • Boom inclination: 60° in relation to the ground. • Forks: parallel to the ground. ★ Carry out two tests: a. with oil temperature at 40 °C b. a. with oil temperature at 80 °C ★ Measure any variations 10 minutes after engine stop ★ Measure inclination using a magnetic bubble placed on the boom ★ Measurement **A** at the tips of the forks ★ Measurement **B** at the mark between cylinder head and rod attachment	Inclination variation	a°	1.1°	0–2.5°
	Fork tip height		Tips down	mm	37.5	10–75
	Stabilizer cylinder (retraction)		RH		Max. 2	0
			LH		Max. 2	0

• MACHINE MODEL WH713-1

Machine model				WH713-1					
Classification	Check item	Test conditions	Unit	Standard value			Permissible value		
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7		
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 0		
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1		
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5		
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 0		
	Boom (extension)			275			275 +5 0		
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 0		
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm						
Control valve spool travel	Boom		mm	l	a	b	l	a	b
	Equipment			45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3

• MACHINE MODEL WH713-1

Machine model					WH713-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	• Neutral → Up	mm	–	90±5
	Boom down lever		• Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	• Neutral → Open		–	90±5
	Equipment crate closing lever		• Neutral → Close		–	90±5
	Accelerator control lever		• Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH713-1

Machine model					WH713-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

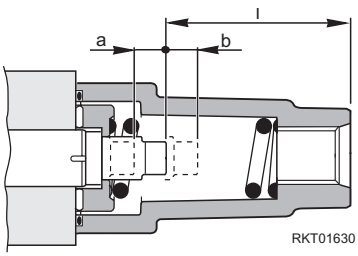
• MACHINE MODEL WH713-1

Machine model					WH713-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1'	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

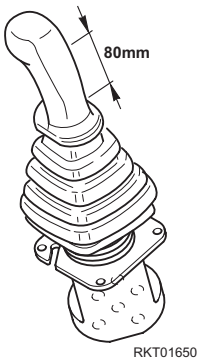
• MACHINE MODEL WH713-1

Machine model					WH713-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Hydraulic drift	Boom angle	• Machine control position: see Figures G and H in this chapter. • Machine levelled • Load P on forks: 3500 kg • Stabilizers: fully lowered. • Boom extension: letter **E** • Boom inclination: 60° in relation to the ground. • Forks: parallel to the ground. ★ Carry out two tests: a. with oil temperature at 40 °C b. a. with oil temperature at 80 °C ★ Measure any variations 10 minutes after engine stop ★ Measure inclination using a magnetic bubble placed on the boom ★ Measurement **A** at the tips of the forks ★ Measurement **B** at the mark between cylinder head and rod attachment	Inclination variation	a°	1.1°	0–2.5°
	Fork tip height		Tips down	mm	37.5	10–75
	Stabilizer cylinder (retraction)		RH		Max. 2	0
			LH		Max. 2	0

• MACHINE MODEL WH714-1

Machine model				WH714-1					
Classification	Check item	Test conditions	Unit	Standard value			Permissible value		
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7		
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 0		
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1		
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5		
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 0		
	Boom (extension)			275			275 +5 0		
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 0		
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm						
Control valve spool travel	Boom		mm	l	a	b	l	a	b
	Equipment			45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3

• MACHINE MODEL WH714-1

Machine model					WH714-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	• Neutral → Up	mm	–	90±5
	Boom down lever		• Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	• Neutral → Open		–	90±5
	Equipment crate closing lever		• Neutral → Close		–	90±5
	Accelerator control lever		• Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH714-1

Machine model					WH714-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

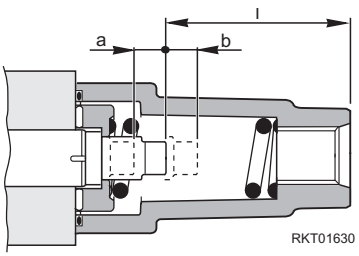
• MACHINE MODEL WH714-1

Machine model					WH714-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1'	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

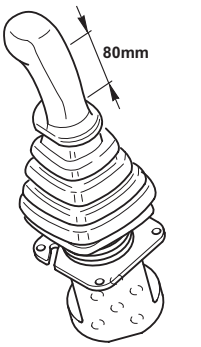
• MACHINE MODEL WH714-1

<table>
<tr><td colspan="4">Machine model</td><td colspan="2">WH714-1</td></tr>
<tr><td>Classification</td><td>Check item</td><td colspan="2">Test conditions</td><td>Unit</td><td>Standard value</td><td>Permissible value</td></tr>
<tr><td rowspan="4">Hydraulic drift</td><td>Boom angle</td><td rowspan="4">• Machine control position:
see Figures G and H in this chapter.
• Machine levelled
• Load P on forks: 3500 kg
• Stabilizers: fully lowered.
• Boom extension: letter E
• Boom inclination: 60° in relation to the ground.
• Forks: parallel to the ground.
★ Carry out two tests:
a. with oil temperature at 40 °C
b. a. with oil temperature at 80 °C
★ Measure any variations 10 minutes after engine stop
★ Measure inclination using a magnetic bubble placed on the boom
★ Measurement A at the tips of the forks
★ Measurement B at the mark between cylinder head and rod attachment</td><td>Inclination variation</td><td>a°</td><td>1.1°</td><td>0–2.5°</td></tr>
<tr><td>Fork tip height</td><td>Tips down</td><td rowspan="3">mm</td><td>37.5</td><td>10–75</td></tr>
<tr><td rowspan="2">Stabilizer cylinder (retraction)</td><td>RH</td><td>Max. 2</td><td>0</td></tr>
<tr><td>LH</td><td>Max. 2</td><td>0</td></tr>
</table>

• MACHINE MODEL WH714H-1

Machine model				WH714H-1					
Classification	Check item	Test conditions	Unit	Standard value			Permissible value		
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7		
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 0		
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1		
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5		
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 0		
	Boom (extension)			275			275 +5 0		
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 0		
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm						
Control valve spool travel	Boom		mm	l	a	b	l	a	b
	Equipment			45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3

• MACHINE MODEL WH714H-1

Machine model					WH714H-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	•Neutral → Up	mm	–	90±5
	Boom down lever		•Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	•Neutral → Open		–	90±5
	Equipment crate closing lever		•Neutral → Close		–	90±5
	Accelerator control lever		•Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH714H-1

Machine model					WH714H-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

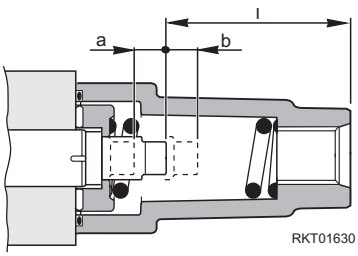
• MACHINE MODEL WH714H-1

Machine model					WH714H-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1'	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

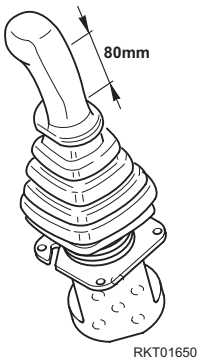
• MACHINE MODEL WH714H-1

Machine model					WH714H-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Hydraulic drift	Boom angle	• Machine control position: see Figures G and H in this chapter. • Machine levelled • Load P on forks: 3500 kg • Stabilizers: fully lowered. • Boom extension: letter **E** • Boom inclination: 60° in relation to the ground. • Forks: parallel to the ground. ★ Carry out two tests: a. with oil temperature at 40 °C b. a. with oil temperature at 80 °C ★ Measure any variations 10 minutes after engine stop ★ Measure inclination using a magnetic bubble placed on the boom ★ Measurement **A** at the tips of the forks ★ Measurement **B** at the mark between cylinder head and rod attachment	Inclination variation	a°	1.1°	0–2.5°
	Fork tip height		Tips down	mm	37.5	10–75
	Stabilizer cylinder (retraction)		RH		Max. 2	0
			LH		Max. 2	0

• MACHINE MODEL WH716-1

Machine model				WH716-1						
Classification	Check item	Test conditions	Unit	Standard value			Permissible value			
Circuit pressure	General (cut-off) valve	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • Check one circuit at a time	bar	260			260±7			
	Servocontrols	• Engine speed: min. • Equipment control in dump at end of travel		35			30 +3.5 0			
	LS differential pressure (unloading valve)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C		20			20±1			
	Steering	• Engine speed: 1500 rpm • Hydraulic oil temperature: 45–55 °C		180			180±5			
Secondary valve pressure	Boom (up)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 290 bar • Check one circuit at a time	bar	275			275 +5 0			
	Boom (extension)			275			275 +5 0			
	Equipment control (curl)	• Engine speed: min. • Hydraulic oil temperature: 45–55 °C • General valve calibration: 260±7 bar		200			200 +5 0			
Engine	Engine speed (with pump under load)	• Engine speed: max • Hydraulic oil temperature: 45–55 °C • Engine oil pressure: within the acceptable range • Total steering + equipment curl	rpm							
Control valve spool travel	Boom		mm	l	a	b	l	a	b	
	Equipment			45	6.5±0.3	6.5±0.3	45	6.5±0.3	6.5±0.3	

• MACHINE MODEL WH716-1

Machine model					WH716-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Pedal and lever travel	Boom up lever	• Pedal and lever travel • Engine not running • At centre of lever knob • Reading at end of travel • Equipment down to the ground	• Neutral → Up	mm	–	90±5
	Boom down lever		• Neutral → Down		–	90±5
	Equipment crate opening lever	 RKT01650	• Neutral → Open		–	90±5
	Equipment crate closing lever		• Neutral → Close		–	90±5
	Accelerator control lever		• Min. → Max.		–	70±10
Force for lever ad pedal operation	Boom up lever	• Engine speed: min. • Oil temperature: 45–55 °C • For PPC valves: tool attachment 80 mm from handle base • Accelerator pedal: from NEUTRAL to MAX		kg	–	1.5±0.5
	Boom down lever				–	1.5±0.5
	Equipment crate opening lever				–	1.5±0.5
	Equipment crate closing lever				–	1.5±0.5
	Accelerator control lever				–	5.0±2.0

• MACHINE MODEL WH716-1

Machine model					WH716-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Work equipment speed	Boom up (from ground to max. height)	• Check position: See Fig. A in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Up	sec.	10.2	10.2±1
	Boom down (from ground to max. height)		Down		8.8	8–10
	Boom extension (full extension)	• Check position: See Fig. B in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Extension	sec.	7.25	6.5–8.0
	Boom retraction (full retraction)		Retraction		7.25	6.5–8.0
	Equipment crate curl (from full dump to max. curl)	• Check position: See Fig. C in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Perform 3 tests and calculate the average	Curl	sec.	3.3	3.7–4.5
	Dump (from max. curl to full dump)		Dump		3.0	2.5–3.5
	Stabilizers up (from fully extended to fully retracted)	• Check position: See Fig. D in this chapter. • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Test one stabilizer at a time • Perform 3 tests and calculate the average	Up	sec.	8.5	6.0–11.0
	Stabilizers down (from fully retracted to fully extended)		Down		9.0	7.0–11.0
	Stabilizer synchronism (up-down movement)	• Machine levelled • Engine speed: MAX. • Hydraulic oil temperature: 45–55 °C • Simultaneous stabilizer command • Measure delay between the time one stabiliser touches the ground and the time the other stabilizer touches the ground and measure delay between the time one stabiliser reaches the fully retracted position and the time the other stabilizer reaches the fully-retracted position.	Up	sec.	0.5	0.5
			Down		0.5	0.5

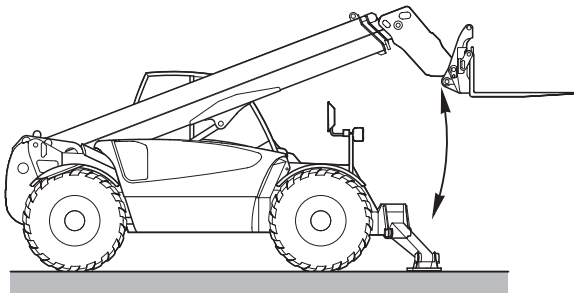
• MACHINE MODEL WH716-1

Machine model					WH716-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Translation speed	Translation speed (no load)	• Wheels lifted with stabilizers and/or jack stands: see Figures **E** and **F** in this chapter. • Check engine at MAX rpm • Transmission oil temperature at 60-70 °C • Measure propeller shaft speed in all gears.	FORWARD GEAR 1st	m/1'	570	513–621
			FORWARD GEAR 2nd		1243	1119–1355
			FORWARD GEAR 3rd		1889	1700–2059
			FORWARD GEAR 4th		2550	2295–2780
			FORWARD GEAR 5th		3863	3477–4211
			REVERSE GEAR 1st		570	513–621
			REVERSE GEAR 2nd		1243	1119–1355
			REVERSE GEAR 3rd		2550	2295–2780

• MACHINE MODEL WH716-1

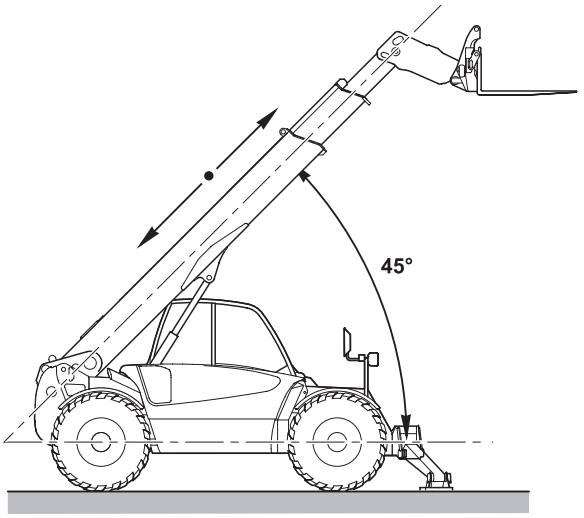
Machine model					WH716-1	
Classification	Check item	Test conditions		Unit	Standard value	Permissible value
Hydraulic drift	Boom angle	• Machine control position: see Figures G and H in this chapter. • Machine levelled • Load P on forks: 3500 kg • Stabilizers: fully lowered. • Boom extension: letter **E** • Boom inclination: 60° in relation to the ground. • Forks: parallel to the ground. ★ Carry out two tests: a. with oil temperature at 40 °C b. a. with oil temperature at 80 °C ★ Measure any variations 10 minutes after engine stop ★ Measure inclination using a magnetic bubble placed on the boom ★ Measurement **A** at the tips of the forks ★ Measurement **B** at the mark between cylinder head and rod attachment	Inclination variation	a°	1.1°	0–2.5°
	Fork tip height		Tips down	mm	37.5	10–75
	Stabilizer cylinder (retraction)		RH		Max. 2	0
			LH		Max. 2	0

Fig. A



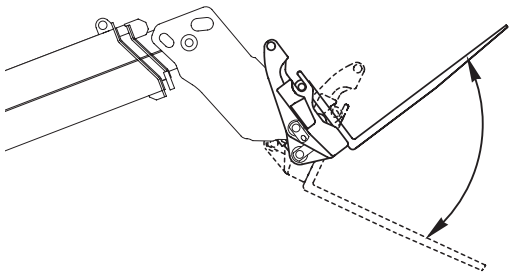
RKT01660

Fig. B



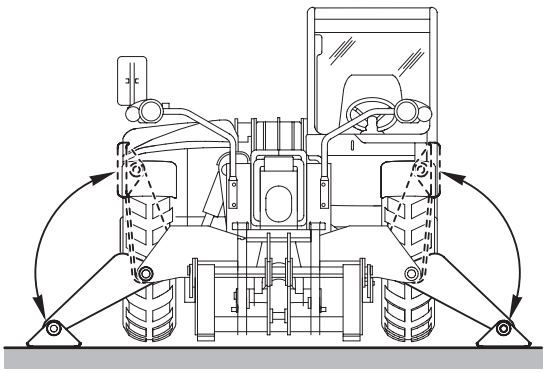
RKT01670

Fig. C



RKT01680

Fig. D



RKT01690

Fig. E

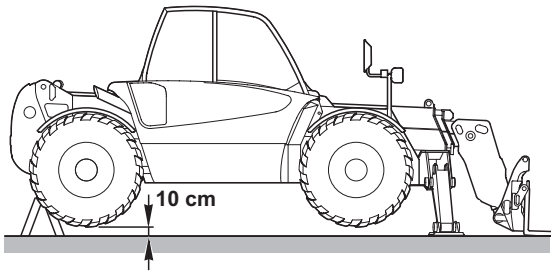


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Fig. F

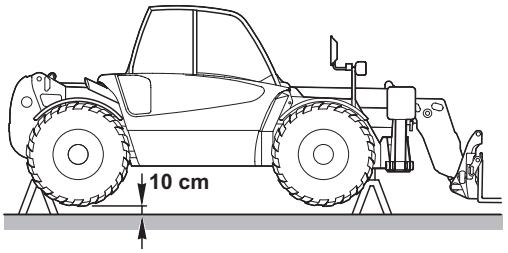

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Fig. G

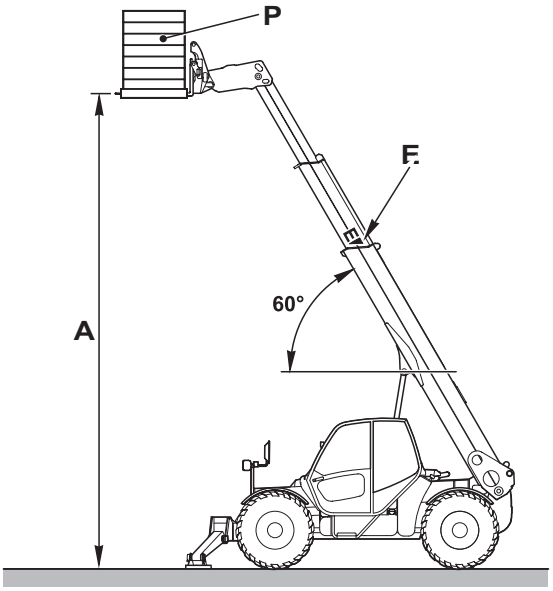

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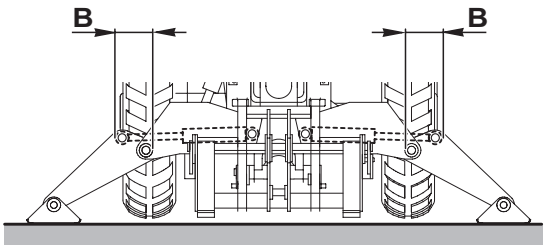
Fig. H



RKT01720

INTRODUCTION

IMPORTANT REMARKS

1 -Pressure checks should be performed with pressure gauges of appropriate scale.

2 -Analogue glycerine filled pressure gauges should be checked and, if necessary, calibrated before use. A maximum deviation of 0.5% at full scale is allowed.

3 -It is advisable to check the pressures using dual channel digital instruments supporting DP (Dynamic Pressure) measurement and controlled transducers, with error at full scale up to 0.5%.

4 -Temperatures should be checked using a digital probe thermometer; a maximum error of 1°C over 200°C is allowed.

5 -For rotation speeds, use a stroboscopic tachometer capable of measuring speeds between 10 and 4.000 rpm.
Unless specified otherwise, rpm values should be measured at the engine pulley.

6 -When measuring time – for voltage and current – use a centesimal chronometer and a tester.

7 -For engine checks and adjustments, please refer to manual no. WHBMNEF000.

⚠ DANGER

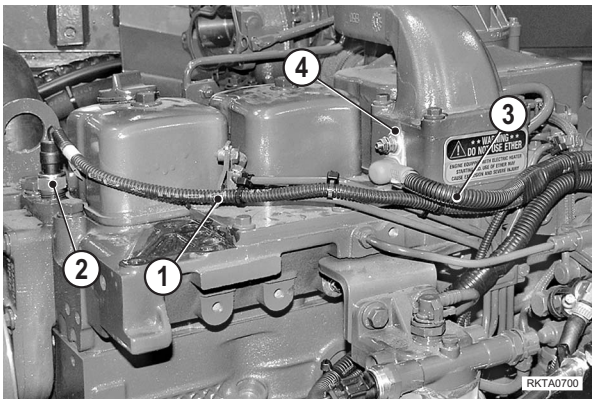
- Always park the equipment on flat, level ground before performing checks, adjustments or troubleshooting operations.
- Unless otherwise stated, the machine's safety devices (outriggers, blocks, parking brakes, etc.) should always be used when carrying out checking procedures.
- When more than one person is involved in carrying out work on the equipment, use the standard signs to indicate that the machine is undergoing maintenance. Do not allow unauthorised persons to stand in the nearby areas.
- Before attempting to check the level of the coolant liquid, allow the liquid to cool. Removing the radiator cap when the coolant liquid is still hot and under pressure may result in severe burns.
- Be extremely careful not to be caught in the moving parts of the equipment (generator belt, fan and rotating parts).

VALVE LASH ADJUSTMENT

⚠ Disconnect the cable from the negative (-) battery terminal.

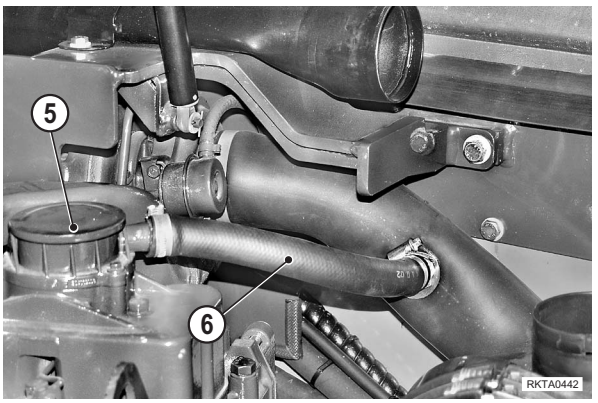
1 - Disconnect the wiring (1) connecting to the coolant liquid temperature sensor (2) and disengage it from the tie-straps.

2 - Disconnect the wiring (3) from the thermostart (4).



3 - Disconnect the oil vapour bleed hose (6) from the valve (5).

4 - Carry out the valve lash adjustment procedure by following the instructions given in the engine workshop manual (code no. WHBMNEF000).

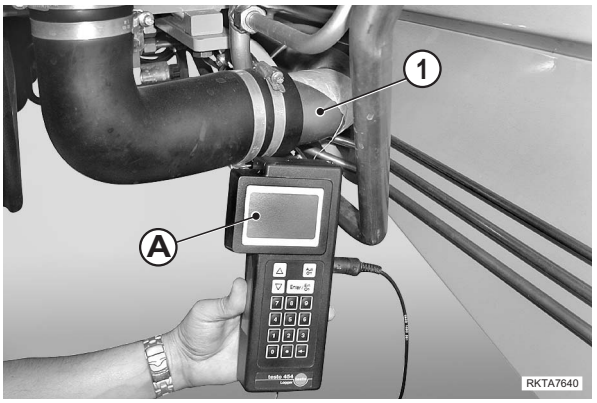


CHECKING ENGINE SPEED

⚠ When checking the engine rotation speeds, be extremely careful not to touch any hot parts and be aware that there is a danger of being caught in the rotating members.

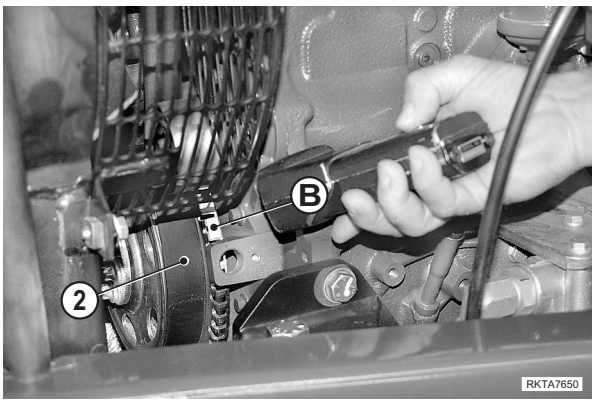
1 - Start the engine and heat the hydraulic oil and perform the entire range of movements that are carried out in normal working conditions, translations included.

★ Check the hydraulic oil temperature by placing the sensor of thermometer "**A**" to the pump suction pipe (1).
Temperature should be 50±5°C.



2 - Position the machine on firm, level ground with the transmission in NEUTRAL.

3 - Stop the engine and apply a measuring strip "**B**" to the engine pulley (2) for use by the stroboscopic tachometer.



• CHECKING THE ENGINE WITH NO LOAD

1 - Start the engine and check the following:
- Minimum engine speed with no load (accelerator pedal released).
- Maximum engine speed with no load (accelerator pedal at maximum position).

Measurement unit: rpm

MACHINE MODEL	ASPIRATED ENGINE		TURBO ENGINE	
	MIN.	MAX.	MIN.	MAX.
WH609-1	1050±50	2500±50	1050±50	2500±50
WH613-1	1050±50	2500±50	1050±50	2500±50
WH713-1	–	–	1050±50	2500±50
WH714-1	–	–	1050±50	2500±50
WH714H-1	–	–	1050±50	2500±50
WH716-1	–	–	1050±50	2500±50

★ If minimum and maximum engine speeds with no load are not within specifications, check the accelerator pedal position retainers and the accelerator cable conduit before starting any other operation (See "ADJUSTING ACCELERATOR CABLE LENGTH").

• CHECKING THE ENGINE UNDER LOAD

1. With stalled converter

1 - Run the engine at maximum speed and apply the service brakes.

2 - With the brakes still applied, engage the 2nd gear; allow the engine to stabilize, and then measure the rpm value.

⚠ Keep the machine in a stalled condition for the minimum time necessary (the interval should not to exceed 30 seconds) and wait at least 15 seconds between one test and the next.

Measurement unit: rpm

MACHINE MODEL	ASPIRATED ENGINE		TURBO ENGINE	
	MIN.	MAX.	MIN.	MAX.
WH609-1	1850	1850–2100	2015	2015–2100
WH613-1	1850	1850–2100	2015	2015–2100
WH713-1	–	–	2015	2015–2100
WH714-1	–	–	2015	2015–2100
WH714H-1	–	–	2015	2015–2100
WH716-1	–	–	2015	2015–2100

2. With stalled converter and hydraulic pump under load

1 - Run the engine at maximum speed and apply the service brakes.

2 - With the service brakes applied:

a - engage 2nd FORWARD gear;

b - perform a full equipment-crate curl and hold it in the full position;

c - turn the wheels as far as they will go;

3 - Within the conditions described above, allow the engine to stabilize, and then measure the rpm value.

4 - Repeat the checking procedure, this time with the 2nd REVERSE gear applied.

⚠ Keep the machine in a stalled condition for the minimum time necessary (this should not exceed 30 seconds) and wait at least 15 seconds between one test and the next.

Measurement unit: rpm

MACHINE MODEL	ASPIRATED ENGINE		TURBO ENGINE	
	MIN.	MAX.	MIN.	MAX.
WH609-1	1350	1350–2100	1550	1550–2200
WH613-1	1350	1350–2100	1550	1550–2200
WH713-1	–	–	1610	1610–2200
WH714-1	–	–	1610	1610–2200
WH714H-1	–	–	1610	1610–2200
WH716-1	–	–	1610	1610–2200

3. With hydraulic pump under load

1 - Apply the parking brakes.

2 - Run the engine at maximum speed.

3 - Perform an equipment crate curl and hold it in the full curl position.

4 - Turn the wheels as far as they will go and force steering.

5 - Within the conditions described above, allow the engine to stabilize, and then measure the rpm value.

Measurement unit: rpm

MACHINE MODEL	ASPIRATED ENGINE		TURBO ENGINE	
	MIN.	MAX.	MIN.	MAX.
WH609-1	2450	2550	2450	2550
WH613-1	2450	2550	2450	2550
WH713-1	–	–	2450	2550
WH714-1	–	–	2450	2550
WH714H-1	–	–	2450	2550
WH716-1	–	–	2450	2550

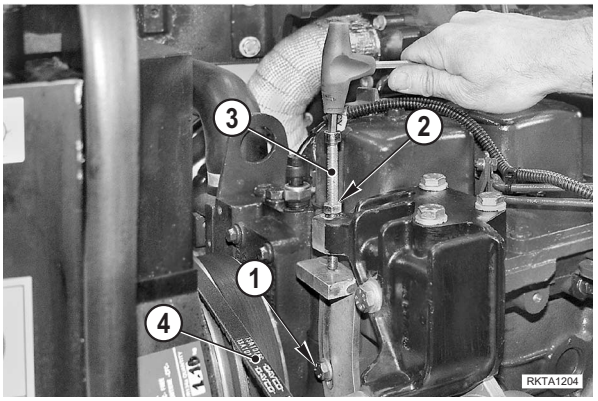
• ANALYSIS

1 - If the readings are not within the prescribed values, check the engine by following the instructions given in the relevant manual, code no. WHBMNEF000.

TENSIONING THE AIR CONDITIONER COMPRESSOR BELT.

1 -Loosen the screw (1) and nut (2).

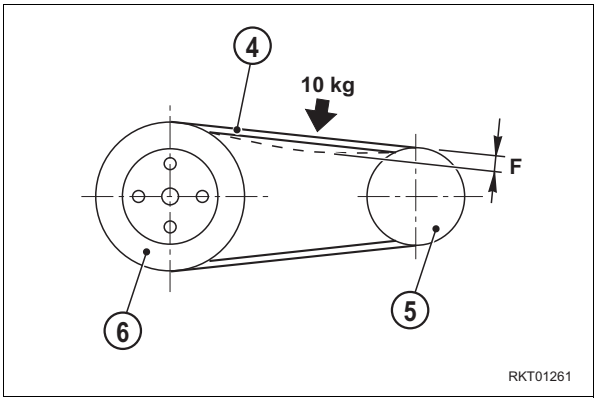
2 -Turn the screw (3) clockwise to tension the belt (4).



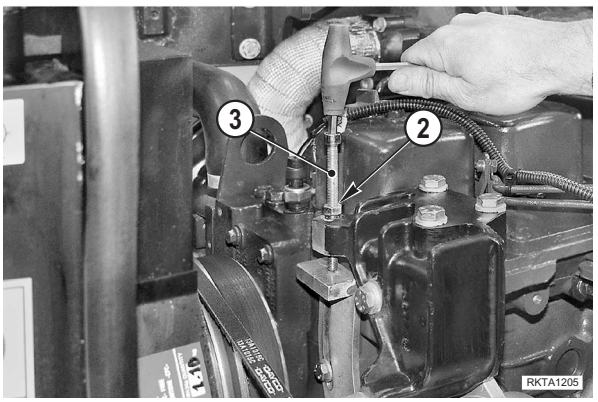
3 -Apply a 10 kg force at the centre of the segment from compressor pulley (5) to engine pulley (6).

4 -Check the resulting "**F**" arrow.

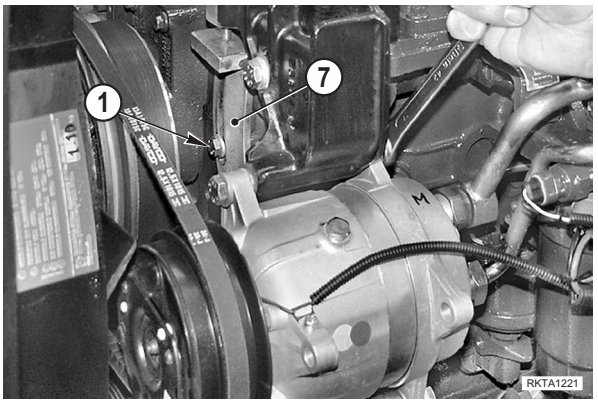
★ **F** = 4-6 mm (normal tension)
F = 3 mm (new belt)



5- Once proper tension is achieved, retain the position of the adjusting screw (3) by tightening the nut (2).

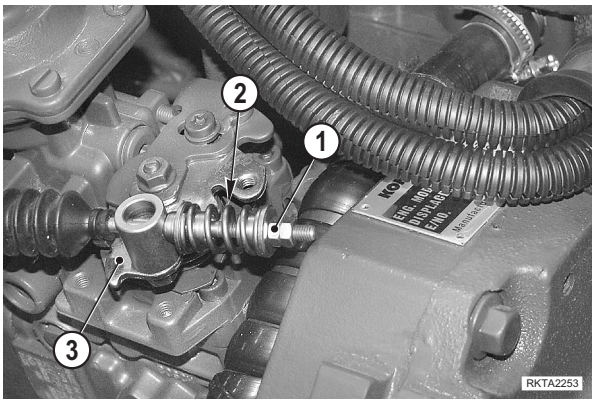


6 -Lock the adjusting bracket (7) with the screw (1).

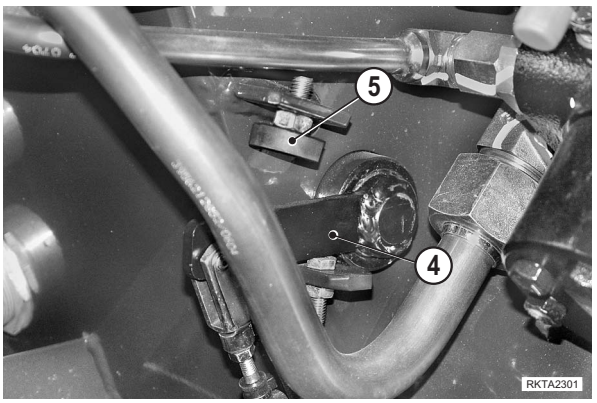


ADJUSTING ACCELERATOR CABLE LENGTH

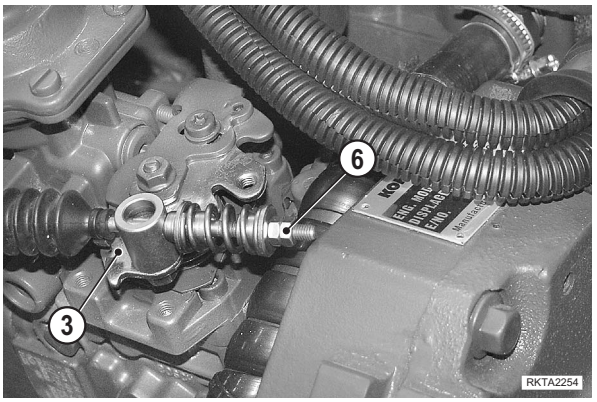
1 - Tighten the nut (1) until lash from the spring (2) is eliminated and the spring is loaded by approximately 1 mm.



2 - Press the accelerator pedal to the floor and make sure the injection pump control lever (3) performs its full travel when the accelerator pedal lever (4) contacts the elastic pad (5).



3 - Lock the check-nut (6).



ADJUSTING BRAKE PEDAL TRAVEL AND POSITIONING THE STOP LAMP MICROSWITCHES

1 - Position the machine on firm level ground with the boom fully retracted and lowered; stop the engine and remove the ignition key.

2 - Install wedges under the wheels.

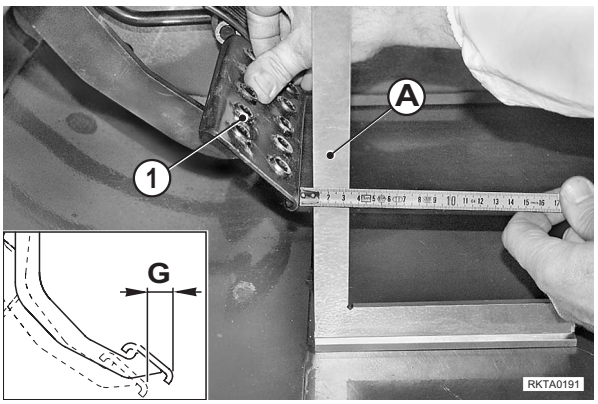
- **Checking procedure**

1 - Remove the mat.

2 - Place a square (**A**) to the cab floor and move the square close to the edge of the brake pedal (1).

3 - Press the brake pedal by hand and check pre-travel.

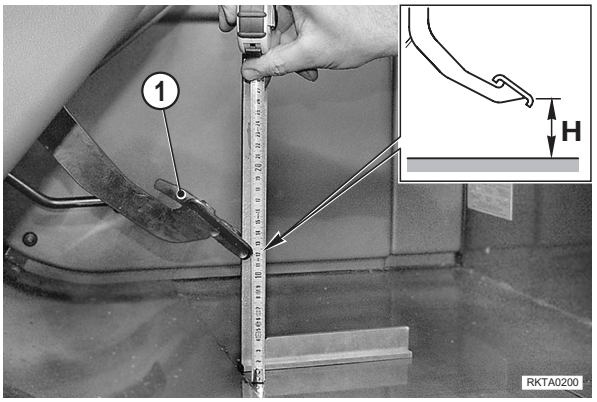
★ Normal pre-travel "**G**": 7 +1 -1 mm



4 - Release the pedal (1) and check the position height wise.

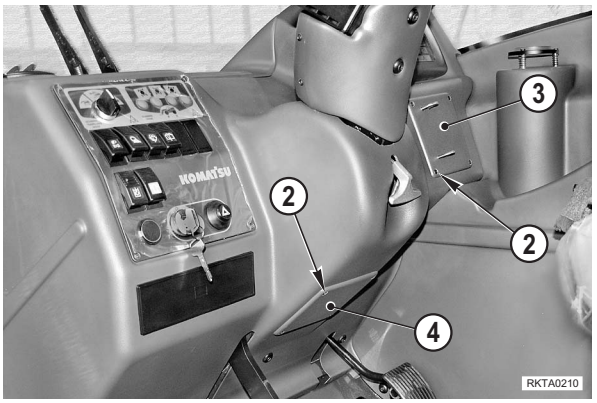
★ Normal height "**H**": 110 +2 -2 mm

5 - If either value is not within specifications, adjust as needed.



- **Pedal height adjustment**

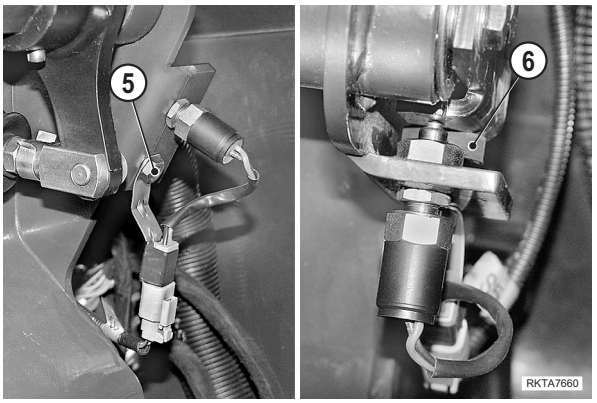
1 - Loosen the screws (2) and remove the covers (3 and 4).



2 - Loosen the nut (5) and adjust pedal height (1) using the stop pad (6).

★ Normal height: 110±2 mm

3 - When adjustment is complete, lock the pad (6) with the nut (5).



- **Sprag length adjustment**

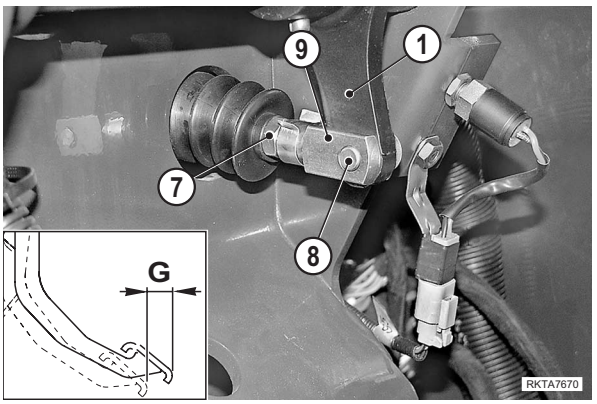
1 - Loosen the nut (7).

2 - Remove the pin (8) connecting the sprag to the pedal (1).

3 - Tighten or loosen the fork (9) in relation to the sprag to adjust pedal pre-travel to specification.

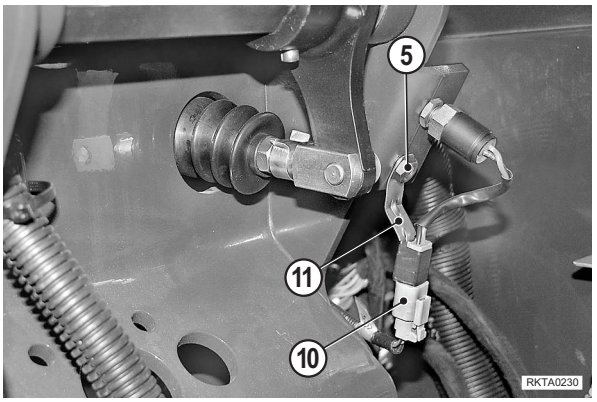
★ Pre-travel "**G**": 7±1 mm

4 - Install the pin (8) to its final position and lock the nut (7).



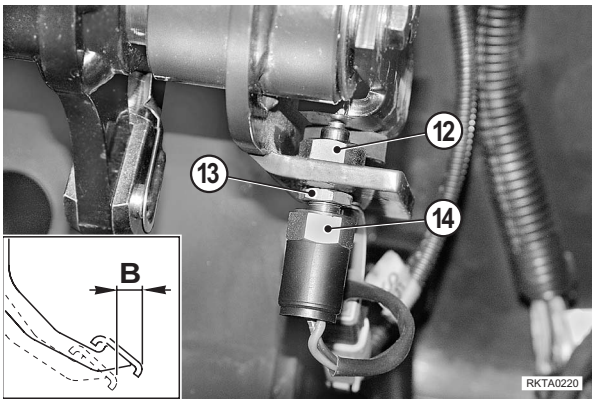
- **Microswitch adjustment**

1 - Disconnect the connector (10), remove the nut (5) and the connector support (11).



2 - Loosen nuts (12 and 13) and adjust the position of the lamp stop microswitch (14), which should be abandoned by the pedal after travel "**B**".

★ Travel "**B**": 11±2 mm



ADJUSTING THE PARKING BRAKES

⚠ These adjustments should be carried out with the axle levers adjusted to the specified clearances. (For details, please refer to "30 REMOVAL AND INSTALLATION").

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

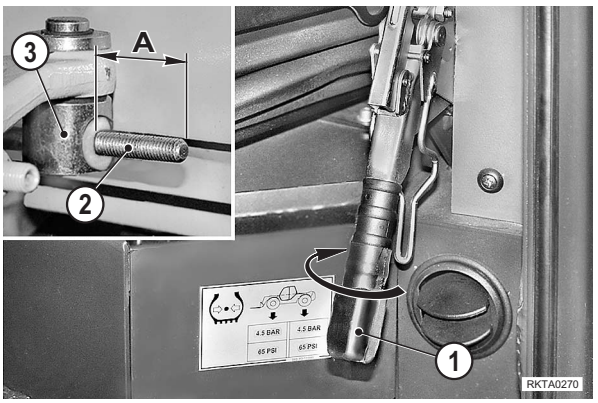
3 - Stop the engine and remove the ignition key.

- **Brake cable length adjustment.**

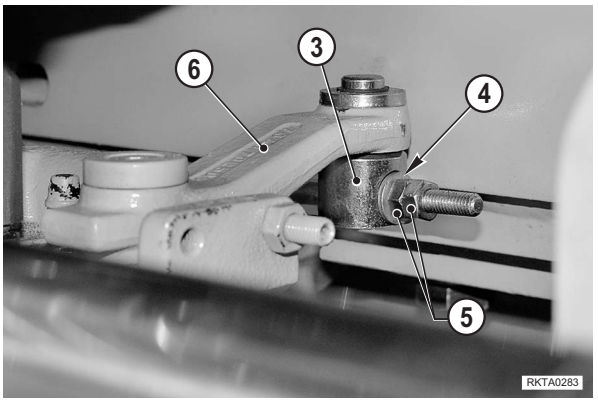
1 - With the lever in the full down position, rotate the parking brake knob (1) clockwise to obtain a projection "**A**" of the cable end (2) in relation to the brake lever gauge block (3).

★ **A** = 32±1 mm.

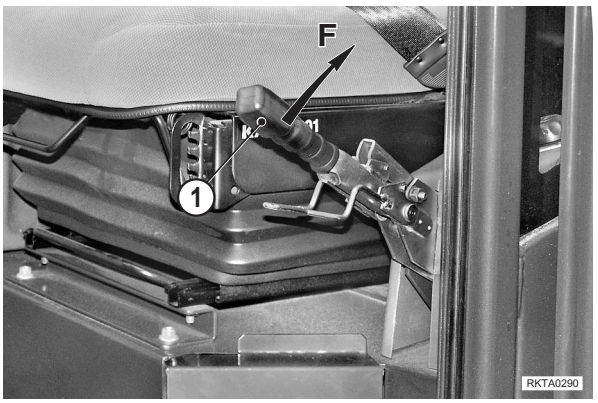
NOTA
Direction of rotation is as it would be for the Operator sitting in the driver seat.



2 - Install the washer (4) and two nuts (5); tighten the nuts (5) until the washer (4) contacts the gauge block (3) of lever (6).
Lock the nuts (5) into position.



3 - Apply a force gauge to the centre of the handle (1) and make sure that the lever back stop is triggered when a 402 Kg force "**F**" is applied "**F**" di 40⁑2 kg.



- **Functional check**

★ Check conditions:
- Tire pressures within specifications.
- Dry, solid road surface with a gradient of 20% approx.
- Machine in operating conditions with no load.

1 - Start the engine and align the machine to drive on a straight line, and then drive up the slope with 20% gradient.

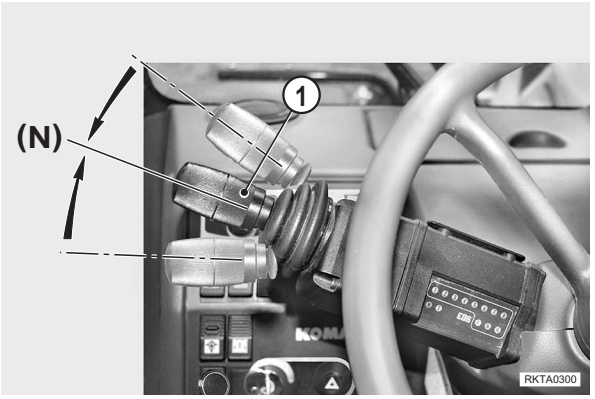
2 - Stop the machine by applying the service brake; move the reversing control lever (1) to the neutral position (N).

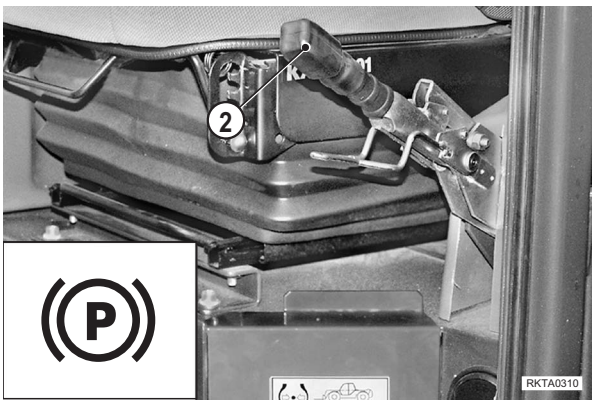
3 - Apply the parking brake (2) (lock position), slowly release the service brake and ensure the machine does not move.

4 - If the machine shows signs of moving downwards, press the service brake pedal, move the brake lever to the unlock position and rotate the lever end (2) anticlockwise by 2 or 3 turns.

5 - Apply the parking brake and check again.

6 - Stop the engine and leave the machine in place for 3 minutes. The machine MUST NOT move for the entire three-minute period.





BLEEDING AIR FROM CIRCUITS

• Pump housing fill

★ The pump housing must be filled:

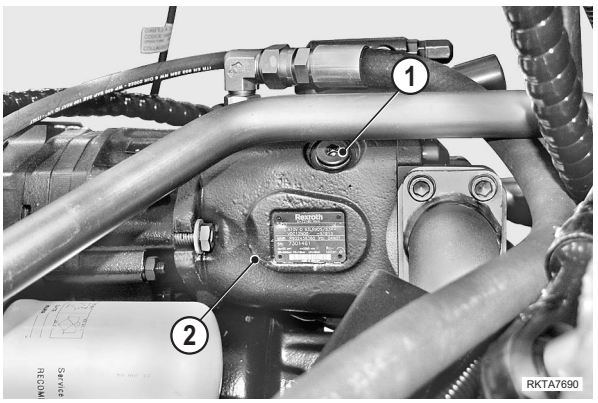
a - Whenever the pump is removed.

b - Whenever the drain hose or suction pipe is removed or replaced.

c - Whenever the hydraulic oil is changed or the tank undergoes maintenance.

1 - Remove the cap (1) and introduce hydraulic oil into the pump housing (2) until the level reaches the locating hole.

2 - Reinstall the cap (1).



• Bleeding air from cylinders

★ The air bleeding procedure should be performed before operating the machine in normal conditions whenever the hydraulic cylinders or the pipes/hoses connected to them are removed.

★ Tackle one movement at a time, starting with the main cylinders (boom extension and boom up).

1 - Start the engine and run the engine at high speed for about 5 minutes to heat the oil.

2 - Return the engine to idle and cause the 1st piston you want to bleed to extend and retract several times.

★ Extend and retract the pistons to within 100 mm approx. of the limit stops.

3 - Stop the engine, check and top up the oil level.

4 - Run the engine at maximum speed and repeat the procedures described in step 2. Return the engine to idle and allow the piston to travel its full stroke until the hydraulic pump is under max. pressure.

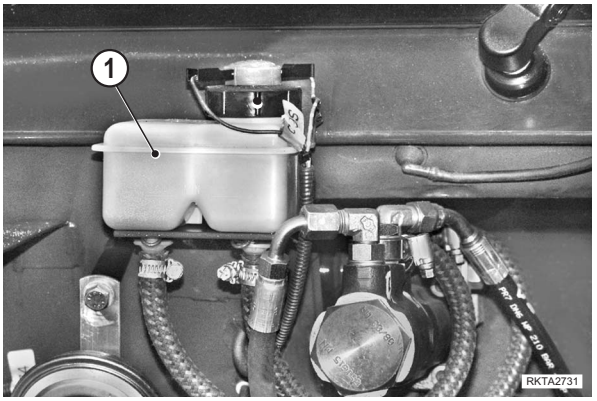
5 - Repeat the procedures (starting from step 2) on all cylinders and make sure you frequently check the oil level.

• Bleeding air from brake circuits

★ This procedure should be carried out whenever work is performed on the brake circuit to remove or replace a component, or when air enters the circuit.

★ The machine should be stopped, with the equipment to the ground.

1 - Make sure the oil in the brake system oil tank (1) is at max level.



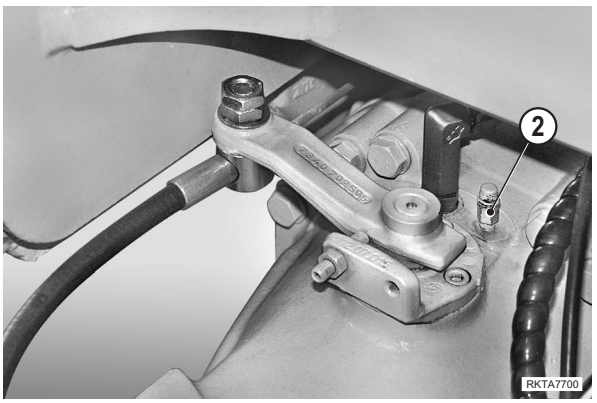
2 - Remove the safety caps and apply a clear hose (3) to the bleed screws (2) to collect the oil.

3 - Press the brake pedal to the floor and simultaneously loosen the bleed screw (2) of the brake unit under maintenance until the pedal reaches the end of its travel.

4 - Hold the pedals at the end of their travel while simultaneously tightening the bleed screw (2).

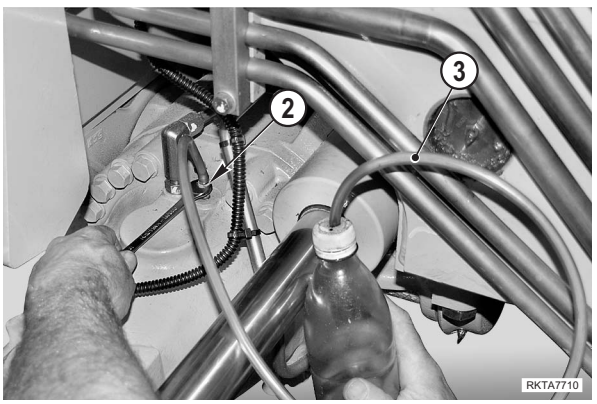
5 - Release the brake pedal, wait a few seconds, and repeat the steps described so far until there are no bubbles in the oil coming out of the bleed screw.

6 - Repeat the same steps on the other brake units.



★ Frequently check the oil level in the oil tank and fill whenever the level is near minimum.

★ At the end of the bleeding procedure, apply the safety caps to the screws (2).



PREPARING THE MACHINE READY FOR HYDRAULIC PRESSURE CHECK AND CALIBRATION

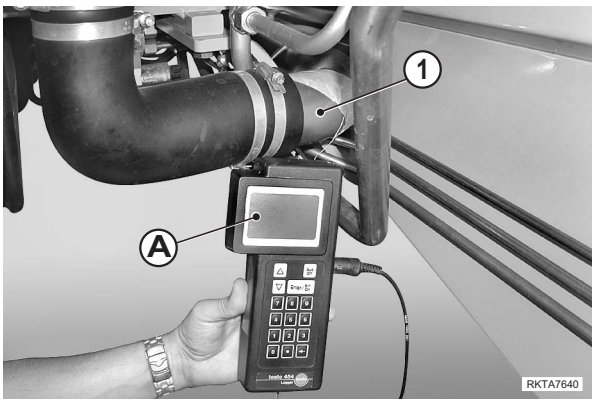
NOTICE

Some checking procedures described here require the provisional installation of mini-taps. These taps should be removed at the end of the checks.

1 - Position the machine on firm, level ground with the transmission in NEUTRAL and the parking brakes applied.

2 - Start the engine and heat the hydraulic oil, and perform the entire range of movements that are carried out in normal working conditions.

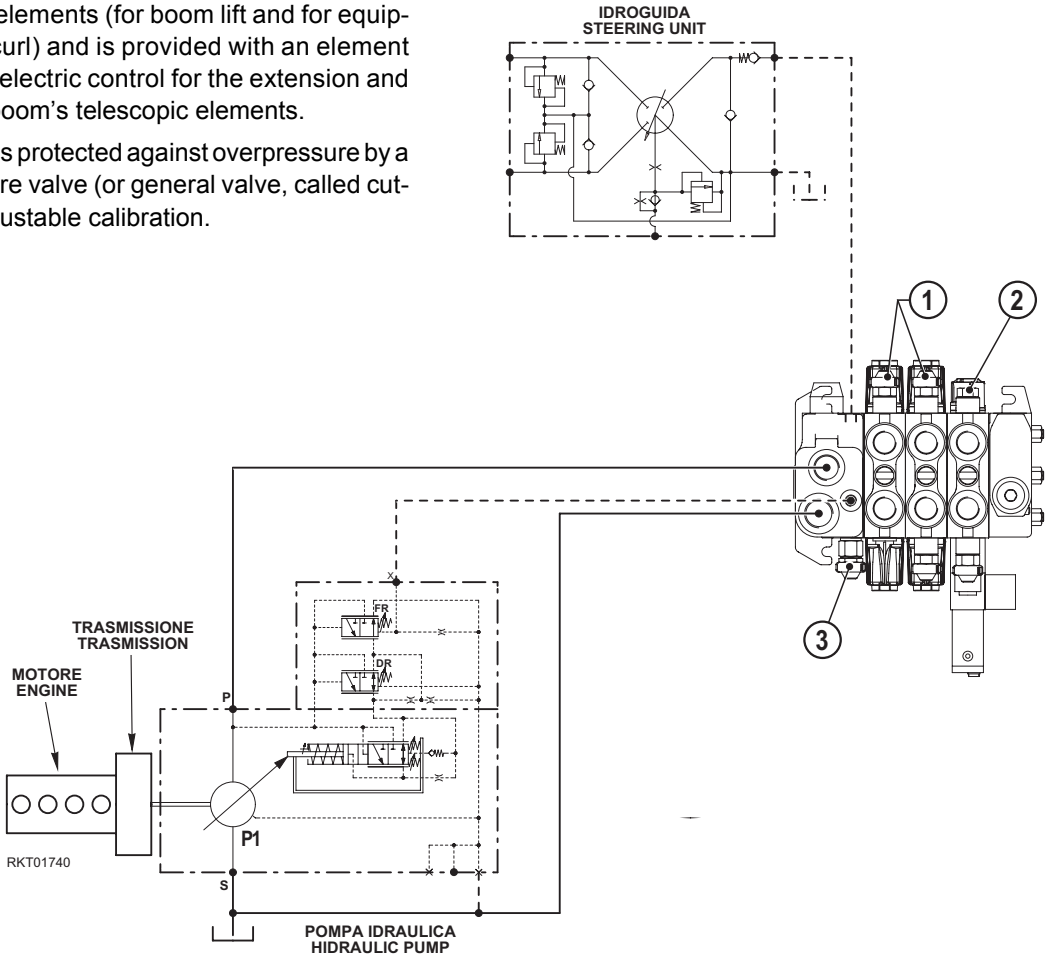
★ Check the hydraulic oil temperature by placing the sensor of thermometer "**A**" to the pump suction pipe (1). Unless specified otherwise, temperature should be 50±5°C.



CHECKING AND CALIBRATING WORK EQUIPMENT HYDRAULIC PRESSURES

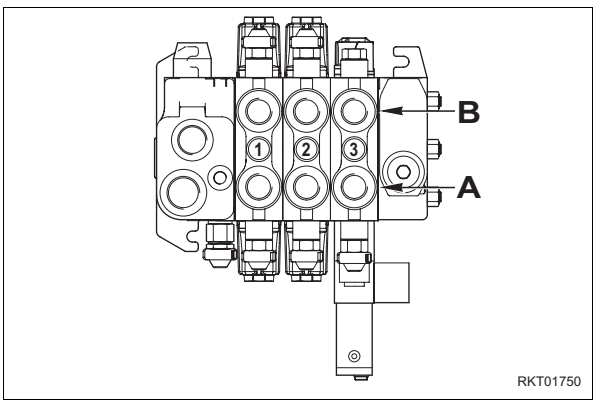
FOREWORD

- The machine is equipped with a control valve with two servo-controlled elements (for boom lift and for equipment dump and curl) and is provided with an element with proportional electric control for the extension and retraction of the boom's telescopic elements.
- The control valve is protected against overpressure by a maximum-pressure valve (or general valve, called cut-off valve) with adjustable calibration.

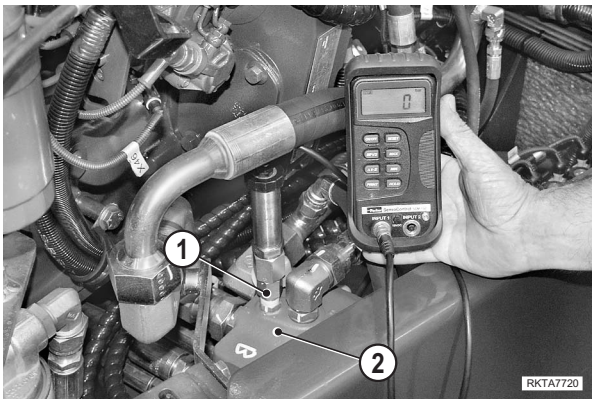


- The control valve is fed by the total capacity of pump P1.
- The capacity of pump **P1** is partialized by the priority valve (inside the control valve head) whenever the power steering is engaged for a steering manoeuvre.
- The control valve contains spools which control the following:

CONTROL	USE
Boom cylinder (Up/Down movement)	A1 - B1
Equipment cylinder (Dump/Curl)	A2 - B2
Telescopic cylinder (Extension/Retraction)	A3 - B3



1. CALIBRATION CHECK GENERAL VALVE (Cut-off valve)



★ Check conditions:
- Engine: at operating temperature
- Hydraulic oil 50±5 °C
- Parking brakes: applied

1 - Connect a 600 bar pressure gauge to the pressure tap (1) of the control valve (2).

2 - Start the engine and run it at IDLE and check the calibration pressure of the cut-off (general) valve while forcing the boom down to the end of its travel.

★ Calibration pressure: 260±7 bar

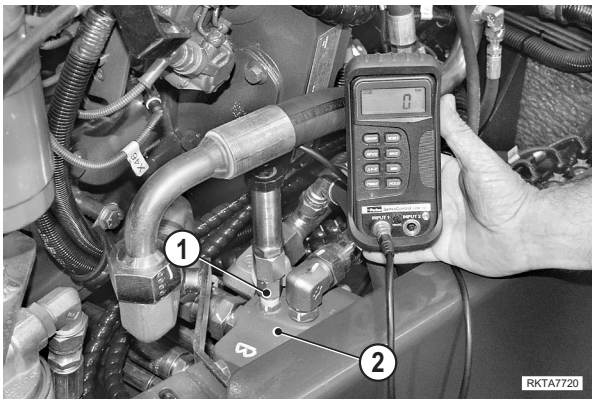
3 - Using the same method as above, also check calibration pressure with the engine running at 2000 rpm.

★ Max allowable variation: 5 bar

★ If general valve pressure does not match the specified value, perform the calibration procedure. (For details, please refer to "3. GENERAL AND SECONDARY VALVE CALIBRATION").

2. SECONDARY VALVE CALIBRATION CHECK

• Boom lift and extension



★ Check conditions:
- Engine: at operating temperature
- Hydraulic oil: 50±5 °C
- Parking brake applied

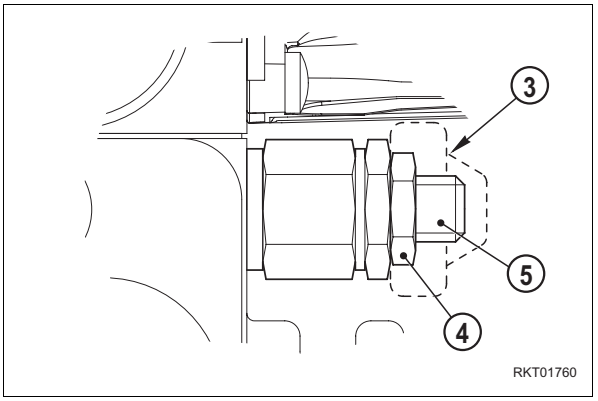
★ All pressure readings are taken at the same check point.

1 - Connect a 400 bar pressure gauge to the pressure tap (1) of the control valve (2).

2 - Remove the general valve seal (3), loosen the nut (4) and tighten the pressure regulating screw (5) by 2 turns. Lock the nut (4).

3 - Start the engine and run it at IDLE; perform a full boom lift motion and measure max pressure.

★ Normal pressure: 275±7 bar.



4 - Lower the boom and, with the engine at IDLE; extend boom to end of travel and measure max pressure.

★ Normal pressure:
WH609-WH613
WH713-WH714-WH714H: 275±7 bar
WH 716: 190±7 bar

★ If valve calibration is not within specifications, perform the calibration procedure. (For details, please refer to "3. GENERAL AND SECONDARY VALVE CALIBRATION").

5 - Loosen the nut (3) and loosen the cut-off valve adjusting screw (4) until normal pressure is restored. This should be checked using the procedure described at step 2.

6 - Install a new seal (orange colour).

• Equipment dump and curl

NOTE
These checks require no change to the calibration of the general valve.

★ Check conditions:
- Engine: at operating temperature
- Hydraulic oil: 50±5 °C
- Parking brake applied

★ All pressure readings are taken at the same check point.

1 - Connect a 600 bar pressure gauge to the pressure tap (1) of the control valve (2).

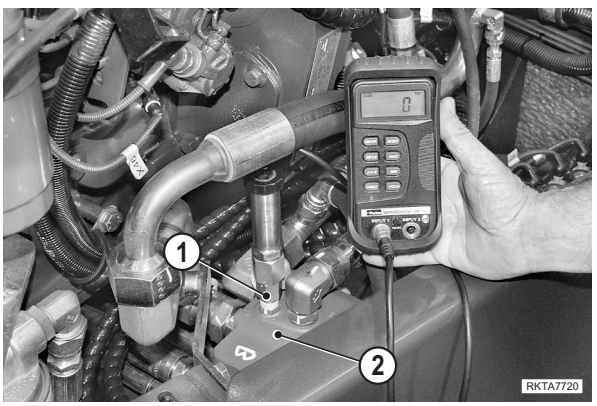
2 - Start the engine and run it at IDLE; perform a full equipment dump motion and measure the max pressure value.

★ Normal pressure: 200±7 bar

3 - Also check max pressure with a full equipment curl.

★ Normal pressure: 200±7 bar

★ If valve calibration is not within specification, perform the valve calibration procedure. (For details, refer to "3. GENERAL AND SECONDARY VALVE CALIBRATION").



3. GENERAL AND SECONDARY VALVE CALIBRATION

- **General cut-off valve (1)**

⚠ Prepare the machine for calibration as described for the pressure checking procedure.

1 -Remove the tamper seal (2) (yellow colour)

2 -Loosen the retaining nut (3).

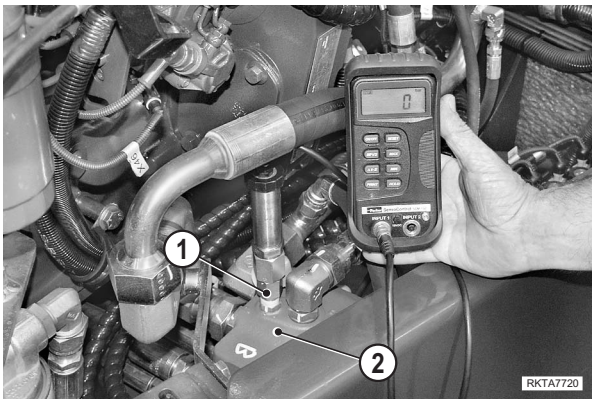
3 -With the engine at IDLE, lower the boom to the end of its travel.

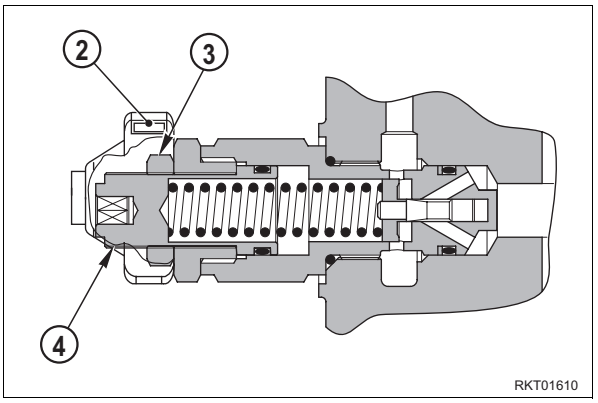
4 -Adjust maximum pressure using the screw (4) provided.
- Turn the screw CLOCKWISE to INCREASE pressure.
- Turn the screw COUNTER-CLOCKWISE to DECREASE pressure.

5 -Tighten the nut (3) to retain the position.

Retaining nut: 20 Nm

6 -Install a new tamper seal (2) (orange colour).





- **Secondary valves**

⚠ Prepare the machine for calibration as described for the pressure checking procedure.

★ This calibration applies to all secondary valves and can be inspected by forcing the movement to the end of its travel when checking.

1 -Loosen the retaining nut (1).

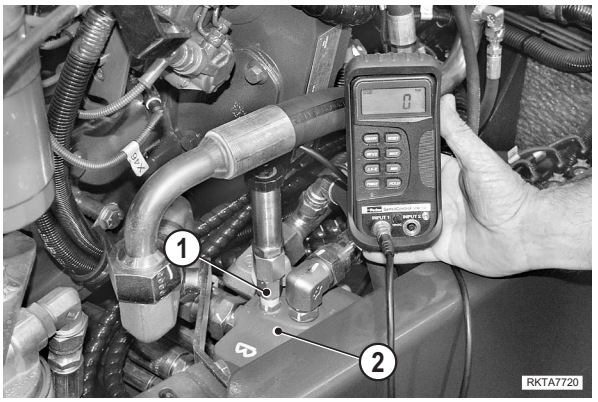
2 -Adjust pressure using the adjusting screw (3).
- Turn the screw CLOCKWISE to INCREASE pressure.
- Turn the screw COUNTER-CLOCKWISE to DECREASE pressure.

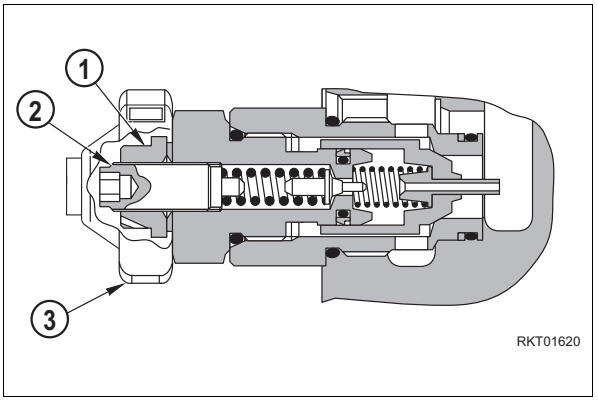
3 -Tighten the nut (2) to retain the position.

Retaining nut: 10±1 Nm

⚠ At the end of adjustment, apply a protection (1) (orange colour) against unauthorized tampering.

4 -Restore the general valve pressure.





4. SERVOCONTROL PRESSURE CHECK

★ Check conditions
- Engine: stopped but at operating temperature
- Hydraulic oil: 50±5 °C
- Parking brake: applied

1 - Remove the PV cap from the servocontrol feed assembly (1) and install a mini-tap (2).

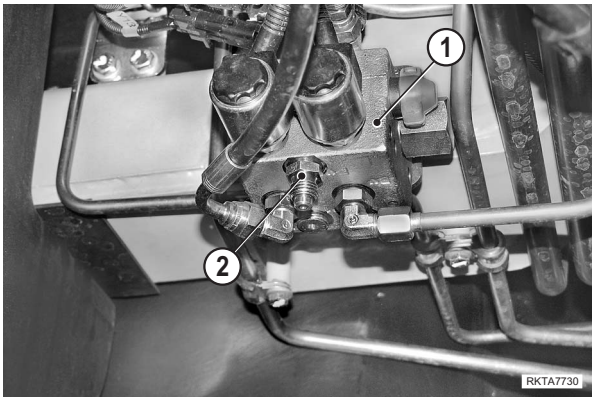
2 - Connect a 60 bar pressure gauge.

3 - Start the engine and run it at IDLE; perform a full curl motion and check max pressure.

★ Normal pressure: 35 $^{0}_{-}$3.5 bar

4 - Gradually run the engine to MAX speed, checking pressure stability.

★ Max allowable variation: 2 bar



5. CHECKING STEERING PRESSURE AND PRIORITY VALVE OPERATION

★ Check conditions:
- Engine stopped but at operating temperature.
- Hydraulic oil: 50±5 °C.
- Parking brakes applied.

• LS signal check

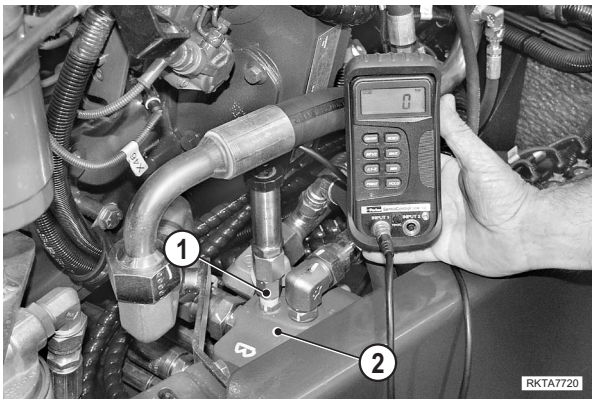
1 - Connect a 60 bar pressure gauge to the pressure tap (1) of the control valve (2).

2 - Start the engine and operate it at 1500 rpm.

3 - Check the pressure value on the pressure gauge with the steering wheel stopped.

★ Normal value: 21±1 bar

4 - Stop the engine and replace the 60 bar pressure gauge with a 600 bar gauge.



5 - Start the engine, operate at 1500 rpm and start a light steering manoeuvre, making sure that pressure increases.

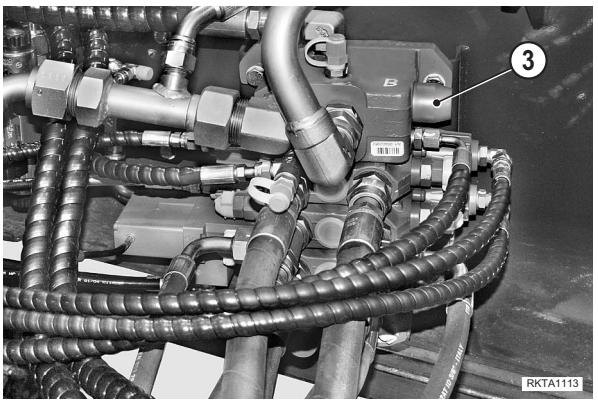
6 - Continue steering until full steering is obtained and make sure that the pressure increases to normal value when the steering wheel is forced.

★ Normal pressure:
WH609 - WH613: 180±5 bar
WH713 - WH714 - WH714A - WH716: 185±7 bar

7 - Ensure that no pressure variation exceeding 5 bar is experienced when increasing to MAX speed.

★ If pressure fails to reach normal value, perform the steering system pressure calibration procedure. (For details, please refer toe "CALIBRATING THE PRESSURE OF THE STEERING SYSTEM").

★ If the pressure displayed on the pressure gauge shows no variation when turning the steering wheel, and the effort needed to execute the steering operation is high, inspect the operation of the priority valve (3).



• Inspection of priority valve operation

1 - Remove the valve plug (4), spring (5), and stem (6) from the priority valve (3).

★ Note down the assembly sequence.

2 - Detach the plug (7) and remove the ball (8) of the inner valve and remove the spring (9).

3 - Check the hole (10) and nozzle (11) for being clean.

4 - Reinstall the spring (9), ball (8) and plug (7).

Plug: Loctite 542

Plug: 20 Nm

★ Do not allow Loctite to penetrate inside the hole (10).

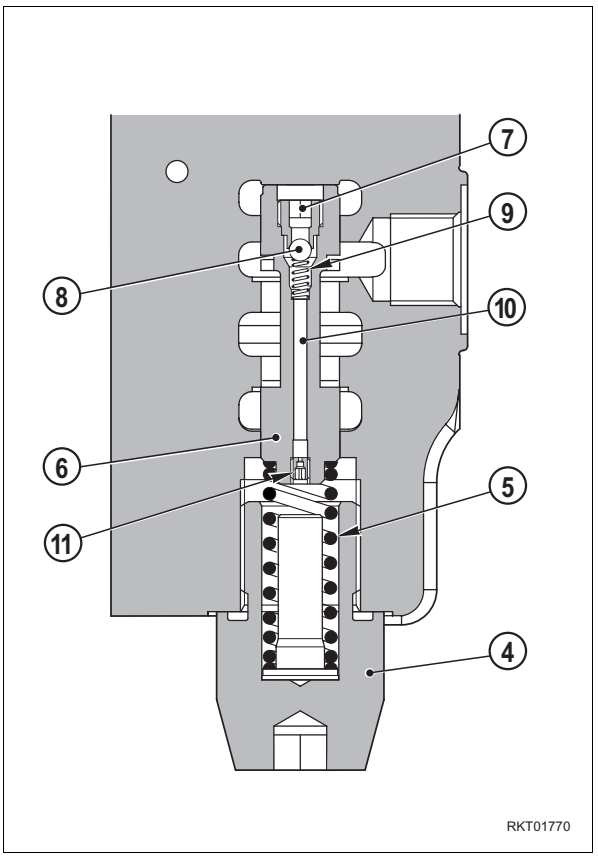
★ Remove any excess Loctite from the valve stem (6).

5 - Lubricate the valve stem (6) and seat it, making sure it slides freely.

6 - Introduce the valve spring (5) and install the valve plug (4).

Plug: 100 Nm

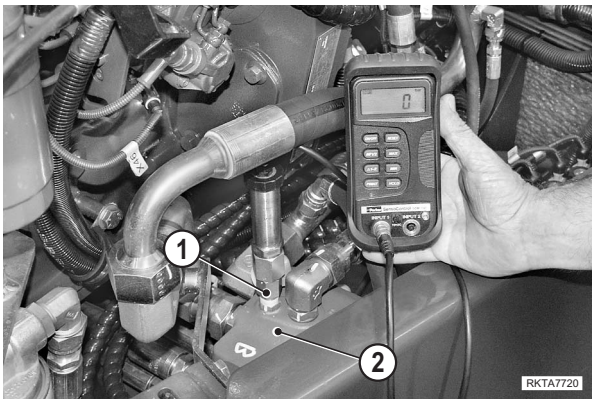
7 - Start the engine, perform a few steering manoeuvres, and if the malfunction is not eliminated, replace the complete valve stem.



CALIBRATING THE PRESSURE OF THE STEERING SYSTEM

★ Check conditions:
- Engine stopped but at operating temperature
- Hydraulic oil: 50±5 °C.

• Checking procedure



1 - Connect a 600 bar pressure gauge to the pressure tap (1) of the control valve (2).

2 - Start the engine and operate the engine at 1500±50 rpm and perform a full steering motion.

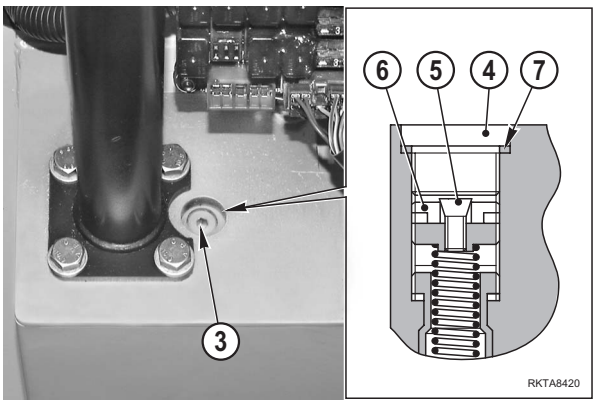
3 - Force the steering wheel as far as it will go while simultaneously checking the steering pressure.

★ Normal pressure:
WH609 - WH613: 180±5 bar
WH713 - WH714 - WH714A - WH716: 185±7 bar

4 - Perform an identical check on the opposite steering direction.

• Calibration procedure

If pressure is not within specification, perform the calibration procedure through the power steering maximum-pressure valve (3).



1 - Remove the plug (4).

2 - Introduce a 4-mm hex wrench and loosen the screw (5).

3 - Adjust pressure using the adjusting screw (6).
- Turn the screw CLOCKWISE to INCREASE pressure.
- Turn the screw COUNTER-CLOCKWISE to DECREASE pressure.

4 - Stop the engine and retain the position of the adjusting screw (6) by tightening the screw (5).

5 - Reinstall the plug (4), ensuring that the seal (7) is correctly in place.

INSPECTING THE OPERATION OF THE UNLOADING VALVE

★ Check conditions:
- Engine stopped but at operating temperature
- Hydraulic oil: 50±5 °C.
- Parking brakes: applied

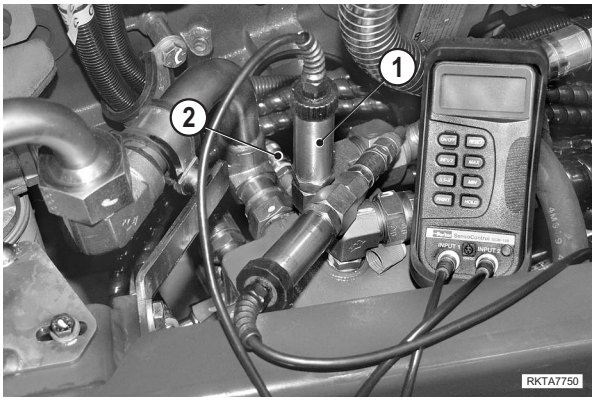
1 - Connect the 600 bar digital pressure gauge for multiple readings to feed pressure tap "**P"** (1), and to pressure tap **LS** (2).

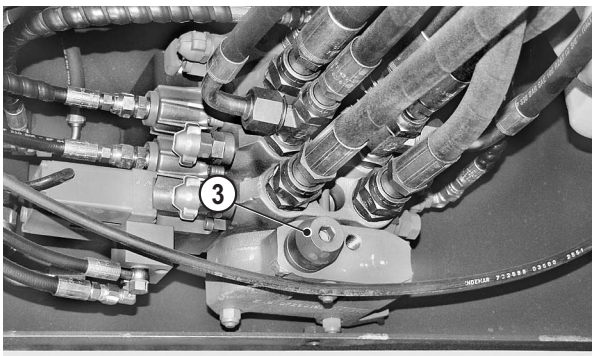
2 - Start the engine and operate it at MAX speed with no load.

3 - When the speed is stabilized, check the **DP** on the pressure gauge display.

★ Normal difference: 21±1 bar

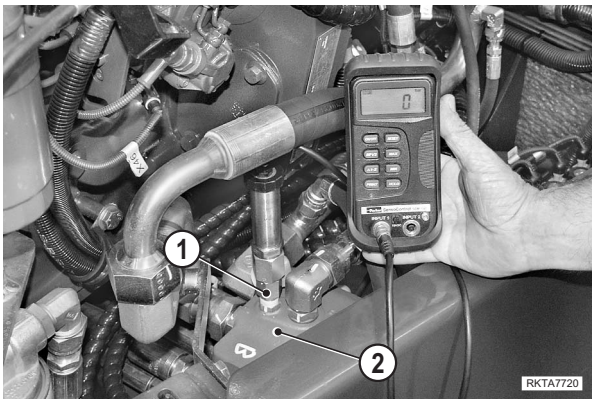
★ If the difference in pressure is not within specification, replace the unloading valve (3).





CHECKING AND CALIBRATING THE DR VALVE (PUMP FLOW VARIATION)

• Checking procedure



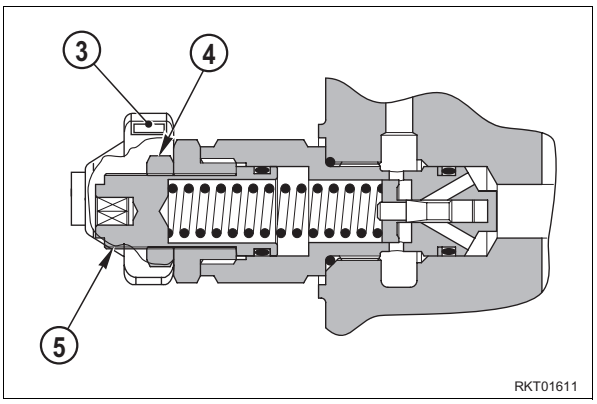
★ Check conditions:
- Engine stopped but at operating temperature.
- Hydraulic oil: 50±5 °C.
- Parking brakes applied.

1 - Connect a 600 bar pressure gauge to the pressure tap (1) of the control valve (2).

2 - Remove the general valve seal (3), loosen the nut (4) and tighten the pressure regulating screw (5) by 2 turns. Lock the nut (4).

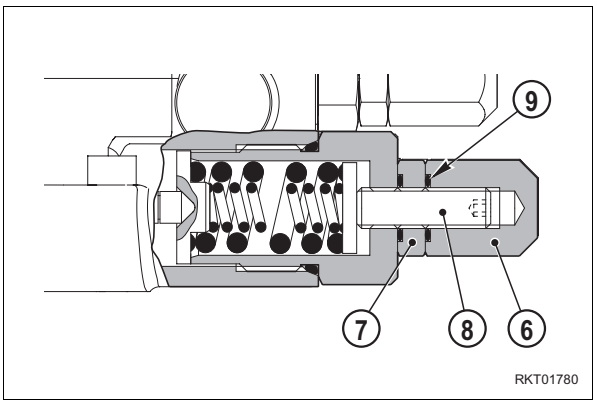
3 - Start the engine and run it at IDLE; lower the boom to its maximum travel and check max pressure.

★ Normal pressure: 280⁑5 bar



• Calibration procedure

If calibration does not match the specified value:



1 - Remove the cap (6).

2 - Loosen the nut (7).

3 - Adjust pressure using the adjusting screw (8).
- Turn the screw CLOCKWISE to INCREASE pressure.
- Turn the screw COUNTER-CLOCKWISE to DECREASE pressure.

7 - Tighten the nut (7) to retain the position.

Retaining nut: 21 Nm

8 - Check the grommet (9) and install the cap (6).

Cap: 21 Nm

9 - Loosen the nut (4) and loosen the cut-off valve adjusting screw (5) until normal pressure is restored. (For details, please refer to "3. GENERAL AND SECONDARY VALVE CALIBRATION").

10 - Install a new seal (3) (orange colour).

CHECKING THE DYNAMIC PUMP DP VALUE

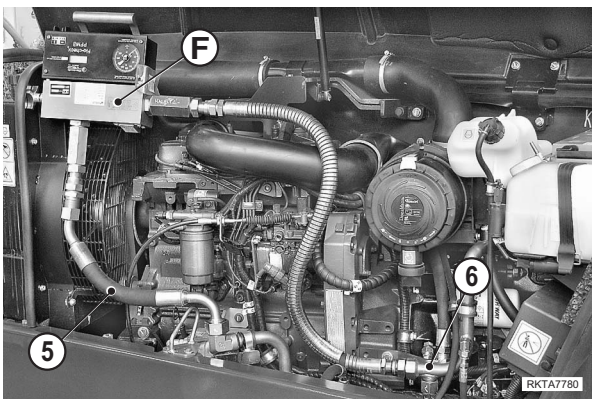
★ Check conditions:
- Engine stopped but at operating temperature.
- Hydraulic oil: 50±5 °C.
- Parking brakes applied.

1 - Remove the plug (**P**) from the pump flow regulating unit (1) and install a pressure tap (2).

2 - Disconnect the **LS** (3) hose from the regulating unit, install a pressure tap (4) and reconnect the hose.

3 - Connect two 600-bar pressure gauges or transducers to the pressure taps.

4 - Disconnect the control valve feed hose (5) and introduce a flow meter "**F**" between the pump feed hose (6) and hose (5).

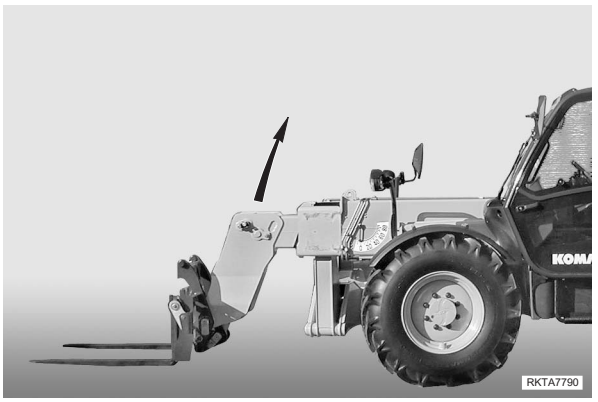


5 - Start the engine and start lifting the boom at increasing speed until a steady flow of 45±3 ℓ/min. is displayed on the flowmeter (**A**).

6 - Once the value is reached, check the pressure on the **P** and **LS** pressure gauges and perform a calculation to obtain the difference in pressure, or check the **DP**.

★ Repeat the measurements several times and calculate the average.

★ Normal DP: 17.5±1 bar



- If pressure is not within specifications:

7 - Remove the cap (7).

8 - Loosen the nut (8).

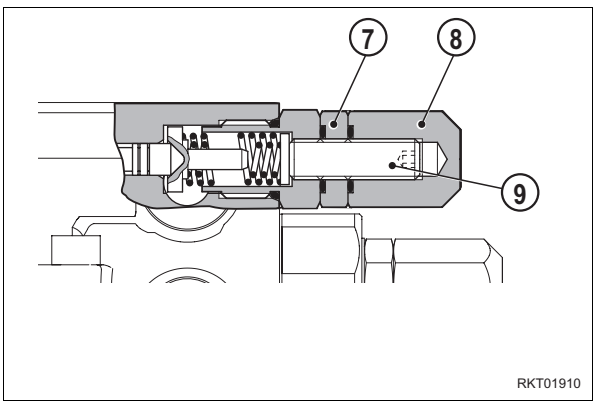
9 - Adjust pressure using the adjusting screw (9).
- Turn the screw CLOCKWISE to INCREASE pressure.
- Turn the screw COUNTER-CLOCKWISE to DECREASE pressure.

10 - Tighten the nut (8) to retain the position.

Retaining nut: 21 Nm

11 - Check the grommet and install the cap (7).

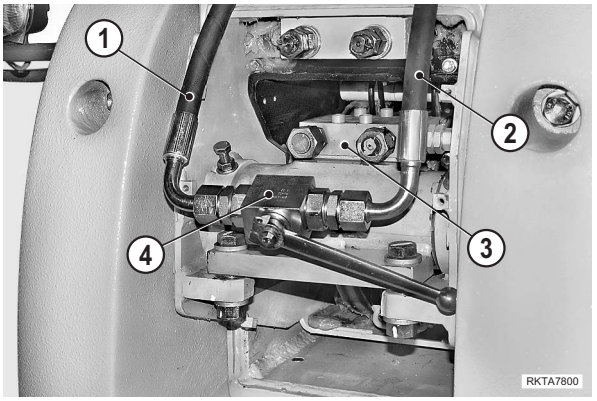
Cap: 21 Nm



CHECKING PUMP FLOW

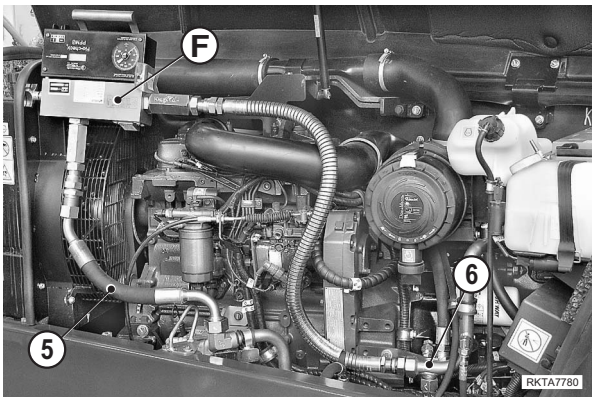
★ Check conditions:
- Engine: stopped but at operating temperature
- Hydraulic oil: 50±5 °C.
- Parking brake: applied

1 - Disconnect the hoses (1) and (2) from the boom extension and retraction cylinder lock valve (3) and connect them to a two-way valve (4).



2 - Disconnect the control valve feed hose (5) and introduce a flow meter "**F**" between the pump feed hose (6) and hose (5).

3 - Connect a 600 bar pressure gauge to the pressure tap (7) of the control valve (8).



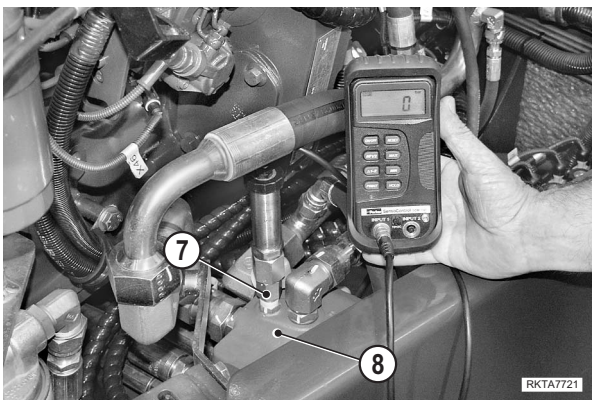
4 - Start the engine and operate it at 2000 rpm under load, operating the boom retraction control and gradually tightening the valve (4) until a pressure of 200±1 bar is reached; then, check pump flow.

★ Normal flow: MIN = 92 ℓ/min
MAX = 98 ℓ/min

5 - Repeat the same check at a pressure of 230±1 bar

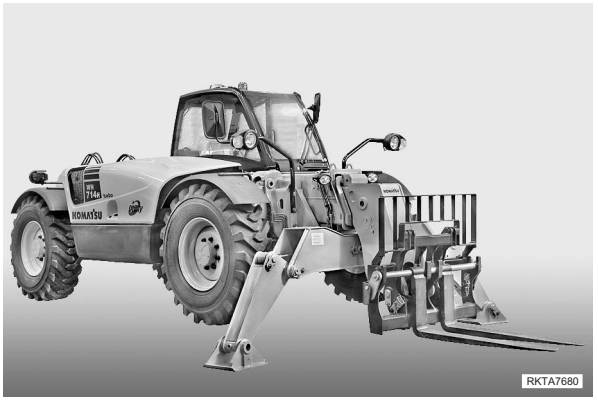
★ Normal flow: MIN = 77 ℓ/min
MAX = 79 ℓ/min

6 - If flow readings are different from the ones specified, recondition or replace the pump.



BRAKE SYSTEM CHECKS

★ Check conditions:
- Engine: stopped
- Machine: on firm level ground, with stabilizers fully extended. If the machine is not equipped with stabilizers, place wedges under the wheels.



The brake system checking procedure consists of two steps:

1 - Inspecting the circuit and brake pumps for leaks.
2 - Inspecting the brake units for leaks.

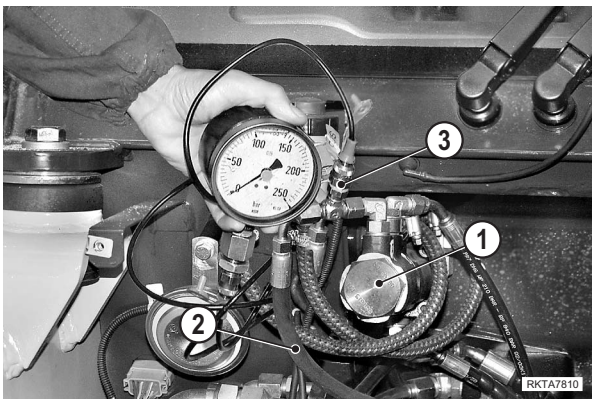
⚠ If both inspections yield positive results, the system lines should be checked for leaks.

• Inspecting the circuit and brake pumps for leaks.

⚠ Carry out the inspection on both front and rear brakes.

1 - Disconnect the relevant brake feed hose (2) from the brake pump (1).

2 - Install a pressure tap (3) connected to a 250 bar pressure gauge between the pump fitting (1) and the feed hose (2).



3 - Start the engine and operate it at IDLE, press the brake pedal and pressurize the circuit to 120 bar.

★ Do not exceed the maximum pressure allowed, which is 150 bar.

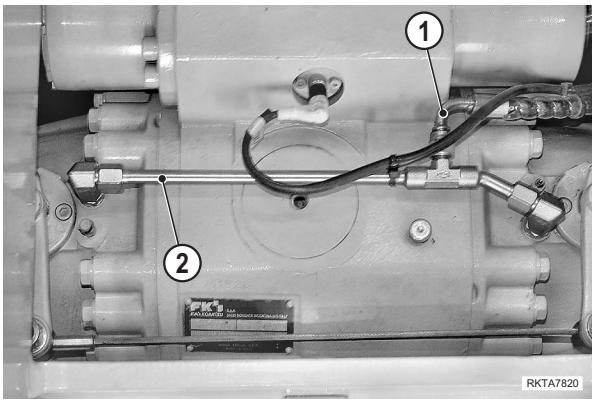
4 - Hold the pressure on the pedal for at least two minutes and check that the pedal pressure and position remain steady.

★ If the position of the pedal needs to be changed in order to hold the pressure, then the loss of pressure is to be blamed on a blow-by condition inside the pump.
Proof of this can be had by checking the oil in the tank. If there is blow-by, the oil will be stirred.

5 - Repeat the same steps on the other brake pump.

• Inspecting the brake units for leaks

1 - Disconnect the feed hose (1) and remove the pipe (2).



2 - Connect the feed hose (1) to an apparatus consisting of an isolator valve (3) a pressure tap (4) and an additional hose (5) to be connected to the fitting of the unit to be checked.

★ The pressure tap (4) should be installed between the hose (5) and the valve (3).

3 - Connect a 250 bar pressure gauge to the pressure tap and open the isolator valve.

4 - Operate the brake pump and pressurize the circuit at a maximum pressure of 150±5 bar.

5 - Keep holding the pressure and close the isolator vale (3) to keep the brake unit pressurized.

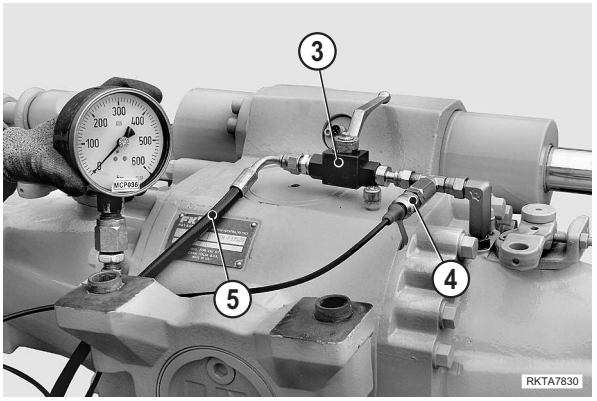
6 - Release the brake pedal and monitor the pressure displayed on the pressure gauge for two minutes.

★ If the pressure value shows a negative variation, then the axle brake piston seals are faulty and servicing is required on both brake units.

⚠ Further proof of leakage is an increased oil level in the axle causing the oil to be stirred. Replace all seal rings in the axle and change the oil.

7 - Repeat the test on the other brake unit using the same procedure described above.

⚠ When checks and repairs, where applicable, are completed, bleed the air from the brake units (See "BLEEDING AIR FROM CIRCUITS").



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TRANSMISSION (POWER SHIFT) CHECKS

The transmission can be affected by three kinds of problems:

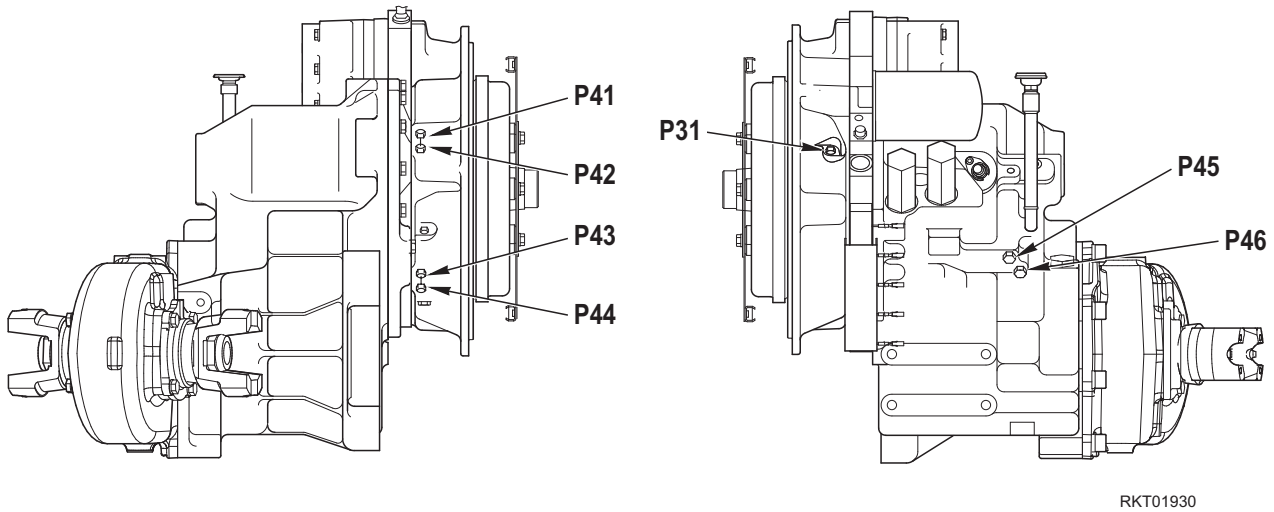
1 - Mechanical problems (worn clutches, bearings, etc.)

2 - Hydraulic problems (operating pressure, pump conditions, etc.)

3 - Electrical problems (faulty solenoids and/or poor electrical connections)

- All transmission checks should be carried out: with the engine at IDLE and MAX rpm – controlled even under load – with the pressures in the hydraulic circuits of the machine and in the equipment perfectly calibrated and with the transmission oil at MAX level.
- Before attempting to perform the inspections on the clutches, make sure the all the shifts and the direction of translation can be selected; also ensure that the service and parking brakes are in perfect operating condition.
- Also check the exchanger for being clean, as the exchanger is expected to keep the transmission oil temperature within specifications.

  ★ Allowable temperature: 70–120 °C



P41 - 1st clutch pressure
P42 - 2nd clutch pressure
P43 - 3rd clutch pressure
P44 - 4th clutch pressure

P31 - General clutch pressure
P45 - Forward gear clutch pressure
P46 - Reverse gear clutch pressure

TROUBLESHOOTING GUIDE

• **Low clutch pressure**	
Cause	**Solution**
1. Oil level is low.	1. Top up the oil level.
2. Pressure-control valve shows a blow-by condition.	2. Clean the valve spool and seat.
3. Feed pump is faulty	3. Replace the pump.
4. Piston seal rings or shaft segments are faulty.	4. Replace the rings and segments.
5. Clutch piston exhaust valve shows blow-by condition.	5. Clean the valve.
• **Low feed pressure**	
Cause	**Solution**
1. Oil level is low.	1. Top up the oil level.
2. Suction filter is clogged.	2. Clean the filter.
3. Feed pump is faulty.	3. Replace the pump.
• **Overtemperature**	
Cause	**Solution**
1. Seal rings are worn.	1. Remove and recondition the converter.
2. Pump is worn.	2. Replace the pump.
3. Oil level is low.	3. Top up the oil level.
4. Exchanger is dirty.	4. Clean the exchanger.
5. Exchanger feed and return hoses are obstructed or damaged.	5. Replace the hoses.
• **Noisy converter**	
Cause	**Solution**
1. Pump is worn.	1. Replace the pump.
2. Bearings are damaged.	2. Fully remove the assembly to inspect the damaged bearings.
• **Poor power**	
Cause	**Solution**
1. Engine speed is low when converter is stalled.	1. Check pump injection.
2. See OVERTEMPERATURE and carry out the checks described there.	2. Solutions are illustrated in the OVERTEMPERATURE section.

TRANSMISSION ASSEMBLY PRESSURE CHECKS

Pressure checks can be carried out on the inner hydraulic circuits of the transmission to find out any malfunctions. These checks concern:

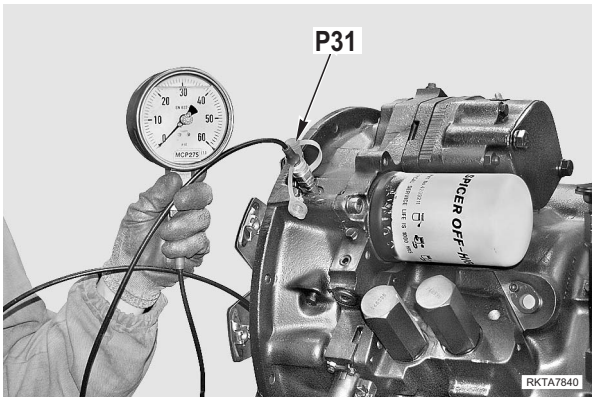
1 - General converter pressure.

2 - Engagement pressure for each individual clutch.

★ Check conditions:

- Engine stopped but at operating temperature.
- Machine in neutral gear, on level ground, with parking brakes applied.
- Transmission oil temperature: 82–93 °C.
- Oil level: MAX.

1. General converter pressure



1 - Remove the **P31** plug and connect a 60 bar pressure gauge.

2 - Start the engine, operate it at IDLE and check the pressure.

★ Normal pressure: 16.75 bar

3 - Gradually increase engine speed to 2000±30 rpm and check pressure gauge reading.

★ Normal pressure: 19.30 bar

★ If the pressure values are lower than the specified values, the transmission pump needs replacing.

4 - Remove the pressure gauge and re-install the plug.

2. Engagement pressure for each individual clutch

★ Check conditions:

- Machine on firm level ground, with wheels raised by outriggers and jack stands or resting on jack stands.
- Engine stopped but at operating temperature.
- Transmission oil temperature: 82–93 °C.
- Transmission oil level: MAX.
- Ports to be used for these checks:

  P45 - FORWARD GEAR clutch pressure

  P46 - REVERSE GEAR clutch pressure

  P41 - 1st clutch pressure

  P42 - 2nd clutch pressure

  P43 - 3rd clutch pressure

  P44 - 4th clutch pressure

3. Inspecting the 1st clutch - forward and reverse gear

1 - Remove the **P41** plug from the 1st clutch and connect a 60 bar pressure gauge.

2 - Start the engine in NEUTRAL, operate it at 1800 rpm and check the pressure on the pressure gauge.

★ Normal pressure: 0–0.2 bar

3 - Engage the 1st FORWARD gear and operate the engine at 1800 rpm.

4 - Check the pressure on the pressure gauge.

★ Normal pressure: 16.5–19.3 bar

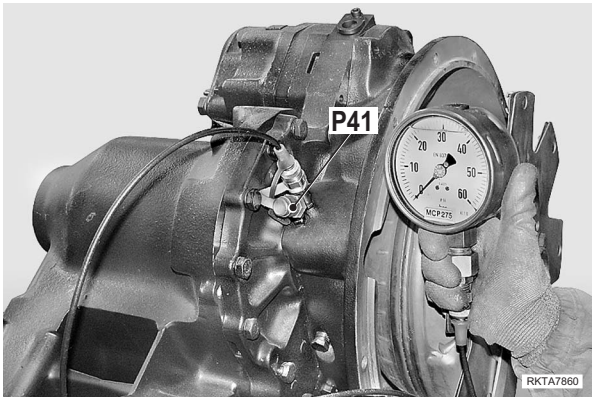
5 - Remove the pressure gauge and re-install the **P41** plug.

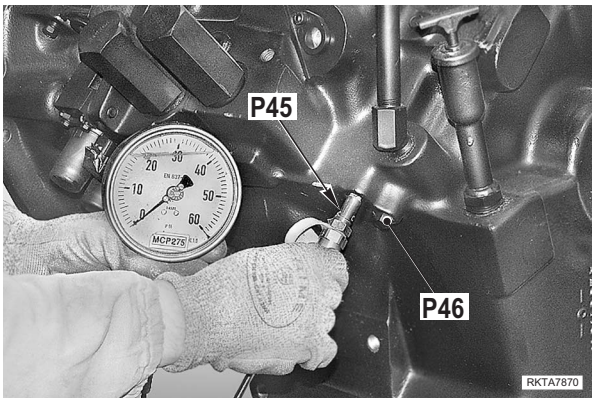
6 - Remove the **P45** FORWARD GEAR selection plug and connect the pressure gauge (60 bar).

7 - Carry out steps from 3 to 5 to check the pressure values. Readings should match the values specified in steps 2 and 4.

8 - Repeat the same procedure for the **P46** REVERSE GEAR plug by engaging the 1st REVERSE gear. Pressure readings should match the values stated in 2 and 4 above.

⚠ If both forward and reverse pressures differ from the specified values, then there is a loss of pressure affecting the thrust piston of the clutch with the lesser pressure.





4. Inspecting the 2nd – 3rd – 4th clutch

1 - Remove the **P42** plug and connect a 60 bar pressure gauge.

2 - Start the engine in NEUTRAL, operate it at 1800 rpm and check the pressure on the pressure gauge.

★ Normal pressure: 0–0.2 bar

3 - Select the 2nd FORWARD gear and operate the engine at 1800 rpm.

4 - Check the pressure on the pressure gauge.

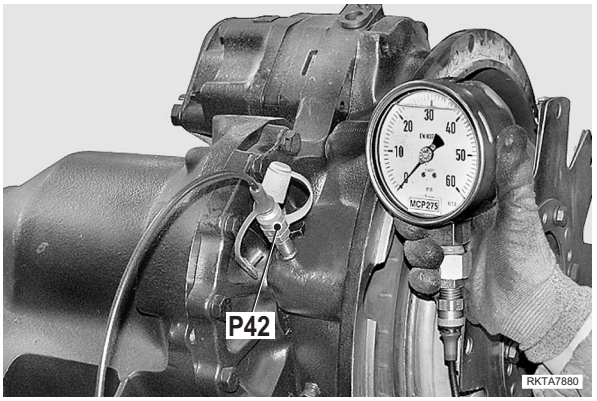
★ Normal pressure: 16.5–19.3 bar.

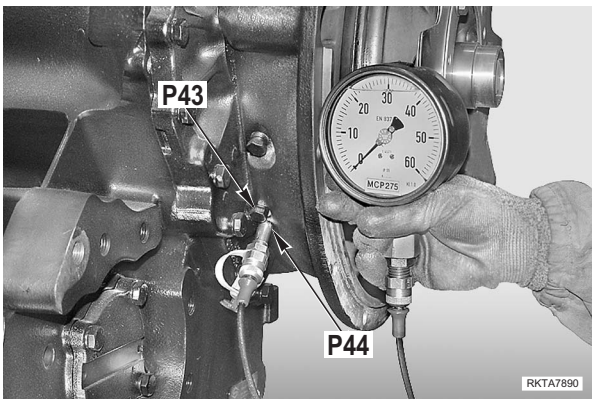
5 - Stop the engine, remove the pressure gauge and re-install the plug.

6 - Repeat the same checks on the lines of the **P43** and **P44** plugs by engaging the 3rd FORWARD and 4th FORWARD gears respectively. Pressures should be:

- with no gear engaged (NEUTRAL): 0–0.2 bar
- in gear: 16.5–19.3 bar

⚠ If clutch pressures with the gears engaged are lower than those specified, then there are leaks in the seal segments. In this case, the transmission needs reconditioning.





5. Transmission clutch wear inspection

This inspection is to be performed after completing the inspection of the engine under load. The same procedures apply. Transmission operating pressures must have been checked before performing this inspection.
If rotation speeds differ from those specified for the INSPECTION OF THE ENGINE UNDER LOAD, then the clutches are worn and need to be replaced.

CHECKING THE SPEED OF THE TRANSMISSION SHAFTS RESPONSIBLE FOR TRANSLATION (CARDAN SHAFTS)

★ Check conditions:

- Machine on firm, level ground with the boom fully lowered and retracted.
- Frame perfectly levelled.
- Engine stopped but at operating temperature.
- Transmission oil: 50–70 °C (measured at the filter).

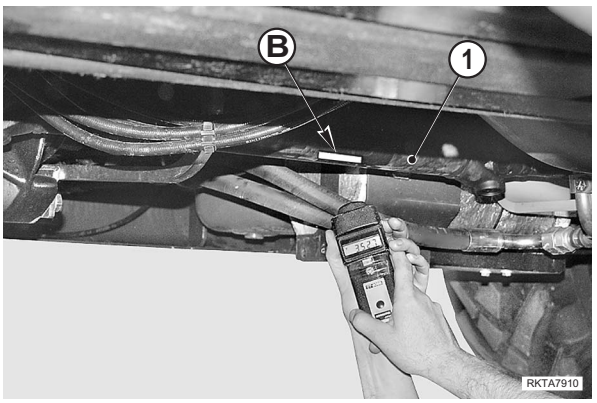
1 - Fully extend the stabilizers to lift the front wheels.

⚠ If the machine is not equipped with stabilizers, apply two jack stands with anti-slip blocks under the front frame in order to raise the machine by 10 cm approximately.

2 - Apply two jack stands "**A**" with anti-slip blocks under the rear frame and raise the jack stands until the rear wheels are lifted by 10 cm. approx.

3 - Apply a reflective strip "**B**" to the rear cardan shaft (1) in order to be able to take rotation speed measurements with a stroboscopic tachometer.

4 - Start the engine and engage all the gears successively, and, for each gear, check the number of cardan shaft revolutions with the engine stabilized at the MAX rpm value.
Also check cardan shaft speed with the reverse gears.



★ Speed to be checked:

			NORMAL SPEED	ALLOWABLE SPEED
TRANSLATION DIRECTION	FORWARD	**1**	570	513 – 621
		2	1243	1119 – 1355
		3	1889	1700 – 2059
		4	2550	2295 – 2780
		5	3863	3477 – 4211
	REVERSE	**1**	570	513 – 621
		2	1243	1119 – 1355
		3	2550	2295 – 2780

★ If shaft speeds are not within specifications, then the clutches are worn.

LEVEL CALIBRATION

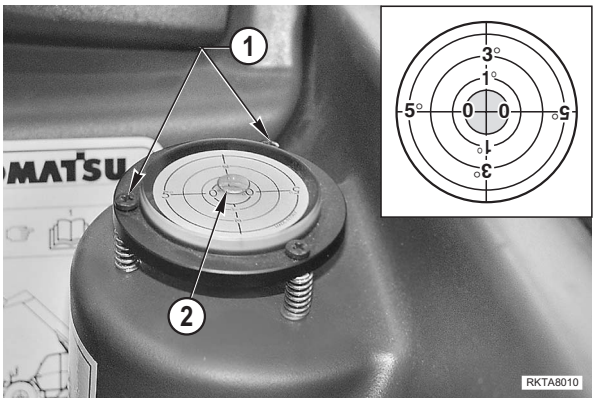
1 - Position the machine on firm and perfectly level ground with the boom fully lowered and retracted.

⚠ Ensure that the forks are not resting on the ground, and then stop the engine.

2 - Ensure that the tires are inflated to the proper pressure.

3 - Level the frame crosswise using an electronic level or a standard 40 cm level ("**A**") placed on the front part of the frame.

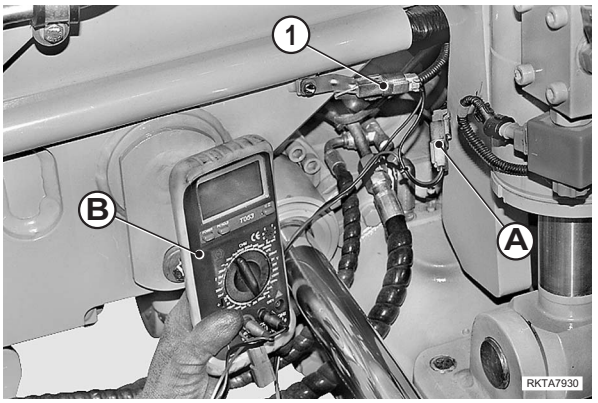
4 - Tighten or loosen the screws (1) until the bubble (2) is perfectly centred in relation to the centre ring.



CHECKING LOAD CELL CALIBRATION

★ Frame perfectly levelled.
- Frame perfectly levelled.
- Tires at prescribed pressure.
- Machine on firm level ground, with standard forks installed.

1 - Disconnect the connector (1). Between the load cell and the wiring, place an extension lead **A** with two sockets for plugging the pins of tester **B**.



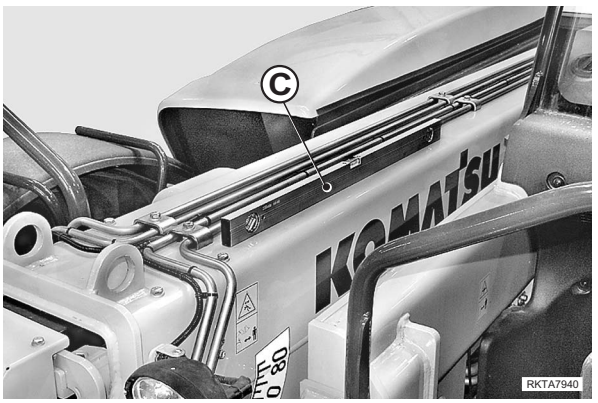
1. Checking load signal with no load

1 - Using a level **C**, position the basic boom parallel to the ground.

2 - Ensure the forks are raised but parallel to the ground.

3 - Check the signal emitted by the load cell.

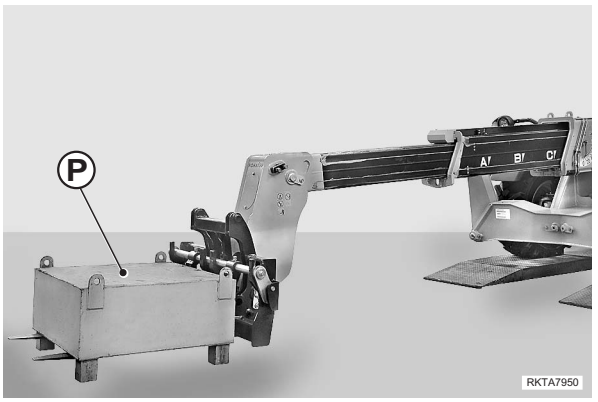
★ Normal signal: 25–35 mA



2. Checking load signal in turnover conditions

1 - Place the specified weight "**P**" on the forks and extend the boom until the rear wheels lift off the ground by about 10 cm.

MACHINE	P
WH 609 - WH613	3500 kg
WH 713	3700 kg
WH714 - WH716	4000 kg
WH 714H	4500 kg



2 - Check the signal emitted by the load cell.

★ Normal signal: 35–45 mA.

CALIBRATING THE OVERTURN PREVENTION SYSTEM (SAR)

- **Calibration conditions:**

1 - Place the machine on a firm (concrete) platform that is perfectly level. Do not apply the brakes and do not retain the machine with outriggers or wedges.

2 - Ensure that calibration is performed with no wind, that the frame is levelled and that the wheels are perfectly aligned.

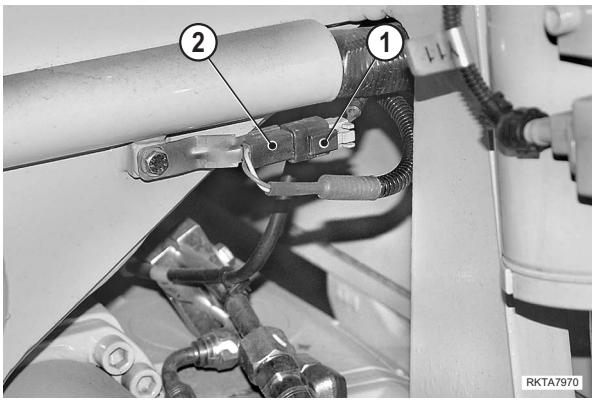
3 - Make sure that the tire pressure is within specifications.

4 - The boom should be fully retracted and lowered to the ground. Ensure that the forks are off the ground and in their horizontal position.

⚠ The calibration procedure should NEVER be carried out with the working basket installed.

5 - Once the load cell connector (1) has been connected to the machine wiring (2), start and operate the engine for at least 15 minutes before starting the calibration procedure.

6 - Stop the engine.

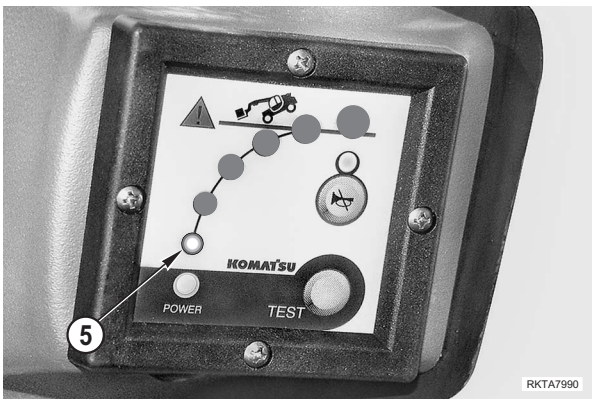


- **Calibration procedure**

1 - Remove the dash front centre protective cover (3).

2 - Introduce a test jumper wire (4) into the female connector (X30).

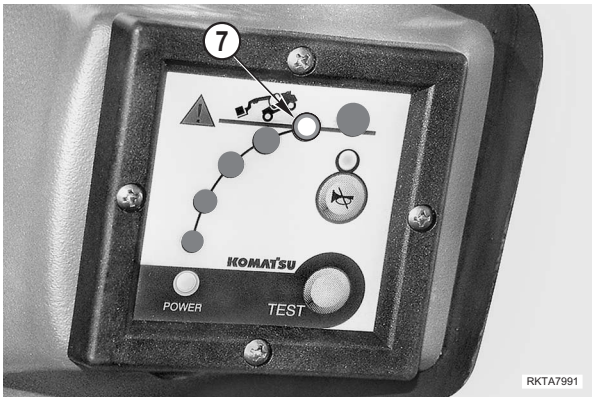
3 - Start the engine to start the overturn prevention unit calibration procedure. The calibration mode is indicated by the green lamp (5).



4 - Press the “TEST” button (6) to save the first value in the load range.
Now, the LED (5) will start blinking for 8 seconds to indicate that the value of minimum load without outriggers is being learnt.

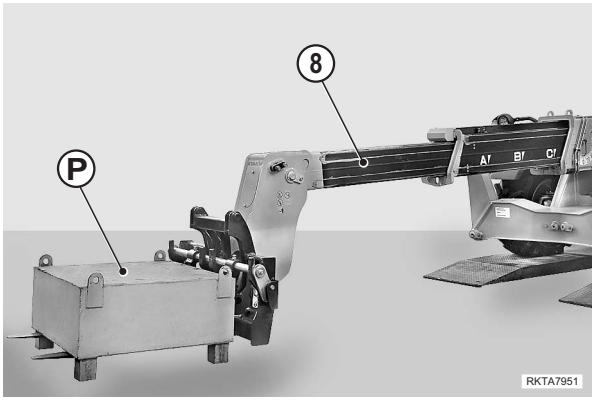
5 - Learning ends when the green LED (5) turns off and is confirmed by an audible tone which is emitted for 2 seconds.

6 - When the tone stops, the red lamp (7) turns on. The red lamp indicates maximum load.



7 - Apply a load "**P**" of at least 2000 kg (2 tons) to the forks.

NOTE
As load, you can use the same weight (one that is suitable to the machine model) you have used for checking the calibration of the load cell.

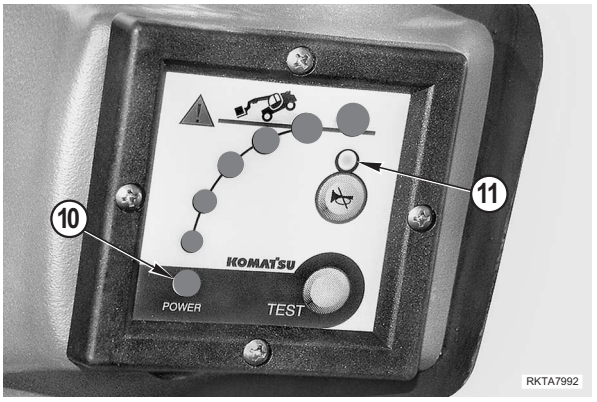


8 - Gradually extend the boom (8), keeping the boom parallel to the ground, until the rear wheels (9) lift off the ground by approximately 10 cm.

9 - Press the TEST button (6) to save the second value of the load range.
Now, the LED (7) will start blinking for 8 seconds to indicate that the value of the maximum load without outriggers is being learnt.

10 - Learning ends when the red LED (7) turns off and is confirmed by an audible tone which is emitted for 2 seconds.

11 - Make sure that the procedure has been performed correctly. If it has, the only LED still activated should be the green LED (10) (POWER ON) while the horn (11) should remain activated until the jumper wire (4) is removed.



IMPORTANT

a - If the jumper wire (4) in connector X30 looses a contact or is removed before calibration is complete, the calibration will **not** be performed and the system will keep the previous calibration as the applcicable one.

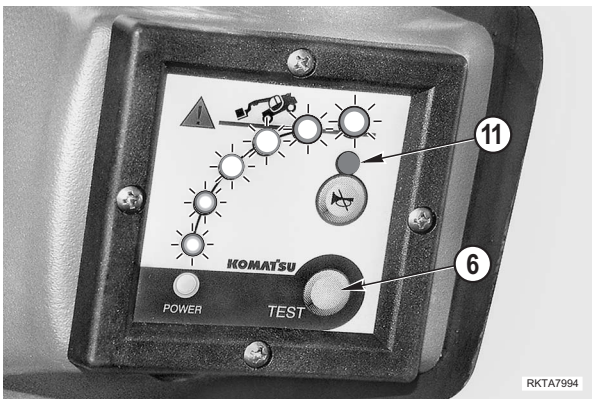
b - In the event of a power cut (12V), the calibration will be **cancelled**. In this case, it is necessary to start a new calibration procedure from the first step.

c - If, at the end of calibration, the overturn prevention device blinks, this indicates that the following conditions are occurring or have occurred:
- error during calibration;
- sensor malfunction;
- poor wiring continuity condition leading to non repeatability of measurement.

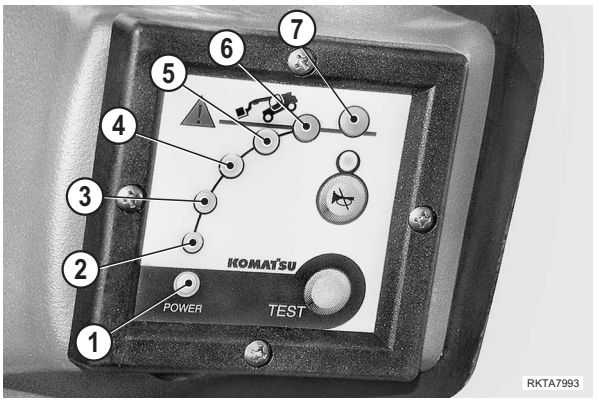
d - In these conditions, all the LEDs will blink and the chime (11) will emit a continuous sound. To know the type of malfunction that is affecting the system, press the TEST button (6). This will display the activation log for LED coding.

IMPORTANT

The only way to reset the system for normal operation is by removing and re-introducing the ignition key.



• Error coding



1. Errors at system start

0 = LED deactivated

1 = LED activated

		Coding					
	Power	LEDs are numbered from bottom to top					
Likely cause	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7
Sensor is not connected or with current < absolute Min.	1	1	0	0	1	0	0
Sensor is shorted or with current > absolute Max.	1	1	0	0	0	1	0
System is not calibrated	1	0	1	0	1	0	1
	Green	Green	Green	Yellow	Yellow	Red	Red

2. Errors during normal operation

0 = LED deactivated
1 = LED activated

		Coding					
	Power	LEDs are numbered from bottom to top					
Likely cause	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7
Sensor is not connected	1	1	0	0	1	0	0
Sensor current is out of absolute range	1	1	0	0	0	1	0
Sensor is shorted	1	1	0	0	1	0	1
	Green	Green	Green	Yellow	Yellow	Red	Red

3. Errors during calibration

0 = LED deactivated
1 = LED activated

		Coding					
	Power	LEDs are numbered from bottom to top					
Probabile causa	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7
Min. current acquisition < absolute Min.	1	0	1	0	1	0	0
Max. current acquisition > absolute Max.	1	0	1	0	0	0	1
Acquired current Min. ≧ Acquired current Max.	1	1	0	1	0	1	0
	Green	Green	Green	Yellow	Yellow	Red	Red

CHECKING WEIGHT PERCENTAGE ON REAR AXLE

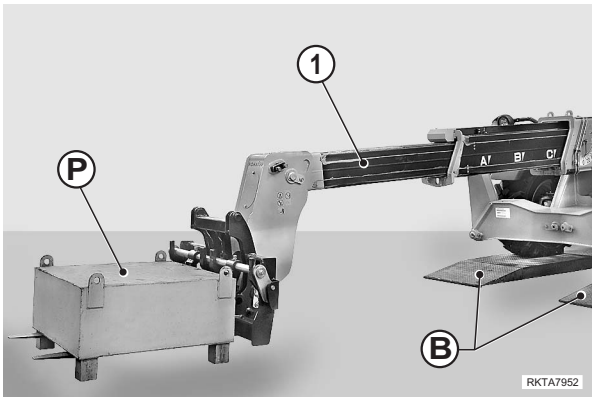
- **Preparing the machine ready for the inspection**

1 - Place a weight "**P**" of at least 2000 kg (2 tons) on the forks.

NOTE
As load, you can use the same weight (one that is suitable to the machine model) you have used for checking the calibration of the load cell.

2 - Translate the machine until placing the rear wheel onto a weighing platform (**A**) and the front wheels onto two platforms (**B**) as high as weighing platform A.

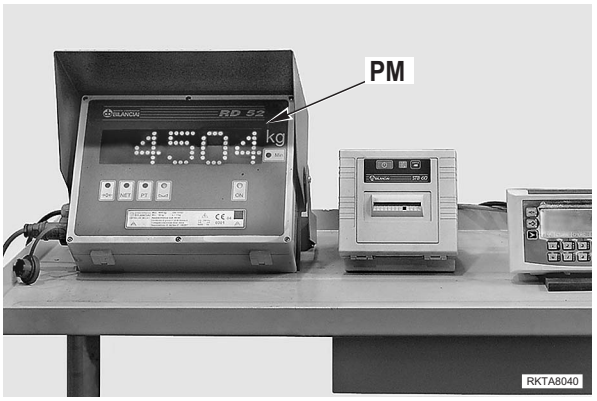
3 - Extend the boom (1) and position weight "**P**". Fully retract the boom.



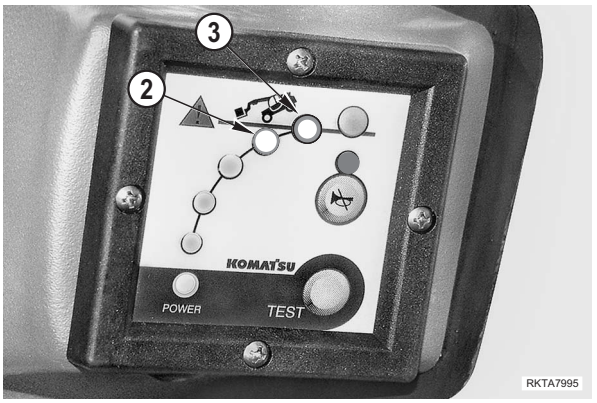
4 - Using a level (**C**), position the boom parallel to the ground.

5 - Stop the engine and check weight "**PM**" on the weighing scale. This value represents the weight that is being applied to the rear axle (E.g.: 4504 Kg).

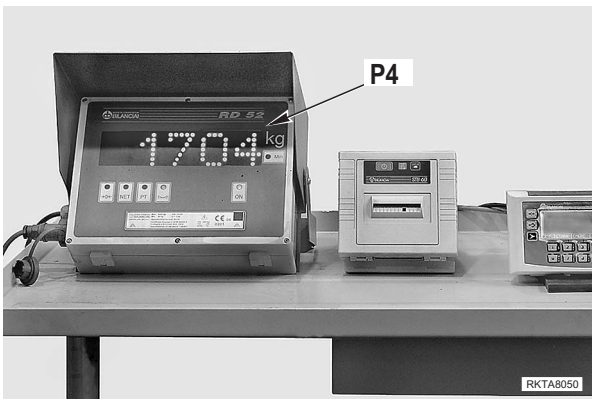
NOTE
If a single scale is not available, you may use two weighing platforms. In this case, the weight applied to the rear axle is the sum of both readings.



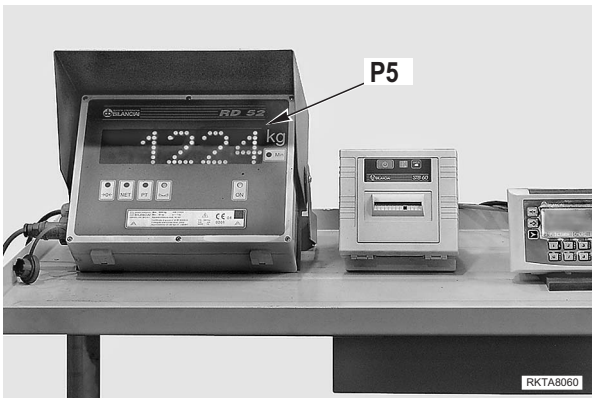
6 - Lift weight "**P**" and slowly extend the boom until the 4th LED (2) illuminates, indicating the pre-overturn limit.



7 - Check the value of weight "**P4**" that is being applied to the axle in this condition (e.g.: 1704 Kg).



8 - Continue extending the boom until the 5th LED (3) illuminates, indicating the limit before overturn.
Check weight "**P5**" (e.g.: 1224 Kg).



9 - Calculate the percentage of weight applied to the rear axle using the formula below:

$$\textbf{Perc4} = \frac{P4}{PM} \times 100 \qquad \textbf{Perc5} = \frac{P5}{PM} \times 100$$

10 - Verify that the values are within the acceptable tolerances:

		Percentage		
MACHINE		**Normal**	**MIN.**	**MAX.**
WH 609 - WH613 WH 713 - WH714 WH714H	4th LED	40	47	54
	5th LED	30	37	44
WH 716	4th LED	40	35	45
	5th LED	30	25	35

★ **EXEMPLE:**

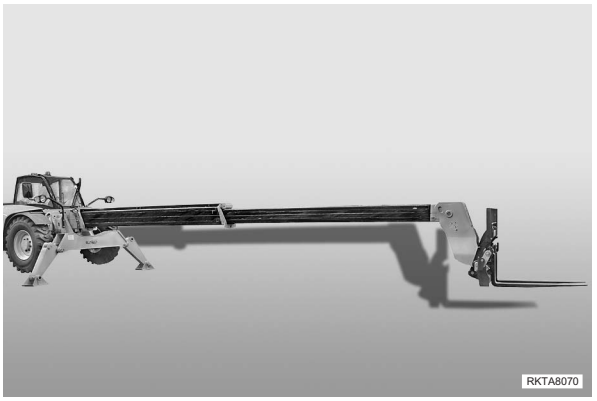
$$\textbf{Perc4} = \frac{1704}{4504} \times 100 = 37.83$$

$$\textbf{Perc5} = \frac{1224}{4504} \times 100 = 27.17$$

CHECKING SHOE CLEARANCE

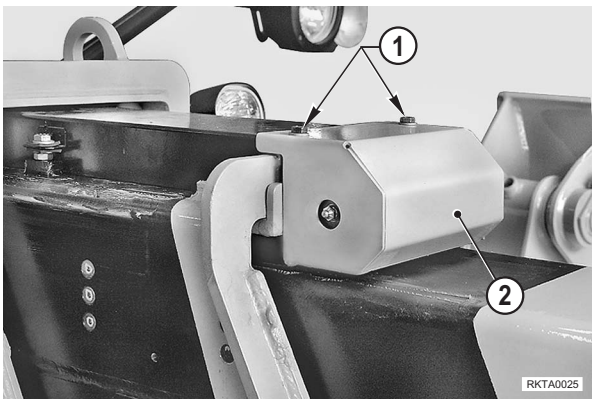
★ This inspection should be performed when servicing the machine after 2000 hours of operation or after the boom has suffered a severe side impact which makes it necessary to check the alignment.

★ Check conditions:
- Machine on firm, level ground, parking brakes applied, or stabilizers fully extended, if equipped.
- Boom fully extended.
- Engine not running.



1. Intermediate boom front shoe clearance

1 - Remove the screws (1) and remove the front cover (2).



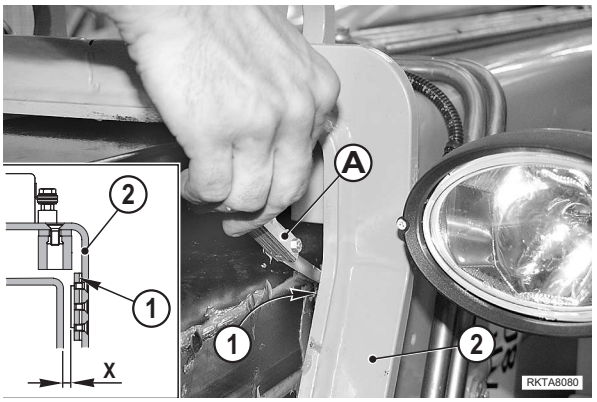
2 - Using a feeler gauge (**A**), check clearance the between upper side shoes (1) and top boom (2).

3 - Add up the readings to obtain the total clearance.

★ Normal total clearance **X** : 1–1.5 mm

★ Max. allowable total clearance: 2.25 mm

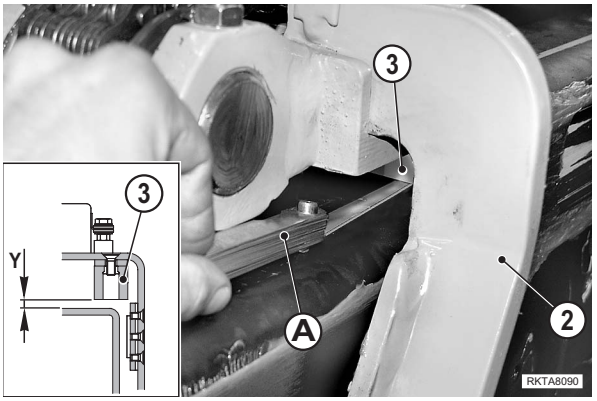
4 - Perform the same check on the lower shoes.



5 - Check clearance between RH and LH upper shoes (3) and top boom (2).

★ Normal clearance **Y** : 1.5 mm

★ Max. allowable clearance: 3 mm



6 - Using the same criteria, check clearances between front shoes from the basic to the intermediate boom.

★ Normal clearances are the same as specified in steps 3 and 5.

7 - After the inspection, install any removed parts and perform a full lubrication procedure.

NOTE

1 - If total clearance exceeds the maximum accepatable value, replace all the shoes.
(For details, refer to "30 REMOVAL AND INSTALLATION").

2 - If total clearance exceeds the maximum allowable value, a shim (1 mm) can be added to the lower shoe. Beyond this limit, replace the upper and lower shoes.
(For details, please refer to "30 REMOVAL AND INSTALLATION").

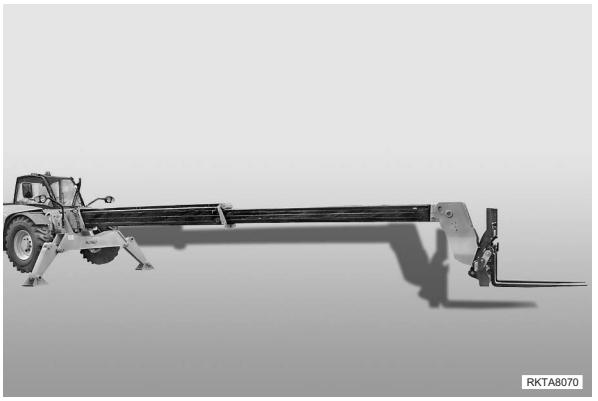
CHECKING BOOM SIDE ALIGNMENT

★ Before attempting to perform this inspection, carry out "CHECKING SHOE CLEARANCE".

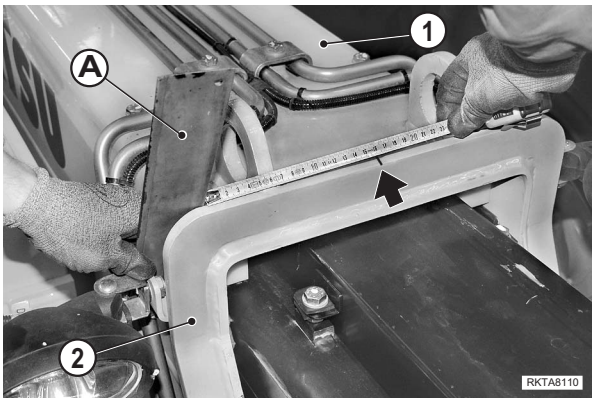
1 - Position the machine on firm, level ground with the frame levelled, the parking brakes applied and the stabilizers, if equipped, down to the ground.

2 - Fully extend the booms while keeping the forks parallel to the ground and slightly raised.

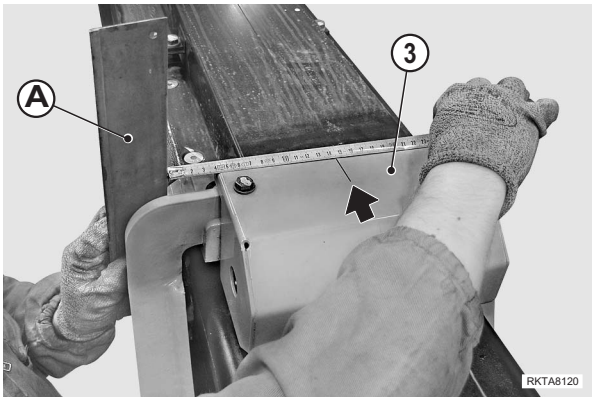
3 - Stop the engine.



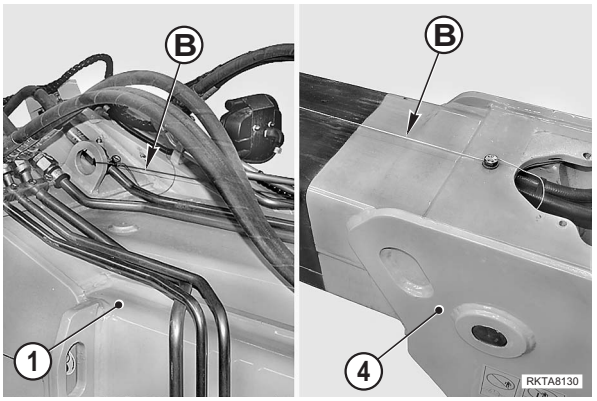
4 - Using a ruler "**A**" placed against the sides of the basic boom (1), mark the centre line on the end flange (2).

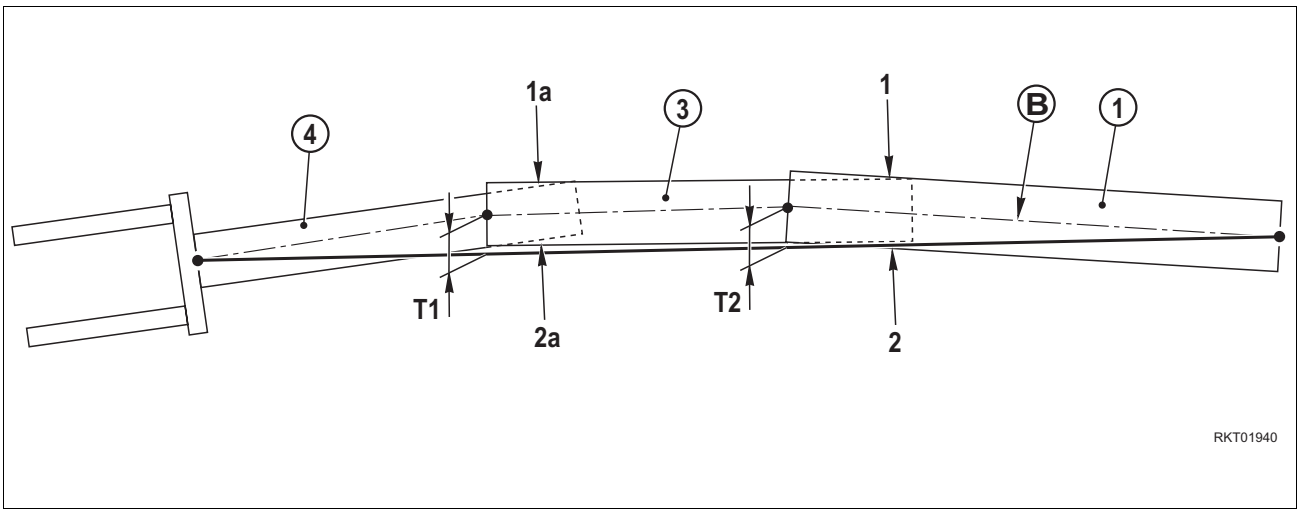


5 - Repeat the procedure described in step 4 on the intermediate boom (3).



6 - Tension a steel cable “**B**”, or a non-extensible rope with approximately 2 mm diameter from the centre of the basic boom (1) to the centre of the top boom (4).





7 - Measure the distance between the axis of the basic boom (1) and cable “**B**” (size **T2**) and the distance between the axis of the intermediate boom (3) and cable “**B**” (size **T1**).
Both values should be lower than the maximum acceptable tolerance.

★ Max tolerance: 5 mm

6 - If one or both values exceed the tolerance value, then one or more shims should be moved from the outer side of the arch to the inner side (in the example shown, from shoes 1 – 1a to shoes 2 – 2a).

⚠ Move one shim at a time and check again.
(For shoe and shim installation and removal, refer to 30. "BOOM SLIDING SHOES").

IMPORTANT
Move the side lower shoe shims and side upper shoe shims simultaneously.

7 - At the end of the alignment, perform a full shoe lubrication procedure.

BOOM CHAINS

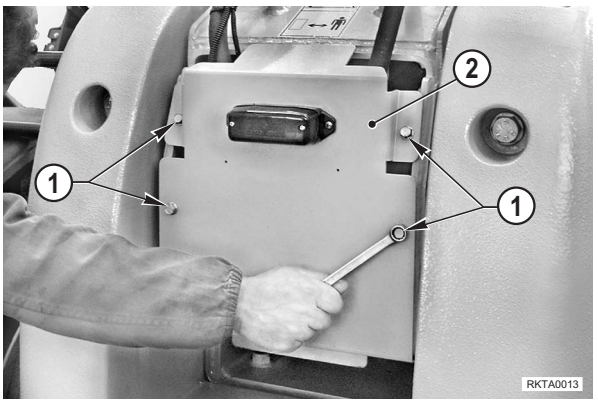
• Oxidation inspection

1 - Position the machine on level ground with enough free space at the front to be able to fully extend the boom.

2 - Move the boom to its horizontal position without load and apply the parking brakes.

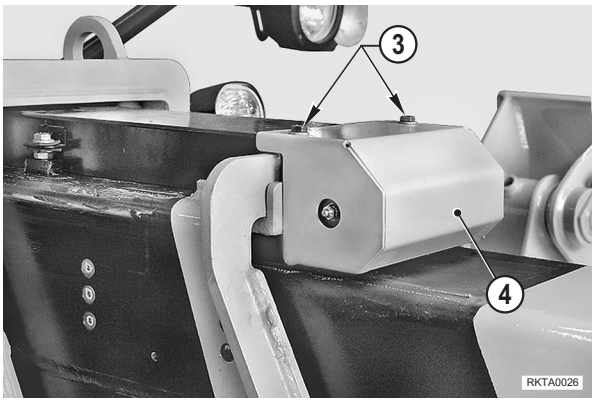
3 - Lower the outriggers, if equipped.
If the machine is not equipped with outriggers, place a safety block under the centre portion of the front frame.

4 - Remove the screws (1) and remove the rear cover (2).

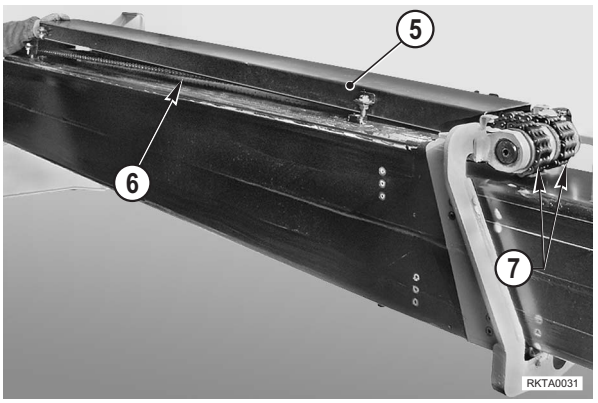


5 - Remove the screws (3) and remove the extension chain protective cover (4).

6 - While an assistant slowly extends the booms, another assistant should visually check the links of the extension chain for oxidation or oxide-contaminated lubricant.



7 - With the boom fully extended, stop the engine, remove the covers (5) and inspect the covered portion of the extension chains (6) and the guide rollers (7).



NOTES

1 - Before inspecting, check chain stretch.

2 - If chains are oxidised superficially and stretch is within normal pasrameter values, remove the chains and perform the full relubrication operation.

3 - If chains are severely oxidised, you should replace the chains even if stretch is within normal parameter values.

• Chain re-lubrication procedure

1 - Thoroughly clean the chains with mild solvent (gas oil or similar) and remove any trace of contaminated grease.

2 - Soak the chains in heated fluid engine oil (SAE 10) (kept at a constant temperature of 70 °C) for at least 12 hours.

3 - Allow the oil to cool and drain the chains before re-installing.

4 - After you have tensioned the chains, perform the maintenance lubrication procedure.

CHAIN TENSIONING

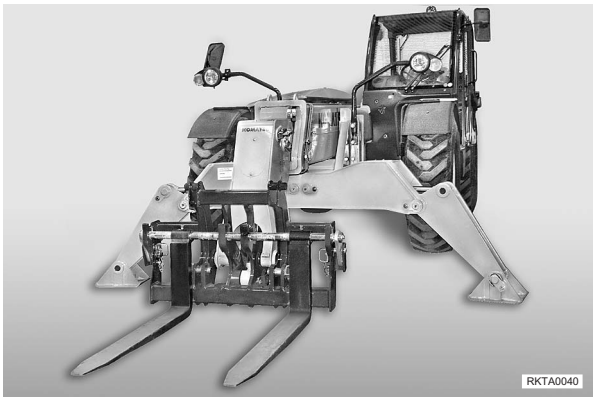
- **Preparation**

1 - Before starting the chain tensioning procedure, lubricate the sliding shoes.

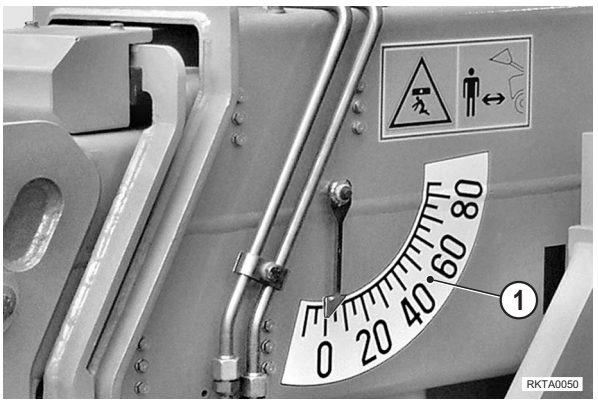
2 - Before starting the inspections and the tensioning procedures, remove the front equipment.

3 - Place the machine on firm, level ground with enough free space at the front to allow a full extension of the boom.

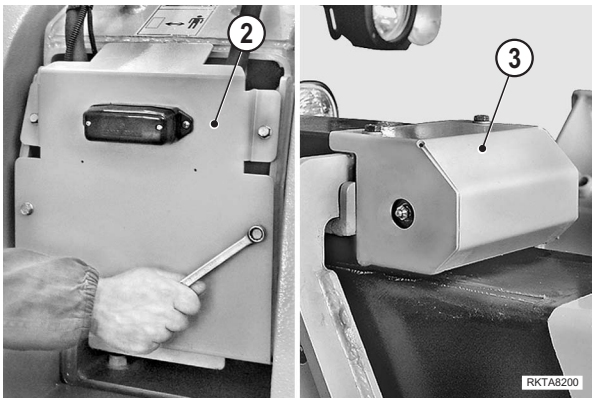
4 - Lower the outriggers, if equipped.
If the machine is not equipped with outriggers, place a safety block under the centre portion of the front frame.

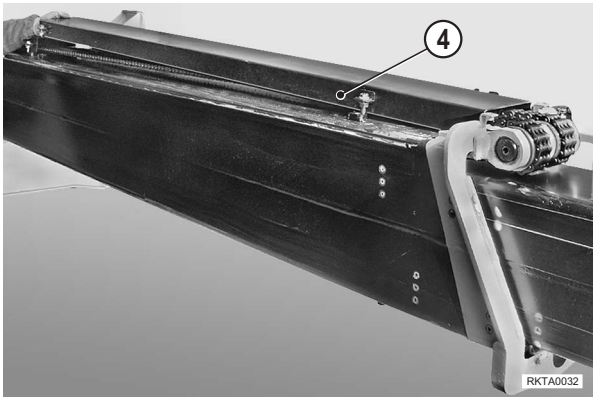


5 - Move the boom to its horizontal position checking the 0° angle on the pendulum goniometer (1).



6 - Remove the extension chain front (3) rear (2) and upper (4) protective covers.



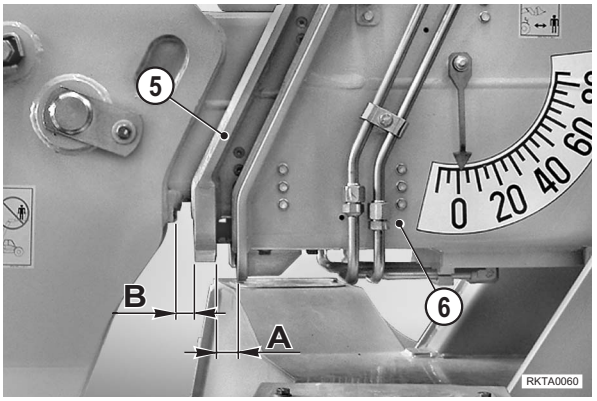


1. Retraction chains:

• Checking procedure

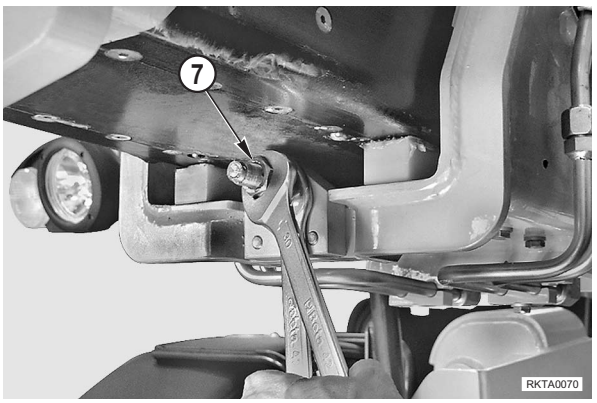
1 - Retract the boom and check value "**B**" for being within the 0-2 mm range when the intermediate boom (5) contacts the basic boom (6) (**A**= 0 mm).

★ If value "**B**" is not within this range, adjust.



• Adjustment procedure

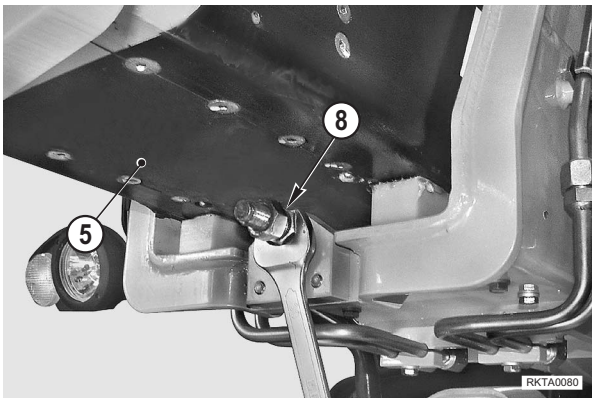
1 - Loosen the check-nut (7) by several turns.



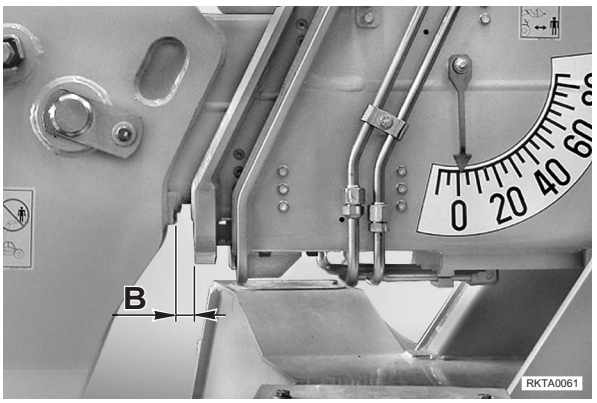
2 - Loosen the adjusting nut (3).

3 - Extend the booms by approximately 500 mm and then retract.

4 - Ensure the intermediate boom (5) just contacts the basic boom (6) (**A**= 0 mm); If necessary, repeat steps 3 and 4 of the adjustment procedure.

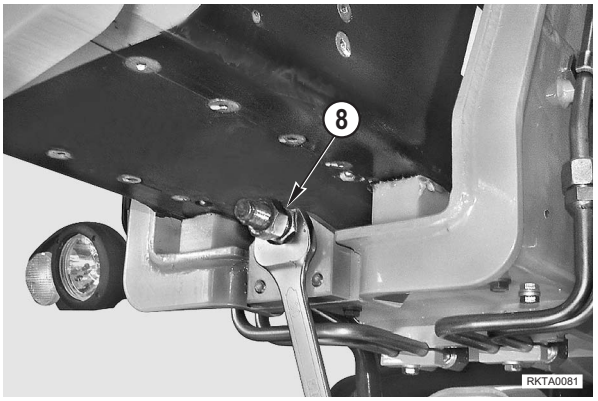


5 - With the intermediate boom in contact with the basic boom, measure value "**B**", which must be smaller than 2 mm.

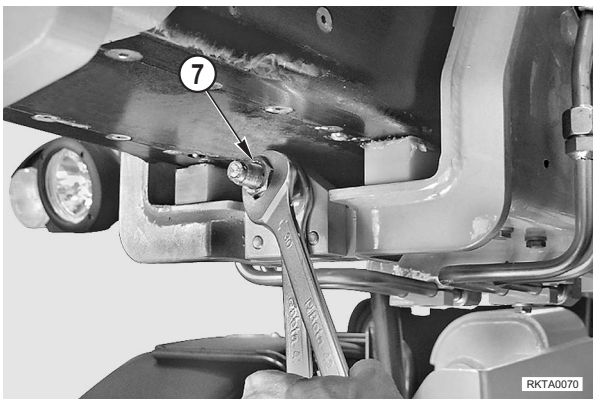


6 - To adjust distance "**B**", extend the boom by about 500 mm and gradually tighten the nut (8) without applying any rotation to the tie rod.

7 - Repeat the inspection until an optimal "**B**" distance (1-2 mm) is obtained.



8 - Tighten the check-nut (7) until snug.



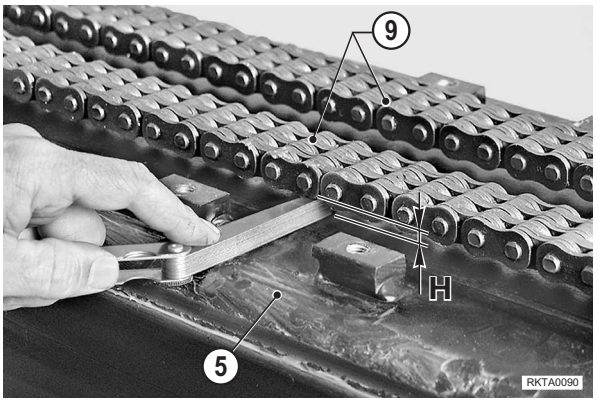
2. Extension chains

• Checking procedure

★ This inspection should be carried out after the retraction chain has been adjusted.

1 - Fully extend the boom and then retract by about 50 mm to eliminate chain tension.

2 - Measure the distance "**H**" between the chains (9) and the surface of the boom (5) half way between the front gear and the rear attachment, i.e. in the area where the protective cover is joined.



★ Adjustment values:

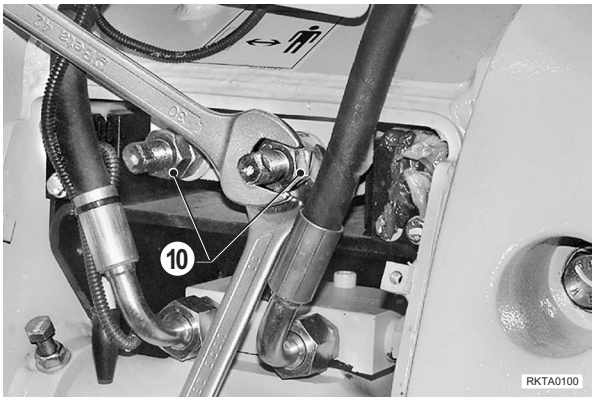
Model	Normal "H" distance:
WH613	14 mm
WH713	12 mm
WH714 **WH714H**	12 mm
WH716	8 mm

★ Difference between the chains: 0-1 mm

- **Adjustment procedure**

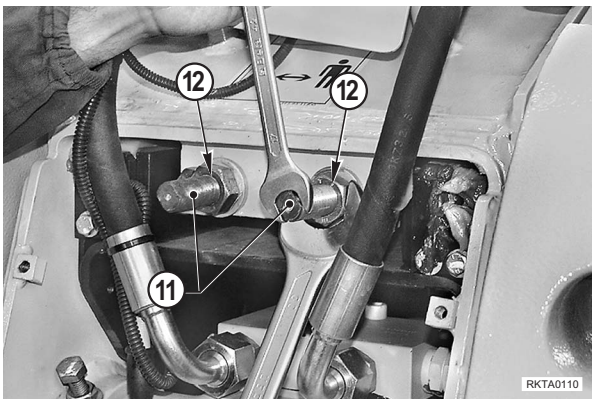
1 - Remove the cotter pins and loosen the check nuts (10) by several turns.

★ Replace the cotter pins at each disassembly.

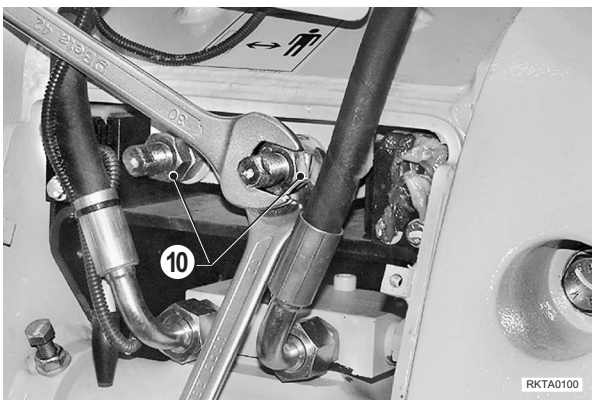


2 - Tighten the tensioner nuts (12) while retaining the tie rods (11) until the specified "**H**" distance is obtained.

⚠ Tighten the tensioner nuts equally and in an alternate manner without causing the tie rods to rotate.



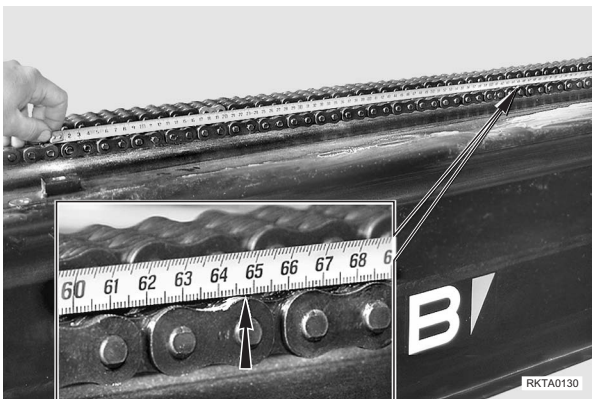
3 - Lock the check-nuts (10).



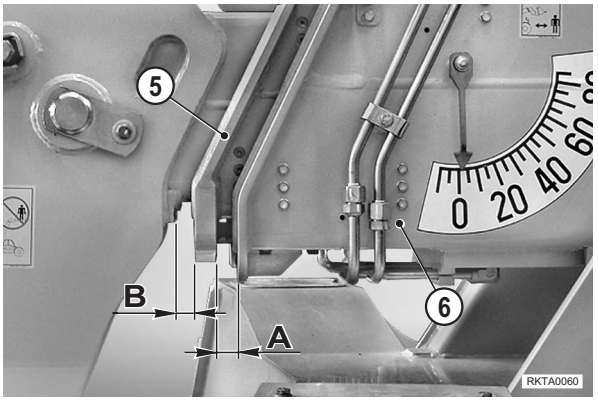
3. Checking chain stretch

★ Perform this inspection before the final tension checks.

1 - Measure the 33-step length of the chains installed to the machine; if the length is 646.7 ± 3.5 mm (which is equivalent to 34 steps on a new chain) replace the chains. (For details, refer to SOSTITUZIONE CATENE)

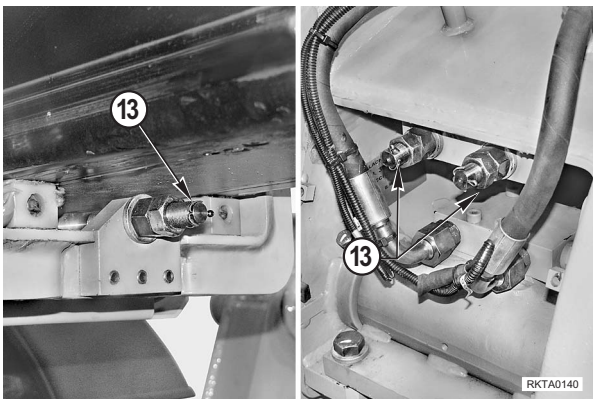


4. Final checks



1 - Extend the boom by about 500 mm and retract the boom slowly, making sure that “**B**” is 0-2 mm when the intermediate boom (5) contacts the basic boom (6) (**A**= 0mm).

2 - If distance “**B**” exceeds 2 mm, adjust the boom retraction chain.
(For details, please refer to "1. Retraction chains:").



3 - Fully extend the boom and then retract by about 50 mm.

4 - Verify that the “**H**” distances between the extension chains and the surface of the intermediate boom are within the specified tolerances.
(For details, please refer to "2. Extension chains").

5 - Install the cotter pins (13).

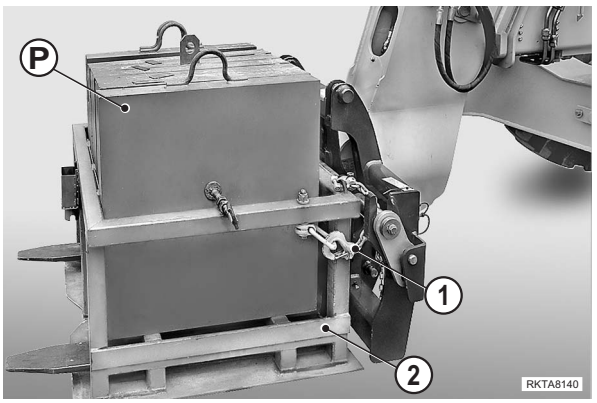
6 - Lubricate the chains and reinstall the extension and retraction chain protective covers as well as the rear cover.

CHECKING FOR BLOW-BY

★ Check conditions:
- No wind.
- Machine with standard forks attached, placed on firm, level ground with the parking brakes applied and the frame perfectly levelled.
- Boom fully lowered to the ground.
- Hydraulic oil temperature: 40 °C throughout the system, measured at the pump suction pipe.
- Tires at prescribed pressure.

1 - Place the specified weight "**P**" on the forks, and secure the weight to the equipment crate (2) with the chains (1).

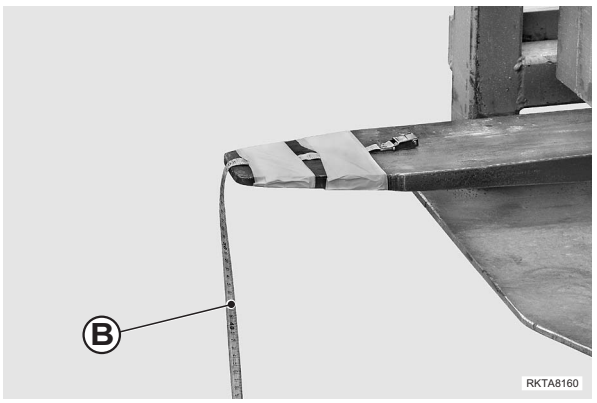
MACHINE	P
WH 609 - WH613	3500 kg
WH 713	3700 kg
WH714 - WH716	4000 kg
WH 714H	4500 kg



2 - Start the engine and fully lower the stabilizers to the ground.

3 - Place a fixed locator "**A**" to the stabilizer stem; note down locator distance in relation to the cylinder head.

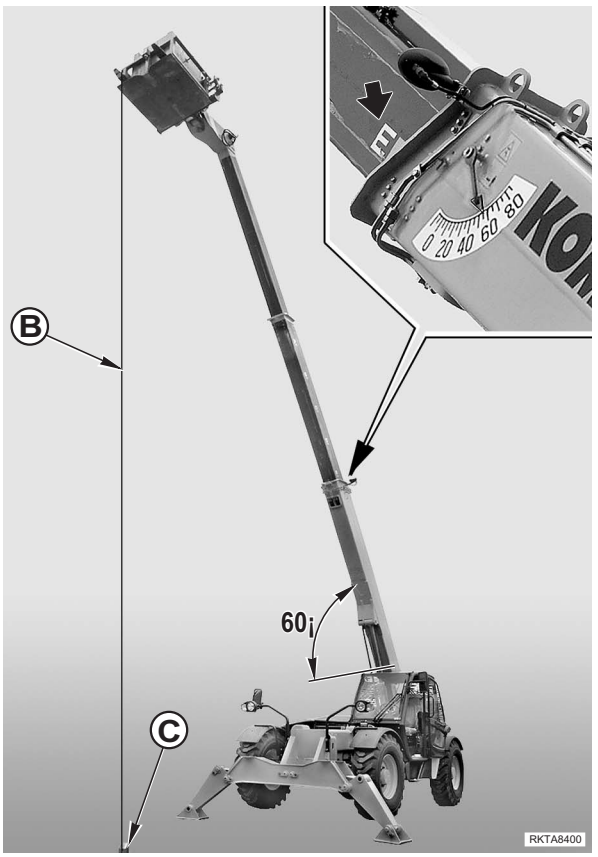
4 - Secure a 20 m tape measure "**B**" to the end of the forks.



5 - Lift the boom to 60°. The angle should be checked at the basic boom using a magnetic level.

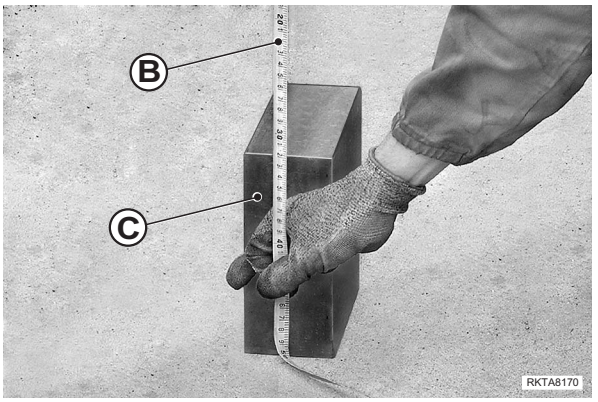
6 - Extend the boom until letter "**E**" of the intermediate boom is visible.

★ Move the locator until flush with the lower portion of the basic boom.



7 - Stop the engine and check the distance of the forks from the ground while holding the tape measure perpendicular to the ground.

⚠ To prevent any parallax errors leading to measuring errors, place a fixed locator "**C**" to the ground.



8 - Wait for 10 minutes and then check:

a - fork end measurement;

b - inclination of the basic boom;

c - distances between the stabilizer cylinder heads and the locator previously applied.

9 - Check the values against the measurements taken in steps 3, 5 and 7.

★ Normal variation:

MODEL	FORK END DOWN MOVEMENT (mm)			BOOM ANGLE VARIATION (°)			STABILIZER STEM RETRACTION (mm)		
	NORMAL	MIN.	MAX.	NORMAL	MIN.	MAX.	NORMAL	MIN.	MAX.
WH609	37.5	10	75	1.1	0	2.5	–	–	–
WH613	37.5	0	75	1.1	0	2.5	–	–	–
WH713	37.5	30	75	1.1	0	2.5	0.5	0	3.0
WH714	37.5	10	75	1.1	0	2.5	0.5	0	3.0
WH714H	37.5	10	75	1.1	0	2.5	0.5	0	3.0
WH716	37.5	0	75	1.1	0	2.5	0.5	0	3.0

10 - Start the engine, retract boom and stabilizers; perform some standard manoeuvres until the hydraulic oil is heated to a temperature of 80 °C (measured at the pump suction pipe).

11 - Repeat the same procedures as above and measure the same data.

★ Normal variation:

MODEL	FORK END DOWN MOVEMENT (mm)			BOOM ANGLE VARIATION (°)			STABILIZER STEM RETRACTION (mm)		
	NORMAL	MIN.	MAX.	NORMAL	MIN.	MAX.	NORMAL	MIN.	MAX.
WH609	37.5	10	75	1.1	0	2.5	–	–	–
WH613	37.5	0	75	1.1	0	2.5	–	–	–
WH713	37.5	30	75	1.1	0	2.5	0.5	0	3.0
WH714	37.5	10	75	1.1	0	2.5	0.5	0	3.0
WH714H	37.5	10	75	1.1	0	2.5	0.5	0	3.0
WH716	37.5	0	75	1.1	0	2.5	0.5	0	3.0

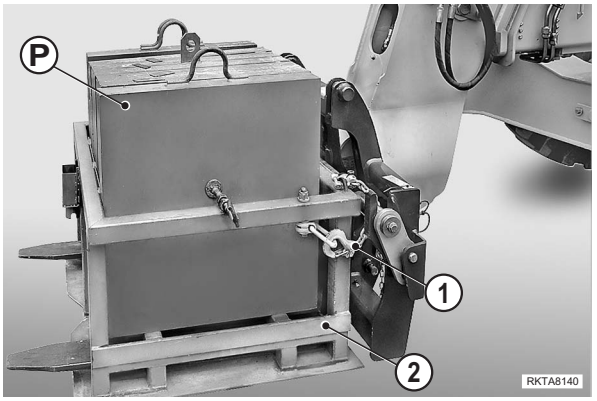
★ If variation exceeds the acceptable tolerance values, check for safety valve leakage and inner cylinder blow-by.
(For details, please refer to "ANALYSIS OF THE CAUSES RESPONSIBLE FOR HYDRAULIC DRIFT").

ANALYSIS OF THE CAUSES RESPONSIBLE FOR HYDRAULIC DRIFT

★ If the boom, equipment, stabilizer, axle-locking, and frame levelling cylinders are affected by hydraulic drift, it is necessary to check whether the cause lies with the safety valves or with the cylinder gaskets.

★ Check conditions applicable to all drift inspections:
- Engine: at operating temperature.
- Hydraulic oil: 45–55 °C.
- Test-weight "**P**" on the forks (secured with chains to the equipment crate):

MACHINE	P
WH 609 - WH613	3500 kg
WH 713	3700 kg
WH714 - WH716	4000 kg
WH 714H	4500 kg

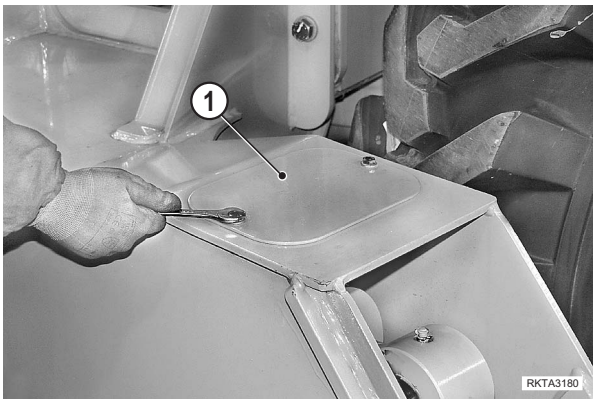


1. Checking procedure for stabilizers (if equipped)

★ Test one stabilizer at a time.

★ Check conditions:
- Boom fully retracted and lowered to the ground.

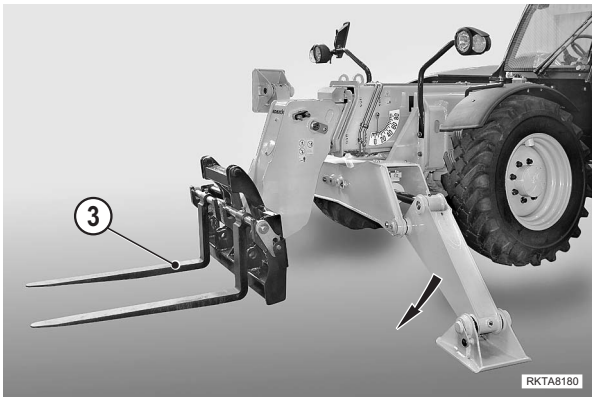
1 -Remove the upper cover (1) to gain access to the safety valve (2).



2 - Start the engine, lower the stabilizer to be checked until the corresponding front wheel lifts off the ground by about 7 cm.

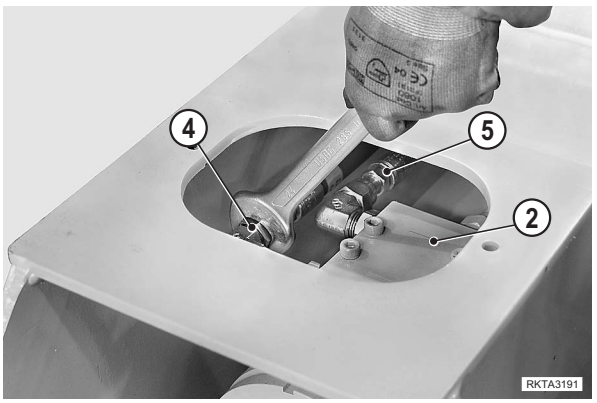
3 - **Only if equipped:** level the frame.

4 - Lower the forks (3) to the ground, and then stop the engine.

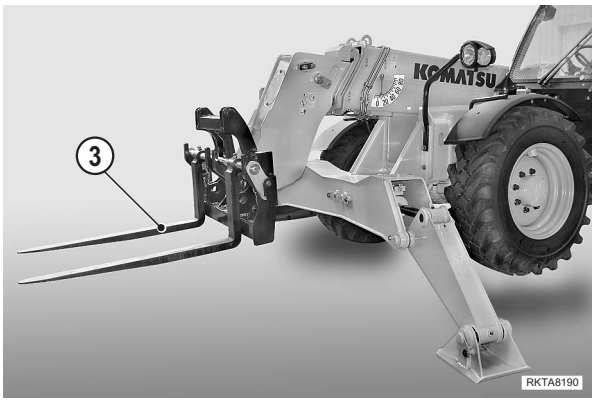


5 - Disconnect the front (4) and rear (5) lines from the valve (2).

★ Cap the hoses to prevent contaminants from entering the passages.



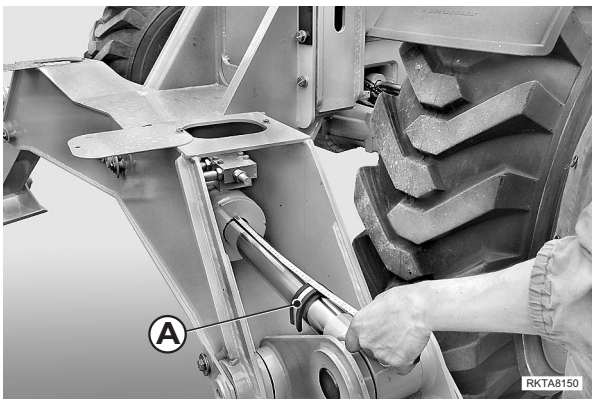
6 - Start the engine and lift the forks (3) off the ground, and then stop the engine.



7 - Place a fixed locator "**A**" to the stabilizer stem; note down locator distance in relation to the cylinder head.

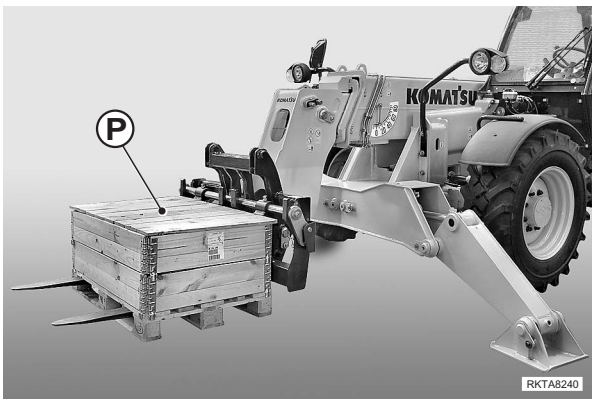
8 - Monitor the position of the stem for 10 minutes.

- If the stem tends to retract and a leak is noticed at the valve fittings, the valve is faulty and needs to be replaced.
- If the stem tends to retract and no leak is noticed at the valve, the drift is caused by blow-by inside the cylinder.

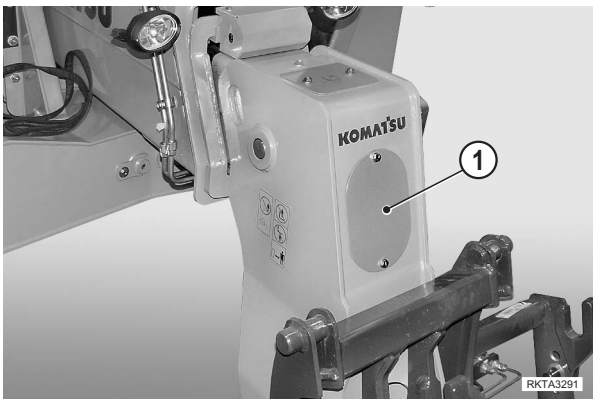


2. Checking procedure for equipment cylinder

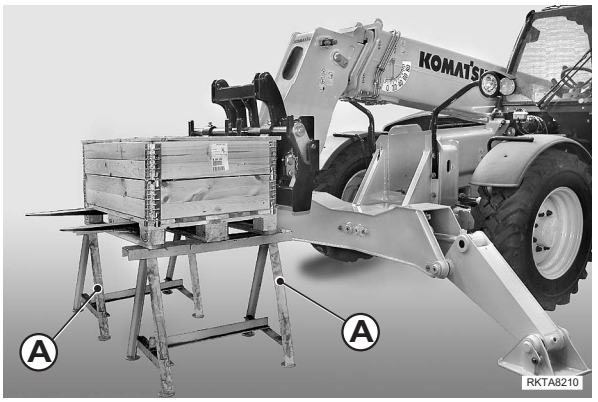
★ Check conditions:
- Stabilizers down to the ground.
- Frame levelled.
- Boom fully retracted.
- Test-weight "**P**" on the forks resting on the ground.
- Engine not running



1 - Remove the front cover (1) to gain access to the safety valve (2).

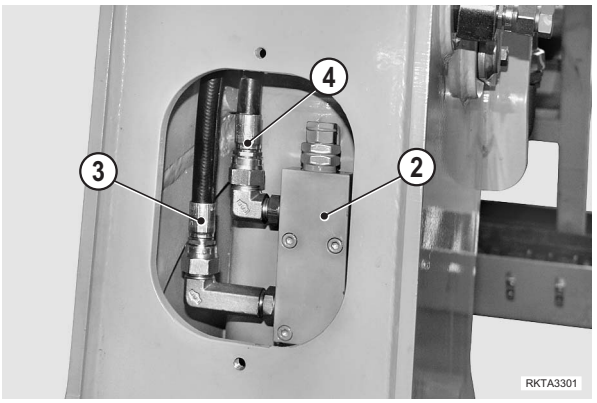


2 - Start the engine, lift the forks by about 70 cm keeping them parallel to the ground and place them on a block or on safety stands ("**A**").



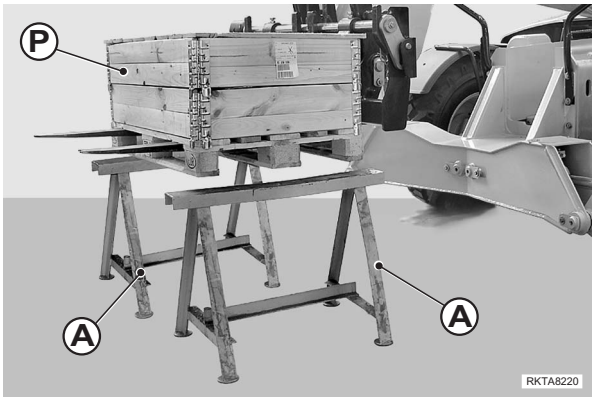
3 - Stop the engine and disconnect the front lines (3) and the rear lines (4) from the valve (2).

★ Cap the hoses to prevent contaminants from entering the passages.



4 - Start the engine and lift the forks off the block by about 10 cm; stop the engine.

⚠ **Leave the block, or safety stands "A", in place.**

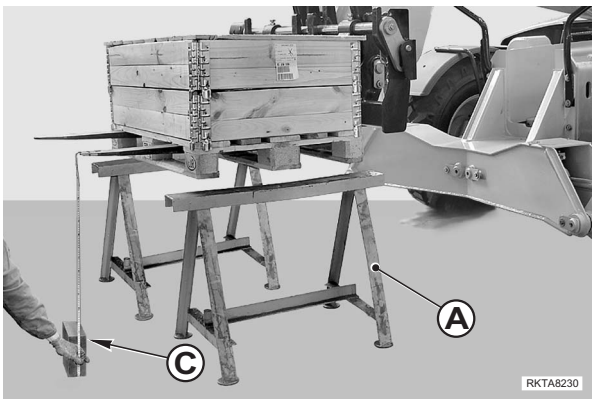


5 - Measure and note down the distance of the tips of the fork from the ground.

⚠ To prevent any measurement errors, place a fixed locator "**C**" to the ground.

6 - Monitor the position of the forks for 5 minutes:

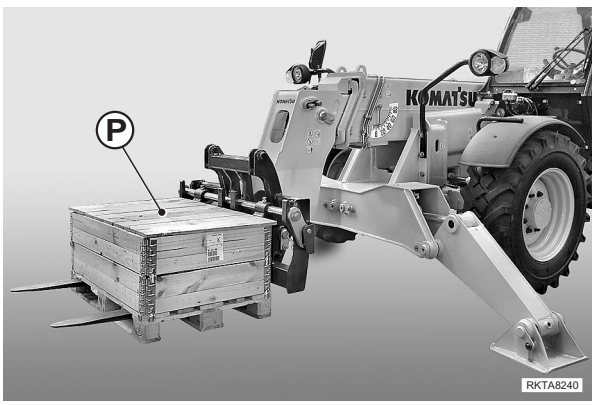
- If the forks tend to overturn and a blow-by condition is affecting the upper fitting (V2) of valve (2), then drift is caused by the safety valve not being sealed properly.
- If the forks tend to overturn and blow-by is at the lower fitting (V1), then drift is caused by blow-by inside the cylinder.



3. Checking procedure for the boom lift cylinder

★ Check conditions:

- Stabilizers fully extended.
- Frame levelled.
- Boom fully retracted.
- Test weight "**P**" on the forks resting on the ground.
- Engine not running.

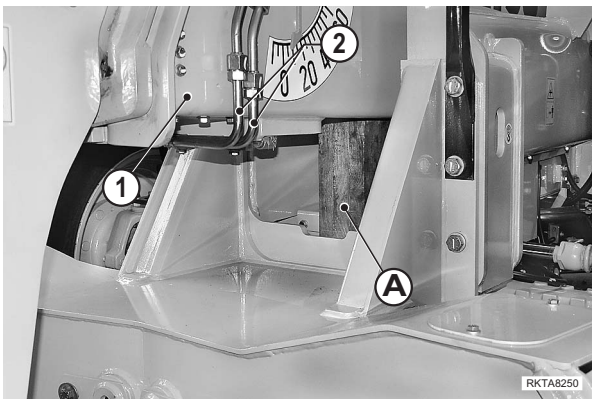


1 - Start the engine and lift the boom (1) until it is possible for a safety block "**A**" to be placed on the frame.

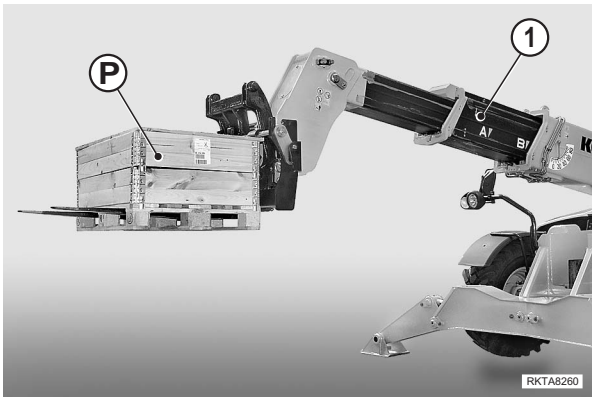
NOTES

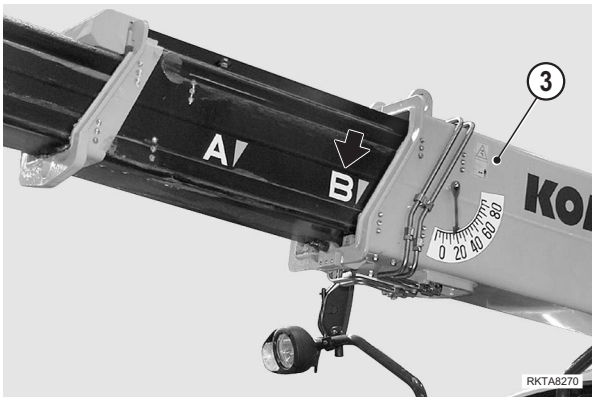
1 - The purpose of the block (should the boom accidentally fall) is to stop the boom before it impacts the ground.

2 - Position the block towards the centre of the machine, past the equipment pipes (2).



2 - Continue lifting the boom (1) until the pendulum goniometer (3) shows a 10° value, and the extend the boom until letter **B** becomes visible.

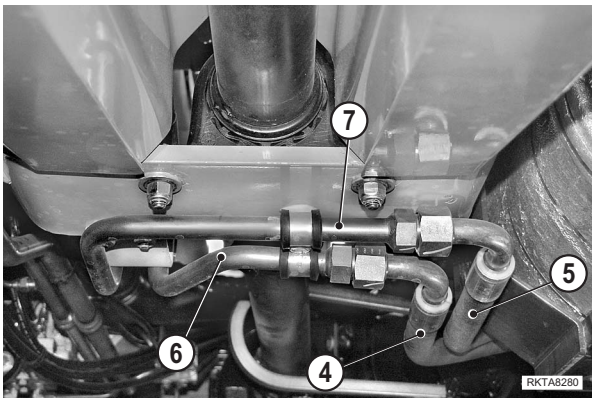




3 - Stop the engine and disconnect the hoses (4 and 5).

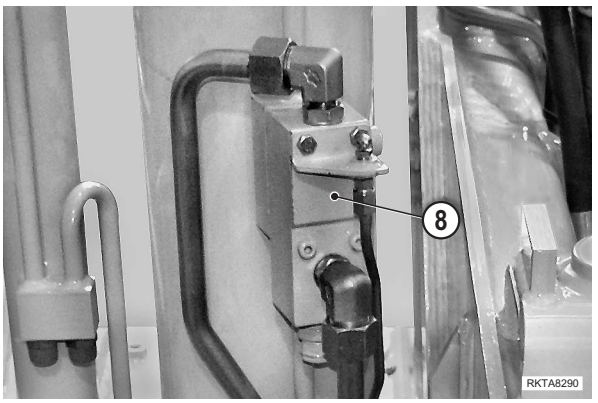
★ Cap the hoses to prevent contaminants from entering the passages.

NOTE
Before proceeding further, allow the oil in the pipes (6 and 7) to flow out.



4 - Go back five minutes later and verify which pipe is still draining.

- If pipe (7) is still draining, the safety valve (8) is faulty and needs to be replaced.
- If pipe (6) is still draining, then the hydraulic drift is caused by blow-by inside the cylinder.

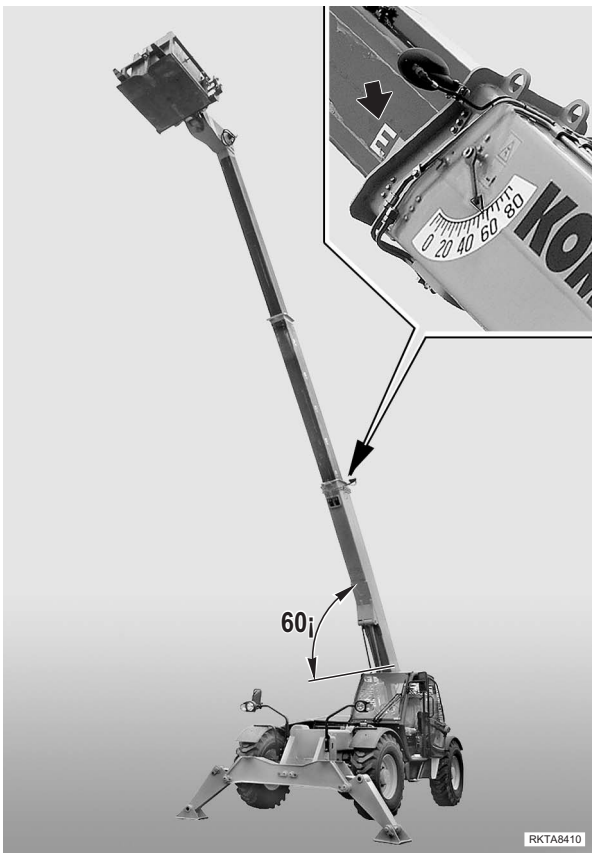


4. Checking procedure for the boom extension cylinder

★ Check conditions:
- Stabilizers fully extended.
- Frame levelled.
- Boom fully retracted.
- Test weight "**P**" on the forks resting on the ground.
- Engine not running.

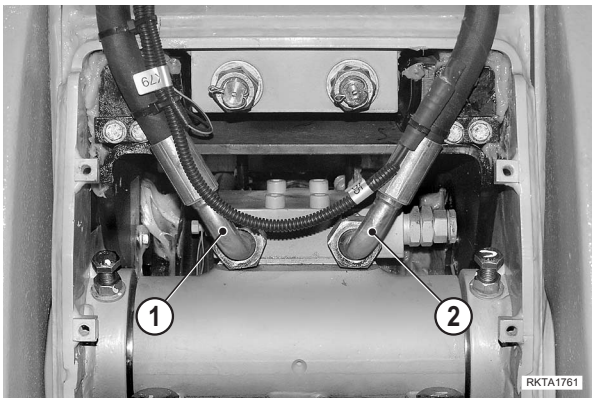
1 - Start the engine and lift the boom to 60°. The angle should be checked at the basic boom using a magnetic level.

2 - Extend the boom until letter "**E**" of the intermediate boom is visible.

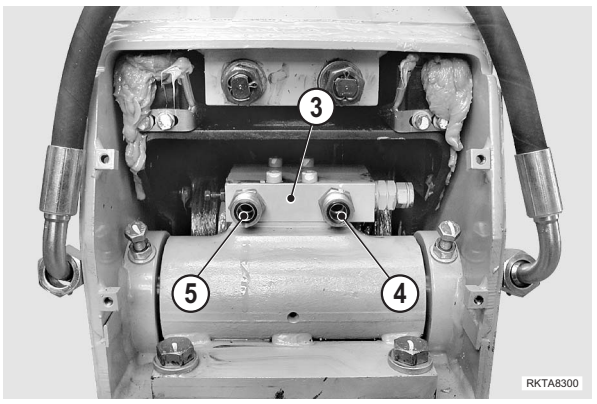


3 - Stop the engine and disconnect the hoses (1 and 2).

★ Cap the hoses to prevent contaminants from entering the passages.



4 - Check draining at the safety valve (3):
- If draining occurs at the right-hand fitting (4) the valve is faulty and needs to be replaced.
- If draining occurs at the left fitting (5), then hydraulic drift is caused by blow-by inside the cylinder.

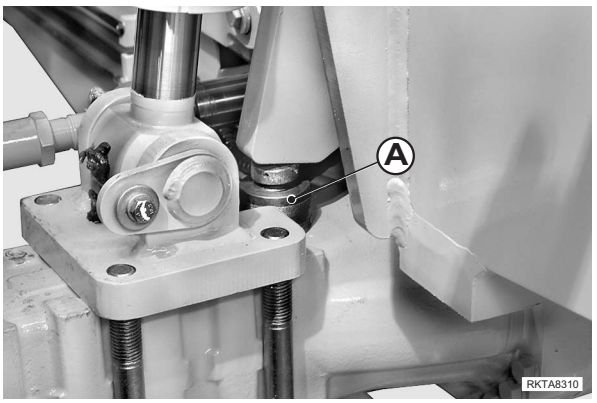


5. Checking procedure for the frame levelling cylinder

★ Check conditions:
- Machine on solid, level ground.
- Frame levelled.
- Boom fully retracted, with no load.
- Engine not running.

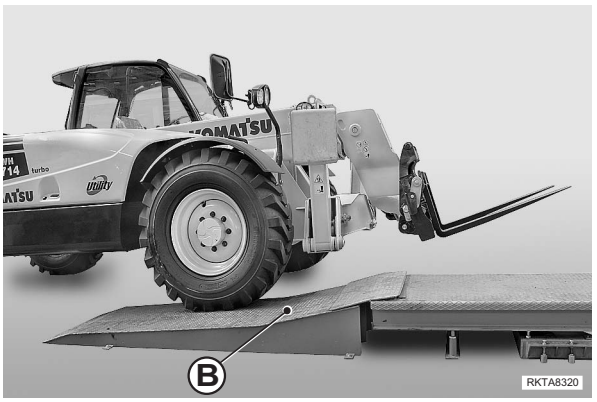
1 - Install and lightly force a screw jack "**A**" between the rear axle (left end) and the frame. This is required in order to counteract axle swing in the next step of the procedure.

NOTE
The screw jack should be positioned on the flat surface of the axle.

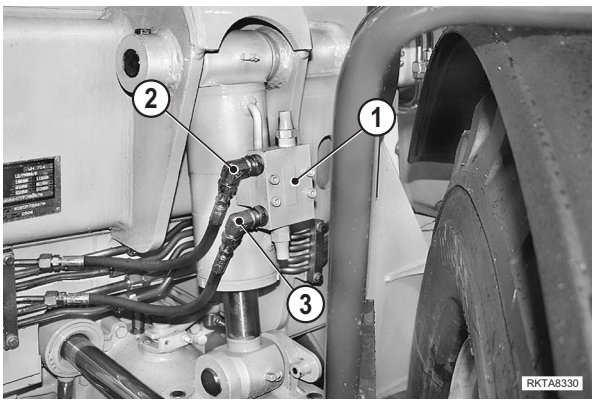


2 - Start the engine and drive the machine onto a raised platform "**B**" with the sole right front wheel.

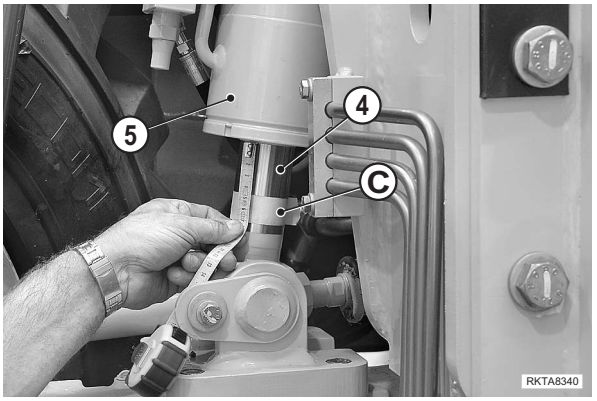
3 - Apply the parking brakes and stop the engine.



4 - Disconnect the hoses (2 and 3) from the safety valve and cap them.



5 - Apply some adhesive tape “**C**” and measure and note down the length of the portion of the stem (4) between the tape “**C**” and the cylinder head (5).



6 - Check draining behaviour.

- If draining is noticed at the safety valve (1), the valve is faulty and needs to be replaced.
- If no draining occurs at the valve and the stem tends to retract in the following 10 minutes, then there is a blow-by condition inside the cylinder.

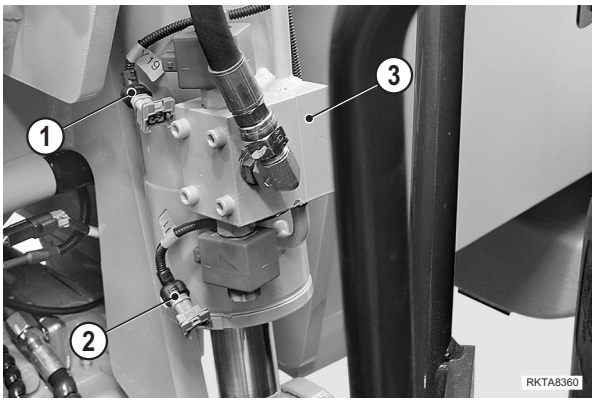
NOTICE!
Remove the adhesive tape previously applied to the stem in step 5.

6. Checking procedure for axle locking cylinder

★ Check conditions:

- Machine on solid, level ground.
- Frame levelled.
- Boom fully retracted, raised above 50°, with no load.
- Engine not running.

1 - Disconnect connectors (1 and 2) from the solenoid valve group (3).

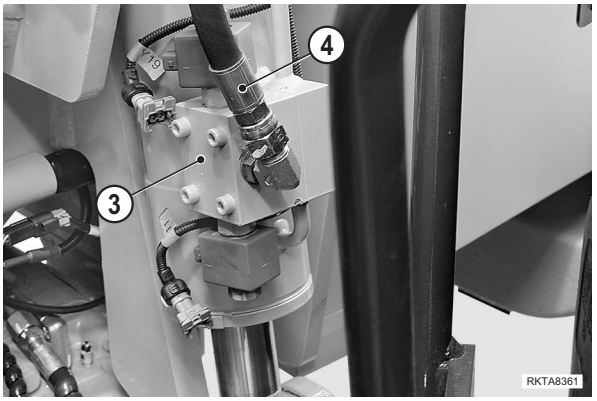


2 - Start the engine and drive the machine onto a raised platform “**A**” by about 8-10 cm with the sole rear left wheel.

3 - Apply the parking brakes and stop the engine.

4 - Disconnect the feed hose (4) from the solenoid group (3) and cap the hose.

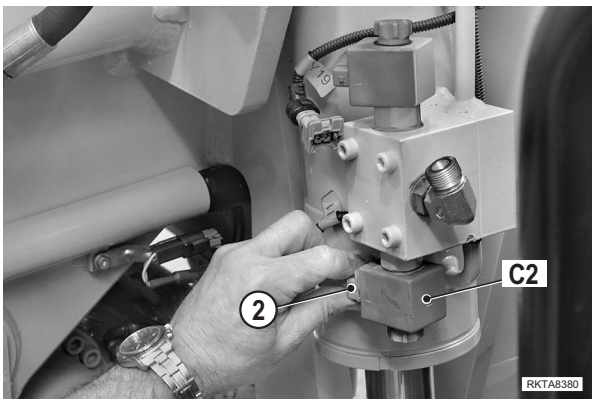
5 - Monitor the draining behaviour of the solenoid valve group for 5 minutes.
- If draining is continuous, then the solenoid valve group (3) is faulty and needs to be changed.
- If no draining is noticed, proceed further with the inspection.



6 - Start the engine and drive the machine back on level ground.

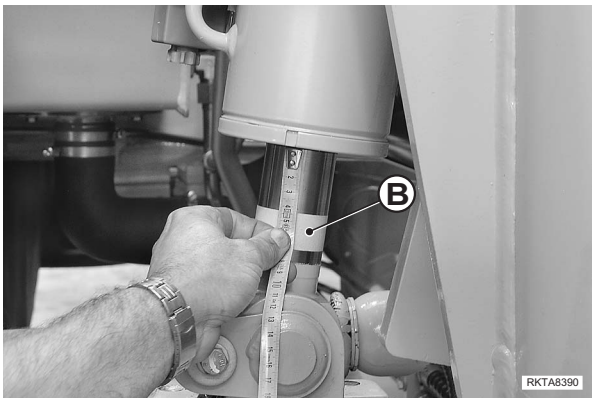
7 - Connect the **C2** solenoid valve connector (2).

8 - Drive the machine back on the raised platform and stop the engine.



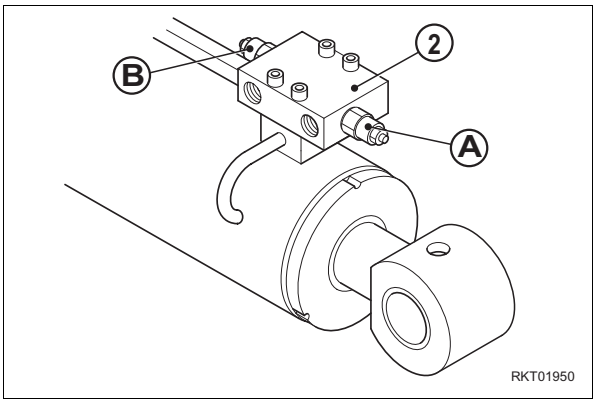
9 - Apply some adhesive tape “**B**” and measure and note down the length of the stem between the tape “**B**” and the cylinder head (5).

10 - Repeat the measurement after 10 minutes.
- If the stem has retracted to any extent, the drift is caused by blow-by inside the cylinder.

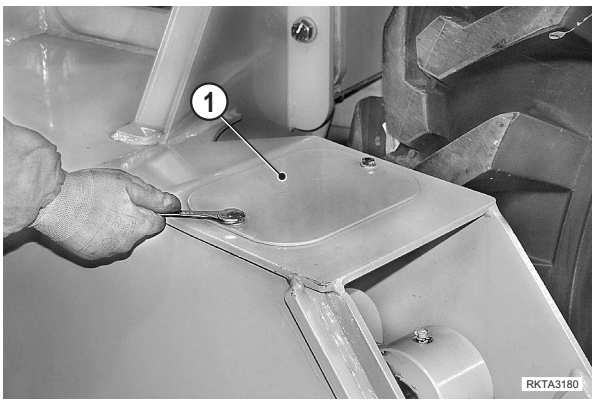


EQUALIZING STABILIZER SPEED

★ After verifying that the individual stabilizer down and up speeds are within standard specifications, it is necessary to check the synchronism between stabilizers both in the down and up movements.
The adjustment reduces the speed of the faster movement in relation to the slower one.
Adjustment is carried out by using the screws below:
A - for down travel adjustment;
B - for up travel adjustment.



1 - Remove the protective cover (1) to gain access to the valve (2).

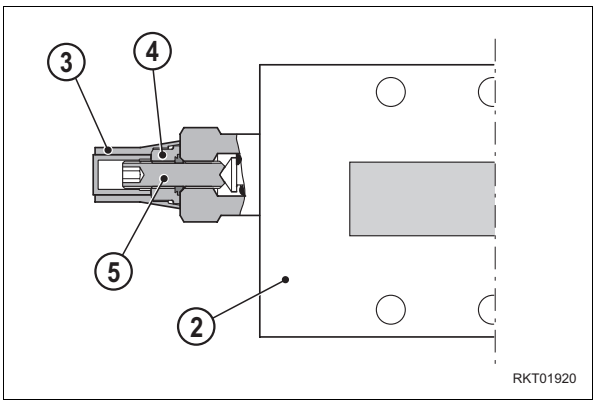


2 - With the engine stopped, remove the tamper seal (3) from the screw you need to adjust.

3 - Loosen the nut (4), tighten the screw (5) by a few degrees and tighten the nut again.

4 - Start the engine, check the synchronism and, if necessary, repeat the adjustment steps until the values are within specifications.

5 - Apply a new tamper seal (3) and place the protective cover (1) back into place.



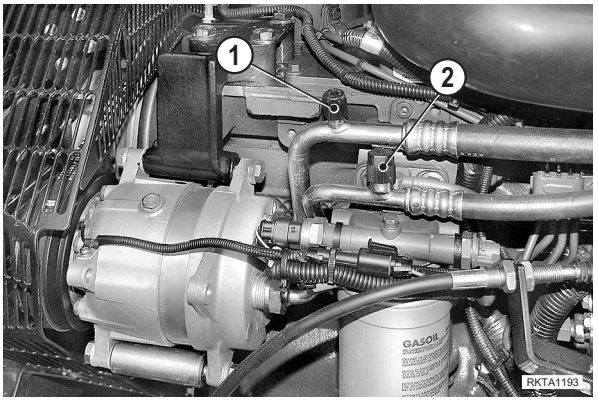
AIR CONDITIONING SYSTEM MAINTENANCE

- **Emptying and filling the air conditioning system**

1 - Connect the maintenance station to the service valves (1 and 2) and follow the maintenance station instructions for emptying the system.

2 - Carefully check the quantity of antifreeze oil that is collected and/or contained in the parts that have been removed because the same quantity shall have to be put back into the system when filling.

3 - Once the necessary repairs have been performed on the A/C system (hose or other part replacement), fill the system by introducing the previously recovered antifreeze oil as well as the coolant gas.
For the filling procedure, follow the maintenance station instructions relevant to A/C system fill.



CHECKING THE A/C SYSTEM'S OPERATING TEMPERATURE

★ Check conditions:
- Machine on level ground with the boom fully lowered and retracted.
- Parking brake applied

1 - Connect the maintenance station to the high pressure valve (A.P.) and to the low pressure valve (B.P.).

2 - Start the engine and operate it at 1500 rpm.

3 - Activate the A/C system by the switch in the cab.

4 - Select an intermediate speed for cab ventilation.

5 - Using a thermometer/hygrometer, check the cab inside temperature for being equal to or under ambient temperature.

★ If cab temperature is higher than ambient temperature, open the doors and windows and allow the cab temperature to adjust and stabilize to ambient temperature.

6 - Close the doors and windows and let the A/C system run in these conditions for 5-10 minutes.

7 - Using a thermometer, check the air temperature at the centre A/C outlets.

★ Position the probe as close as possible to the point where the air comes out.

8 - Compare the average values of the temperature readings with the table to the side:

9 - If the average temperature value derived from the temperature readings is not within the range given in the table, the system needs to be checked.

Ambient temperature (°C)	20	25	30	35
Outgoing air temperature (°C)	6 – 8	8 –10	8 – 12	9 – 14

• Checking the A/C system

Check the A/C system once the procedures in steps 1, 2, 3, 4 and 6 above have been carried out.
The system failure diagnostics is performed using a pressure-based method.
When the pressures are not within the acceptable range given in the table below, look for the cause of malfunction by checking the high pressure (A.P.) and the low pressure (B.P.) pressure gauges.

Outside temperature (°C)	Unit with R134a			
	B.P. (kg/cm²)		A.P. (kg/cm²)	
	Min.	Max	Min.	Max
20	1.2	2.5	6.0	9.0
25	1.0	2.5	7.5	10.5
30	1.1	2.4	9.5	13.0
35	1.3	2.4	12.0	15.5
40	1.5	1.8	18.0	18.8
45	1.8	1.9	21.5	22.0

The following conditions may exist:

Condition	Cause - Malfunction
High B.P, normal or low A.P.	• Electromagnetic pulley slips or does not engage properly. • Expansion valve is stuck in the open position • Compressor is damaged
Low B.P, high or normal A.P.	• Expansion valve is stuck in the closed position or clogged • Filter is saturated with dampness • The B.P or A.P line is obstructed between the filter and the evaporator
Normal B.P, normal A.P.	• Hot air ingestion into the evaporator unit, into the lines or into the cab • Hot water circulating in the heating unit • Ice has formed on the evaporator
High B.P, high A.P.	• Normal condition with very high ambient temperature (higher than 43°C) • Excess of coolant (30 –35% more) • Condenser overheating • Air in the system • Obstruction of the A.P. line between the compressor and the condenser hose, past the A.P. temperature reading point.
Normal or low B.P, low A.P.	• Normal condition with very low temperature (lower than 5 °C) • Coolant fluid level low (70 –75% less) (leaks are likely) • Obstruction of the A.P. line between the compressor and the condenser hose, upstream from the A.P. temperature reading point. • Compressor is damaged
B.P. is approximately equal to A.P.	• Compressor belt missing • The electromagnetic pulley slips or does not engage • Compressor is damaged

30 REMOVAL AND INSTALLATION

HOW TO READ THE MANUAL

1. Removal and Installation of the groups

(1) The procedures and information needed to carry out the work of removing or Installing units or groups are given in the removal procedure. The sequence of operations is not repeated in the installation procedure.

(2) Information needed for installation is marked with the symbol [*1]; The same symbol is repeated at the end of each removal procedure for the same item, to indicate to which installation item it refers.

(Example)
REMOVAL GROUP ●●●: ..... Title of operation

⚠: ..... Safety precautions to be followed when carrying out the operation.

1 - Remove XXXX (1): ..... Step in removal procedure.
★: ..... Technique or important point to remember when removing XXXX (1)

2 - ▲▲▲ (2): ..... [*1] This sign means that information is given for the installation procedure

3 - Remove ■■■ (3):
..... ℓ: ..... Recovery of oil or water, and the quantity to be recovered.

INSTALLATION GROUP ●●● :..... Title of operation.

● To install, reverse removal procedure.

[*1]: ..... Technique to be used for installation
★: ..... Technique or important point to remember when removing ▲▲▲ (2)

● Addition of water or oil: ..... Step in removal procedure.

★: Point to remember when adding water or oil.

2. To the precautions to be taken during the removal or installation of the groups, must be added the specific "PRECAUTIONS TO BE TAKEN WHEN WORKING".
Always make sure that these precautions are taken.

3. List of special tools.

(1) For details of the descriptions, codes and quantities of each tool (A1; A2 etc.) mentioned in the operational procedures, see the list "SPECIAL TOOLS" supplied in this section.

4. List of the tightening torques and weights, and the quantities oil, liquids or grease needed to fill tanks and containers

(1) In the operating procedures, you will find the symbols  ; In the following order, these represent the values of «TIGHTENING TORQUES», «WEIGHT OF PARTS OR GROUPS», «QUANTITIES OF OIL OR LIQUIDS TO BE INTRODUCED», «SCREW LOCKING MATERIAL, SEALANTS AND LUBRICATION», «LUBRICATING GREASE».

NOTE
If no symbol is indicated, the values to be used are those given in the introductory sections of this manual.

PRECAUTIONS TO BE TAKEN WHEN WORKING

★ When dismantling or installing a part, always take the following general precautions.

1. Precautions for removal operations
- If not otherwise indicated, lower the work equipment until it rests on the ground.
- If the coolant liquid contains an anti-freeze substance, follow the instructions given for drainage.
- After having removed flanges and tubes, insert plugs to prevent impurities from entering.
- Before removing a cylinder, fully retract the piston and tie it with wire.
- Use a sufficiently large container to collect the oil.
- Before removing a part from the machine, check the alignment reference marks which show the correct installation position. If necessary add further marks to avoid incorrect installation.
- While dismantling the connectors, always grasp them firmly to avoid undue strain on the wiring.
- If necessary, attach markers to the wires and tubes to avoid muddling them up during installation.
- Check the number and height of the adjustments to a given clearance and store them in a safe place.
- When raising the machine or some parts of it, use adequate equipment for the weight of the part concerned.
- When using screws or eyebolts to remove items of the machinery, screw them alternately, and as deeply as they will go.
- Before removing a piece, clean the surrounding area and, after removal, cover the area to prevent dirt or dust from gaining entrance

2. **Precautions to be taken during installation**
- Tighten nuts and screws with the specified tightening torques.
- Install the flexible hoses, taking care not to entangle or twist them.
- Bend the cotter pins and stops in such a way as to secure them.
- When coating the threads with adhesives, clean the piece to remove oil and grease, then apply just enough adhesive to cover the threading in a uniform manner.
- When applying a liquid sealant, clean the surface involved, remove residual oil and grease, check that there are no dents or dirt, then apply the liquid sealant in a uniform manner.
- Clean all the parts, remove dirt, rust, burrs, or dents.
- Apply a film of engine oil over all the moving parts.
- Apply a film of anti-friction grease (ASL800040) over all surfaces assembled with pressure, to avoid sticking.
- After having mounted the snap-rings, check that they are firmly positioned in their seatings.
- When installing electrical system jacks, remove any oil, dust or water that may have penetrated into them, then connect them firmly.
- If using eyebolts, check that they are not distorted, screw them in fully, and then align the eye with the hoisting hook.
- Mount the flanges in a uniform manner, and tighten the screws in criss-cross sequence, to avoid excessive pull on one side only.

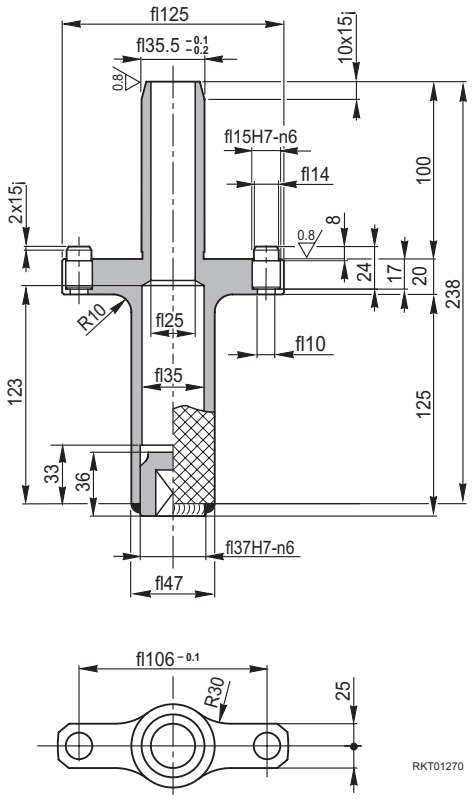
3. Precautions to be taken on completion of removal and installation operations
- If the coolant liquid has been drained away, close the drainage plug and add new liquid up to normal level. Start the engine to circulate the liquid throughout the cooling system and then top up the level once more.
- When the hydraulic equipment has been dismantled, add engine oil to the indicated level. Start up the engine to circulate the oil in the hydraulic circuits, and then top up to the indicated level.
- If hoses or hydraulic equipment, such as hydraulic cylinders, pumps, motors, solenoid valves and valves, are removed for repairs or substitution, bleed air from the hydraulic circuits after having re-assembled the machine.
- For details, see “20. CONTROL AND ADJUSTMENTS”.
- After having re-assembled cylinder joints or cylinders, or work equipment articulations, lubricate thoroughly.

SPECIAL TOOLS

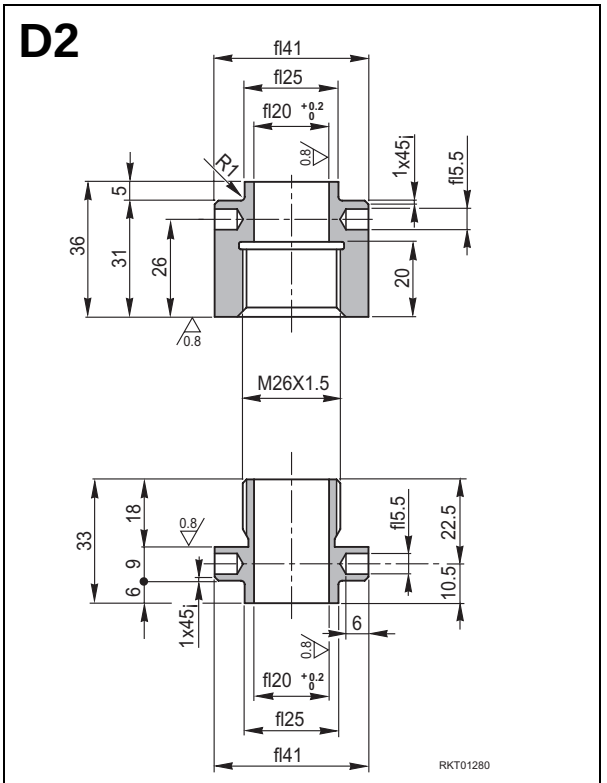
Nature of work	Symbol		Code	Description	Q.ty	Notes
Removal of telescopic boom	A	1	ATR201501	Tool	1	–
Disassembly/Assembly of steering unit	B	1	00239496	Tool	1	Removal of inner gasket
		2	00239497	Tool	1	Removal of dust seal
		3	00239498	Tool	1	Mounting of inner gasket
		4	00239499	Tool	1	Mounting of dust seal
Assembly of transmission	C	1		Tool	1	Removal regolator group
Disassembly/Assembly axles	D	1		Wrench	1	–
		2		Tool	1	Removal/installation of differential planetary wheel pins
		3		Bushing	1	
		4		Tool	1	Installation of differential planetary wheel pins
		5		Wrench	1	Flange locking
				Wrench	1	
		6		Wrench	1	Flange ring nut locking
		7		Wrench	1	Pinion locking
		8		Block	1	–
		9		Spacer	1	–
		10		Bearing inner ring installation kit	1	Installation pinion bearing
					1	
					1	
		11		Tool	1	Pinion dimension measuring
		12		Bearing outer ring installation kit	1	Installation pinion bearing
		13		Wrench	1	Installation pinion bearing
		14		Plunger	1	–
		15		Plunger	1	–
		16		Tool	1	Arm alignment

Nature of work	Symbol		Code	Description	Q.ty	Notes
Disassembly/Assembly axles	D	17		Bush	1	–
		18		Extension	1	
		19		Plunger	1	
		20		Plunger	1	
		21		Plunger	1	
		22		Plunger	1	
		23		Plunger	1	
		24		Plunger	1	
		25		Bearing inner ring installation kit	1	Planetary bearing installation
		26		Plunger	1	
		27		Plunger	1	

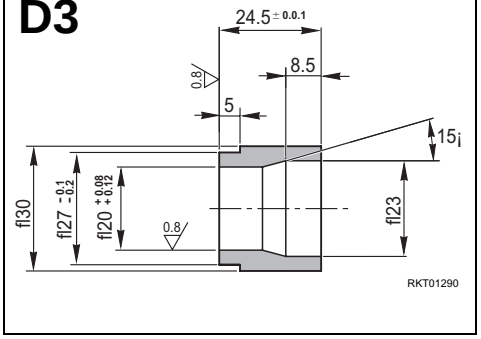
D1


fl125
fl35.5 -0.1 -0.2
10x15j
0.8
fl15H7-n6
fl14
100
2x15j
0.8
8
24
17
20
238
R10
fl25
fl10
fl35
123
125
33
36
fl37H7-n6
fl47
fl106 -0.1
R30
25
RKT01270

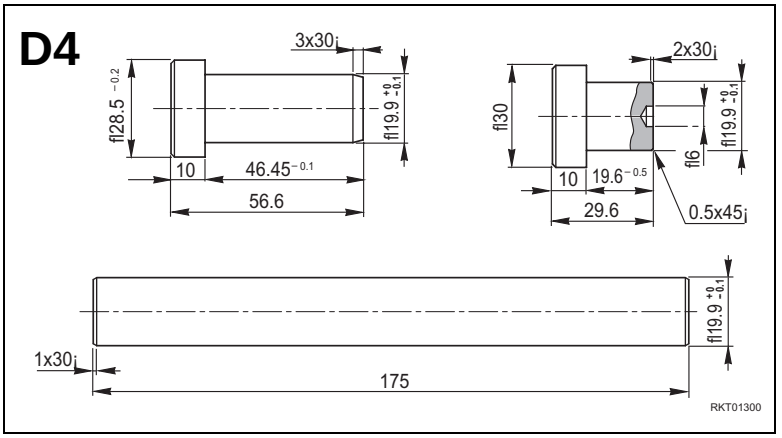
D2


fl41
fl25
fl20 +0.2 0
0.8
1x45j
fl5.5
R1
5
36
31
26
20
0.8
M26X1.5
33
18
9
6
0.8
fl5.5
22.5
10.5
1x45j
6
0.8
fl20 +0.2 0
fl25
fl41
RKT01280

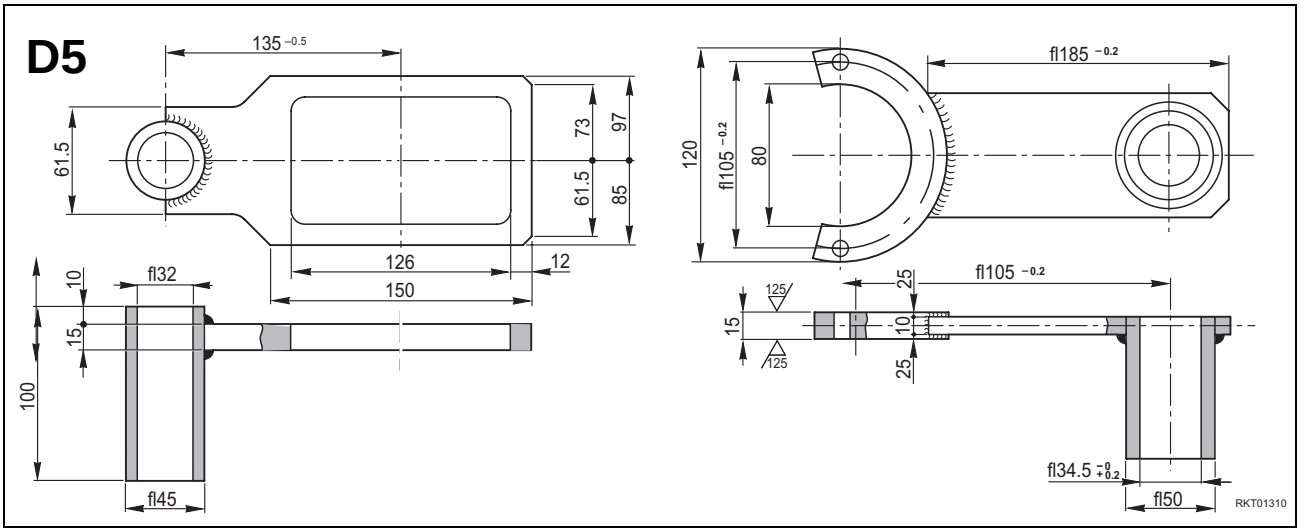
D3

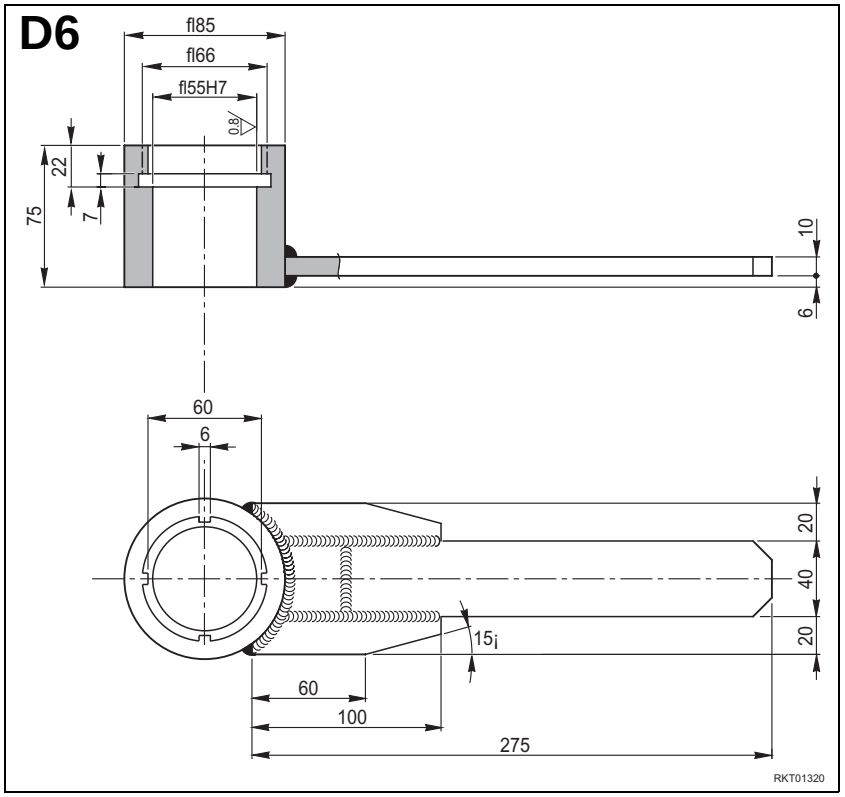

24.5 ± 0.0.1
0.8
8.5
5
15j
fl30
fl27 -0.1 -0.2
fl20 +0.08 +0.12
0.8
fl23
RKT01290

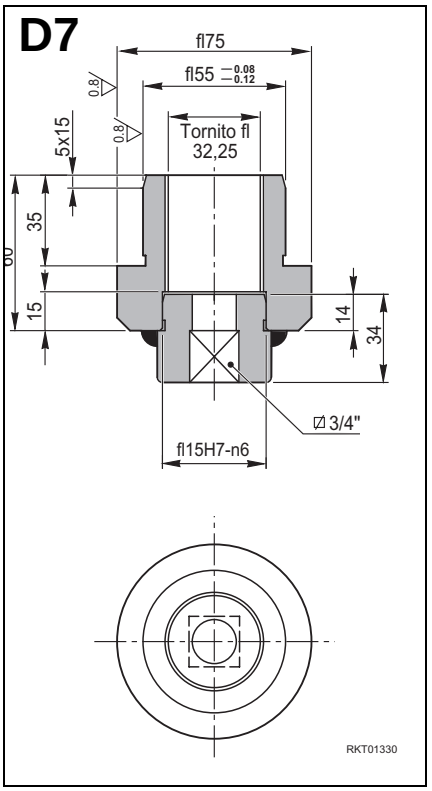
D4

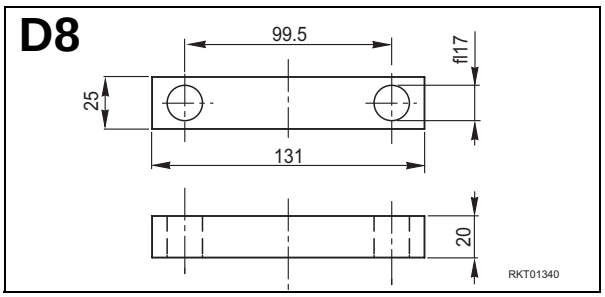

3x30j
fl28.5 -0.2
fl19.9 +0 -0.1
10
46.45 -0.1
56.6
2x30j
fl30
fl19.9 +0 -0.1
fl6
10
19.6 -0.5
29.6
0.5x45j
fl19.9 +0 -0.1
1x30j
175
RKT01300

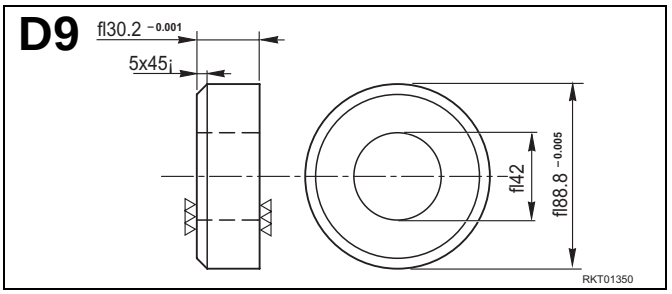
D5

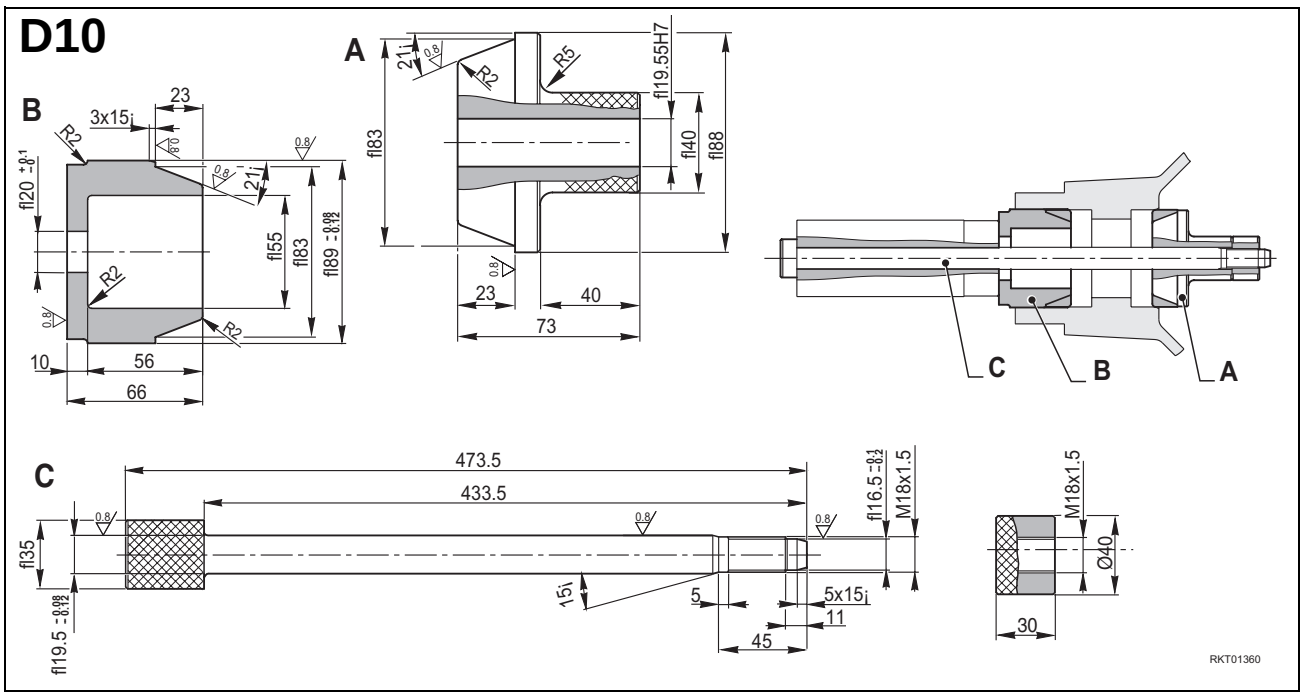

135 -0.5
61.5
73
97
61.5
85
126
12
150
10
fl32
15
100
fl45
fl185 -0.2
120
fl105 -0.2
80
fl105 -0.2
125
25
15
10
125
25
fl34.5 +0 -0.2
fl50
RKT01310


D6
fl85
fl66
fl55H7
0.8
22
7
75
10
6
60
6
20
40
20
15j
60
100
275
RKT01320

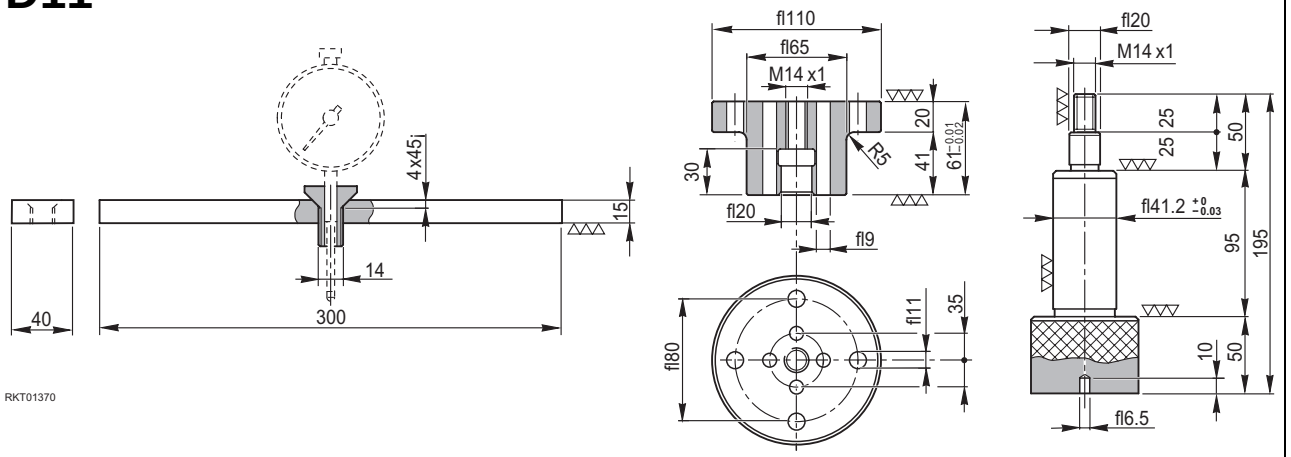

D7
fl75
fl55 −0.08 −0.12
0.8
5x15
Tornito fl
32,25
35
15
14
34
⍁ 3/4"
fl15H7-n6
RKT01330


D8
99.5
fl17
25
131
20
RKT01340

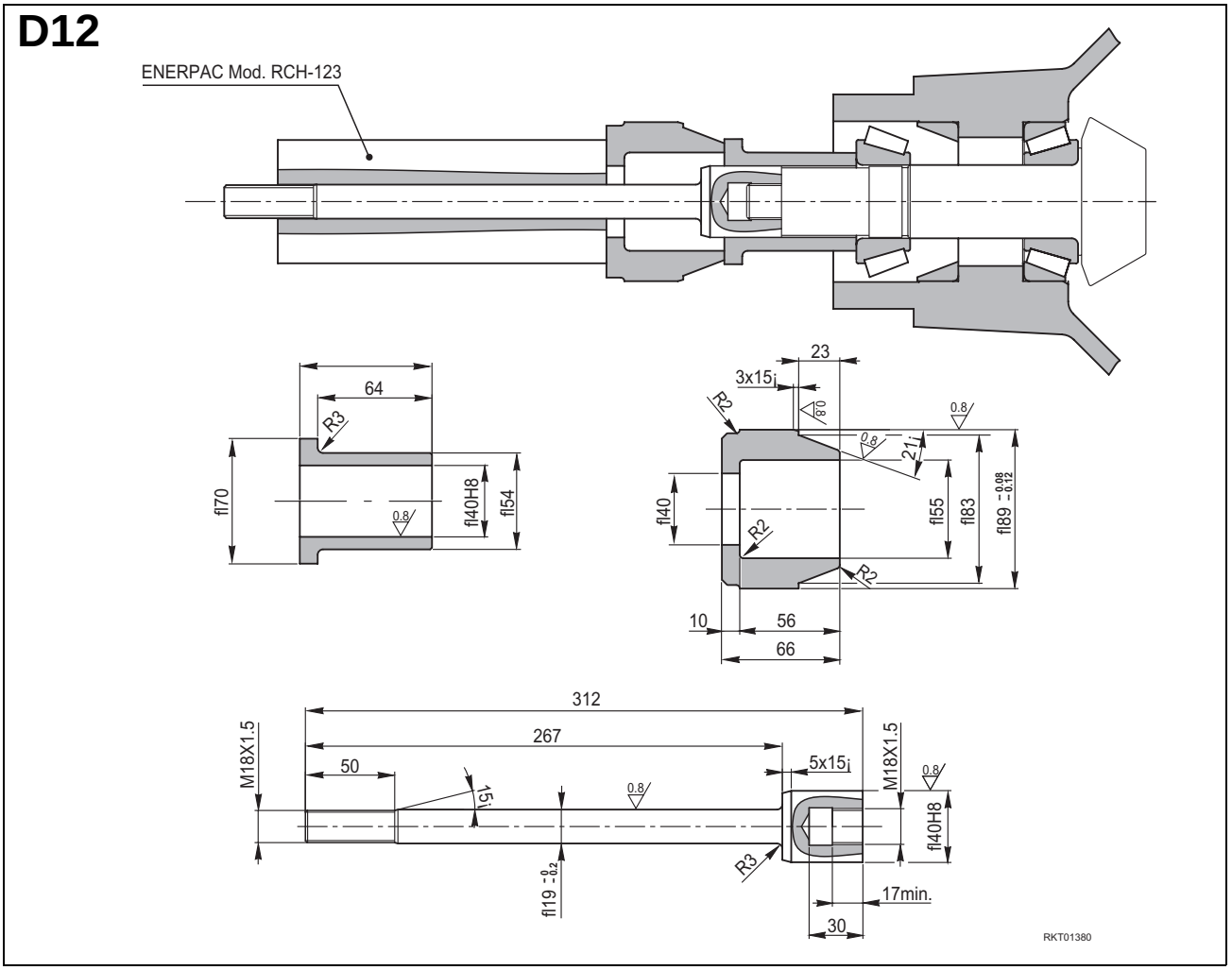

D9
fl30.2 −0.001
5x45j
fl42
fl88.8 −0.005
RKT01350


D10
A
B
C
21j
0.8
R2
R5
fl19.55H7
fl83
fl40
fl88
23
40
73
3x15j
R3
60°
fl20 +0.1
fl55
fl83
fl89 −0.02 −0.12
10
56
66
C
B
A
473.5
433.5
fl16.5 −0.1 −0.2
M18x1.5
fl35
fl19.5 −0.08 −0.12
15j
5
5x15j
11
45
30
Ø40
RKT01360

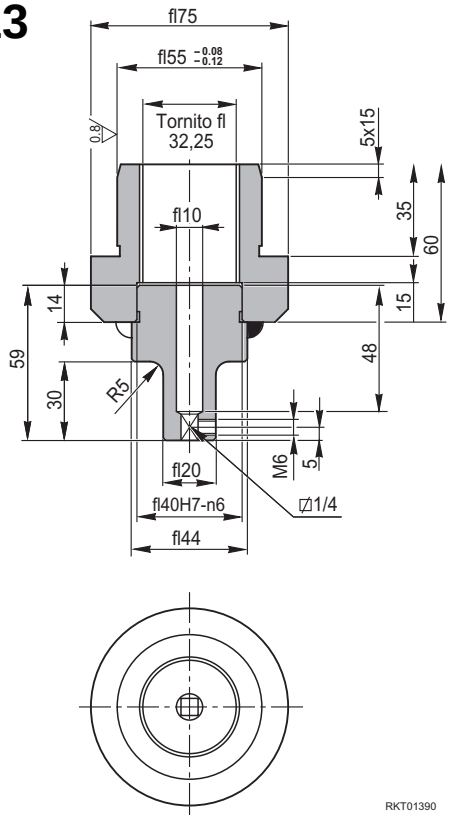
D11


4x45j
15
14
40
300
RKT01370
fl110
fl65
M14 x1
20
30
R5
41
fl20
fl9
fl80
fl11
35
fl20
M14 x1
25
25
50
fl41.2
95
195
10
50
fl6.5

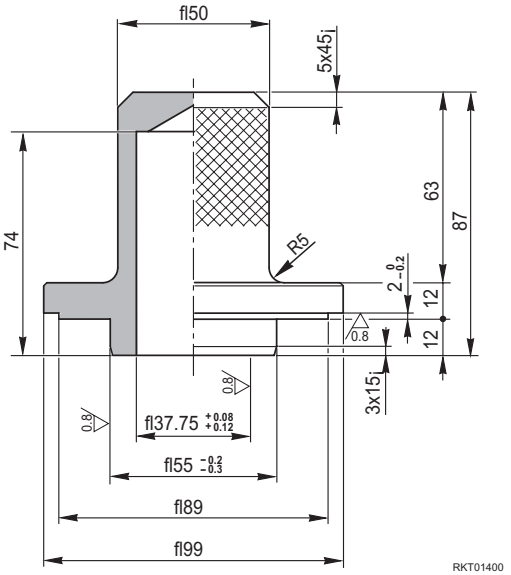
D12


ENERPAC Mod. RCH-123
64
R3
fl70
fl40H8
fl54
0.8
23
3x15j
R2
0.8
2 j
fl40
fl55
fl83
fl89
R2
R2
10
56
66
312
267
50
5x15j
M18X1.5
M18X1.5
15
0.8
fl40H8
fl19
R3
17min.
30
RKT01380

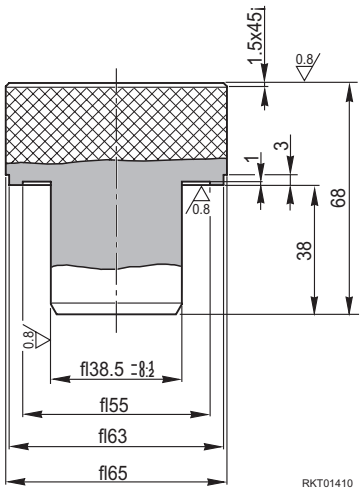
D13



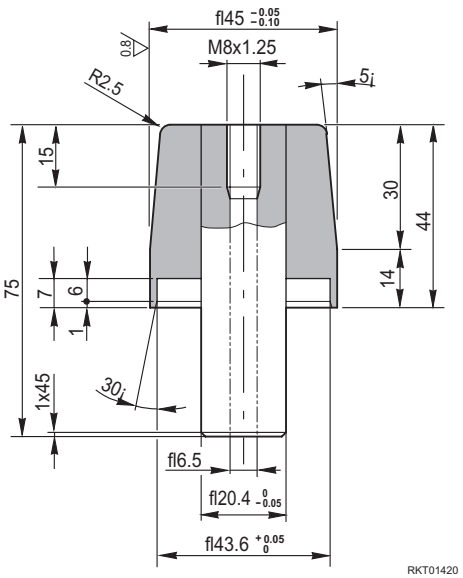
D14



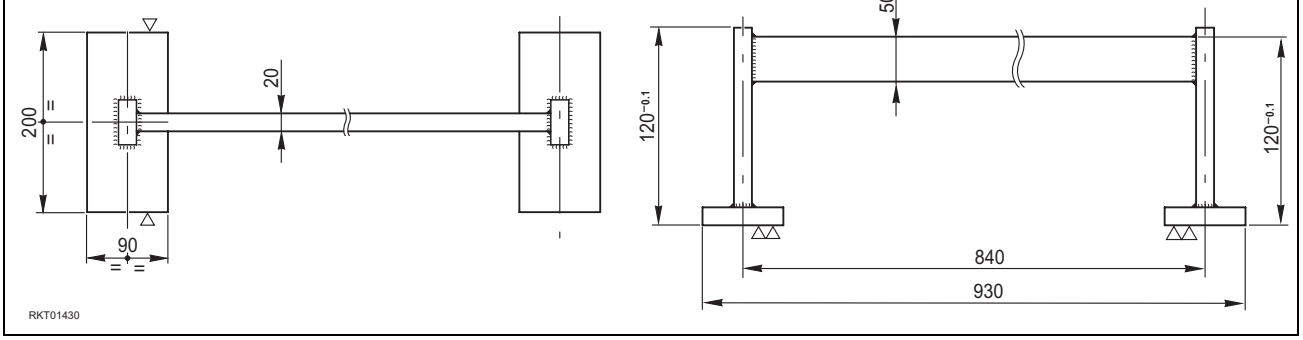
D15



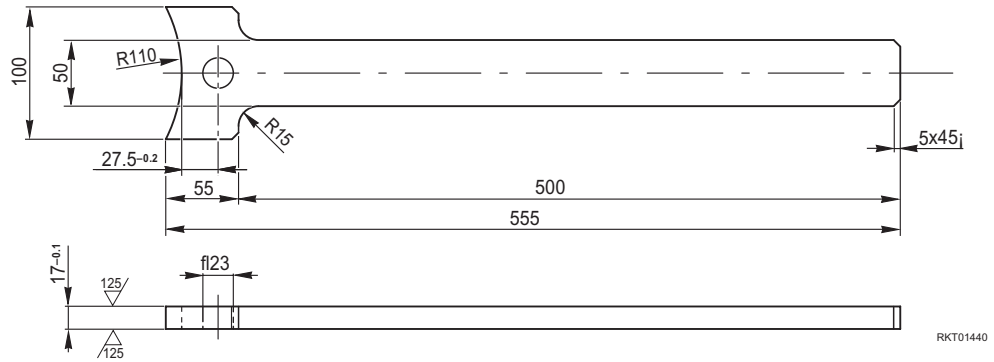
D17



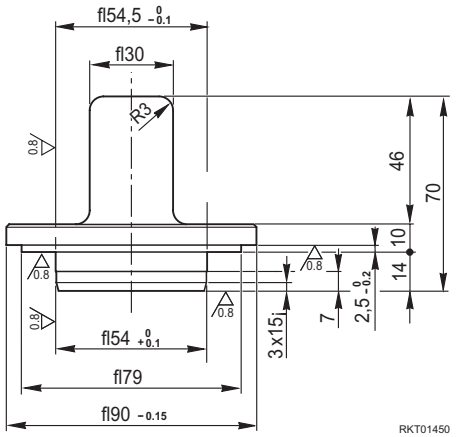
D16



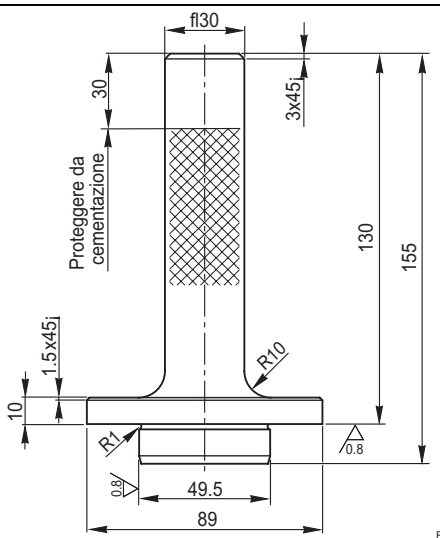
D18



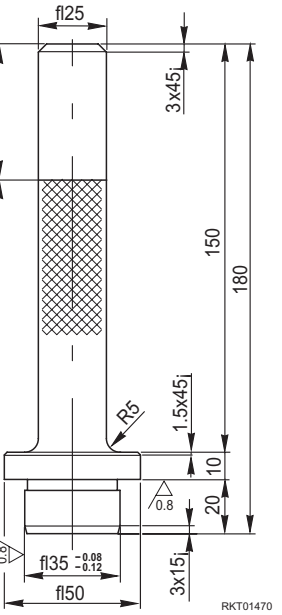
D19



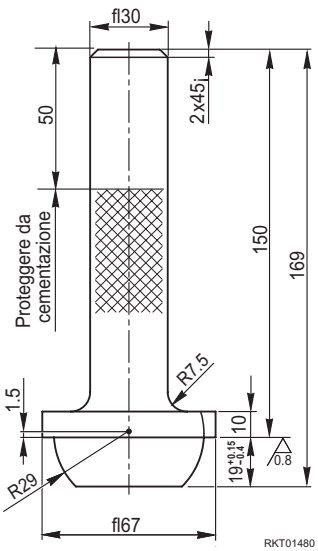
D20



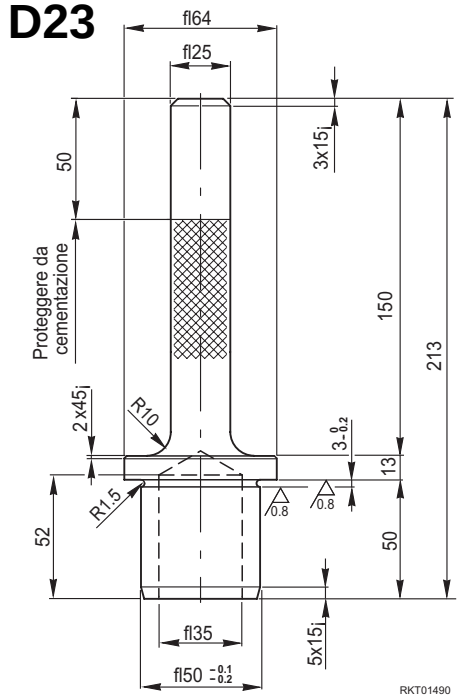
D21



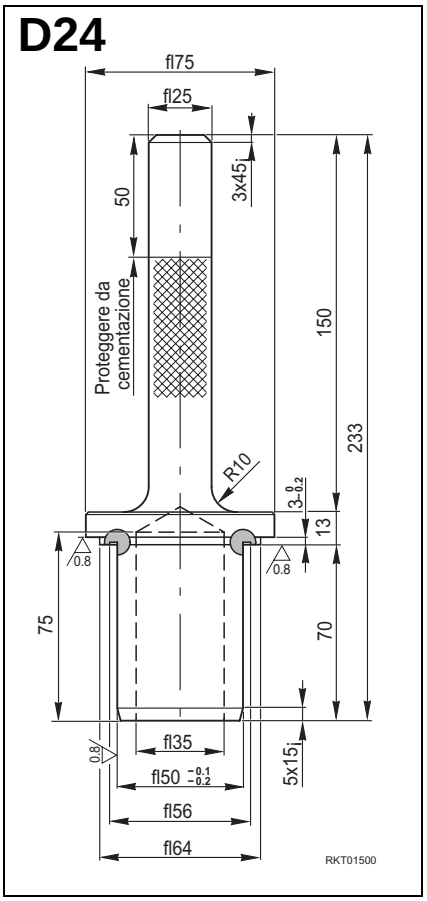
D22



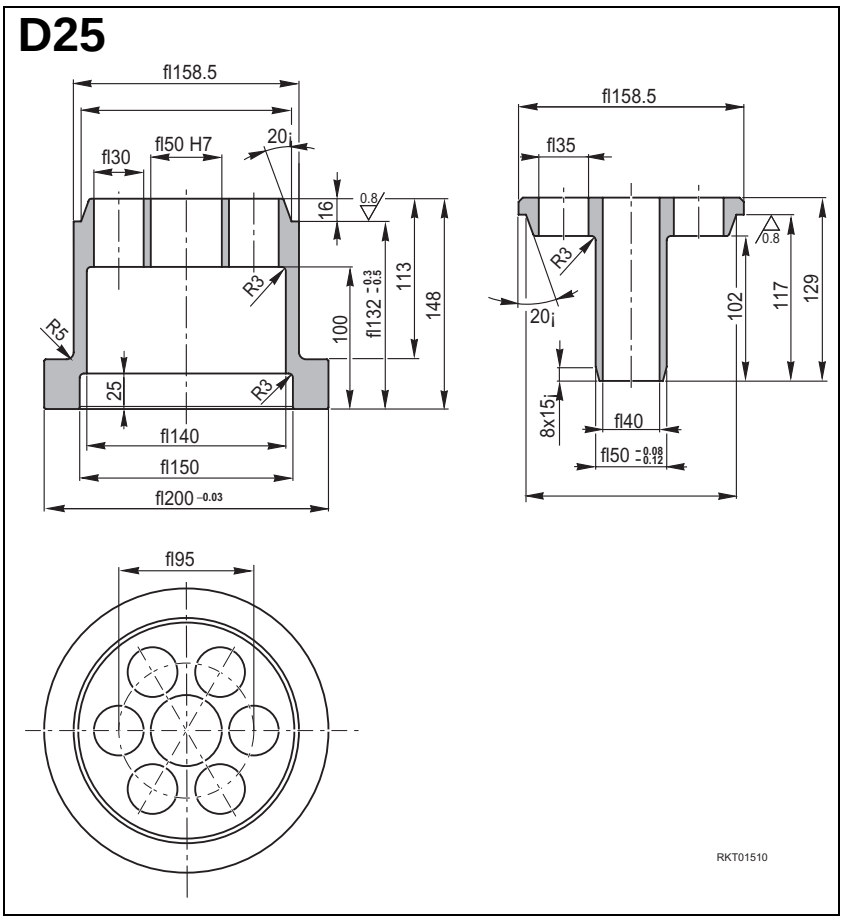
D23



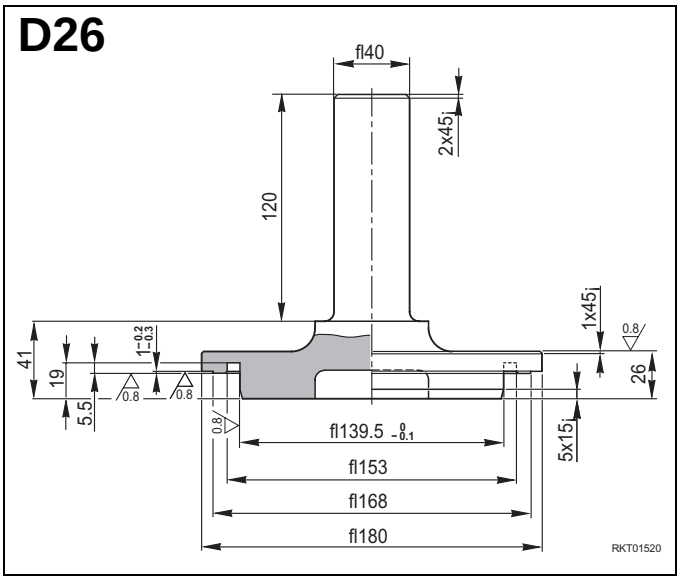
D24



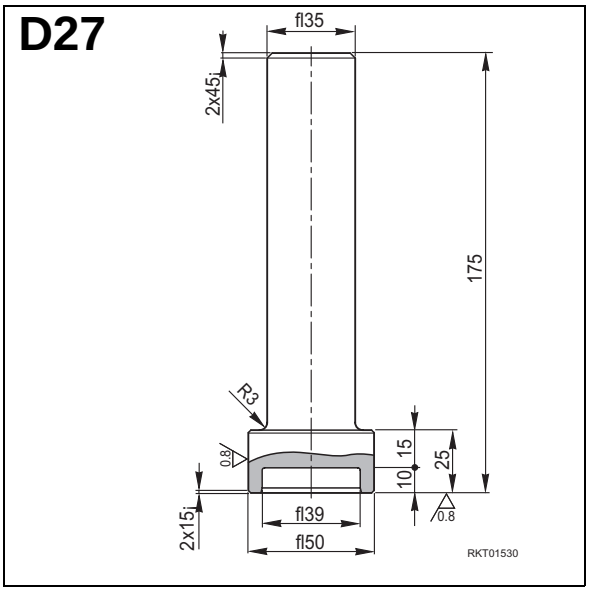
D25



D26



D27

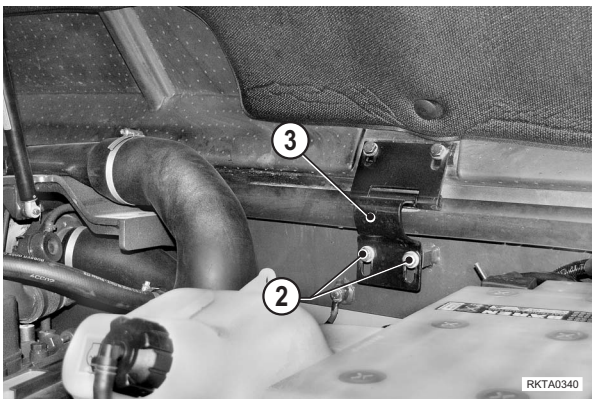


ENGINE HOOD

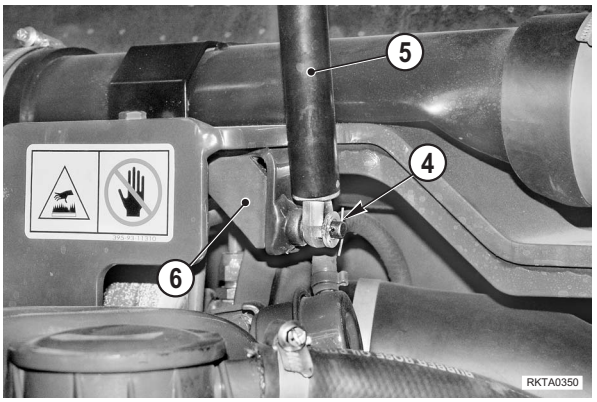
Removal

1 -Lift the engine hood (1).

2 -While supporting the engine hood, loosen and remove the screws (2) retaining the hinges (3).



3 -Remove the cotter pin (4), the backing washer, and disconnect the gas damper (5) from its support (6).



4 -Lower the hood and place an anti-slip block (A) between lower edge of hood and body; then, strap the hood and connect it a hoist.

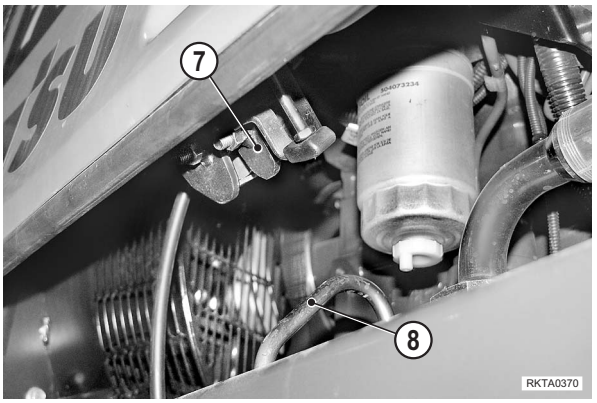
5 -Remove the hood (1). [*1]

Installation

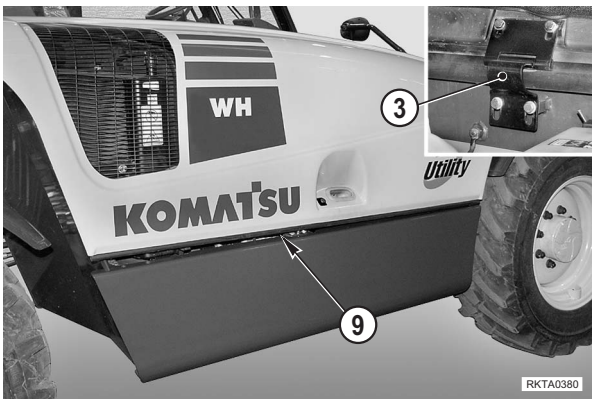
- To install, reverse the removal procedure.

[*1]

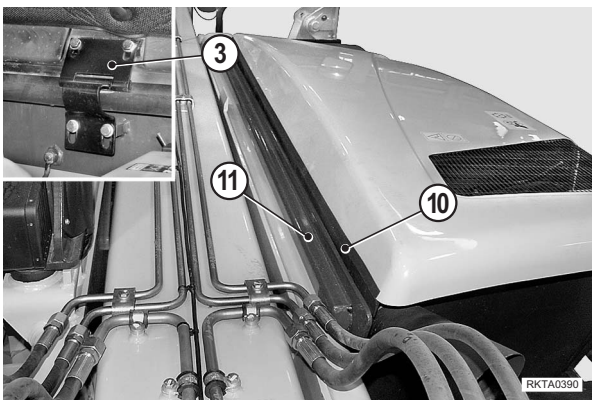
1 - Adjust the position of the hood, ensuring that the lock assembly (7) is centred in relation to the retaining hook (8).



2 - Adjust the hinges vertically (3) to allow the closure sealing strip (9) to evenly rest along the length of the hood.



3 - Adjust the hinges (3) horizontally until full contact between the sealing strip (10) and the engine-transmission mount (11) is achieved.

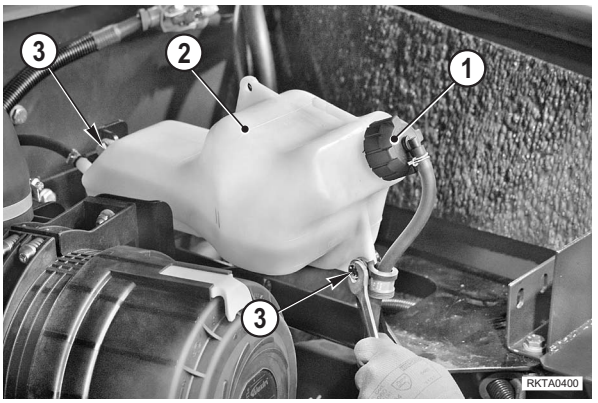


AIR FILTER

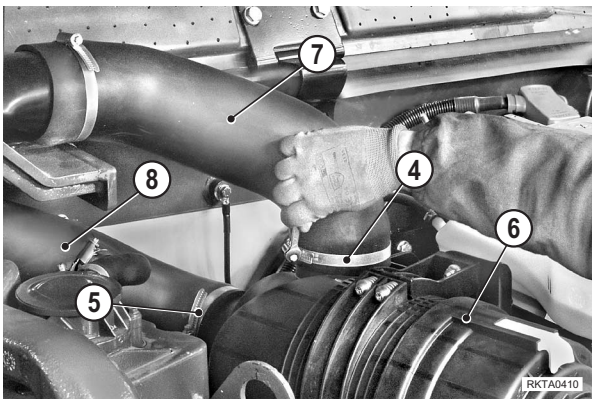
Removal

1 - Unscrew and remove the cap (1) from the surge tank (2).

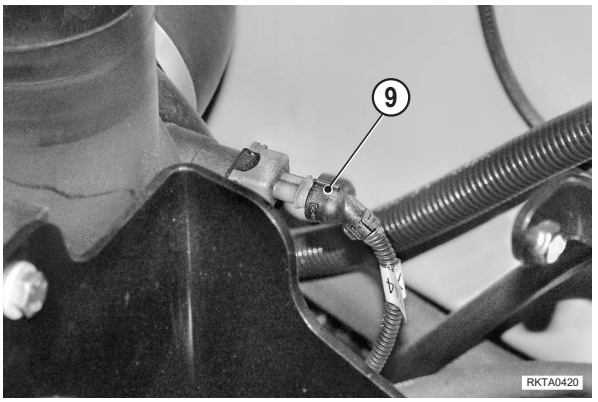
2 - Loosen and remove the screws (3), remove the surge tank (2), and position the tank aside.



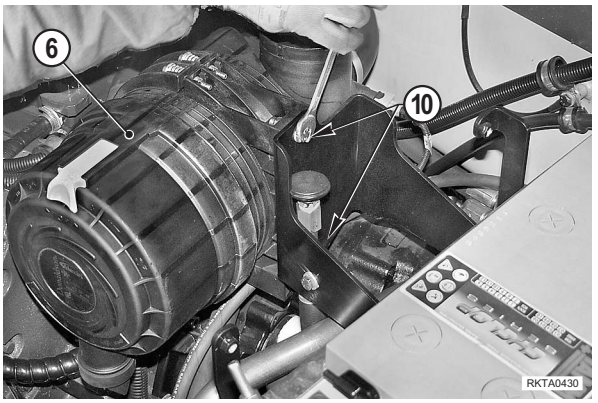
3 - Loosen the clamps (4), (5) and disconnect the outside air inlet hose (7) and engine intake hose (8) from the filter (6).



4 - Disconnect the air cleaner clogging sensor connector (9).



5 - Loosen and remove the screws (10) together with washers and nuts and remove the filter (6).



Installation

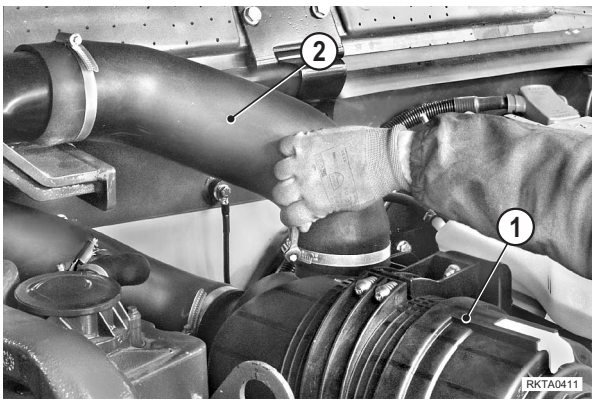
- To install, reverse the removal procedure.

TURBOCOMPRESSOR (only if equipped)

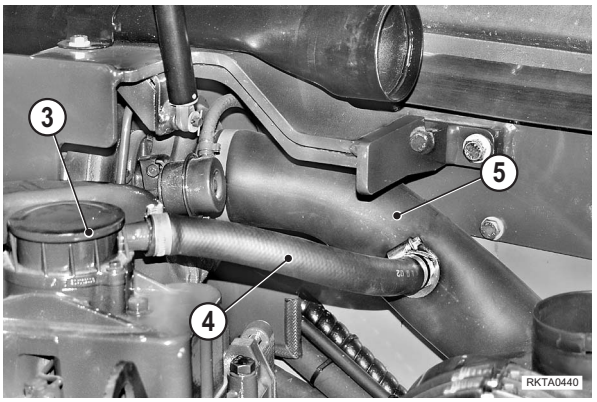
Removal

1 - Remove the engine hood.
(For details, see "ENGINE HOOD").

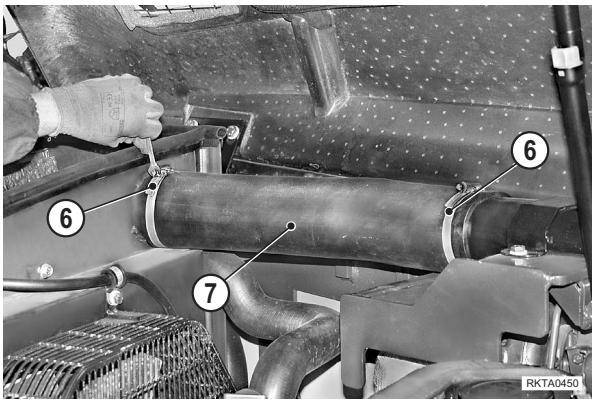
2 - Disconnect the outside air inlet hose (2) from the air cleaner (1).



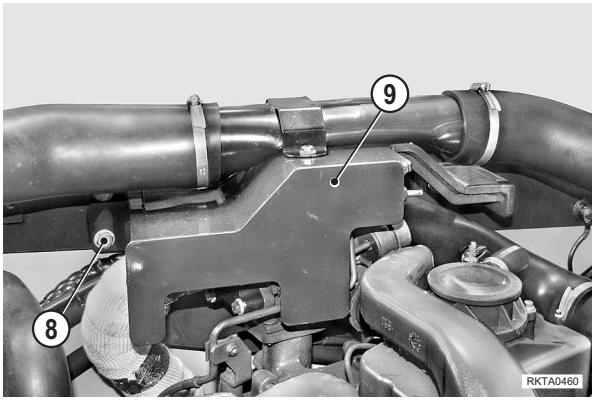
3 - Disconnect the hose (4) from the oil vapour bleed valve (3) and remove the air cleaner-to-turbocompressor hose (5).



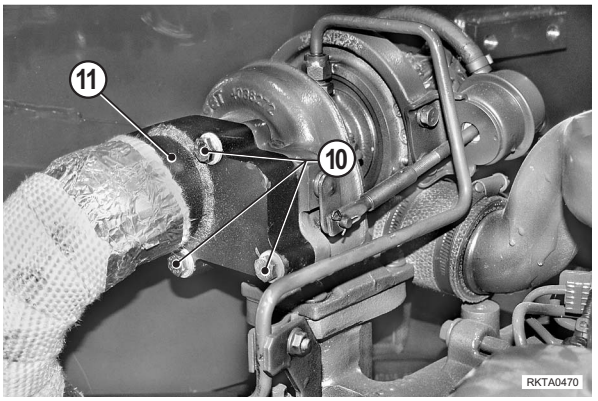
4 - Loosen the clamps (6) and remove the hose (7).



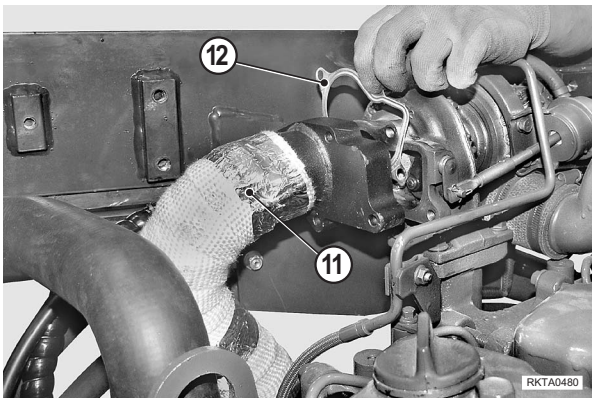
5 - Loosen and remove the three screws (8) and remove the support (9).



6 - Loosen and remove the screws (10) retaining the exhaust pipe (11).



7 - Disconnect the exhaust pipe (11) and recover the gasket (12).



8 - Remove the turbocompressor following the instructions given in the engine workshop manual (code WHBMNEF000).

Installation

- To install, reverse the removal procedure.

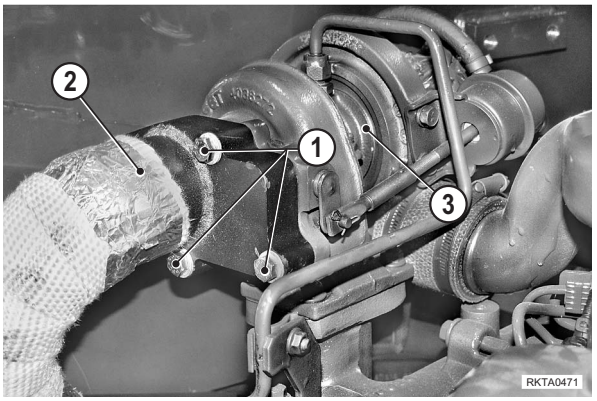
EXHAUST PIPE

Removal

- **1st Length**

1 - Loosen and remove the screws (1) securing the pipe (2) to the turbocompressor (3) (models with turbo engine), or to the exhaust manifold (models with aspirated engine).

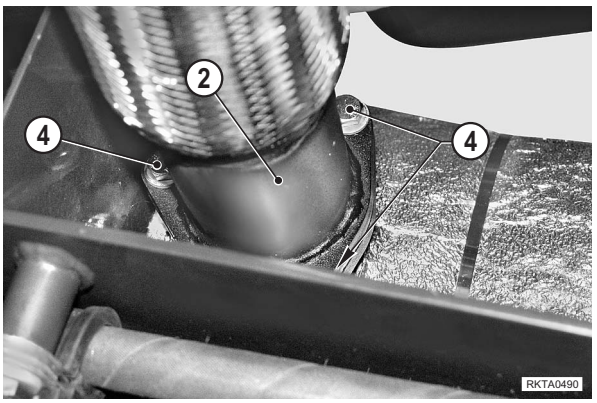
★ **Models with aspirated engine:**
replace the gasket between exhaust pipe and manifold at each disassembly.



2 - Loosen and remove the screws (4) together with their respective washers, and remove the pipe (2).

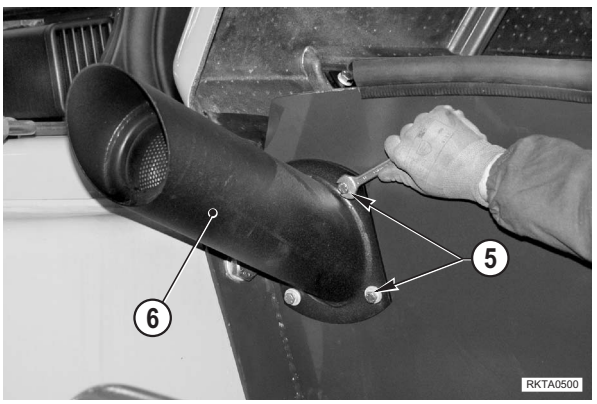
★ Replace the gasket between exhaust pipe and muffler at each disassembly.

3 - Remove the pipe (1).



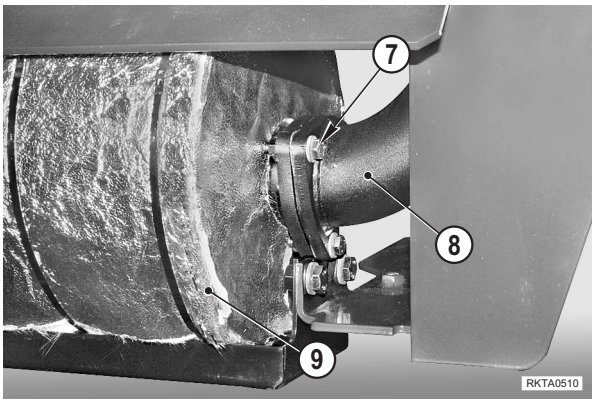
- **2nd Length**

1 - Loosen and remove the screws (5) and remove the tail pipe (6). [*1]



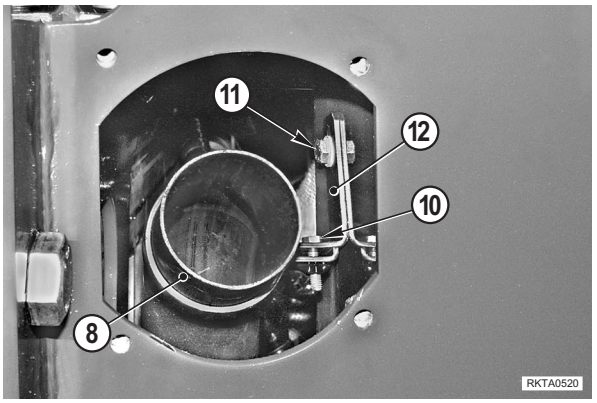
2 - Loosen and remove the screws (7) securing the 2nd length of the pipe (8) to the muffler (9).

★ Replace the gasket between exhaust pipe and muffler at each disassembly.



3 -Loosen the screw (10) remove the retaining screw (11), and remove the clamp (12).

4 -Remove the pipe (8).



Installation

- To install, reverse the removal procedure.

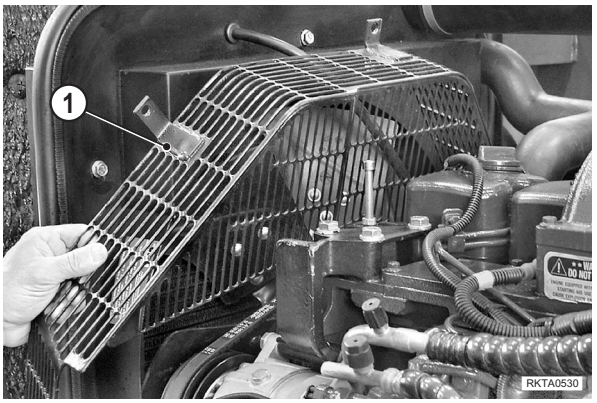
[*1]

★ Before locking the tail pipe (6), adjust it until it is centred in relation to the 2nd length of the exhaust.

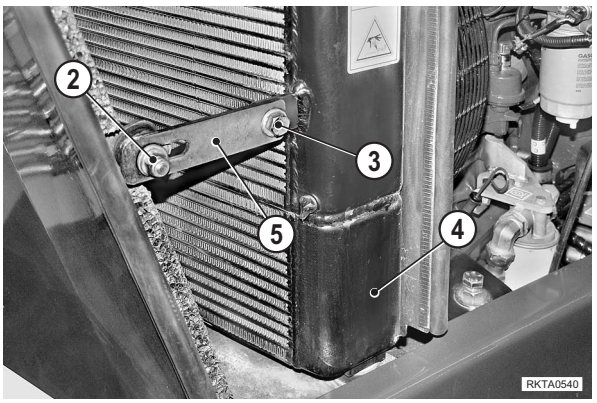
GENERATOR – FAN BELT

Removal

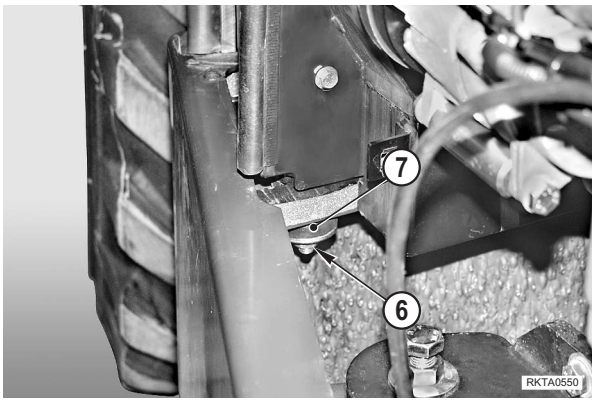
1 - Loosen and remove the retaining screws and remove the fan guard (1).



2 - Loosen the screws (2) and (3); remove the screws (2) and disengage the radiator (4) from the brackets (5).

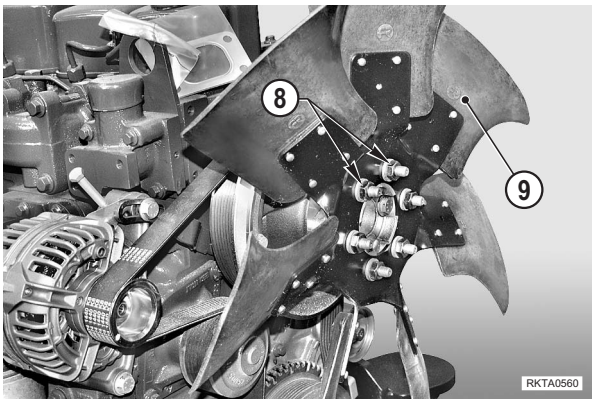


3 - Loosen the lower nuts (6) retaining the anti-vibration supports (7).

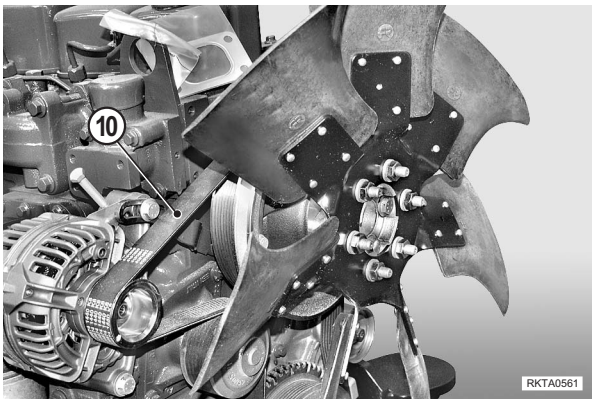


4 - Turn the radiator over and towards the rear of the machine to gain access to the fan retaining nuts (8) and washers.

5 - Remove the fan.



6 - Remove the worn belt (10) and replace it by performing the relevant procedures described in the engine workshop manual. [*1]



Installation

- To install, reverse the removal procedure.

[*1]

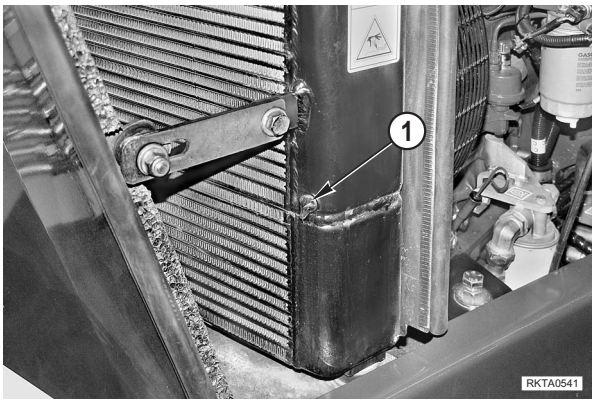
★ Tension the belt by performing the belt tensioning procedure described in the engine workshop manual (code WHBMNEF000).

RADIATOR-EXCHANGER ASSEMBLY

Removal

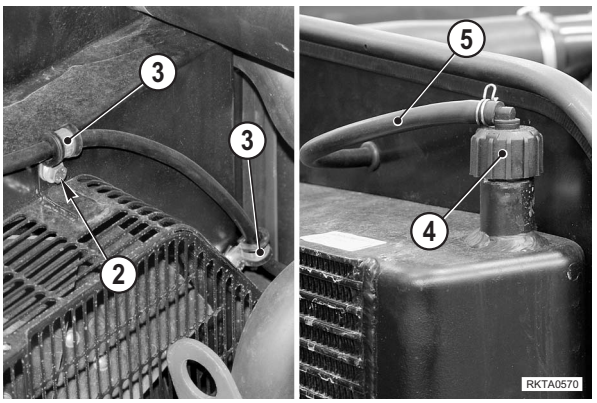
1 - Unscrew the cap (1) and drain the coolant liquid. [*1]

Coolant liquid: 20 ℓ approx.

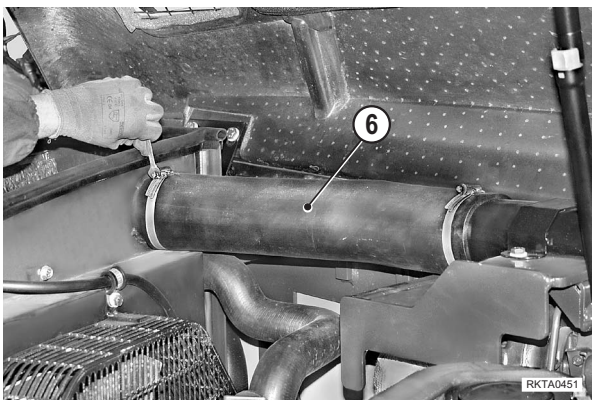


2 - Loosen and remove the screws (2) retaining the clamps (3).

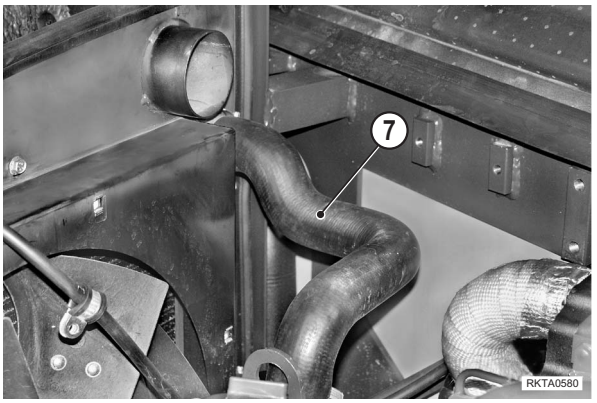
3 - Disconnect the hose (5) connecting to the expansion tank from the cap (4).



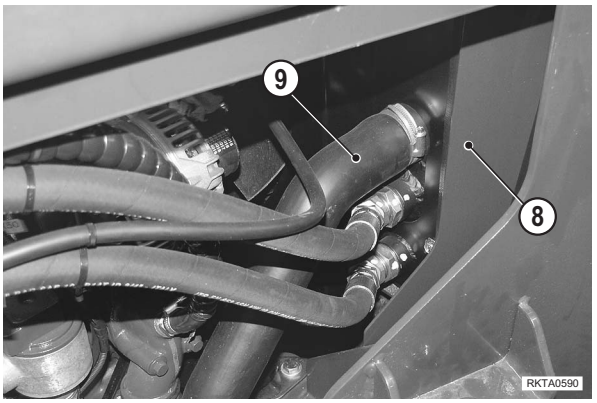
4 - Disconnect and remove the engine air intake hose (6).



5 - Disconnect the coolant liquid inlet hose (7) from the radiator.



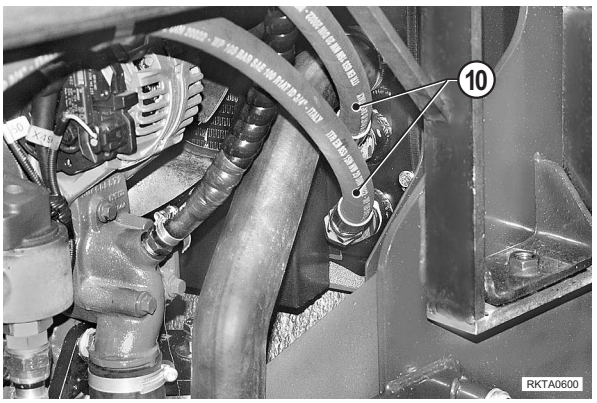
6 - Disconnect the coolant liquid outlet hose (9) from the radiator (8).



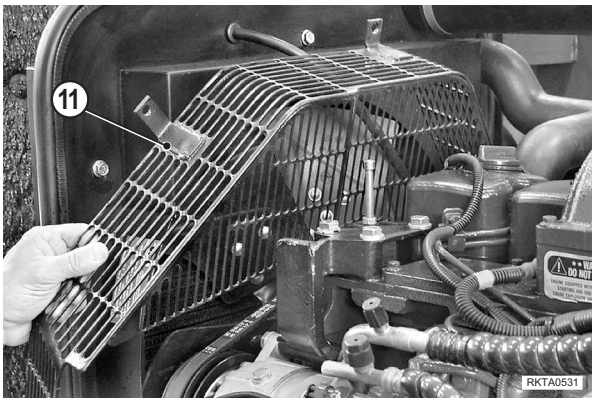
7 - Disconnect the transmission oil inlet and outlet hoses (10) from the exchanger. [*2]

★ Mark the hoses to avoid mixing them up during installation.

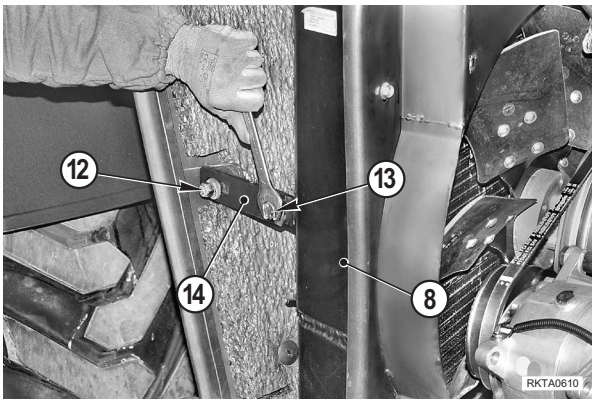
★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.



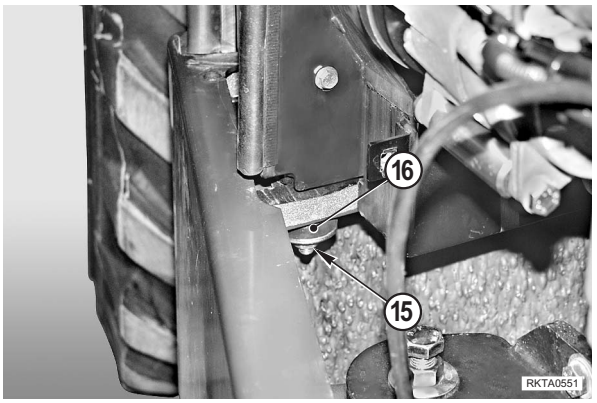
8 - Remove the retaining screws and remove the fan guard (11).



9 - Loosen the screws (12), (13); remove the screws (12) and disengage the radiator (8) from the brackets (14).



10 - Loosen and remove the lower nuts (15) retaining the anti-vibration supports (16).

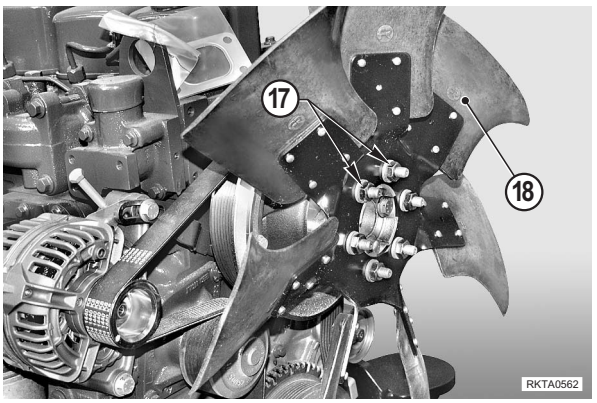


11 - Turn the radiator over towards the rear of the machine to gain access to the nuts (17) retaining the fan (18).

12 - Remove the fan.

13 - Connect the radiator assembly to a hoist and remove it from the machine.

Radiator assembly: 30 kg. approx.



Installation

- To install, reverse the removal procedure.

[*1]

★ Carry out the coolant liquid filling procedure.

Coolant liquid: 20 ℓ approx.

[*2]

★ Top up the transmission oil.

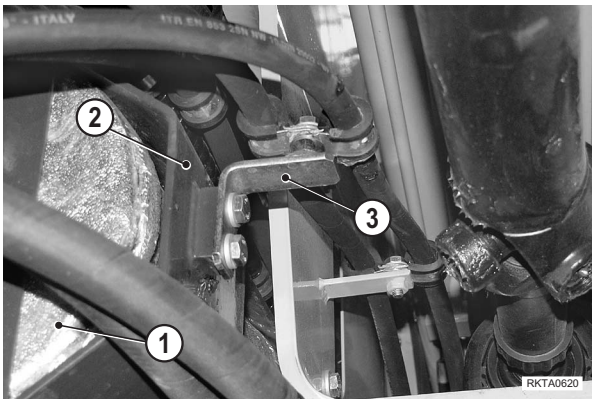
MUFFLER

Removal

1 - Remove both lengths of the exhaust duct.
(For details, see "EXHAUST PIPE").

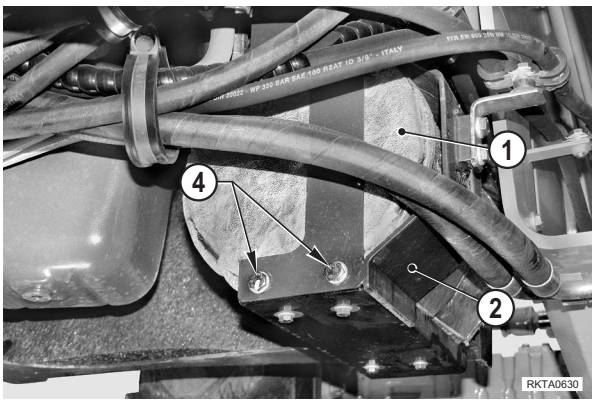
2 - Using a couple of belts, try to support the muffler (1) temporarily.

3 - Disconnect the support (3) from the muffler support (2).



4 - Loosen and remove the rear screws (4) along with their respective washers.

5 - Loosen and remove the support's front screws, remove their respective washers and remove the muffler (1) together with its support (2).



Installation

- To install, reverse the removal procedure.

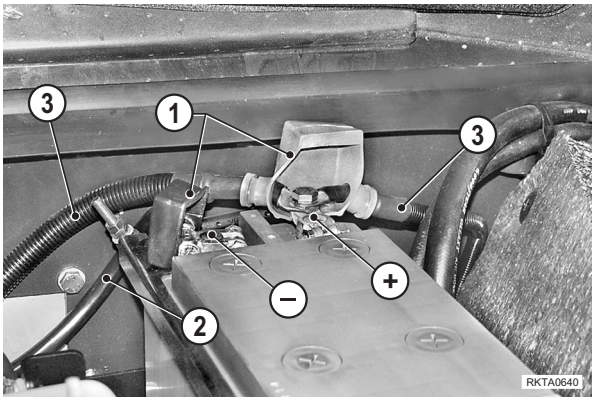
BATTERY – BATTERY TRAY

Removal

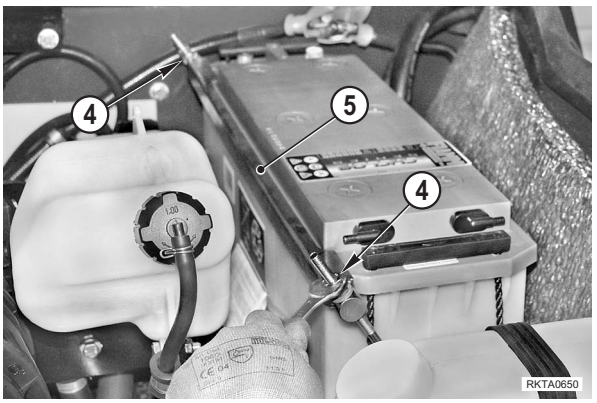
- **Battery**

1 - Lift the terminal shields (1) and disconnect the cables (2) and (3).[*1]

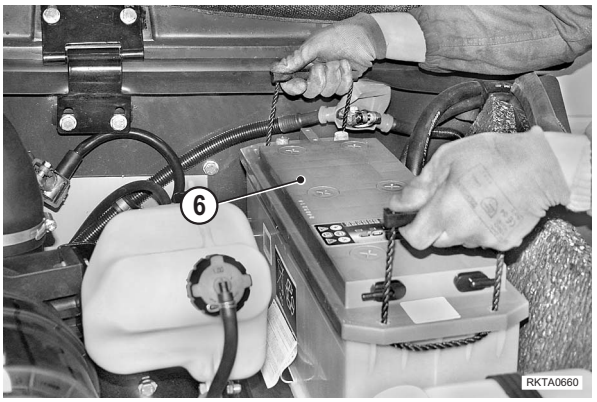
⚠ Disconnect the negative (–) cable first, and then the positive (+) cable.



2 - Loosen the nuts (4) until you are able to remove the bracket (5) and the battery retaining rods.



3 - Using the handles provided, remove the battery (6).



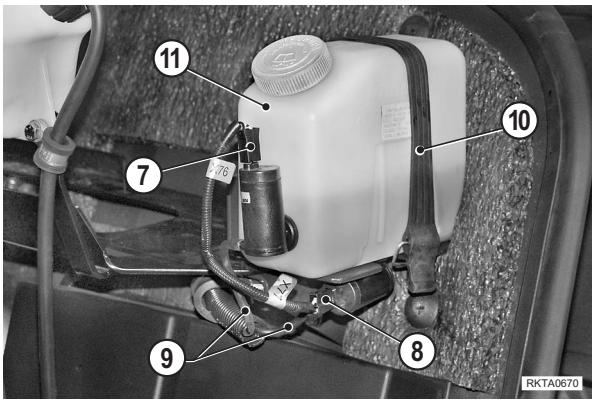
- **Battery tray**

1 - Disconnect the washer pump connectors (7), (8).

★ Record the positions for connection.

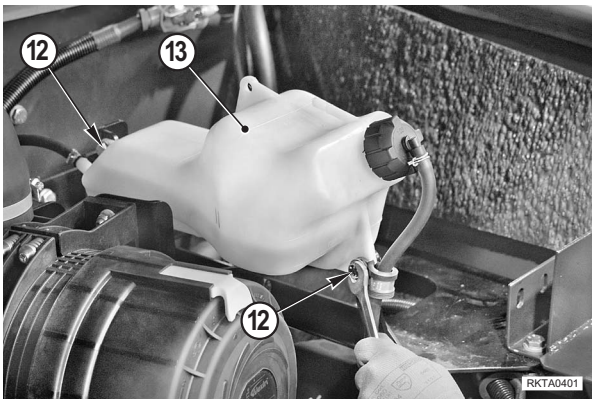
2 - Mark and then disconnect the feed pipes (9).

3 - Release the strap (10) and remove the tank (11).

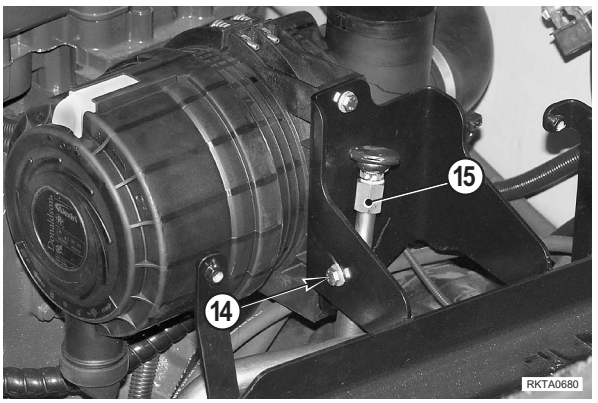


4 -Loosen and remove the screws (12), nuts and washers retaining the surge tank (13).

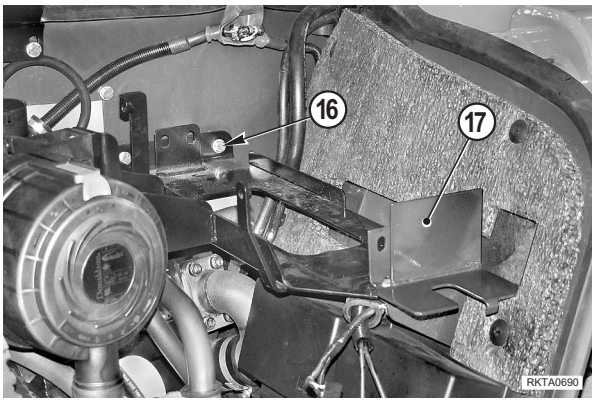
5 -Remove the tank and position the tanks aside.



6 -Loosen and remove the screw (14) and the nut retaining the converter breather tube (15).



7 -Loosen and remove the screws (16) together with their respective washers and remove the battery tray (17).



Installation

- To install, reverse the removal procedure.

[*1]

★ Connect the positive (+) terminal first, and then the negative (–) terminal.

CYLINDER HEAD

Removal

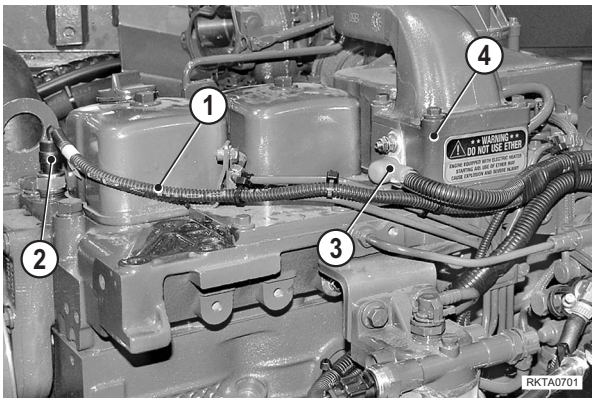
⚠ Disconnect the cable from the negative (–) battery terminal.

1 - Drain the coolant liquid.

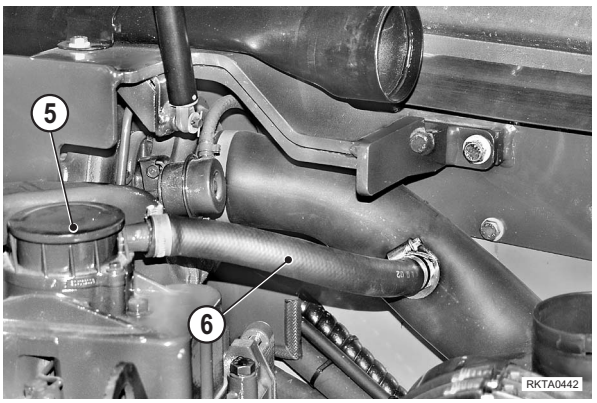
Coolant liquid: 20 ℓ approx.

2 - Disconnect the wiring (1) connecting to the coolant liquid temperature sensor (2) and disengage it from the tie-straps.

3 - Disconnect the wiring (3) from the thermostart (4).



4 - Disconnect the oil vapour bleed hose (6) from the valve (5).



5 - Disconnect or remove:

a - the 1st length of the exhaust pipe.

b - the turbocompressor.

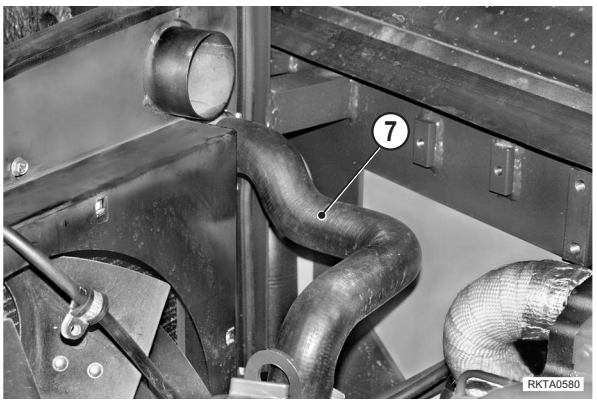
c - the coolant liquid surge tank.

d - The fan guard, the fan and the generator belt.

e - **Only if equipped:** the air conditioner compressor complete with support.

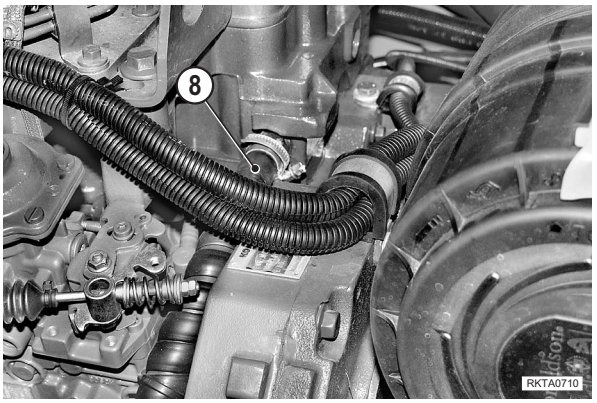
(For details, see the relevant section for each component).

6 - Disconnect the feed hose (7) to the radiator from the cylinder head.



7 - Disconnect the cab heating feed hose (8) from the cylinder head.

8 - Remove the cylinder head and/or replace the cylinder head gasket by following the instructions given in the engine workshop manuals (code WHBMNEF000).



Installation

- Install the cylinder head by following the instructions given in the engine workshop manuals (code WHBMNEF000) and the reverse order for the parts connected to it.

1 - Carry out the coolant liquid filling procedure.

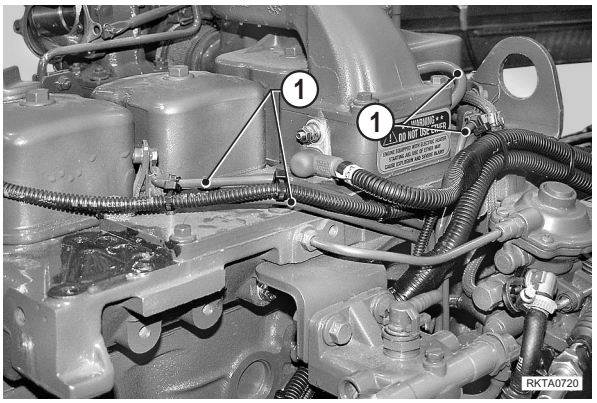
Coolant liquid: 20 ℓ approx.

INJECTORS

Removal

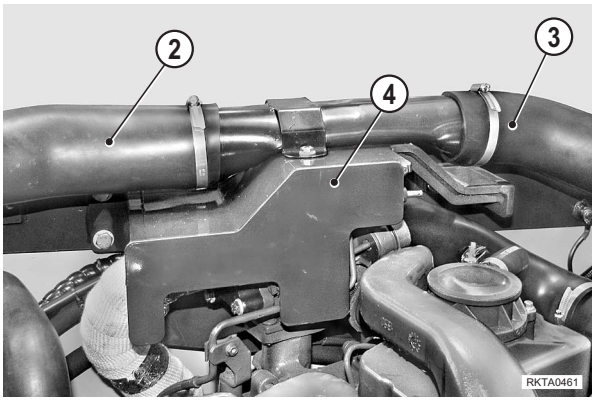
1 - Disengage the feed pipes (1) to the injectors from the wire harness straps and from the retaining clamps.

2 - Perform all the preliminary valve adjusting procedures described, without removing the valve covers.



3 - Disconnect and remove the engine air intake hoses (2), (3), and the centre support (4).

4 - Remove the injectors in accordance with the instructions given in the engine workshop manual (code WHBMNEF000).



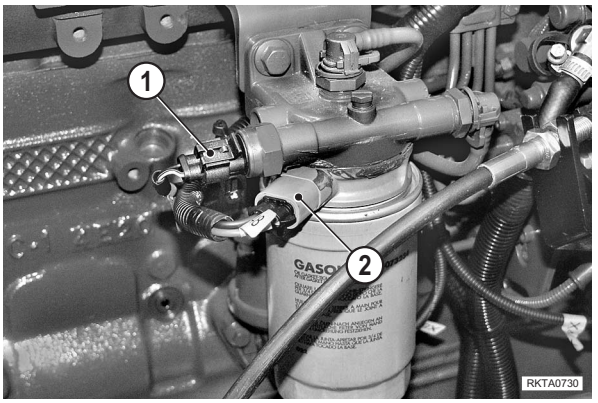
Installation

- To install, reverse the removal procedure.

INJECTION PUMP

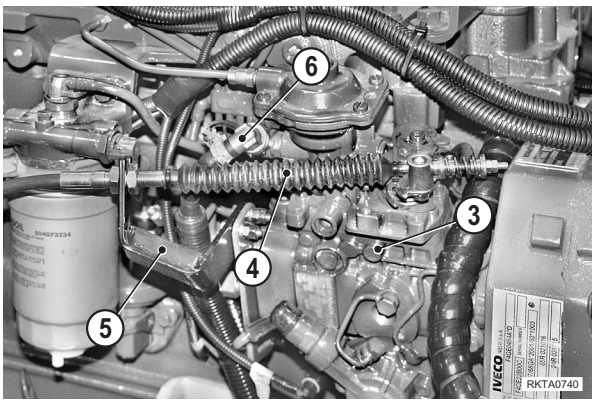
Removal

1 - Disconnect the fuel temperature and heating control connectors (1), (2) from the filter.

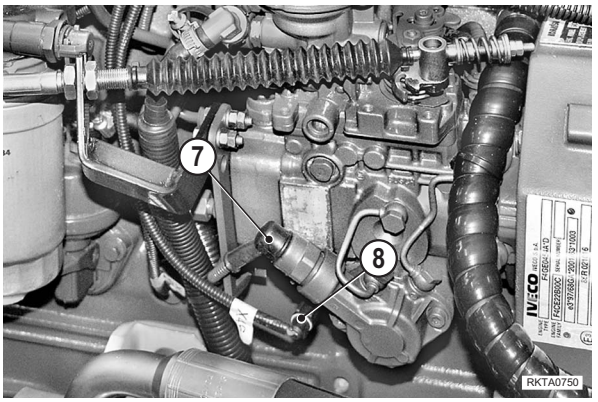


2 - Disconnect the accelerator control cable (4) from the injection pump (3) and remove the support bracket (5).

3 - Disconnect the fuel recovery hose (6) from the pump (3).



4 - Disconnect the temperature sensor connector (7) and the solenoid valve connector (8).



5 - Remove the injection pump by following the instructions given in the engine workshop manual (code WHBMNEF000).

Installation

- To install, reverse the removal procedure.

1 - Bleed the system using the procedure described in the engine workshop manual.

HYDRAULIC PUMP

Removal

⚠ Lower and fully retract the boom and allow the stabilizers (if equipped) to lower to the ground; apply the parking brake, stop the engine, and remove the ignition key.

1 - Open the engine hood.

⚠ Disconnect the cable from the negative (–) battery terminal.

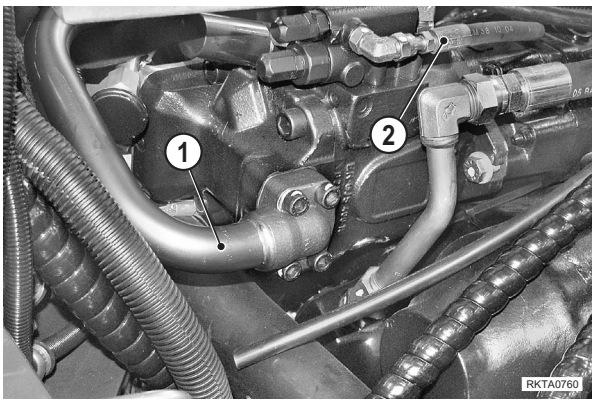
2 - Drain the hydraulic oil.

Hydraulic oil: 1.5 ℓ approx.

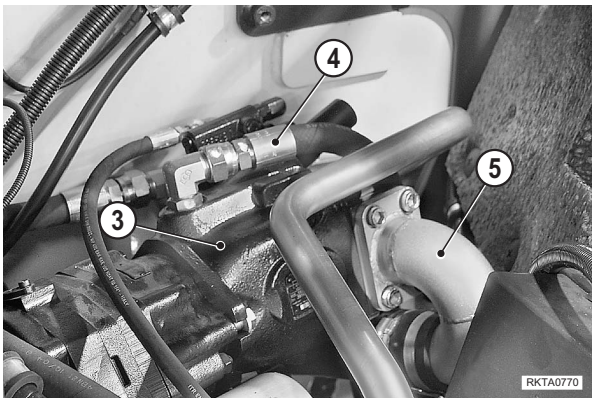
3 - Remove the air filter, the washer tank, the surge tank, and the battery.
(For details, see the relevant removal procedure).

4 - Disconnect the feed pipe (1) and the servo-control hose (2) from the pump assembly. [*1]

★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.



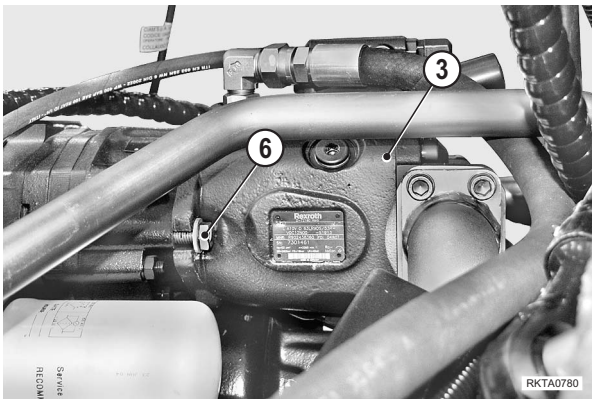
5 - Disconnect the housing drain hose (4) and the suction pipe (5) from the pump (3). [*1]



6 - Loosen and remove the screws (6) and their respective washers.

7 - Disengage the pump (3) and remove it.

Pump: 24 kg approx.



Installation

- To install, reverse the removal procedure.

[*1]

★ Carefully check the condition of the O-rings on the pump and on the suction and feed flanges.

★ Coat the O-rings with grease to hold them in position in their seats.

1 - Loosen the cap (7) and fill the pump housing with hydraulic oil.

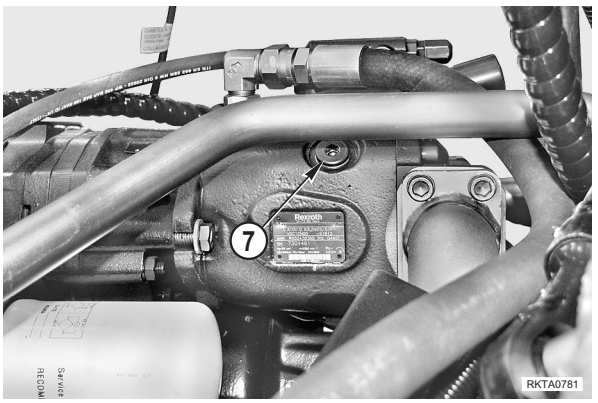
Oil: 1.5 ℓ approx.

2 - Reinstall the cap (7).

3 - Fill the hydraulic oil reservoir to the maximum-fill level.

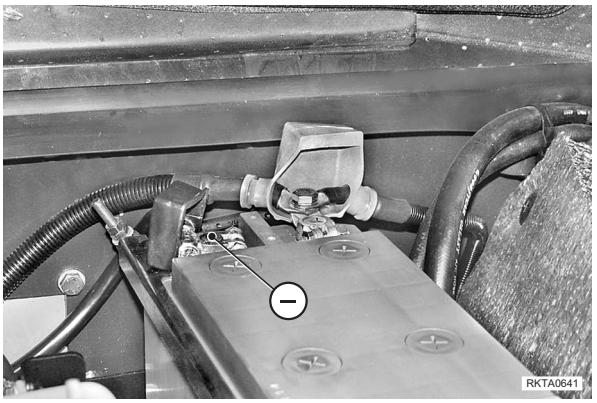
4 - Start the engine to allow the oil to circulate and check for any leaks.

5 - Stop the engine, check the oil level and, if necessary, top it up.



COMPLETE ENGINE– SHIFT ASSEMBLY

Removal



⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground; apply the parking brake, stop the engine and remove the ignition key.

⚠ Disconnect the negative (–)battery terminal.

1 - Drain the hydraulic oil.[*1]

Hydraulic oil: 95 ℓ approx.

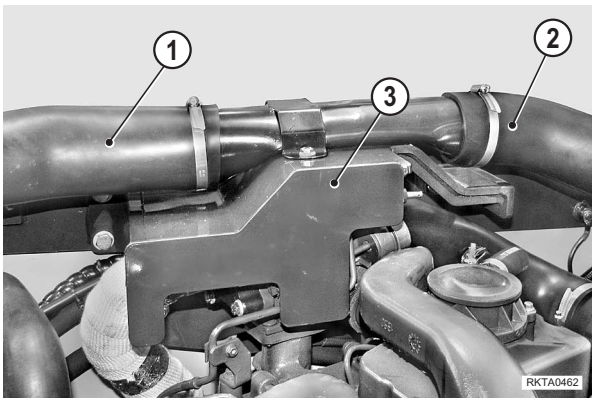
2 - Drain the coolant liquid. [*1]

Coolant liquid: 20 ℓ approx.

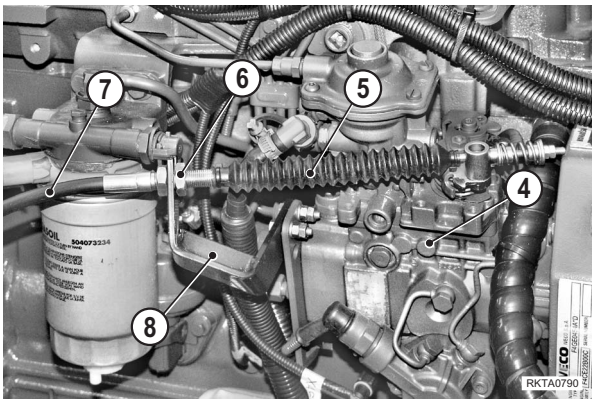
3 - **Only if equipped.**
Drain the coolant fluid off the air conditioning system. (For details, see "20 TESTING AND ADJUSTMENTS"). [*1]

4 - Remove:
- a - The engine hood.
- b - The battery and battery tray.
- c - The air filter.
- d - The exhaust piping

(For details, see the relevant sections).



5 - Remove the engine air intake hoses (1), (2), and the centre support (3).

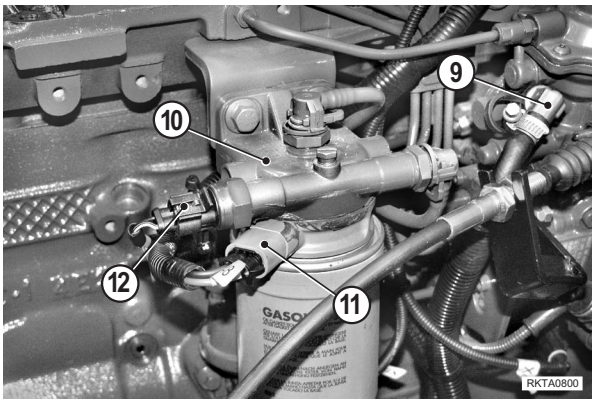


6 - Disconnect the accelerator control cable (5) from the injection pump (4).

7 - Loosen the nut (6) and disengage the conduit (7) from the support (8).

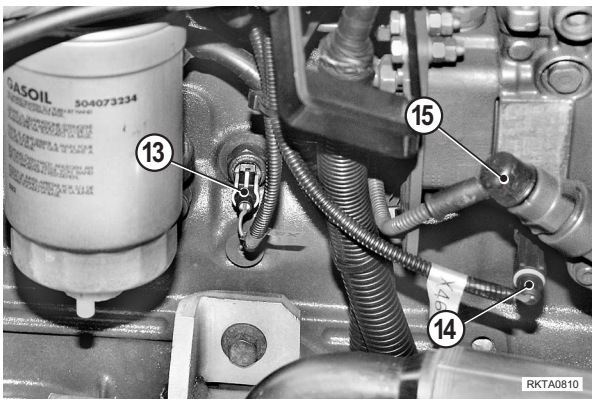
8 - Disconnect the fuel return line (9) from the injection pump.

9 - Disconnect the heating and fuel temperature sensor connectors (11), (12) from the filter support (10).



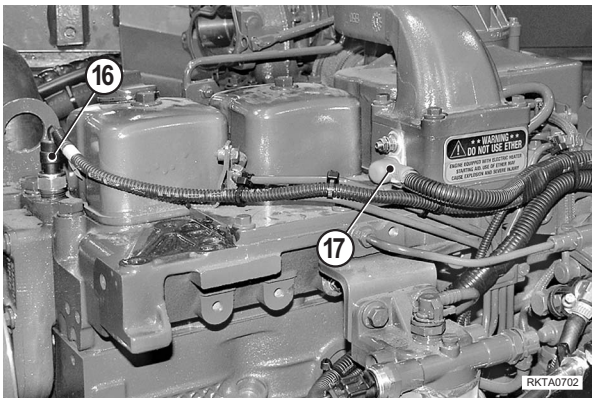
10 - Disconnect the connector (13) from the engine oil pressure sensor.

11 - Disconnect the connector (14) from the engine stop solenoid valve and disconnect the connector (15) from the temperature sensor.

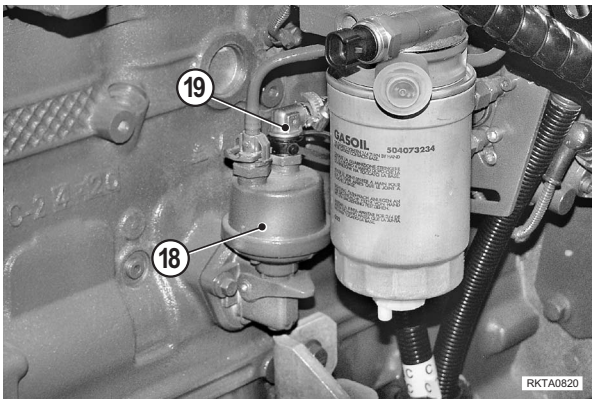


12 - Disconnect the connector (16) from the coolant liquid temperature sensor.

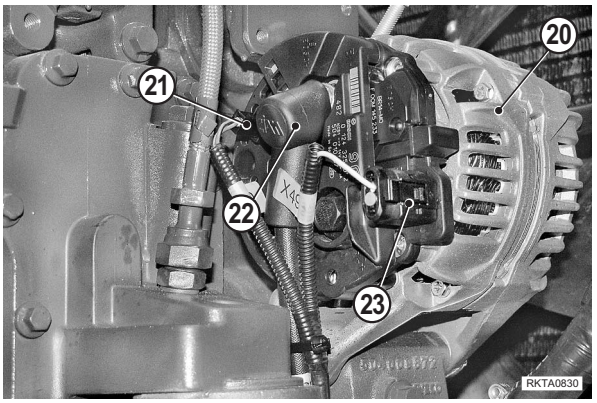
13 - Disconnect the wiring (17) from the thermostart.



14 - Disconnect the fuel feed line (19) from the pump (18).

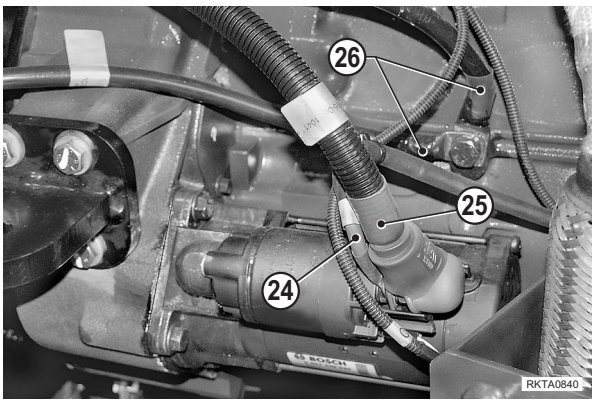


15 - Disconnect the wirings (21), (22), (23) from the generator (20).



16 - Disconnect the wirings (24), (25) from the starter motor.

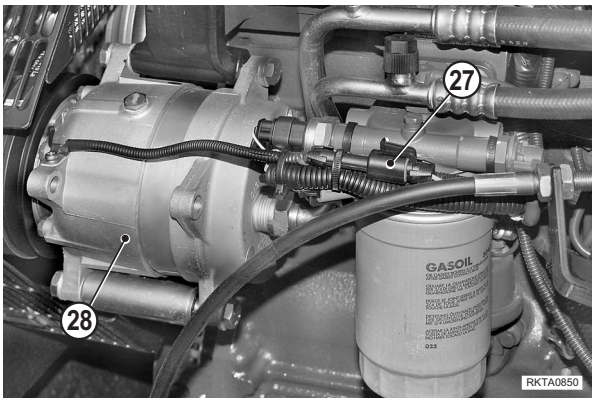
17 - Disconnect the ground cables (26) from the engine block.



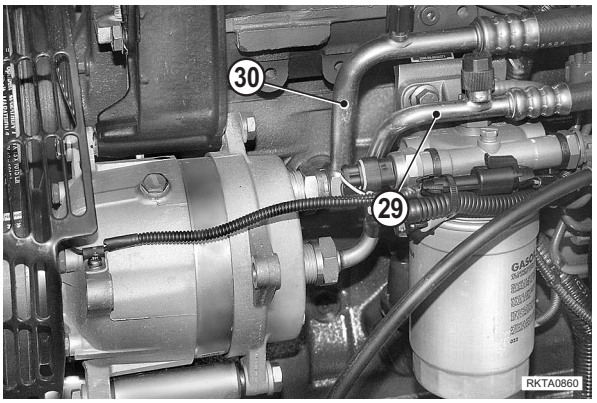
18 - **Only if equipped.**

a - Disconnect the connector (27) connecting the air conditioner compressor (28).

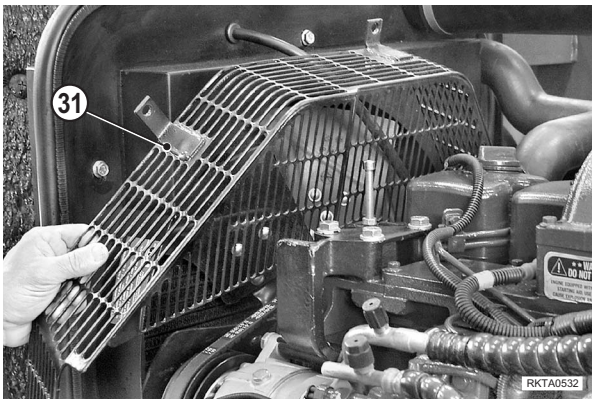
b - Drain the coolant fluid off the air conditioning system.
(For details, see "20 TESTING AND ADJUSTMENTS").



c - Disconnect the coolant fluid feed and return lines (29), (30) from the air conditioner compressor.

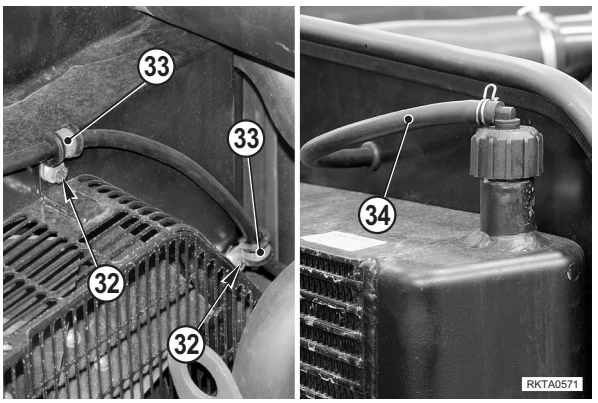


19 - Remove the fan guard (31).

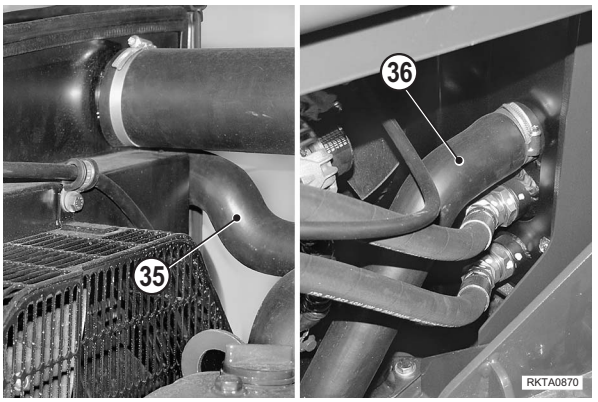


20 - Loosen and remove the screws (32) retaining the clamps (33).

21 - Disconnect the hose (34) connecting to the expansion tank from the radiator cap.



22 - Disconnect the upper coolant inlet hose (35) and the lower coolant outlet hose (36) from the radiator.

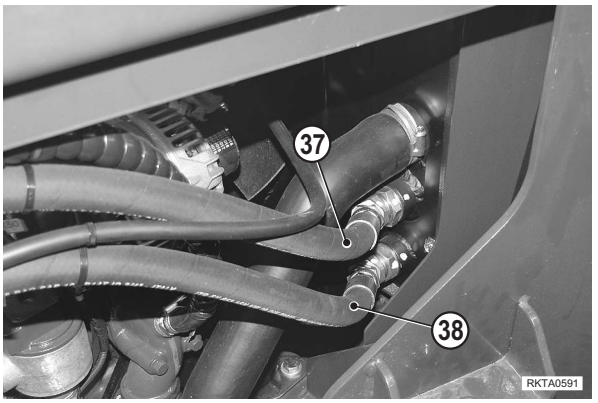


23 - Disconnect the transmission coolant inlet and outlet hoses (37), (38) from the exchanger.

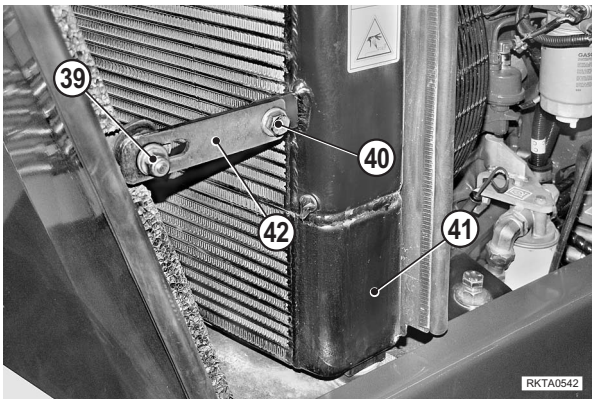
[*2]

★ Mark the hoses to avoid mixing them up during installation.

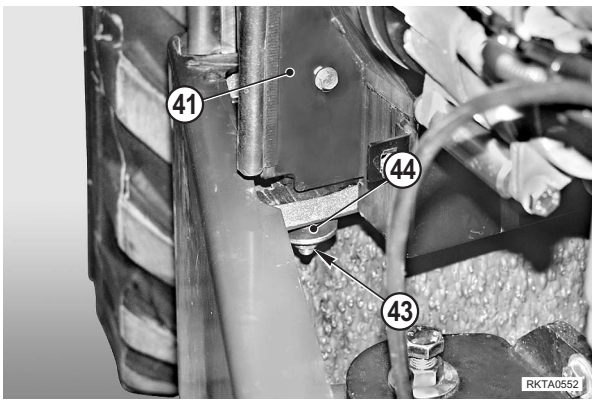
★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.



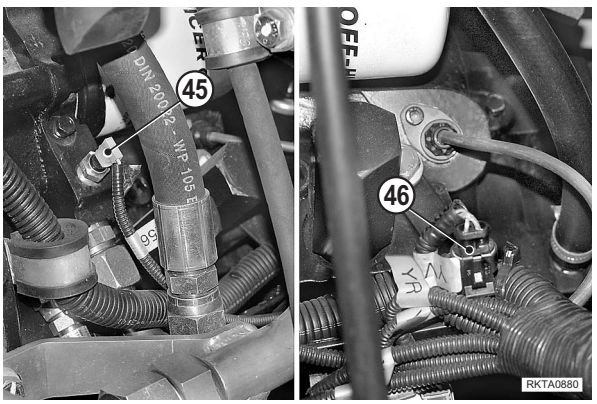
24 - Loosen the screws (39), (40); remove the screws (39), and disconnect the brackets (42) from the radiator (41).



25 - Loosen by several turns the lower nuts (43) retaining the anti-vibration supports (44) and tilt the radiator (41) towards the rear of the machine.



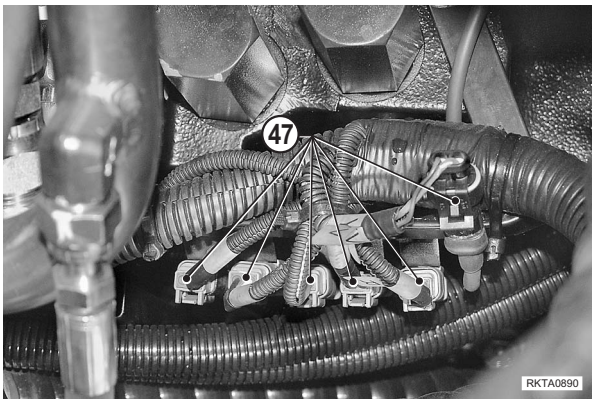
26 - Disengage from the clamps and disconnect the temperature sensor and transmission input revolution sensor connectors (45), (46).



27 - Disconnect the gear select solenoid valve connectors (47).

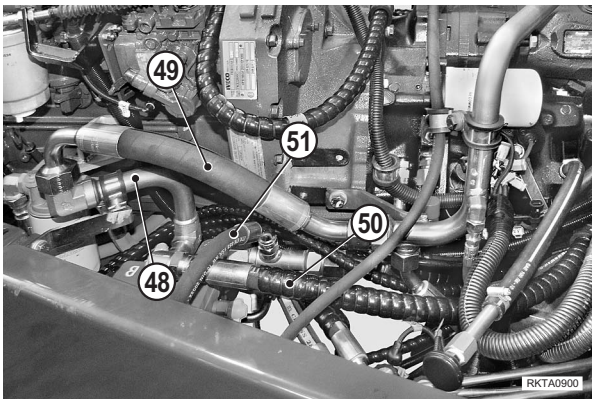
[*3]

⚠ If the codes on the connectors appear damaged or are illegible, mark all the connectors in order to avoid mixing them up during installation.



28 - Disconnect the feed hose (49) connecting to the control valve, the servo-control feed assembly hose (50), and the solenoid valve block feed hose (51) from the tube (48).

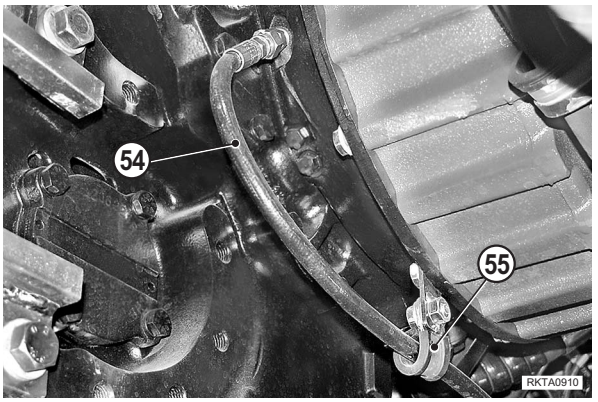
★ Immediately cap the hoses and tube to prevent contaminants from entering the passages.



29 - Disconnect the pump housing drain hose (52) and the LS hose (53). [*4]

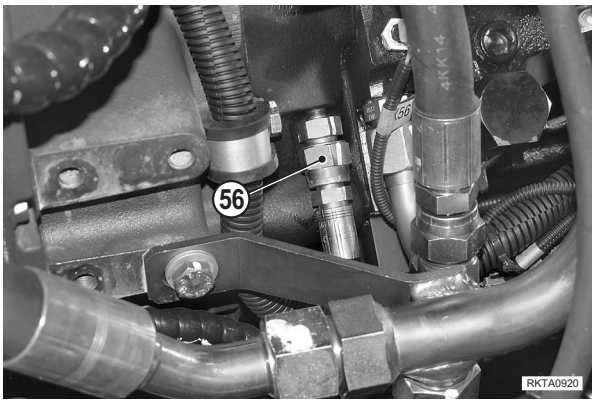
30 - Disconnect the brake pump servo-control feed hose (54) and the retaining clamp (55) from the transmission.

★ Immediately cap the hose to prevent contaminants from entering it.

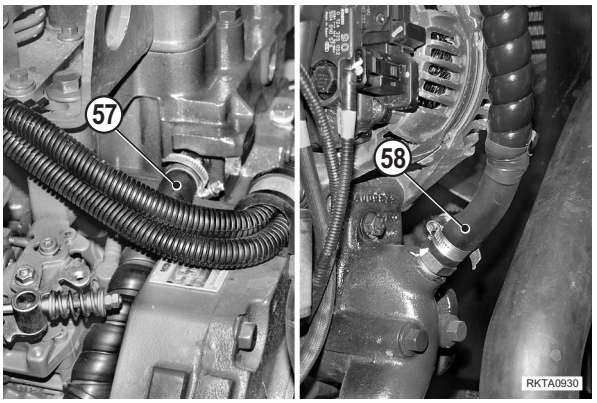


31 - Disconnect the brake pump servo-control drain hose (56) from the transmission.

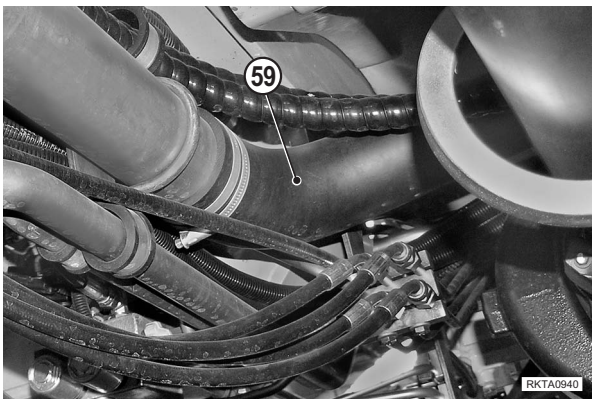
★ Immediately cap the hose to prevent contaminants from entering it.



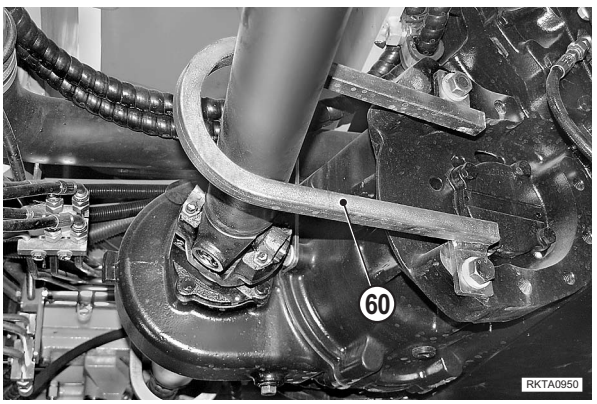
32 - Disconnect the cab heating hoses (57), (58) from the cylinder head and engine thermostat.



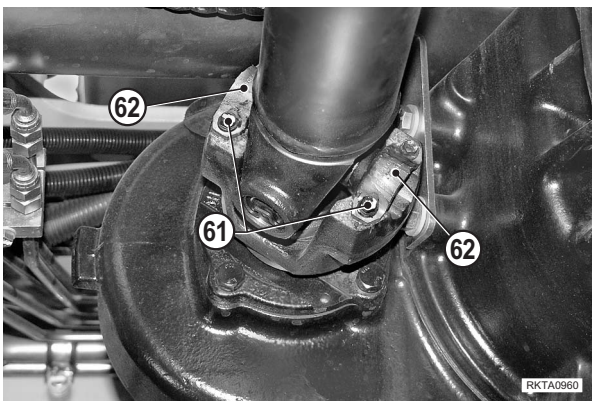
33 - Disconnect the hydraulic pump suction tube (6).



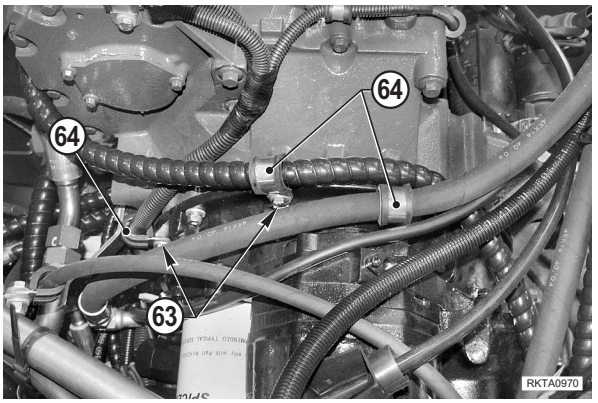
34 - Remove the rear drive shaft protection bar (60).



35 - Loosen and remove the screws (61) and the clevises (62).

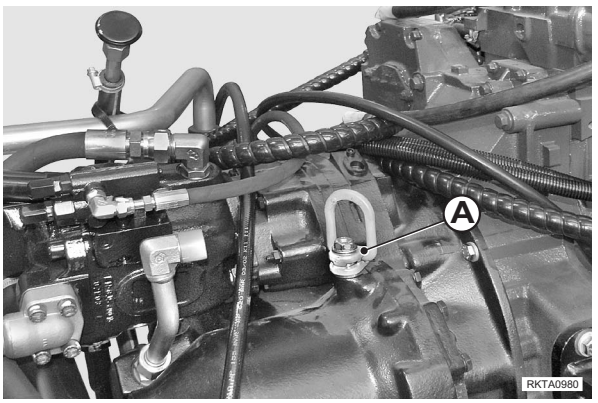


36 - Loosen and remove the engine-to-shift screws (63) that retain the hose supporting clamps (64).



37 - Perform a visual check to ensure that all wiring and hoses connected to the engine are totally free from clamps or ties.

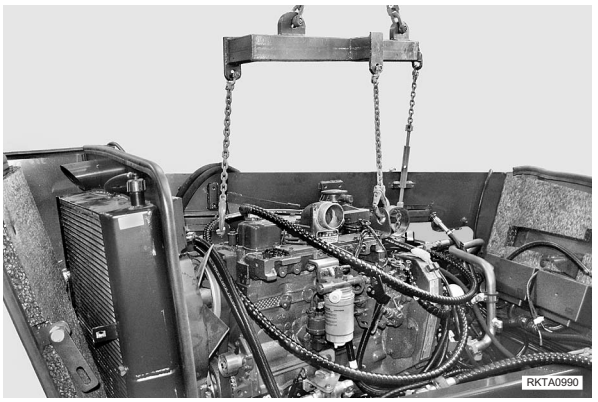
38 - Screw a pivot-type eye-bolt (A) to the transmission.



39 - Connect the engine-shift assembly to a hoist using three ropes or chains – one of the three should be adjustable lengthwise.

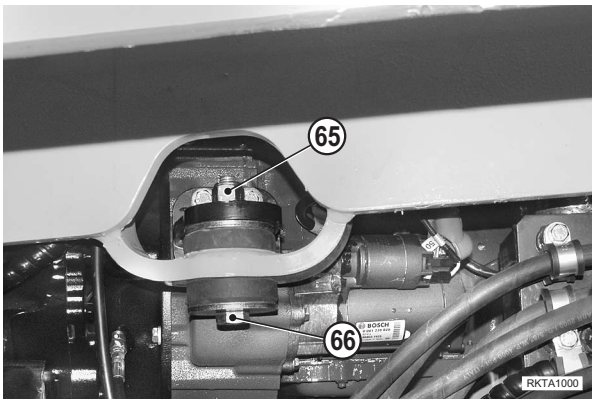
★ Connect the ropes or chains of equal length to the engine lift brackets.

Complete assembly: 680 kg

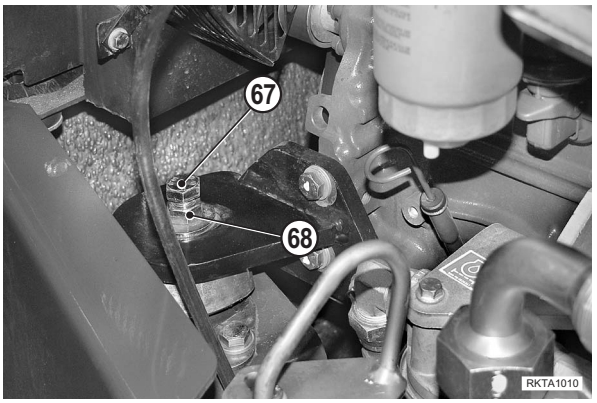


40 - Loosen and remove the self-locking nut (65) and the engine's left front retainer screw (66).

[*5]

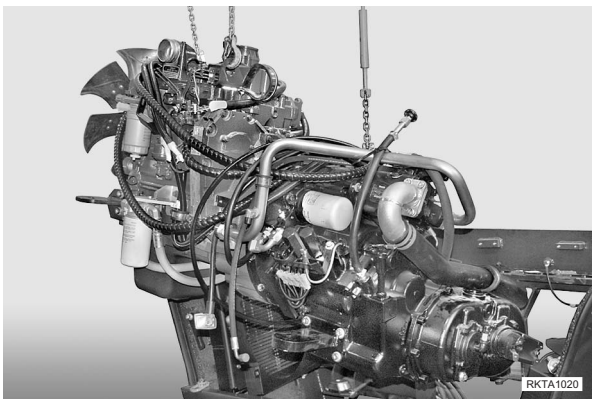


41 - Loosen the nuts (67) and remove the screws (68) from the remaining engine mounts. [*6]



42 - Tension the ropes or chains and start lifting to pull the assembly out of the vehicle.

⚠ Ensure that the assembly will be lifted starting from the engine side and will remain tilted by approx. 20 cm.



Installation

- To install, reverse the removal procedure.

[*1]

★ Perform all the filling procedures.

Hydraulic oil: approx. 95 ℓ
coolant liquid: approx. 20 ℓ
Coolant fluid: (For details, see "20 TESTING AND ADJUSTMENTS".

[*2]

★ Check the transmission oil level before starting the engine.

[*3]

★ Thoroughly check to ensure that the connectors are properly connected.

[*4]

★ Fill the pump housing with hydraulic oil.

Oil: 1.5 ℓ approx.

[*5]

Nut: 130±3 Nm

[*6]

★ Tighten the screw (68) as far as it will go; then loosen by 3 turns and lock the nut (67).

Nut: : 130±3 Nm

1 -Start the engine and allow the engine to idle for a few minutes.

2 -Stop the engine and check all levels.

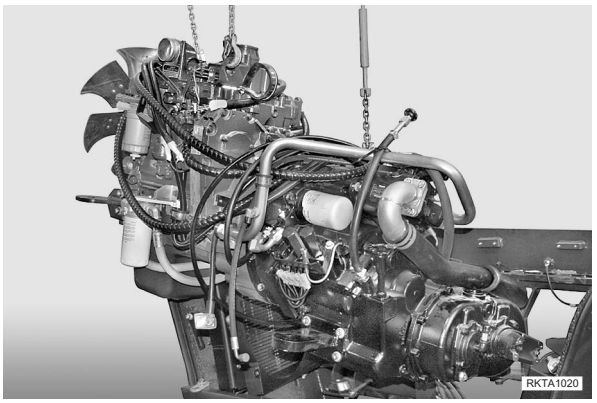
3 -Start the engine again and bleed all hydraulic circuits.

ENGINE-TRANSMISSION

Detachment

1 - Remove the complete transmission assembly.
(For details, see "COMPLETE ENGINE– SHIFT ASSEMBLY").

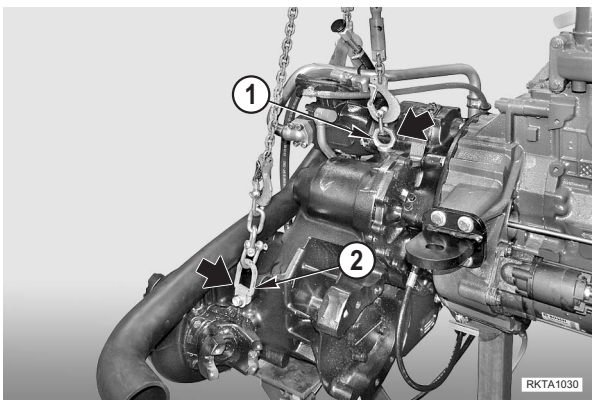
2 - Mount the assembly to a suitable stand.



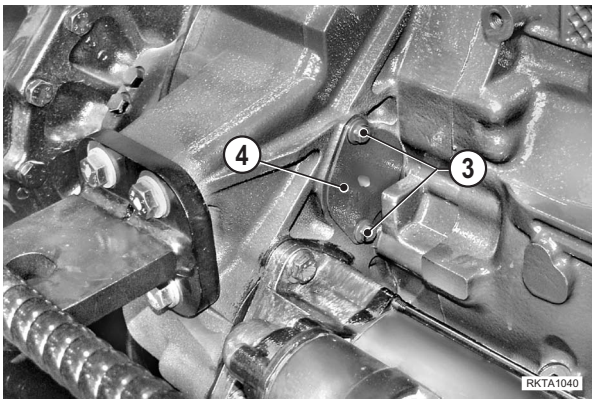
3 - Remove the hydraulic pump.
(For details, see "HYDRAULIC PUMP").

4 - Screw an eye-bolt (1) and a pivot-type lift element (2) to the transmission at the positions shown in the picture.

5 - Connect to a hoist using either end of the adjustable rope or chain and put the assembly under slight tension.

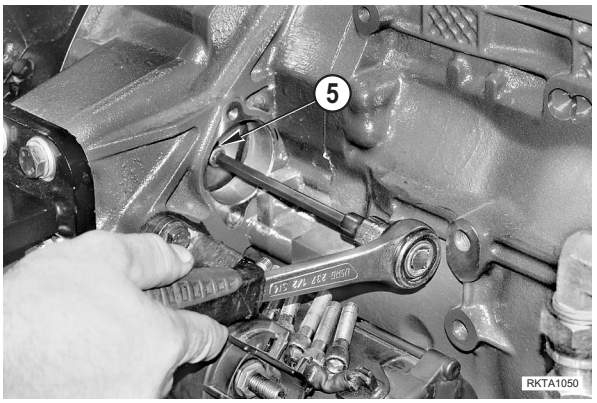


6 - Loosen and remove the screws (3) and remove the cover (4).

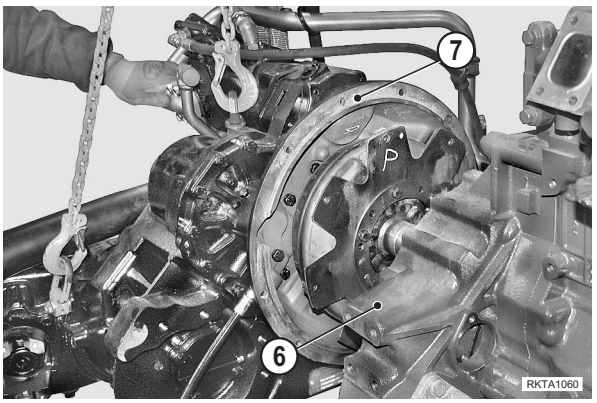


7 - Slightly rotate the engine flywheel until you locate the hydrodynamic coupling retaining screws (5).

8 - Remove the screws (5). [*1]



9 - Loosen and remove the engine mounting screws (6) and the transmission mounting screws (7) and detach one assembly from the other. [*2]



Joining

- To join the assemblies, reverse the detachment procedure.

  ★ Ensure that the coupling surfaces are clean and dent-free.

[*1]

  ★ To ease the joining of the flywheel to the hydrodynamic coupling before attempting to join the engine to the transmission, tighten a threaded stem (A) to the coupling. The stem will serve as guide.

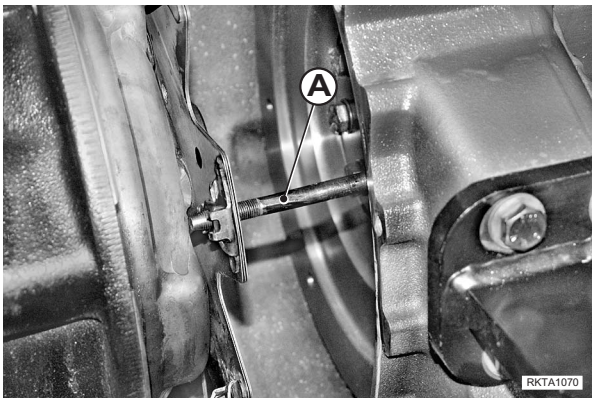
  Screws: Loctite 262

  Screws: 39 Nm

[*2]

  Screws: 49 Nm

  ★ Tighten in an alternate and criss-cross manner.



CONTROL VALVE ASSEMBLY

Removal

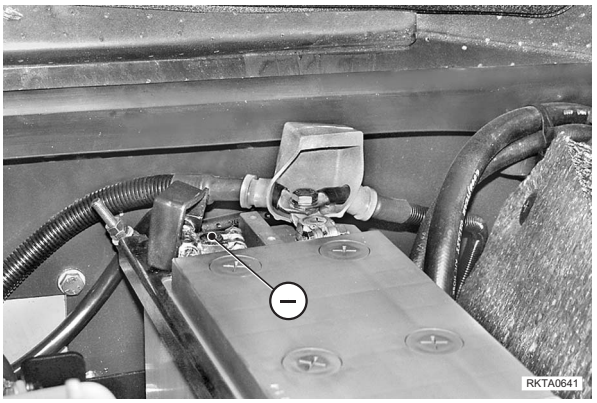
⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground; apply the parking brake, stop the engine and remove the ignition key.

1- Open the engine hood.

⚠ Disconnect the cable from the negative (–) battery terminal.

2 - Drain the hydraulic oil.[*1]

Hydraulic oil: 95 ℓ approx.



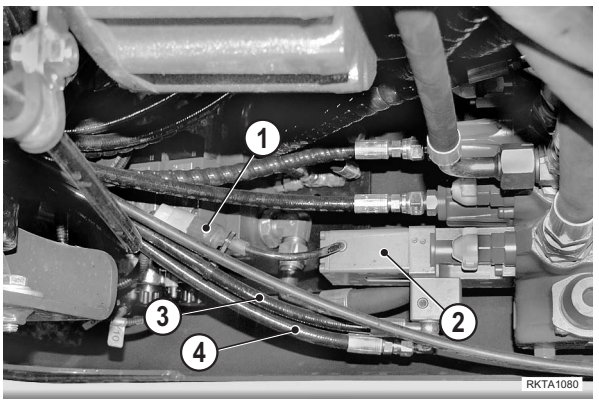
3 - Disconnect the connector (1) of the boom extension/retraction proportioning solenoid valve (2).

4 - Disconnect the lines (3), (4) from the valve (2).

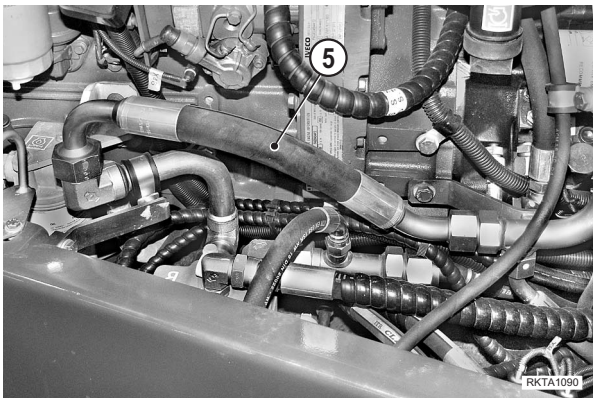
NOTES

a - Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages and to avoid oil drippings.

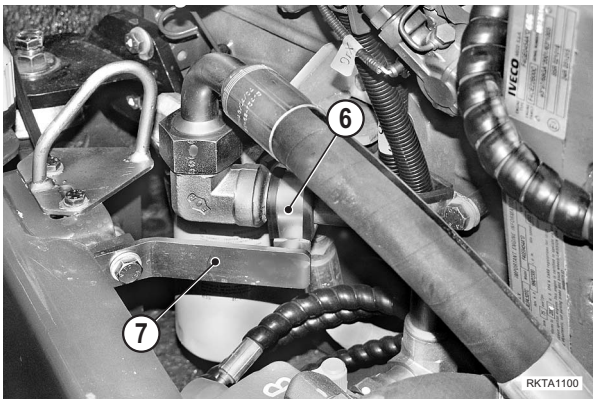
b - Before attempting to remove the control valve, thoroughly clean the floor and any areas that are soiled with oil in order to prevent slipping.



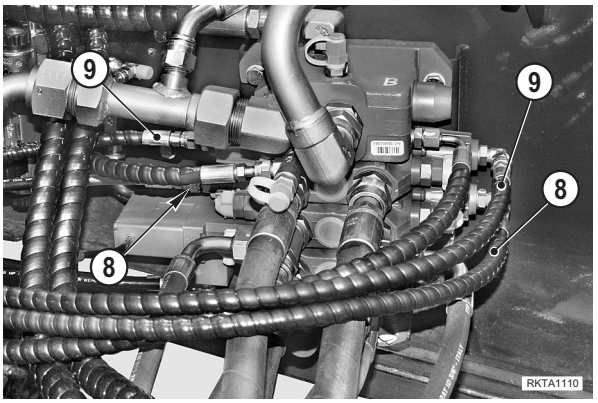
5 - Remove the pump feed hose (5).



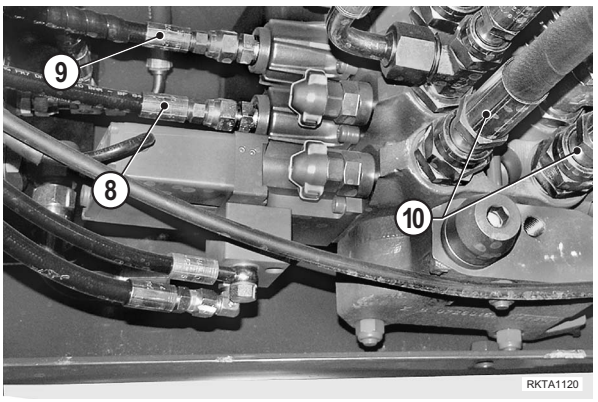
6 - Disconnect the clamp (6) and remove the bracket (7).



7 - Mark and then disconnect the equipment curl/dump control valve servo-control hose (8) and the boom lifting/lowering control valve servo-control hose (9).

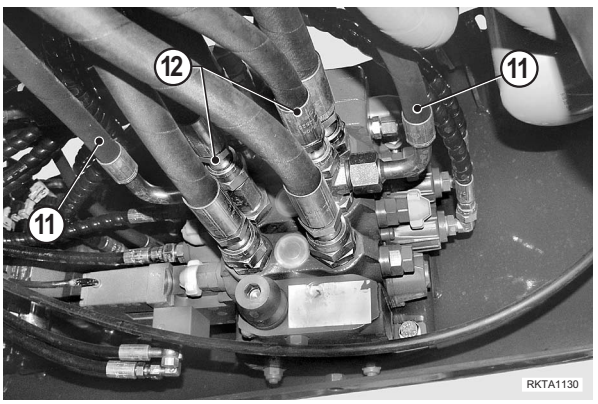


8 - Mark and then disconnect the boom extension and retraction control hoses (10).

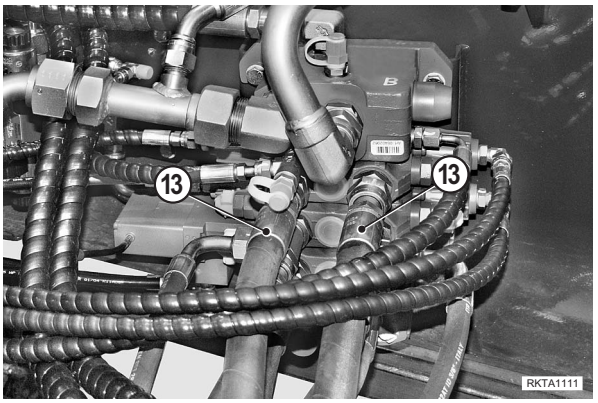


9 - Disconnect the hoses (11) connecting to the compensator cylinder.

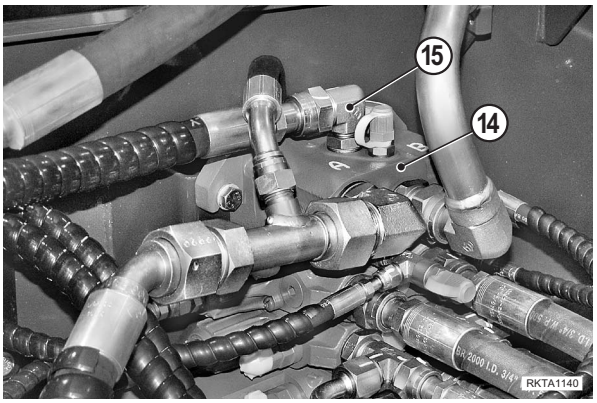
10 - Disconnect the hoses (12) connecting to the equipment curl/dump cylinder.



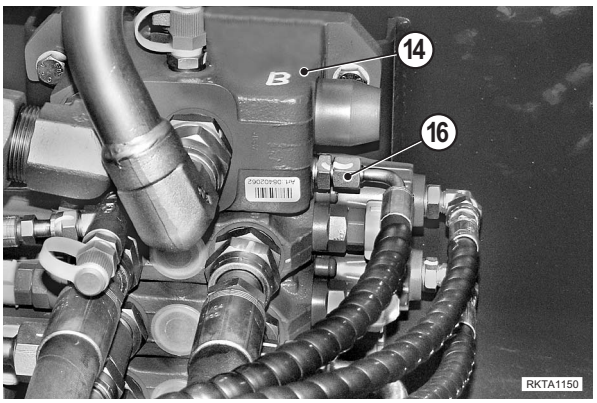
11 - Disconnect the boom lifting/lowering hoses (13).



12 - Disconnect the power steering feed hose (15) from the head (14).



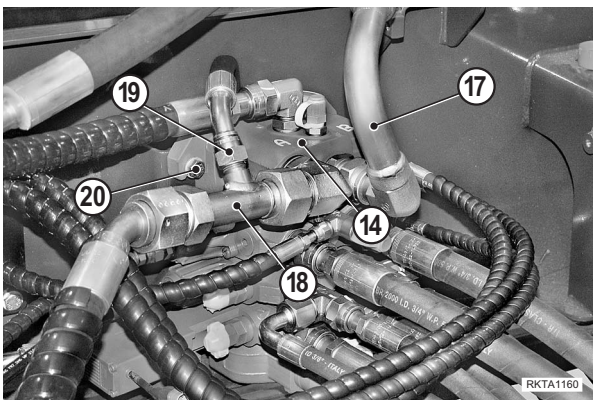
13 - Disconnect the servo-control feed assembly LS signal hose (16) from the head (14).



14 - Disconnect and remove the pump feed tube (17) from the head (14).

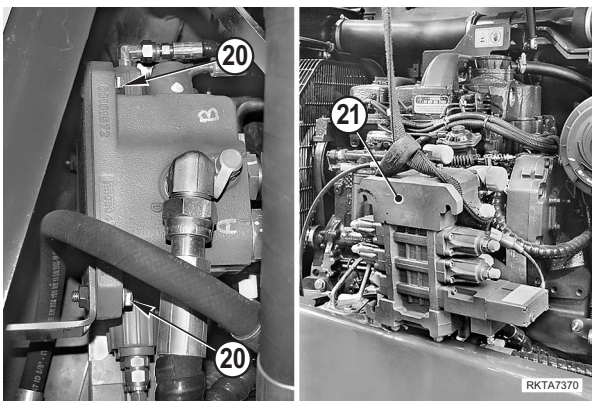
15 - Disconnect the solenoid valve block drain hose (19) from the control valve drain line (18).

16 - Disconnect the control valve drain line (18) from the head (14).



17 - Loosen and remove the three screws shown (20) and remove the complete control valve assembly (21).

control valve: without unions 30 kg
with unions 32 kg



Installation

- To install, reverse the removal procedure.

[*1]

★ Fill the hydraulic oil reservoir to the maximum-fill level.

Hydraulic oil: 95 ℓ approx.

1 - Start the engine to allow the oil to circulate and check for any leaks.
Perform several motions to bleed the air from the system.

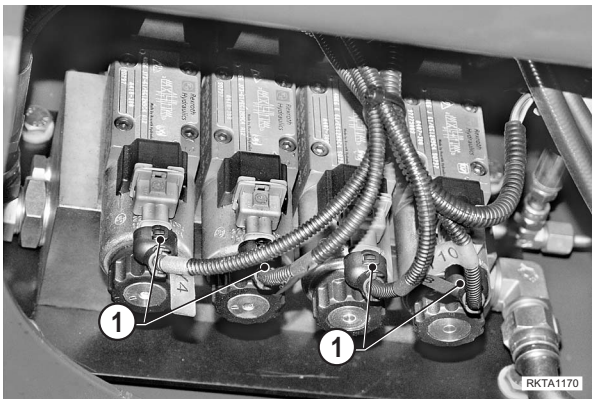
2 - Stop the engine, check the oil level and, if necessary, top it up.

BRACKET CONTROL, EQUIPMENT LOCK, AND FRAME LEVELLING SOLENOID VALVES

Removal

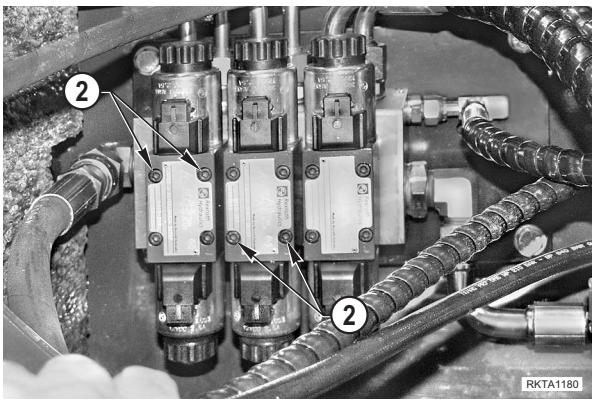
1 - Disconnect the connectors (1) of the solenoid valves that need replacing.

⚠ If the codes on the connectors appear damaged or are illegible, mark all the connectors in order to avoid mixing them up during installation.



2 - Loosen and remove the 4 screws (2) and remove the solenoid valve that needs replacing. [*1]

★ Always recover the O-rings.



Installation

- To install, reverse the removal procedure.

[*1]

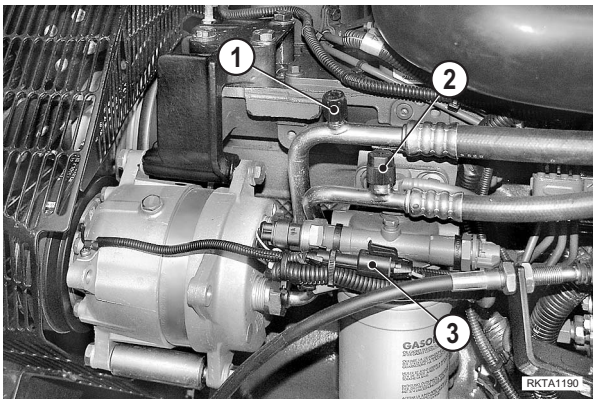
★ Apply a coat of grease to the seats of the O-rings to hold the O-rings in position.

AIR CONDITIONER COMPRESSOR (only if equipped)

Removal

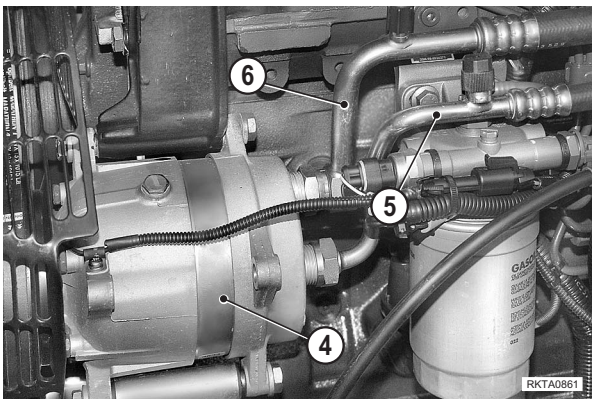
1 - Connect the outlets (1) and (2) to the air conditioning system maintenance station and draw the coolant fluid. (For details, see "20 TESTING AND ADJUSTMENTS").

2 - Disengage the connector (3) from the clamp and disconnect the connector.

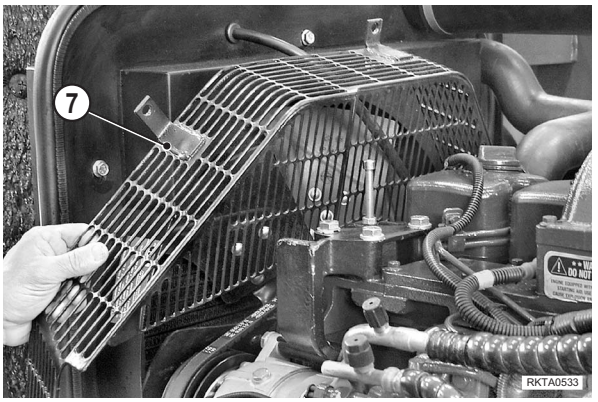


3 - Disconnect the coolant fluid feed and return pipes (5), (6) from the air conditioner compressor (4). [*1]

★ Always recover the O-rings.

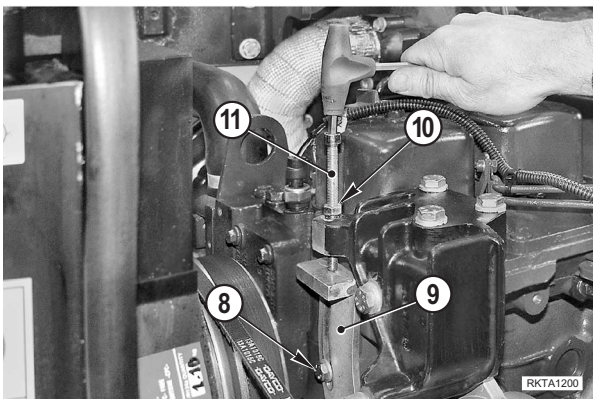


4 - Remove the fan guard (7).



5 - Loosen the screw (8) retaining the tensioner (9).

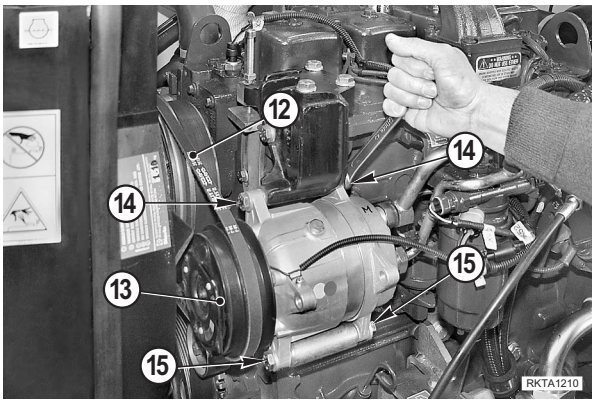
6 - Loosen the nut (10) and rotate the screw (11) to loosen the belt.



7 - Disengage the belt (12) from the pulley (13).

8 - Loosen the compressor retaining screws (14).

9 - Loosen the screws (15) and remove the compressor (4).



Installation

- To install, reverse the removal procedure.

[*1]

★ Ensure that the O-rings are undamaged.

Fittings and O-rings: refrigerant oil

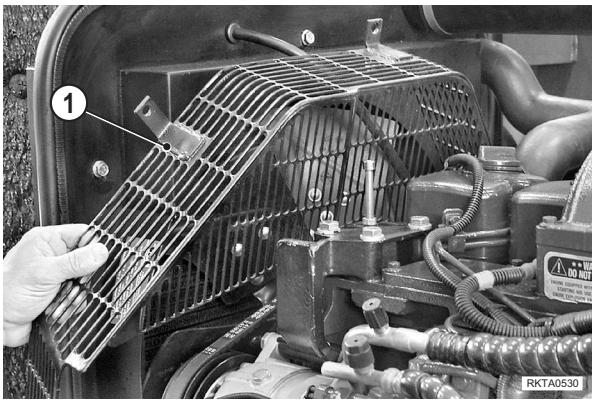
1 - Tension the compressor belt.
(For details, see "AIR CONDITIONER COMPRESSOR BELT").

2 - Connect the maintenance station to the air conditioning system and recharge the system.
(For details, see "20 TESTING AND ADJUSTMENTS").

AIR CONDITIONER COMPRESSOR BELT

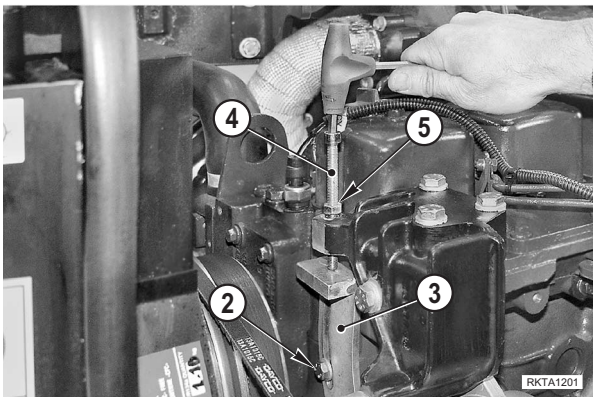
Removal

1 -Remove the screws and remove the fan guard (1).

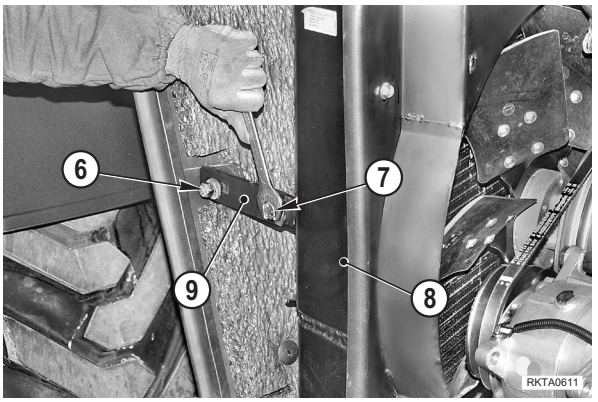


2 -Loosen the screw (2) retaining the tensioner bracket (3)..

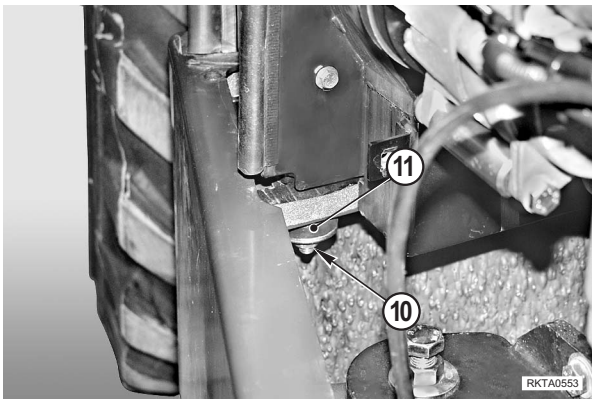
3 -Loosen the belt tension nut (4) and screw (5).



4 Loosen the screws (6), (7); remove the screws (6) and disengage the radiator (8) from the brackets (9). [*1]

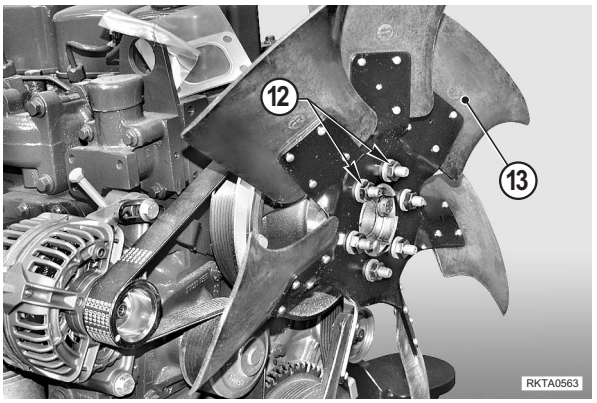


5 -Loosen the lower nuts (10) retaining the radiator's anti-vibration supports (11).

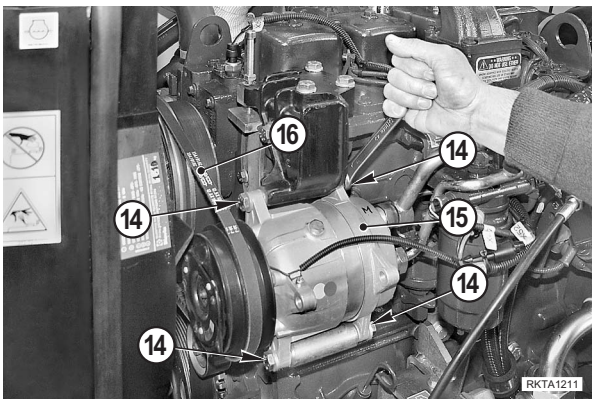


6 - Turn the radiator over towards the rear of the machine to gain access to the fan retaining nuts (12) and washers (13).

7 - Remove the fan (13). [*2]



8 - Loosen the screws (14) retaining the compressor (15) and remove the belt (16).



Installation

- To install, reverse the removal procedure.

[*1]

Bracket nuts: 117.6 Nm

[*2]

Fan retaining nuts: 42 Nm

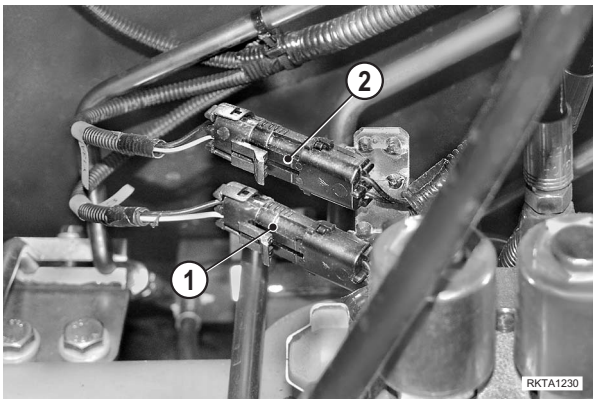
1 - Perform the belt tensioning procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

SERVO-CONTROL FEED VALVE

Removal

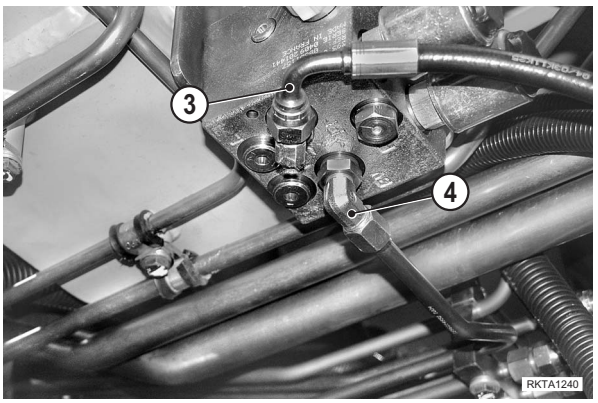
⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground; apply the parking brake, stop the engine and remove the ignition key.

1 - Mark and then disconnect the connectors (1), (2).



2 - Disconnect the lower hoses (3), (4).

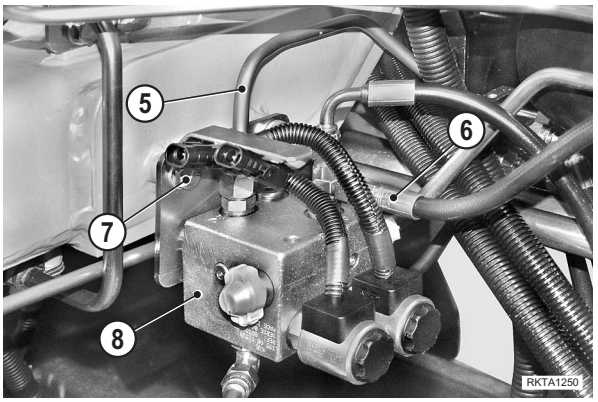
★ Immediately cap the hoses to prevent contaminants from entering the passages.



3 - Disconnect the upper lines (5) and (6).

★ Immediately cap the hoses to prevent contaminants from entering the passages.

4 - Loosen the screws (7), and remove the valve (8).



Installation

- To install, reverse the removal procedure.

1 - Start the engine to allow the oil to circulate and check for any leaks.
Perform several boom and equipment motions in order to bleed the air from the system.

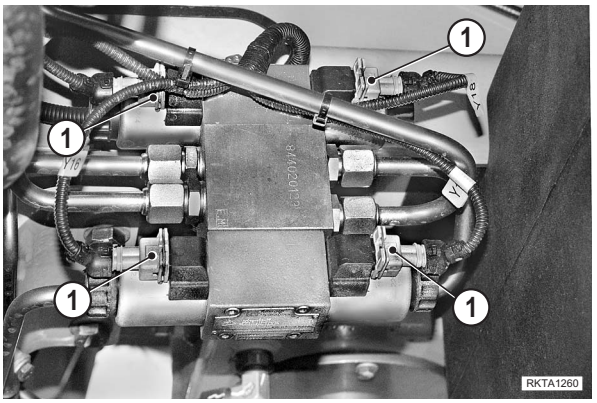
STEERING SELECTION SOLENOID VALVE ASSEMBLY

Removal

⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground; apply the parking brake, stop the engine and remove the ignition key.

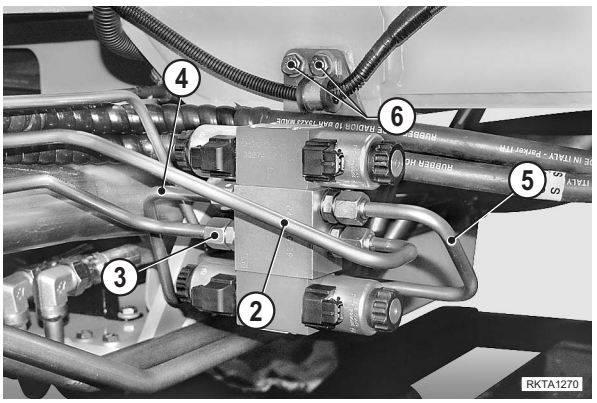
1 - Disconnect the 4 solenoid valve connectors (1).

⚠ If the codes on the connectors appear damaged or are illegible, mark all the connectors in order to avoid mixing them up during installation.



2 - Disconnect the feed (2) and drain (3) pipes and the tubes (4), (5) connecting to the steering cylinders.

3 - Loosen the screws (6) and remove solenoid valve assembly.



Installation

- To install, reverse the removal procedure.

1 - Start the engine to allow the oil to circulate and check for any leaks.
Perform several steering motions in all manners and in both directions in order to bleed the air from the system.

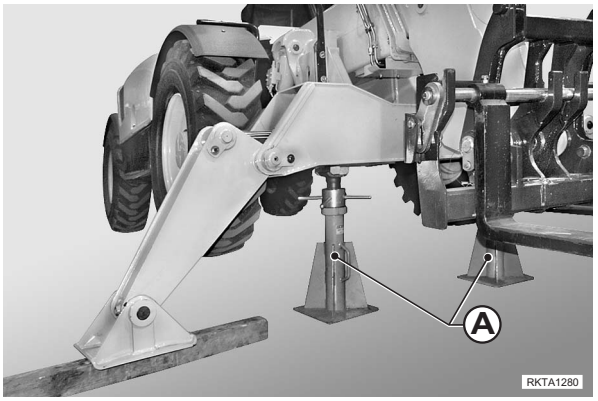
FRONT AXLE

Preparation

- **Machine with outriggers**

1 - Fully lower the boom, lower the outriggers and force them down to the ground until they have reached the end of their travel.

2 - Position and force two safety jacks "**A**" and anti-slip blocks under the outrigger support and apply wedges under both rear wheels.



- **Machine without outriggers**

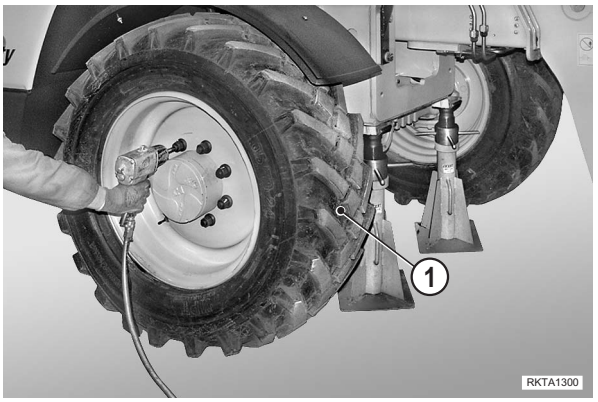
1 - Install two screw jacks "**A**", together with safety blocks, under the frame on the front of the machine.

2 - Raise the screw jacks until the front wheels have been lifted off the ground by 2-3 cm.

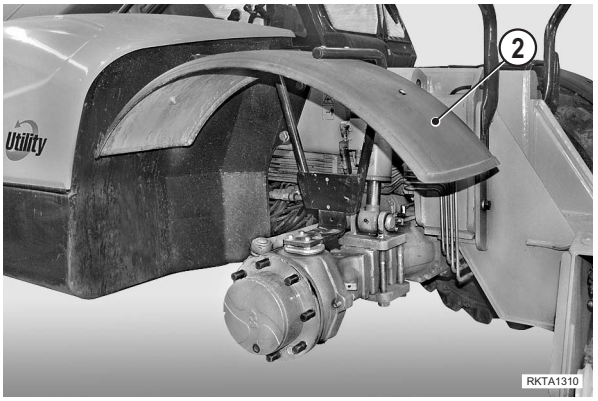
3 - Install wedges under the rear wheels.

Removal

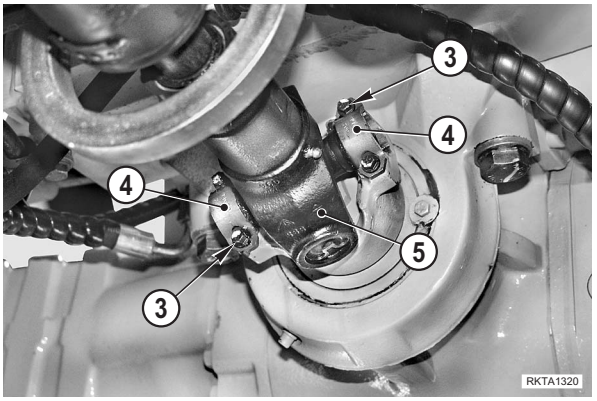
1 - Remove the front wheels (1). [*1]



2 - Remove the fenders (2).

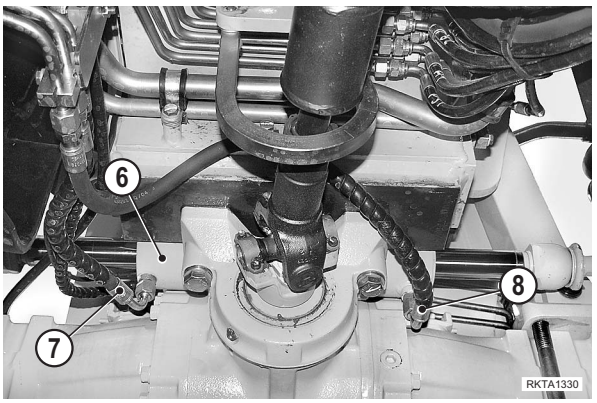


3 - Loosen and remove the screws (3) and clevises (4); disconnect the front propeller shaft (5). [*2]

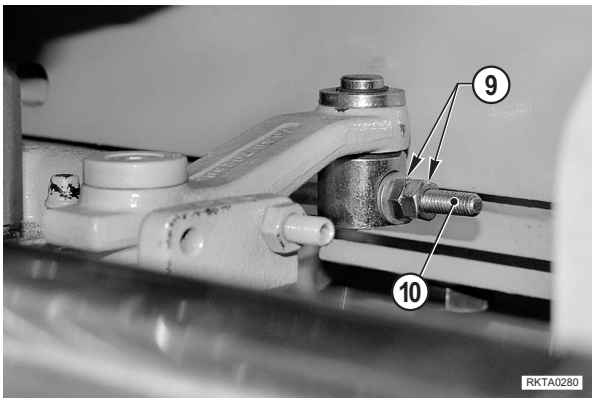


4 - Disconnect the hoses (7),(8) from the steering cylinder (6).

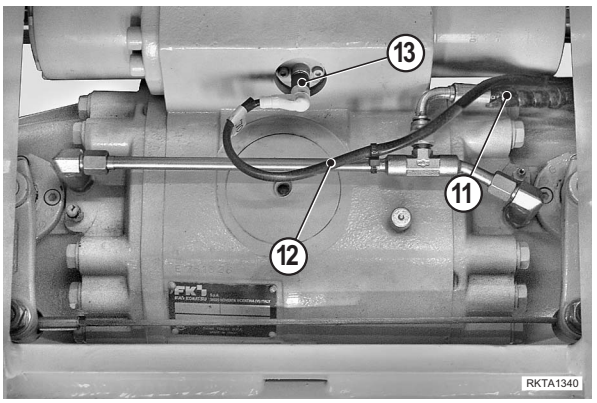
★ Cap the hoses and plug the holes to prevent contaminants from entering the passages.



5 - Loosen and remove the parking brake adjustment nuts (9) and disconnect the control cable (10).

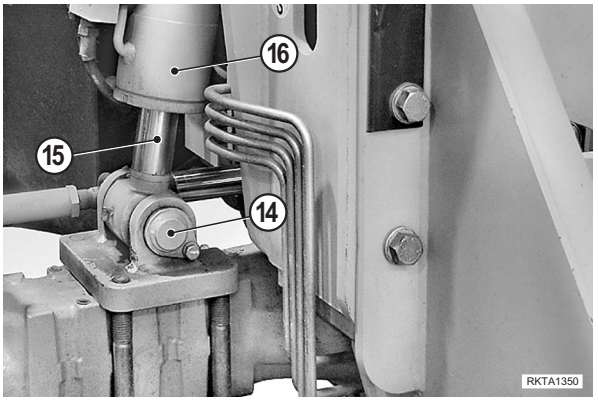


6 - Disconnect the service brake hose (11) and the wiring (12) of the steering sensor (13).



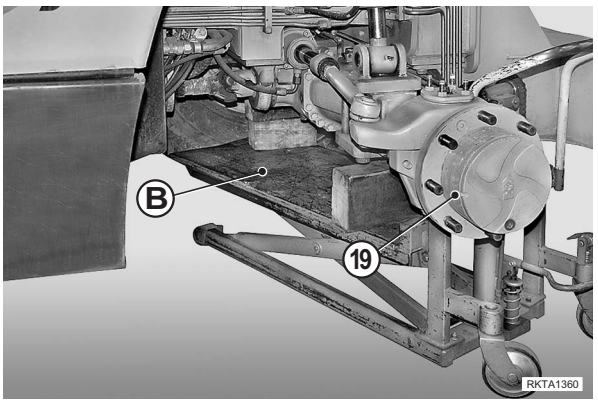
7 - Remove the pin (14) and disconnect the piston (15) of the frame levelling cylinder (16) from the axle.

⚠ If no frame levelling is provided, disconnect the rod.

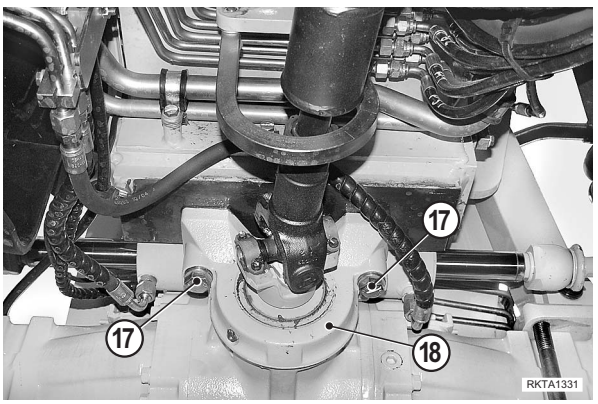


8 - Install a wheel lift "**B**" under the axle and place anti-slip blocks at the ends of the axle shafts.

9 - Raise the lift and ensure that the anti-slip blocks do engage the axle while the raising of the lift takes place.



10 - Loosen and remove the screws (17) retaining the supports (18); lower the axle until disengaging the centring pins; remove the complete axle (19). [*3]



Installation

- To install, reverse the removal procedure.

[*1]

Front wheel nuts: 550±11 Nm

[*2]

Screws: 38±1 Nm

[*3]

Screws: 780±16 Nm

REAR AXLE

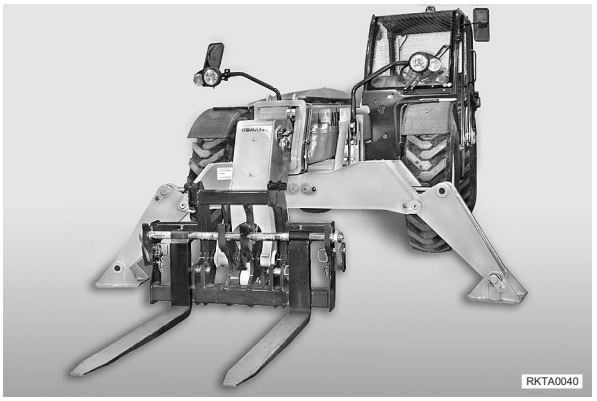
Preparation

- **Machine with outriggers**

1 - Fully lower the boom; lower and slightly force the outriggers to the ground, and stop the engine.

- **Machine without outriggers**

1 - Fully lower the boom, apply the parking brakes, and stop the engine.

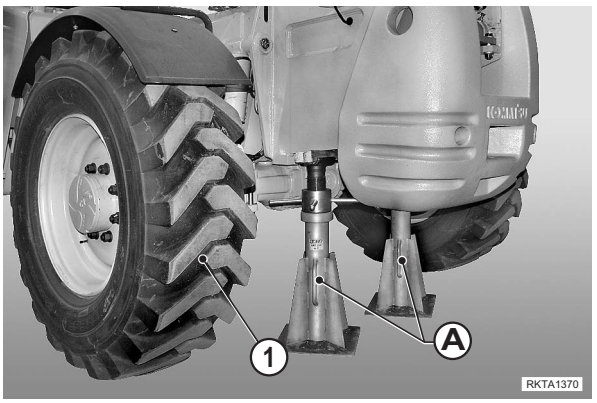


Removal

1 - Install two screw jacks "**A**" under the frame.

★ If the machine is equipped with additional ballasts, install the screw jacks under the rear ballast, together with anti-slip blocks.

2 - Raise the "**A**" jacks equally, enough to lift and remove the wheels (1). [*1]

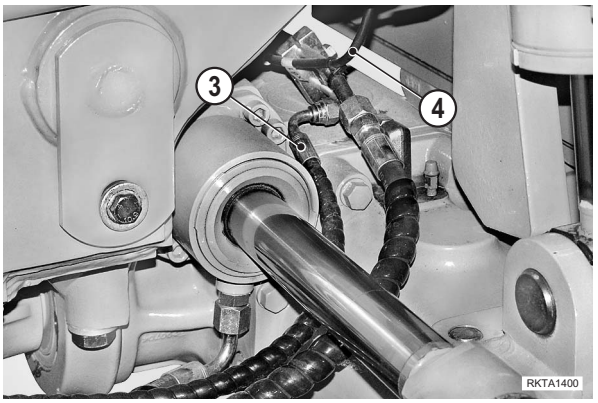


3 - Install a safety stand "**B**" under the ballast.

4 - Loosen and remove the nuts and remove the fenders (2).

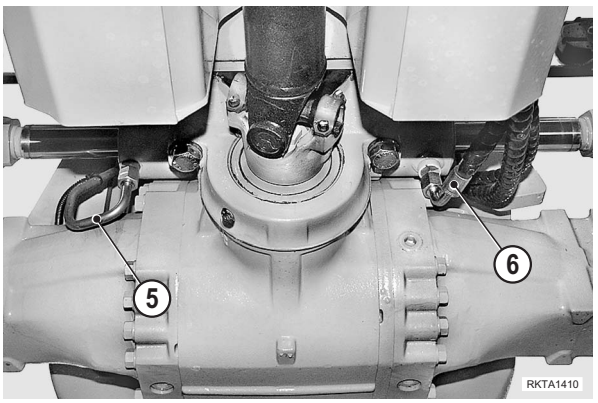
5 - Disconnect the service brake hose (3) and the wiring (4) of the steering sensor.

★ Immediately cap the hoses to prevent contaminants from entering the passages.



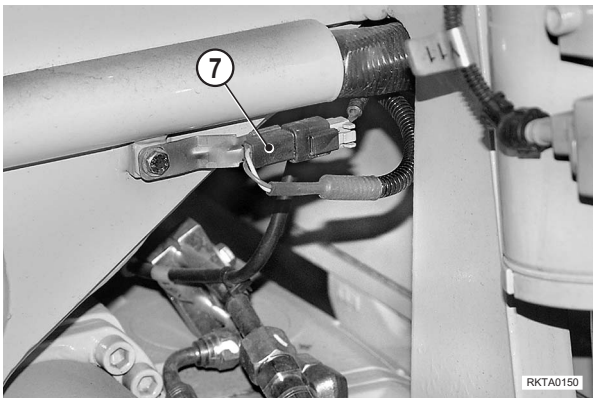
6 - Disconnect the hoses (5),(6) from the steering cylinder.

★ Immediately cap the hoses to prevent contaminants from entering the passages.

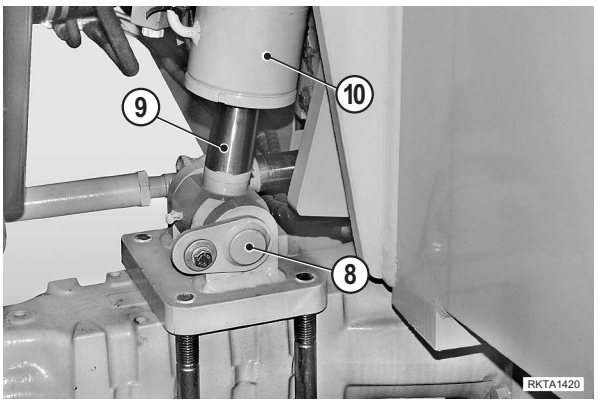


7 - Disconnect the load cell connector (7).

⚠ If the load cell is changed, or if the axle is changed, then you should test and calibrate the overturn prevention control unit.
(For details, see "20 TESTING AND ADJUSTMENTS").

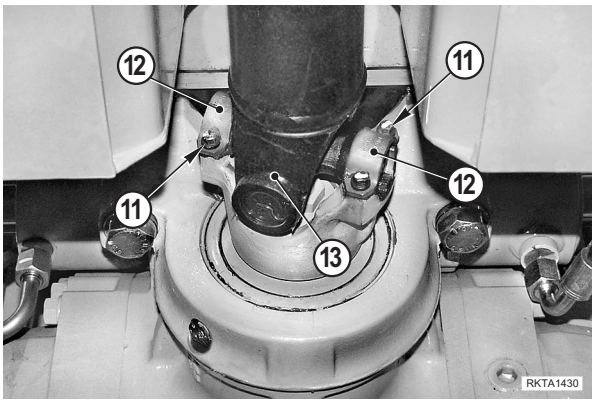


8 - Remove the pin (8) and disconnect the piston (9) of the locking cylinder (10) from the axle.



9 - Loosen and remove the screws (11) and clevises (12); disconnect the rear propeller shaft13).

[*2]



10 - Install a wheel lift together with anti-slip blocks under the axle, remove the axle by carrying out the procedures described for the removal of the front axle.
(For details, see "FRONT AXLE").

[*3]

Installation

- To install, reverse the removal procedure.

[*1]

Wheel nuts: 550±11 Nm

[*2]

Screws: 38±1 Nm

[*3]

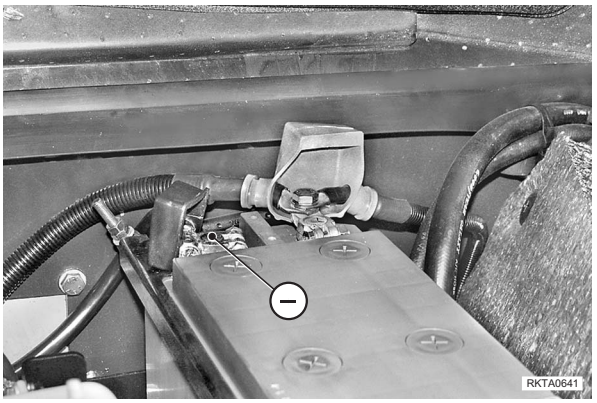
Screws: 780±16 Nm

TELESCOPIC BOOM

Removal

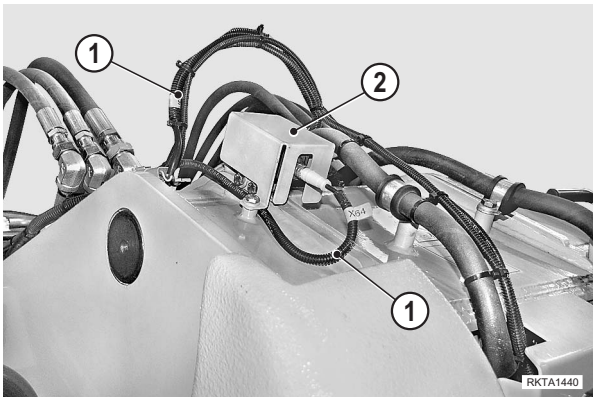
⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground.
Remove the equipment in use from the telescopic boom.
Apply the parking brake, stop the engine and remove the ignition key.

⚠ Disconnect the cable from the negative (–) battery terminal.



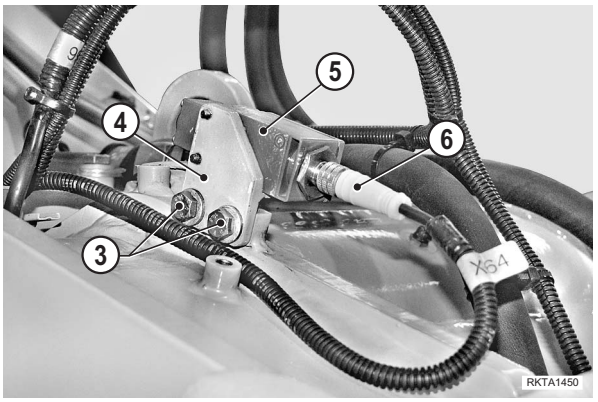
1 - Disengage the wiring harnesses (1) from the straps.

2 - Remove the microswitch cover (2).



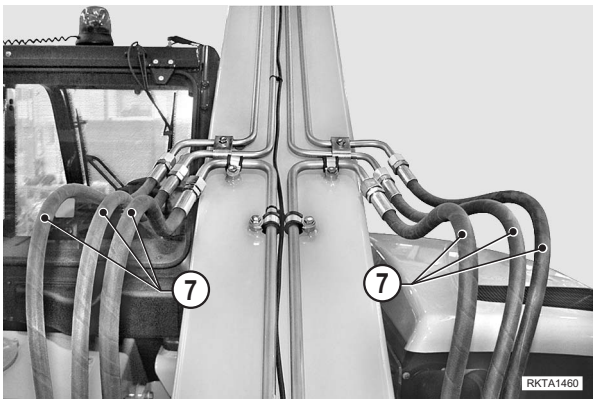
3 - Remove the screws (3); remove the bracket (4) and the microswitch (5) and position them aside.

4 - Disconnect the connector (6).

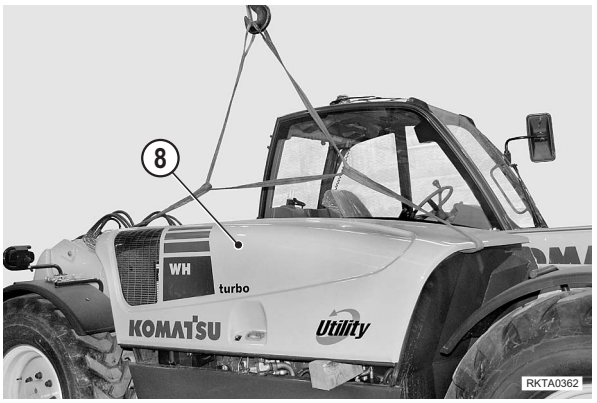


5 - Disconnect the hoses (7).

★ Immediately cap the hoses to prevent contaminants from entering the passages.

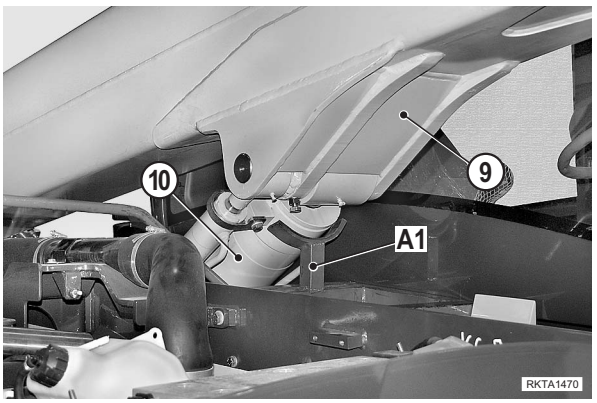


6 - Remove the engine hood (8).
(For details, see "ENGINE HOOD").



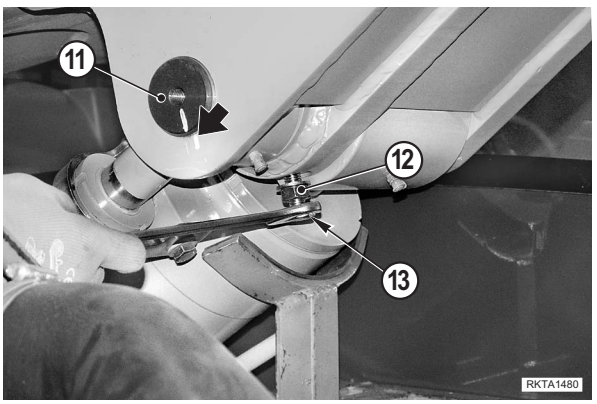
7 - Lift the telescopic boom (9) and install the **A1** support tool (code no. ATR201501) under the lift cylinder head.

8 - Slowly lower the boom until the cylinder (10) rests on the **A1** tool (code no. ATR201501).



9 - Mark the radial position of the pin (11).

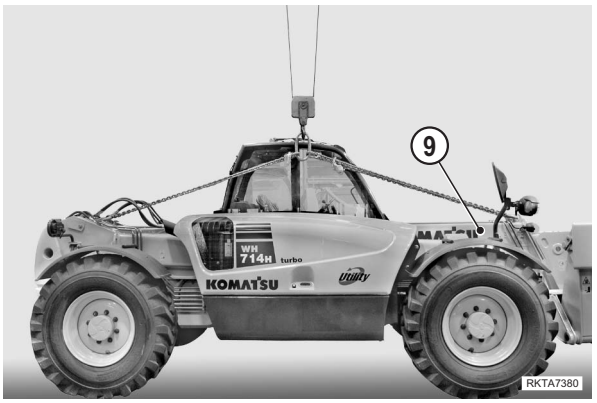
10 - Loosen the nut (12) and screw (13) and remove the nut and the screw.



11 - Connect a hoist to the complete boom (9), using three ropes or chains – the one attached to the rear of the boom should be adjustable lengthwise.

⚠ Use the connections provided.

Boom: WH609: 1382 kg
WH613: 2112 kg
WH713: 2288 kg
WH714: 2318 kg
WH716: 2588 kg



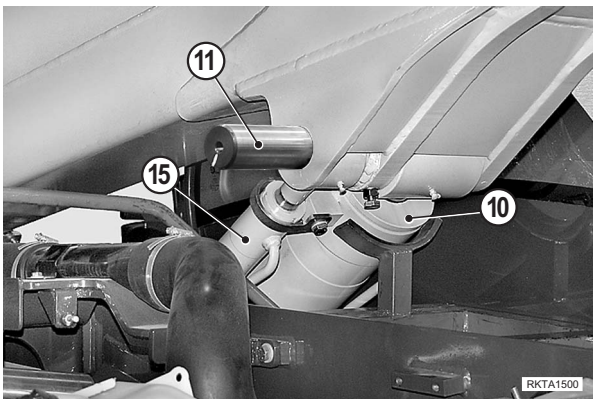
12 - Slightly tension the ropes or chains and pull the fulcrum pin (14) out.

★ Recover the shoulders mounted between the boom and the frame.

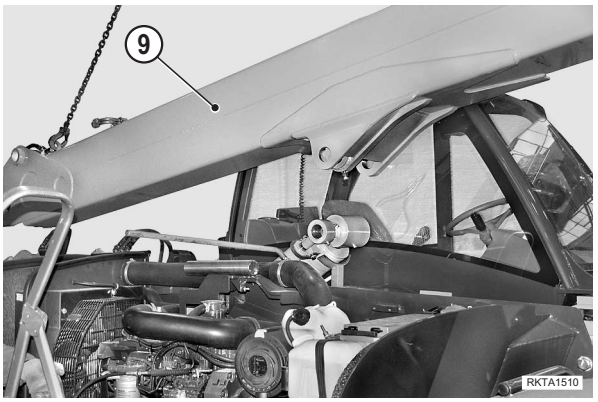
★ Do not mix or invert the position of the shoulders.

13 - Remove the pin (11) providing the attachment for the lift cylinder (10) and offset cylinder (15).

★ If necessary, use a push puller to remove the pin.

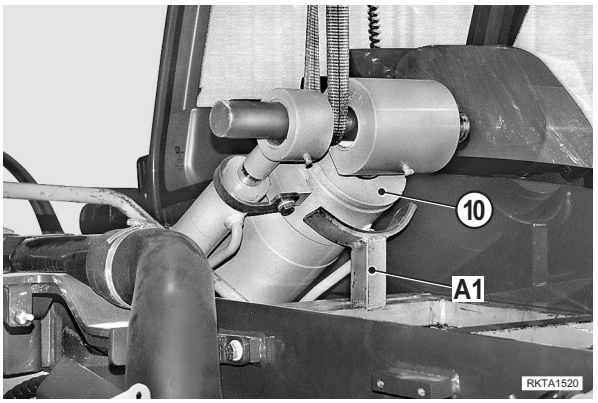


14 - Remove the complete boom (9).

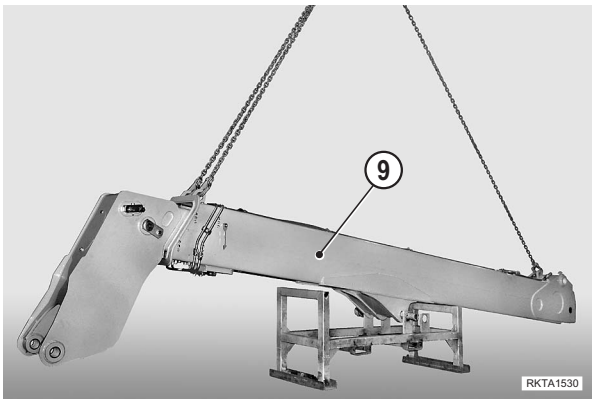


Installation

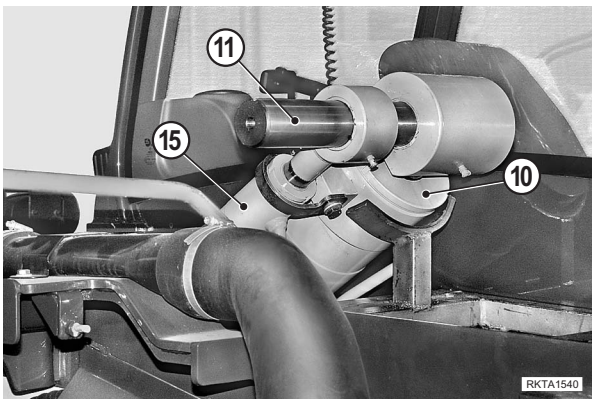
1 - Install the **A1** tool (code no. ATR201501) under the lift cylinder (10).



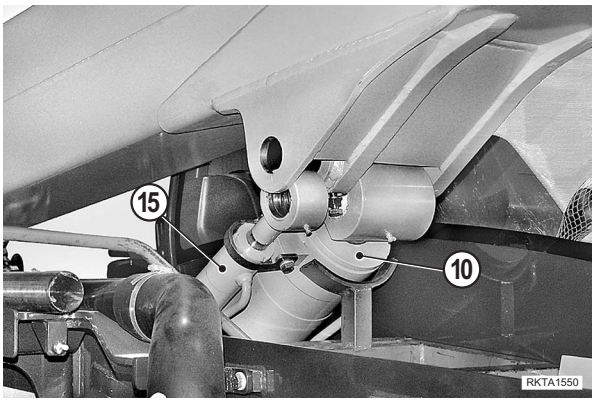
2 - Connect the boom (9) to a hoist using three chains or ropes – one of which should be adjustable lengthwise.



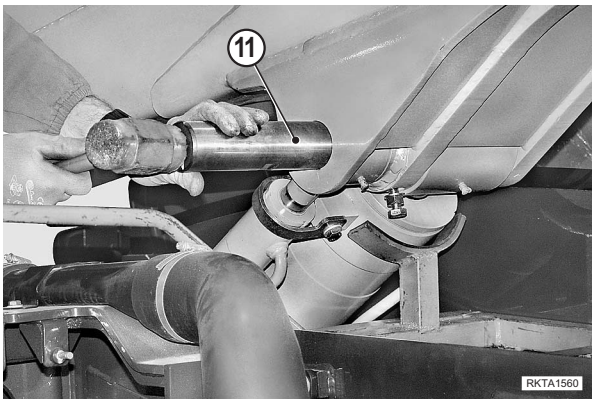
3 - Using the attachment pin (11), align the rods of the lift cylinder (10) and offset cylinder (15).



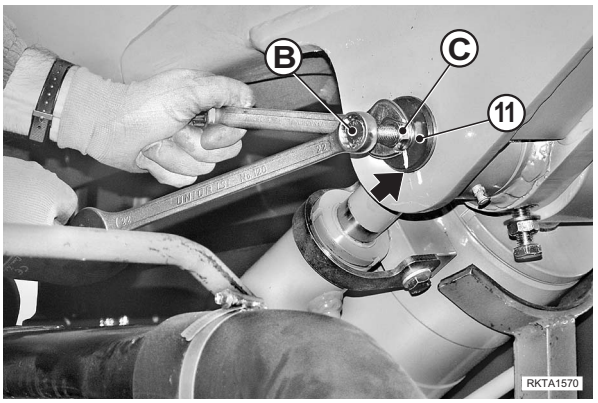
4 - Position the boom in such a way as to centre the pistons of cylinders (10) and (15) into the attachment eyelets.



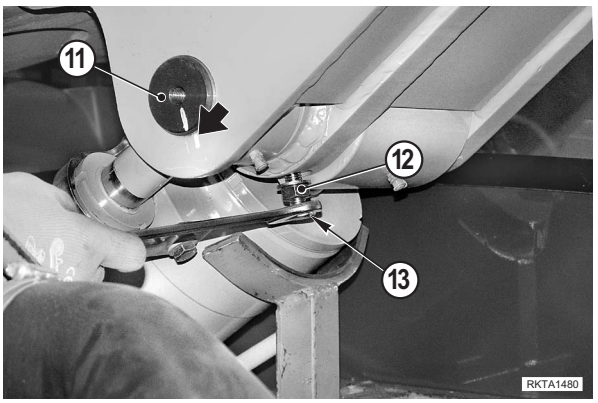
5 - Align the holes and introduce the pin (11).



6 - Tighten a screw (B) into the centre hole on the pin (11) and lock the screw with a nut (C).

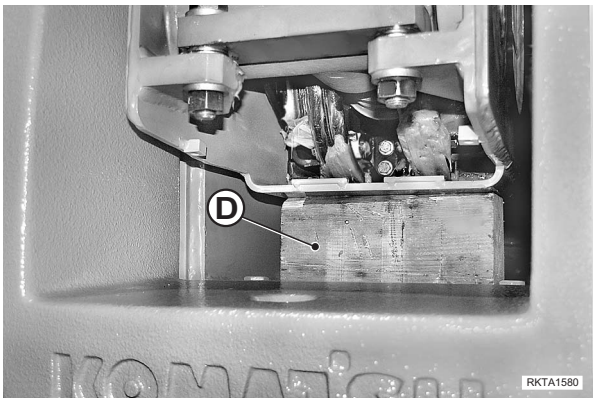


7 - Orient the pin to the marks made during removal and gradually tighten the screw (13) until it is fully locked. Lock the position with the nut (12).



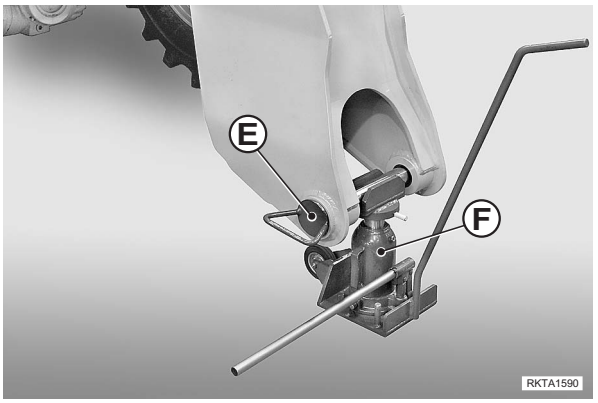
8 - Install a block (D) approximately 12 cm thick under the boom on the fulcrum side.

9 - Lower the boom until the fulcrum side rests on the previously installed block.

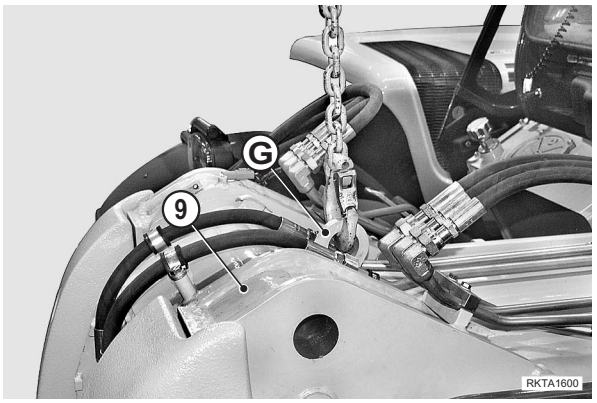


10 - Introduce a pin (E) into the equipment attachment hole.

11 - Place and a hydraulic jack (F) of min. 5 ton capacity firmly in place under the pin (E).

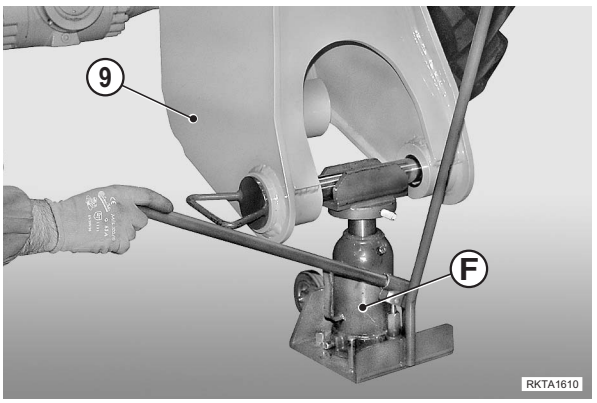


12 - Remove the boom lift ropes or chains, and then connect to the hoist a standard chain fastened to the attachment (G) of the boom (9) on the fulcrum side. Put under slight tension.



13 - Slightly lower the jack (F) and remove the block (D).

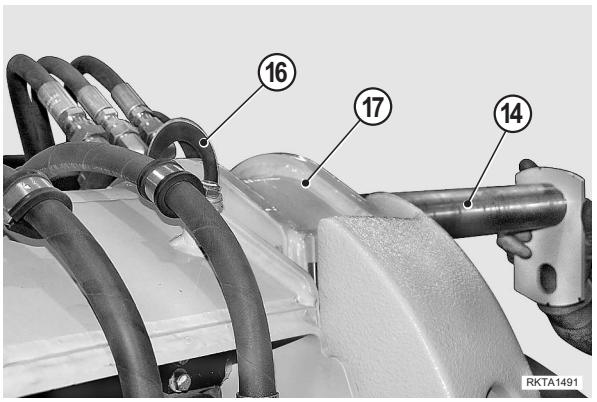
14 - As you work on the hydraulic jack (F) with the hoist, swing the boom (9) and locate the fulcrum pin hole centering position.



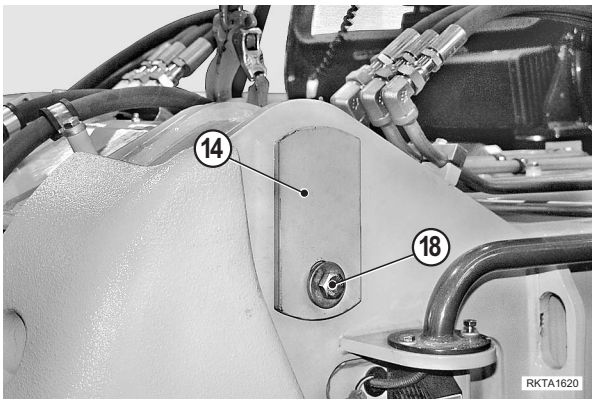
15 - Introduce a shim (16) to the right between the frame (17) and the boom (9); introduce the pin (14) and then introduce the remaining shims on the left side.

★ The quantity of shims used should be enough to leave less than 1 mm clearance between the boom and the frame.

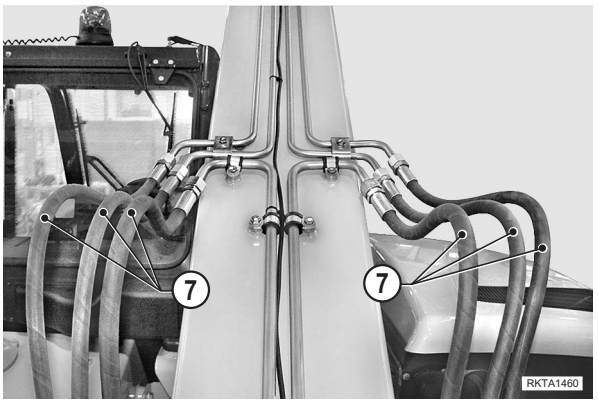
★ If more than two shims are needed, you should install the larger amount of shims to the left side.



16 - Lock the fulcrum pin (14) with the screw (18) and the respective washer.

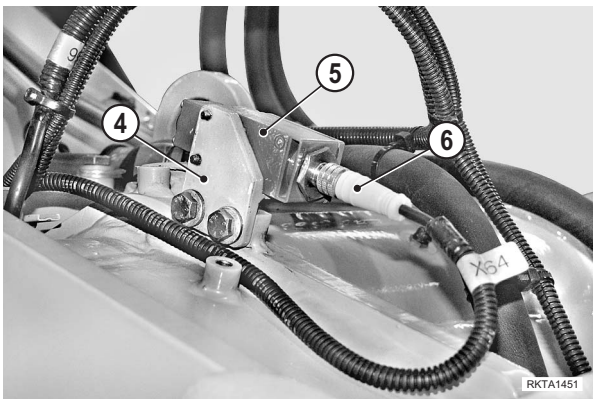


17 - Connect the hoses (7).

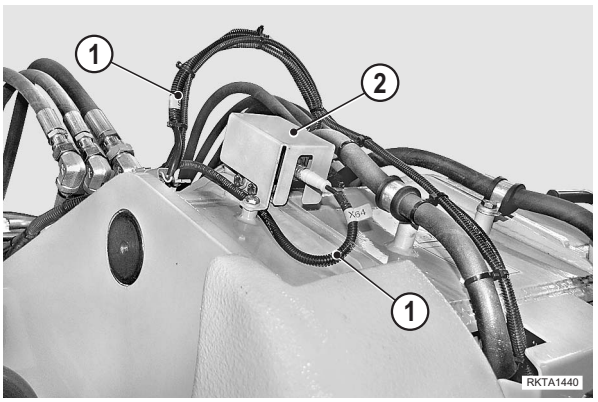


18 - Install the support (4) and the microswitch (5).

19 - Connect the connector (6).



20 - Install the cover (2) and secure the wiring harness (1) with the pull straps.



21 - Start the engine and perform some full arm lifting and arm lowering movements.

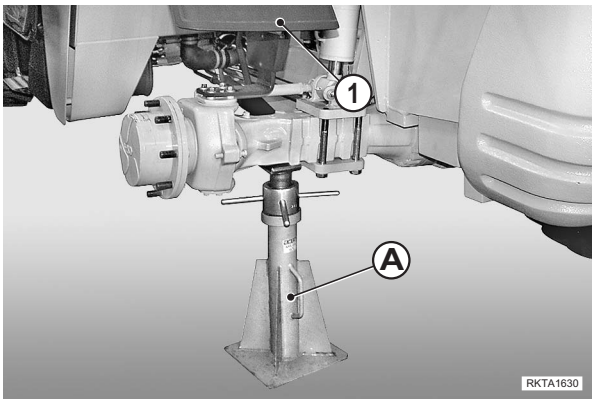
22 - Install the equipment, and perform a few motions to bleed the air from the circuits.

LIFT AND OFFSET CYLINDERS

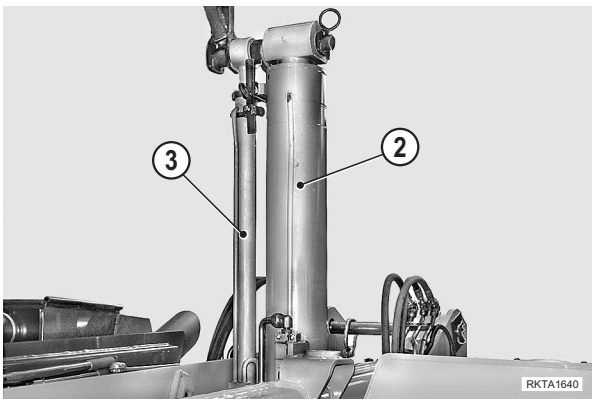
Removal

1 - Remove the telescopic boom:
(For details, see "TELESCOPIC BOOM").

2 - Install a screw jack (A) under the left side of the rear axle and remove the left wheel and fender (1).

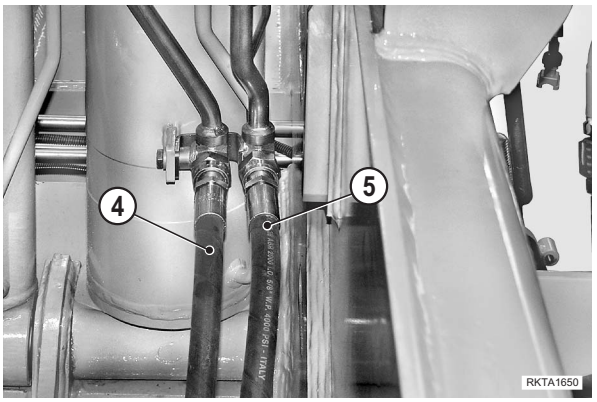


3 - Connect a hoist and move the cylinders (2), (3) to their upright position.



4 - Mark and disconnect the hoses (4), (5) of the lift cylinder (2).

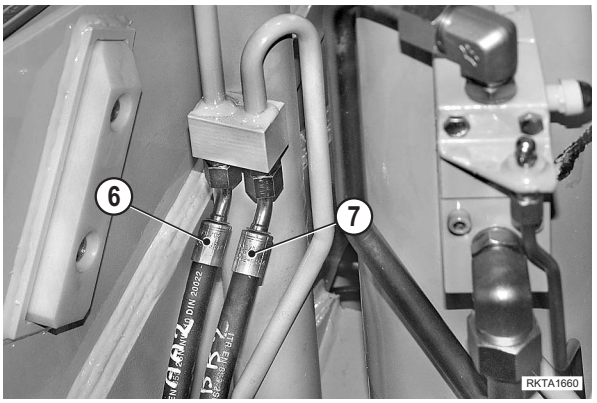
★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.



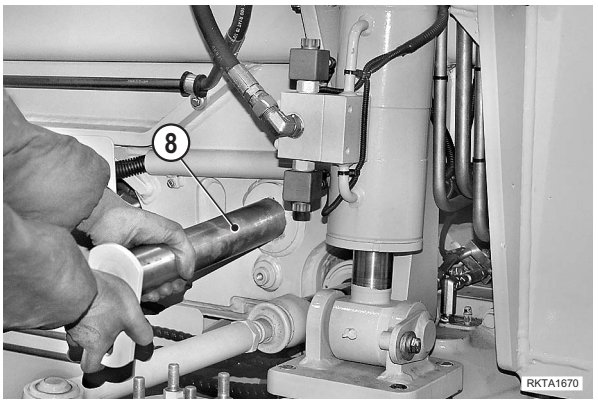
5 - Mark and disconnect the hoses (6), (7) of the offset cylinder (3).

★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.

⚠ The holes on the offset cylinder should be sealed to prevent telescoping to take place during removal.



6 - Remove the screw, slide the pin (8) out and remove the cylinders (2), (3).



Installation

- To install, reverse the removal procedure.

1 - Perform a full lubrication procedure.

2 - Start the engine and perform several lifting and lowering motions to bleed the air form the circuits.

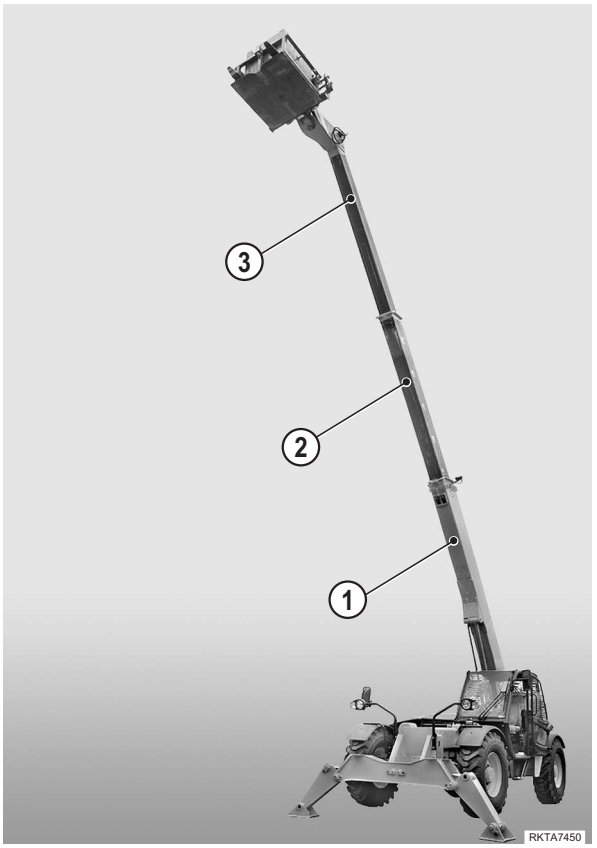
INTERMEDIATE AND TOP BOOM

Removal

★ This procedure refers to machines with a 3-stage boom; in the case of machines equipped with a 2-stage boom, you should ignore the procedures described here for chains and chain covers and housings.

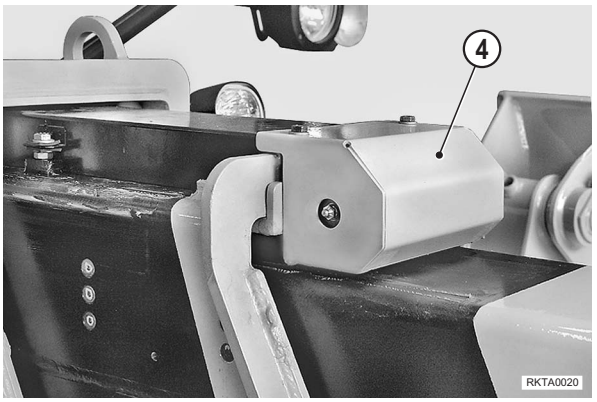
★ Definitions used in this section are as follows:
a - Basic boom (1)
b - Intermediate boom (2)
c - Top boom (3)

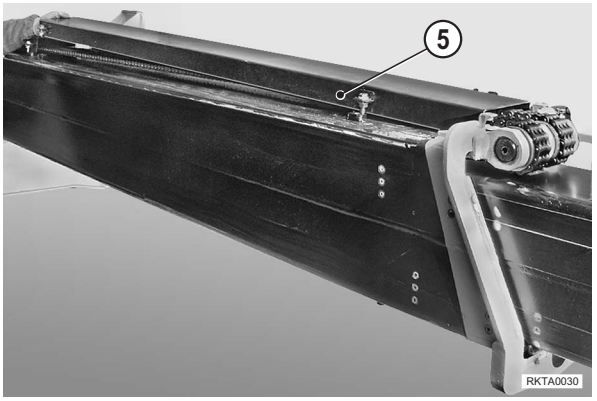
★ In order to perform the extension cylinder's retraction and extension motions, it is necessary to have an independent power unit (or a manual pump) available, filled with the same type of hydraulic oil as the machine.



1 - Place the machine on firm, level ground; apply the parking brakes and remove the front equipment.

2 - Fully extend the boom and remove the chain housings (4) and covers (5). [*1]

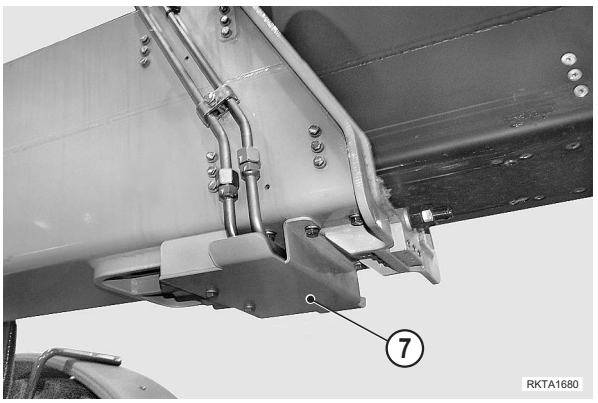




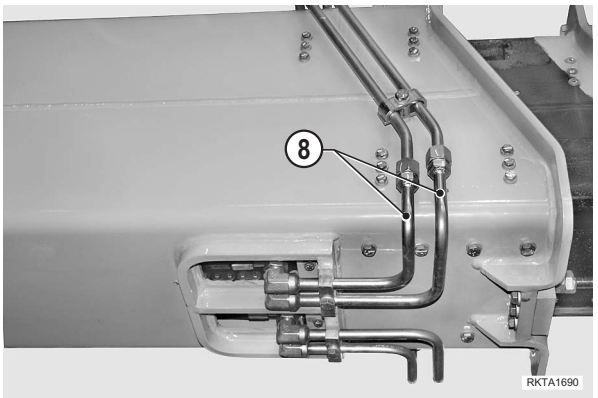
3 - Remove the rear cover (6)

4 - Retract the boom until it is 40 cm away from the closure of the intermediate boom.

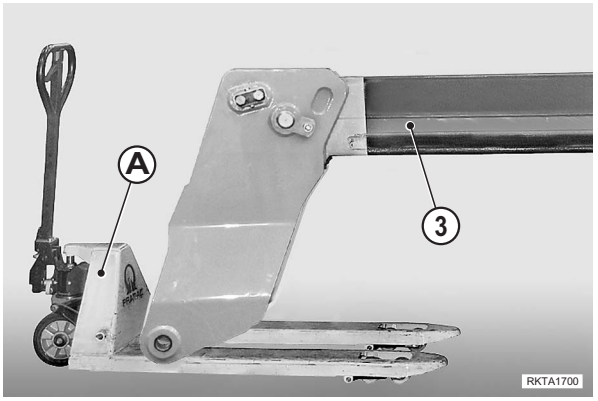
5 - **Only if equipped.**
Remove the lower cover (7).



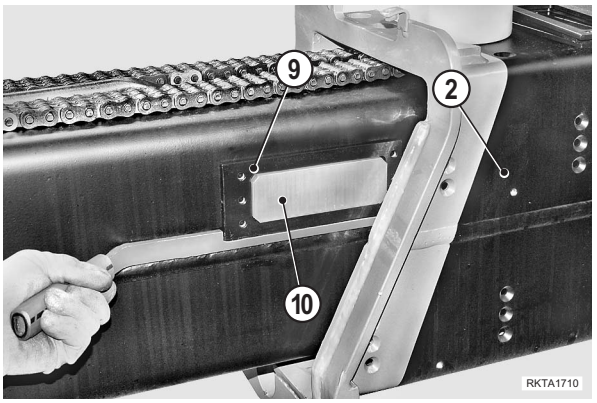
6 - Disconnect and remove both left and right iron pipes (8).



7 - Place a wheel support stand or a pallet truck (A) under the top boom; rest the top boom on the stand or truck (3).

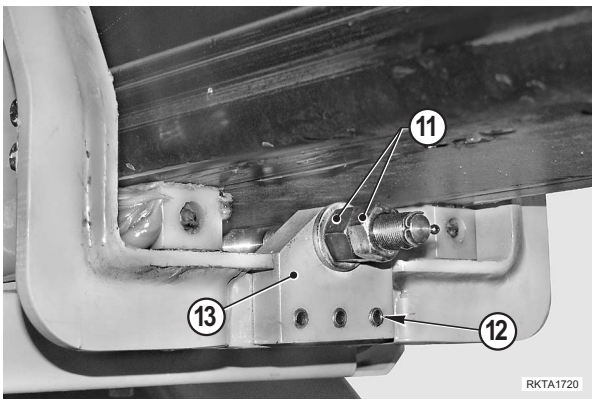


8 - Loosen and remove the screws securing the check plates (9) along with the side guide shoes (10) of the intermediate boom (2).

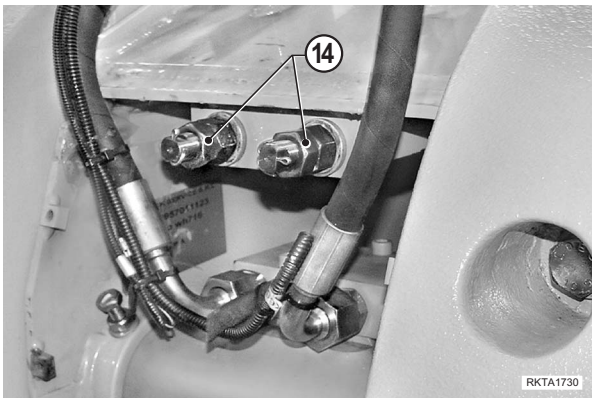


9 - Remove the retraction chain cotter pin and retaining nuts (11).

10 - Loosen the screws (12) and remove the support (13).

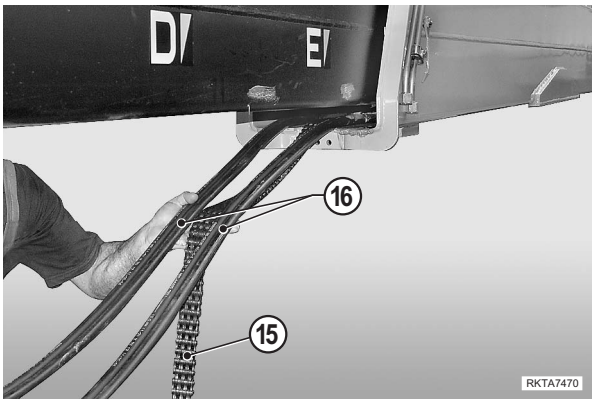


11 - Remove the extension chain tensioner cotter pins and nuts (14). [*2]

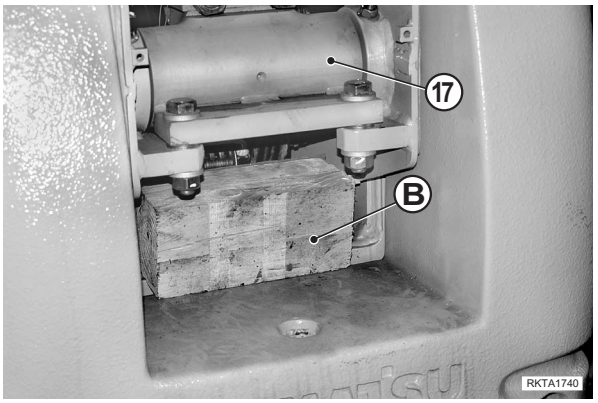


12 - Start the engine and perform an extension motion until the boom reaches the end of its travel; then stop the engine.

⚠ Make sure to guide and keep tensioned the retraction chain (15) and the equipment rubber hoses (16) while extending the boom.



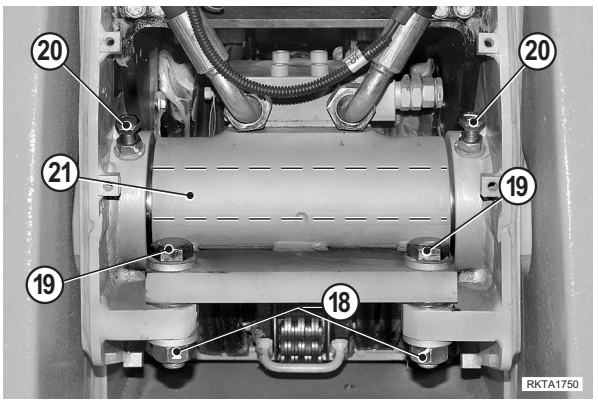
13 - Place a support block (B) under the cylinder head (17).



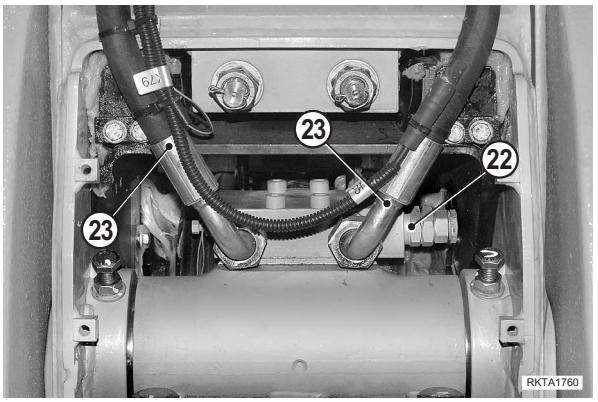
14 - Remove the nuts (18) and screws (19) retaining the extension cylinder rod attachment. [*3]

15 - Loosen and remove the nuts and screws (20) retaining the extension cylinder rod attachment pin (21).

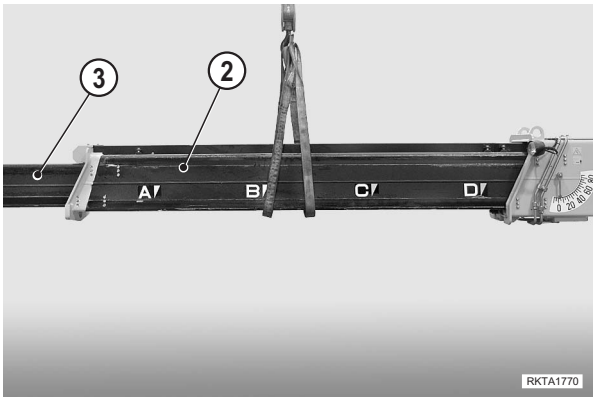
16 - Remove the pin (21) through the ballast holes.



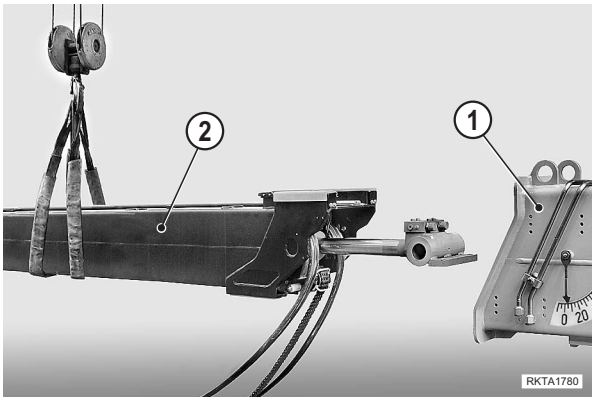
17 - Disconnect the hoses (23) from the safety valve (22).



18 - Connect the intermediate boom (2) complete with top boom (3) to a hoist and pull them out from the basic boom.



19 Rest the entire assembly on stands..



Installation

- To install, reverse the removal procedure.

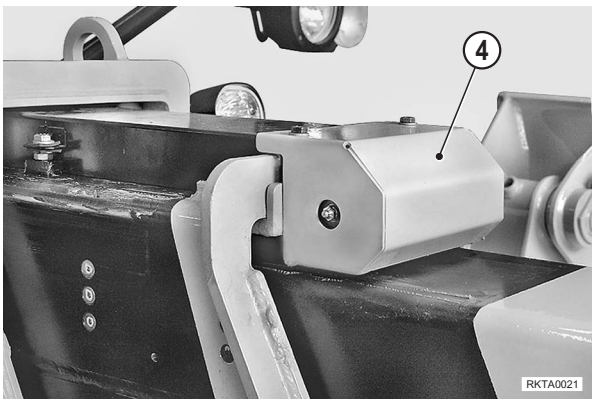
[*1]

★ Before attempting to re-install the chain housings (4) and covers (5):

a - Perform the extension chain tension adjustment procedure.

b - Perform the extension travel adjustment procedure. (For details, see "20 TESTING AND ADJUSTMENTS").

c - Perform a full chain and pin lubrication procedure.



[*2]

Check-nuts: 270 Nm

[*3]

Screws: 580 Nm

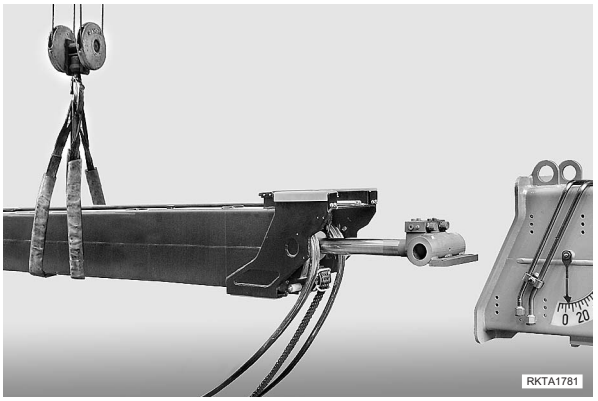
1 - Start the engine and perform full extension and retraction motions in order to bleed the air from the circuit.

2 - Stop the engine and check the hydraulic oil level.

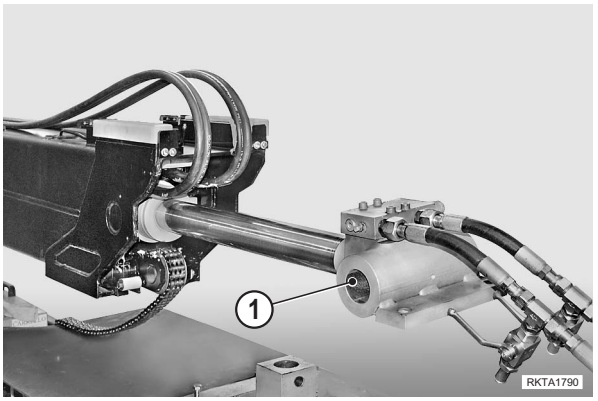
EXTENSION CYLINDER

Removal

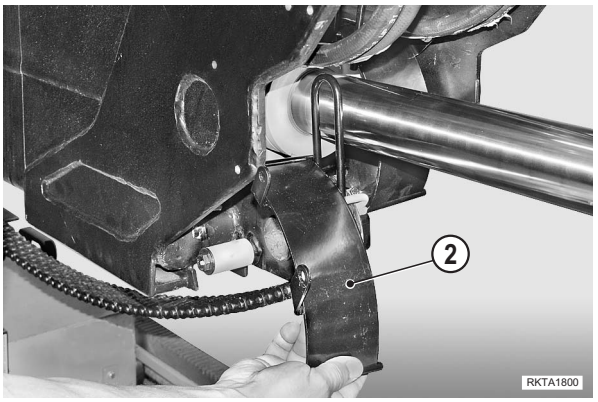
1 - Remove the intermediate and top boom from the machine.
(For details, see "INTERMEDIATE AND TOP BOOM").



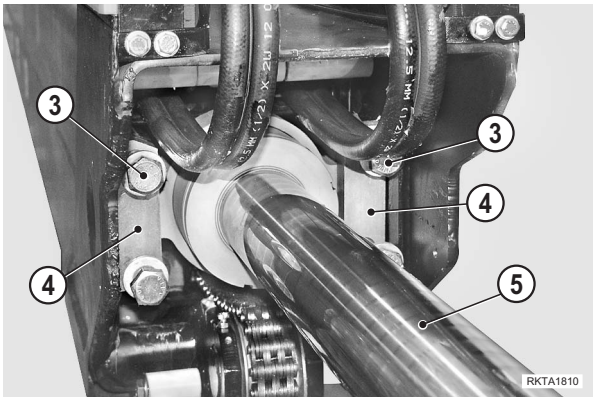
2 - Using a separate power unit (or a manual pump) filled with the same oil type as the machine, cause the piston (1) to return until it is within 80 cm of the end of its travel.



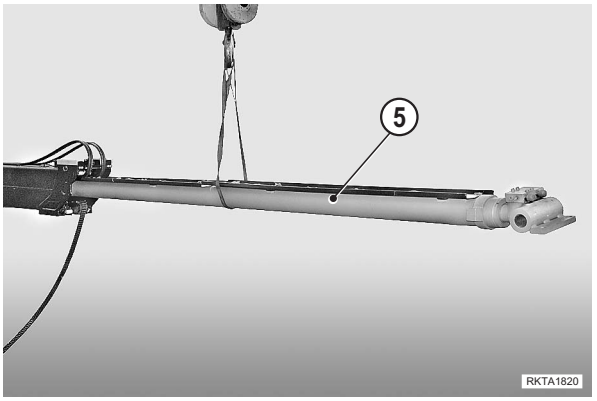
3 - Remove the guides (2) for the equipment hoses.



4 - Loosen and remove the screws (3) together with their respective washers and plates (4) retaining the cylinder (5). [*1]



5 - Partially remove the cylinder (5).
Connect the cylinder to a hoist and then remove it completely.



Installation

- To install, reverse the removal procedure.

[*1]

Screws: 580±12 Nm

1 - Start the engine and perform full extension and retraction motions in order to bleed the air from the circuit.

2 - Stop the engine and check the hydraulic oil level.

BOOM SLIDING SHOES

Replacement

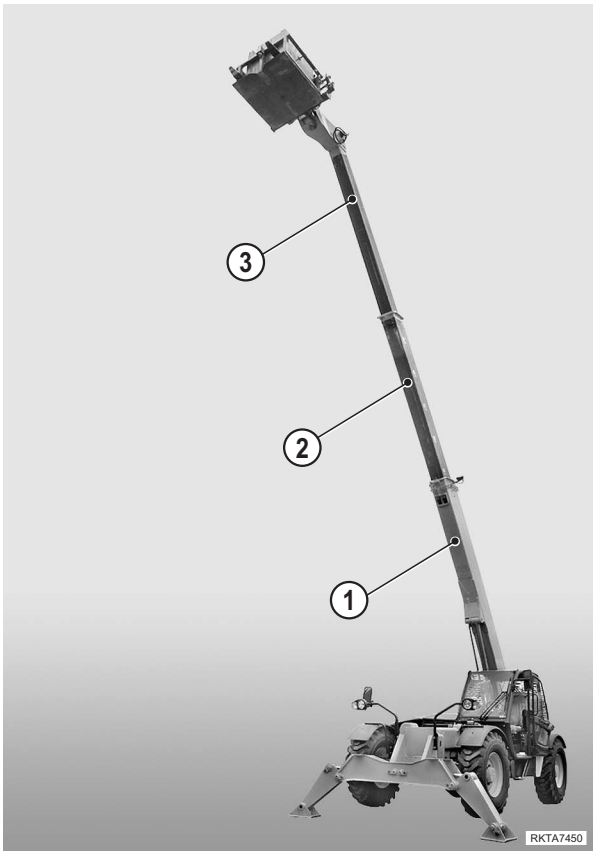
⚠ Lower and fully retract the boom and lower the stabilizers (if equipped) to the ground; apply the parking brake.
If the machine is not equipped with stabilizers, place wedges under the wheels.

NOTES

1 -The operations described below regard 3-stage booms; the same operations apply to 2-stage booms, except for chain-related procedures.

2 -We recommend changing one shoe at a time in order to avoid inverting or mixing up the shims that are responsible for determining run clearance.

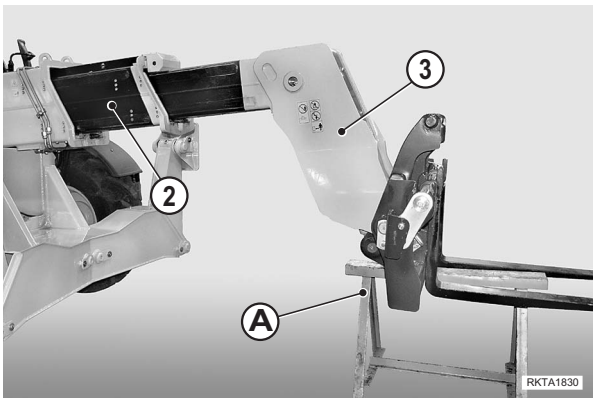
3 -Definitions used in this section are as follows:
a - Basic boom (1)
b - Intermediate boom (2)
c - Top boom (3)



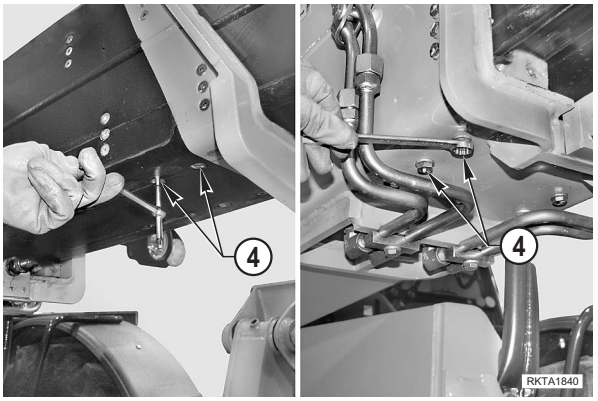
1. Lower shoes for intermediate and top booms.

1 -Lift the complete boom and extend the intermediate boom (2) by approximately 60-70 cm.

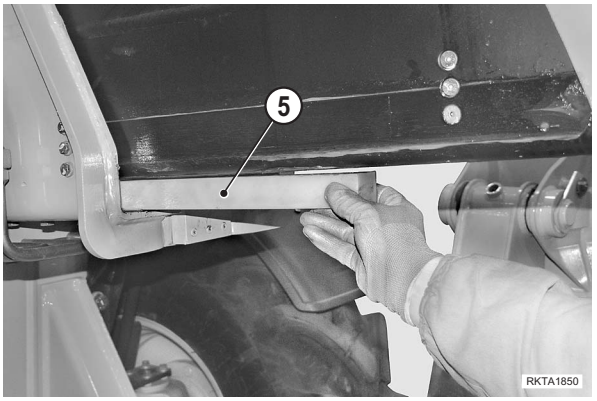
2 -Place a stand (A) under the top boom (3); lower the complete boom again, slightly forcing it, and then disengage the shoes.



3 -Stop the engine, loosen and remove the retaining screws (4) (2 screws for each shoe).

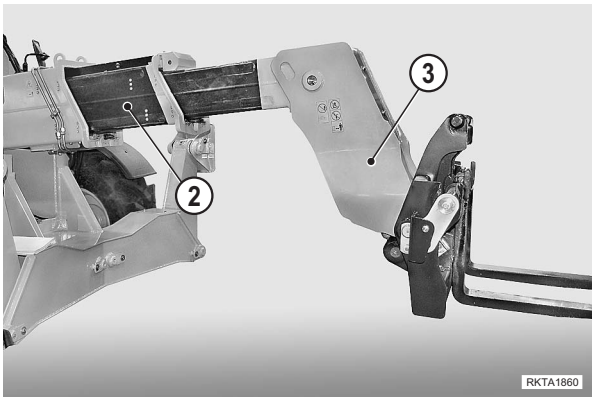


4 - Remove the worn shoes (5), install new shoes and lock them in position with their respective screws.

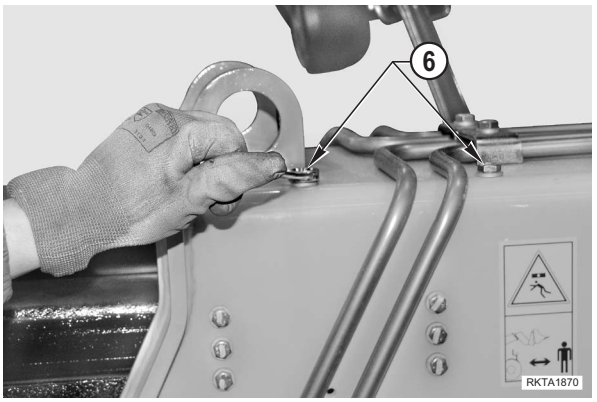


2. Upper shoes for intermediate boom.

1 - Start the engine and remove the stand (A) you have installed in the previous step.



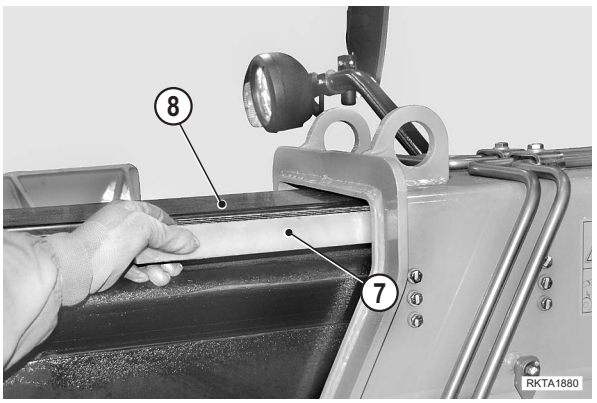
2 - Loosen and remove the screws (5) (2 screws for each shoe).



3 - Remove the worn shoes (7) and their respective shims (8); install new shoes and lock them in position with their respective screws.

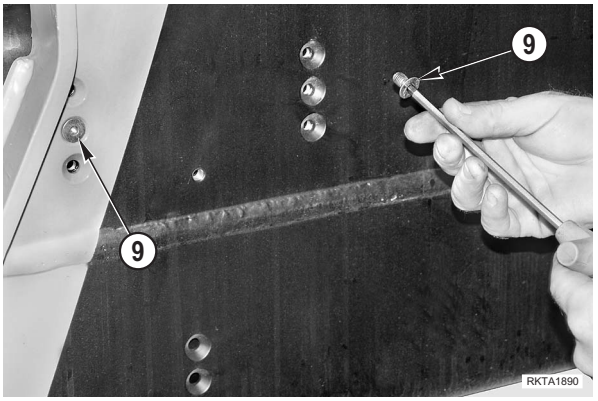
4 - Recover the shims, apply them to the new shoes and reinstall the complete shoes.

★ To cause the shims to properly adhere the new shoes, apply instant adhesive ASL800020 to the shims in several points.



3. Side shoes for intermediate and top boom.

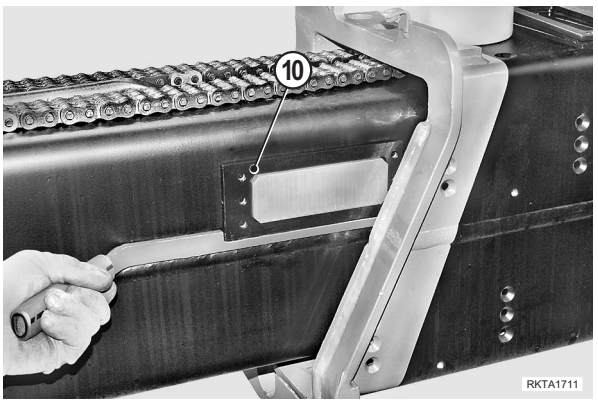
1 - Loosen and remove the retaining screws (9) (n°6 screws for each shoe).



2 - Remove the worn shoes (10) with their respective shims.

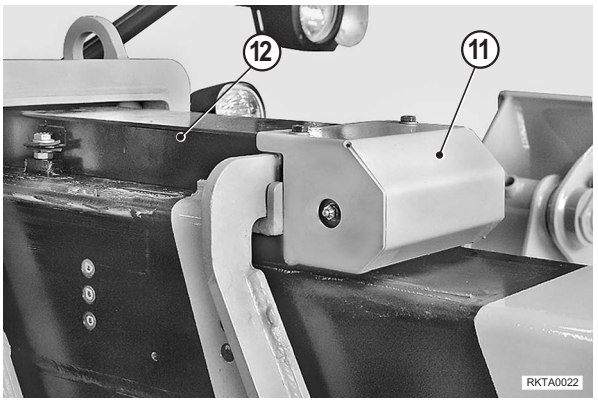
3 - Recover the shims, apply them to the new shoes and re-install the complete shoes.

★ To cause the shims to properly adhere to the new shoes, apply instant adhesive ASL800020 to the shims in several points.

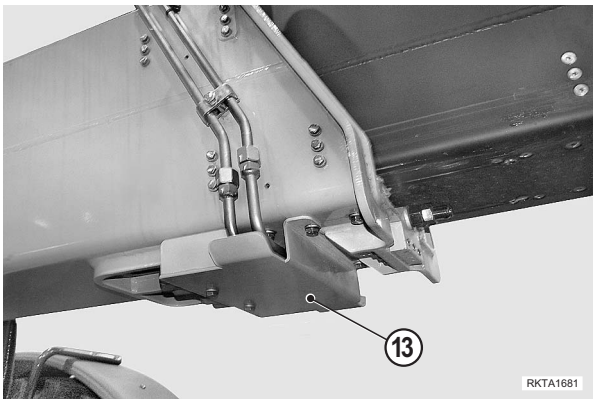


4. Upper shoes for top boom.

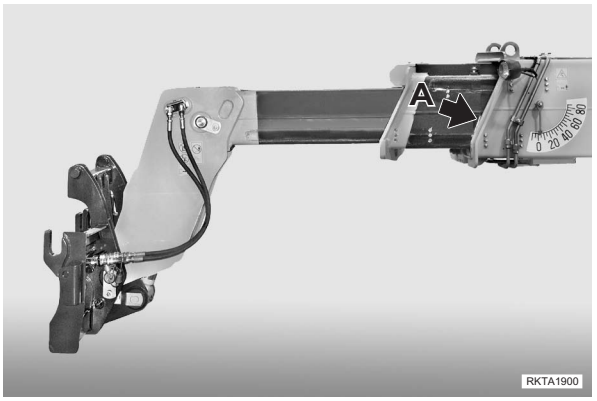
1 - Fully extend the booms.
Stop the engine and remove the chain front housing (11) and top cover (12).



2 - Remove the lower cover (13) (only if equipped).



3 - Start the engine and retract the booms until the letter "**A**" (for load diagram reference) is totally covered.

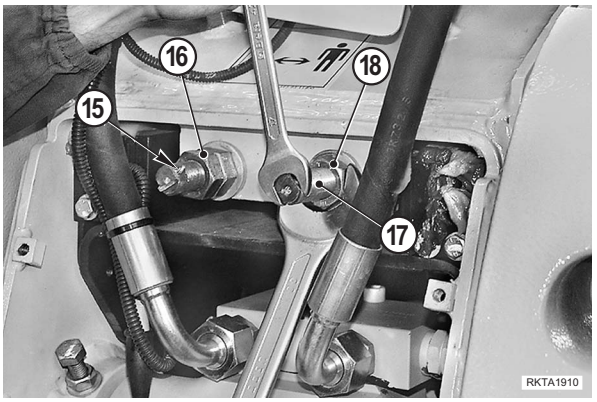


4 - Remove the rear cover (14).

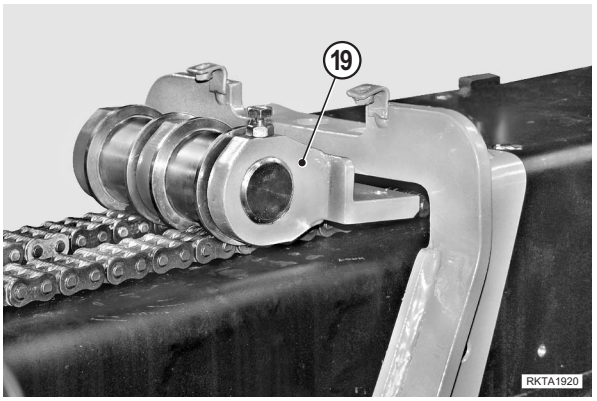
5 - Remove the cotter pins (15) and check-nuts (16) while holding the rods (17) in position; loosen the extension chain tensioner rod nuts (18) in an alternate manner; remove the nuts (18).

★ Replace the cotter pins at each disassembly.

★ Prevent rod rotation.



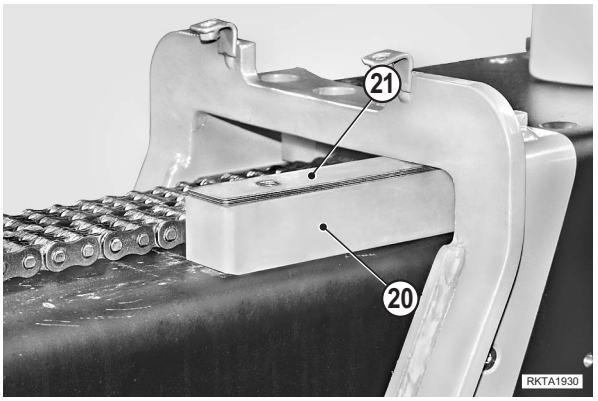
6- Loosen and remove the upper screws and remove the support (19) of the idler wheels guiding the chains.



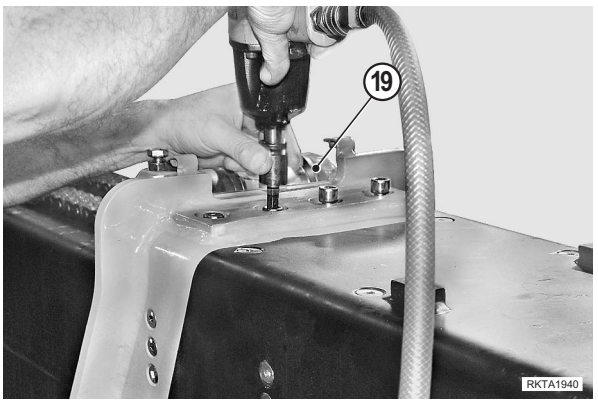
7 - Loosen the retaining screws (2 for each shoe) and remove the worn upper shoes (20) together with their respective shims (21).

8 - Recover the shims, apply them to the new shoe, and reinstall.

★ To cause the shims to properly adhere to the new shoes, apply instant adhesive ASL800020 to the shims in several points.



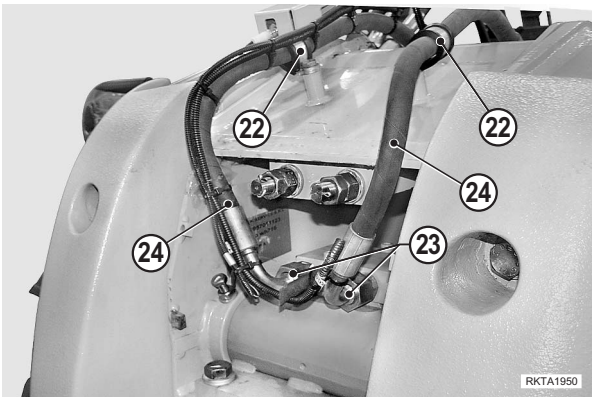
9 - Install the chain guide idler wheel support (19) and perform the tensioning procedure before installing the housings and covers.



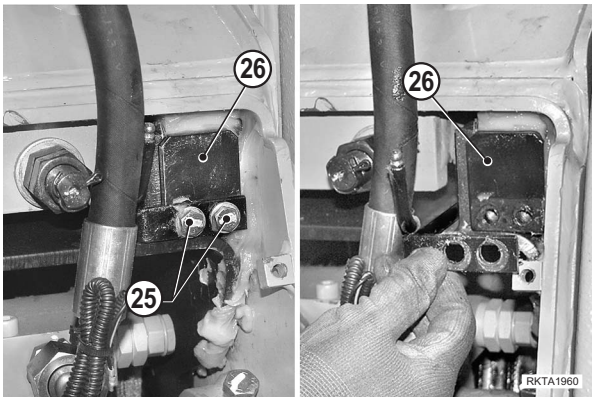
5. Rear upper shoes for intermediate boom

1 - With the boom fully lowered, remove the rear cover (14).

2 - Disconnect the hose clamps (22) and connections (23); move the hoses (24) towards the middle of the boom to clear the work area.



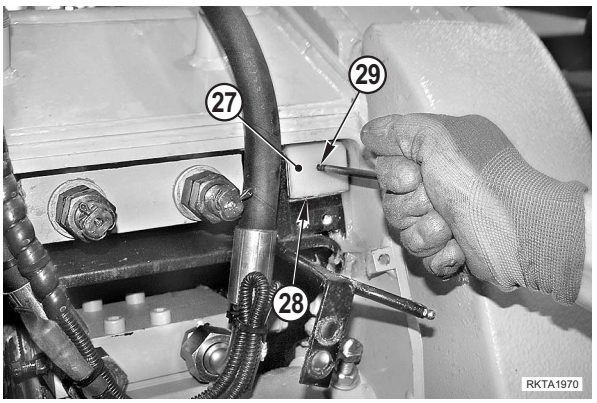
3 - Loosen and remove the screws (25) and remove the check plates (26); partially extract the shoe lubrication ducts.



4 - Tighten a threaded bar into the holes provided and remove the worn shoes (27) complete with lower (28) and side (29) shims.

5 - Recover the shims, apply them to the new shoes and reinstall the complete shoes.

★ To cause the shims to properly adhere to the new shoes, apply instant adhesive ASL800020 to the shims in several points.



6. Rear upper shoes for top boom

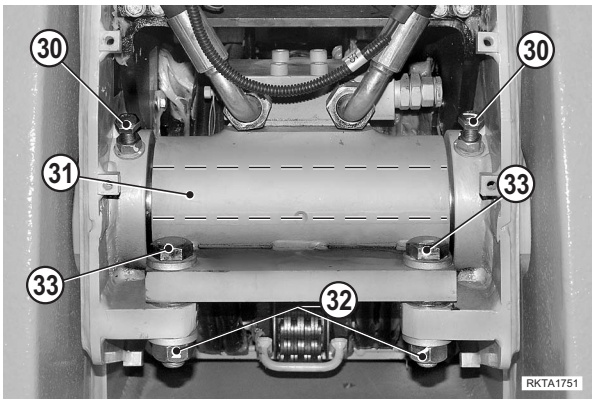
1 - With the boom fully lowered and with the rear cover removed, disconnect the hoses (24).

2 - Loosen and remove the screws (30).

3 - Remove the piston attachment pin (31).

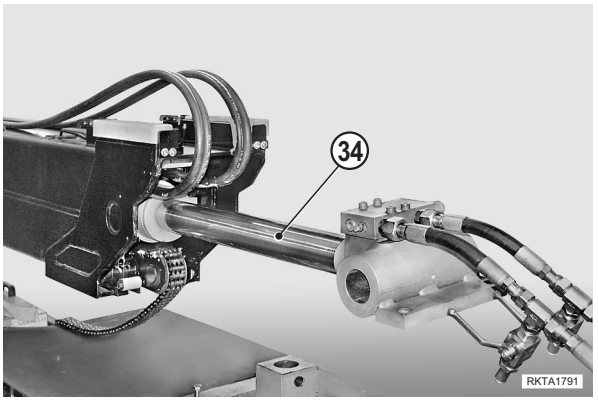
4 - Loosen and remove the nuts (32) and washers and remove the screws (33).

Nuts: 580±12 Nm



5 - Connect an external power unit to the cylinder and let the piston (34) slide out of the cylinder by approximately 70-80 cm.

★ Make sure that the external power unit is filled with the same type of hydraulic oil as the machine.

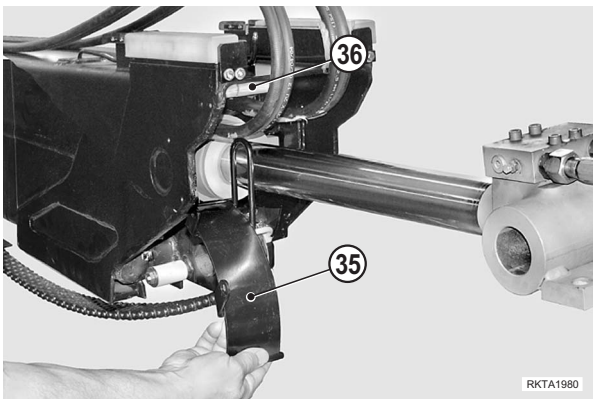


6 - Remove the hose guides (35).

7 - Remove the screws and remove the upper guide rollers (36).

8 - Remove the check plates and remove the shoes complete with shims as described in paragraph "5. Rear upper shoes for intermediate boom".

9 - Install by reversing the removal procedure.



7. Rear lower shoes for intermediate and top boom.

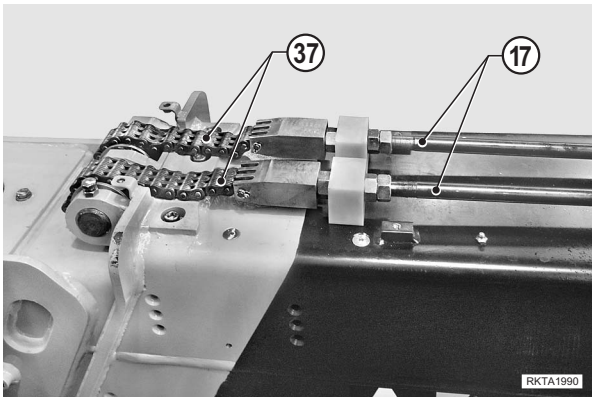
NOTE
This procedure should only be carried out when overhauling the boom or the machine, as the amount of wear on these parts is virtually negligible.

1 - Remove the intermediate and top booms.
(For details, see "INTERMEDIATE AND TOP BOOM").

2 - Remove all side and front guide shoes.
(For details, please refer to paragraphs 1, 2, 3, and 4).

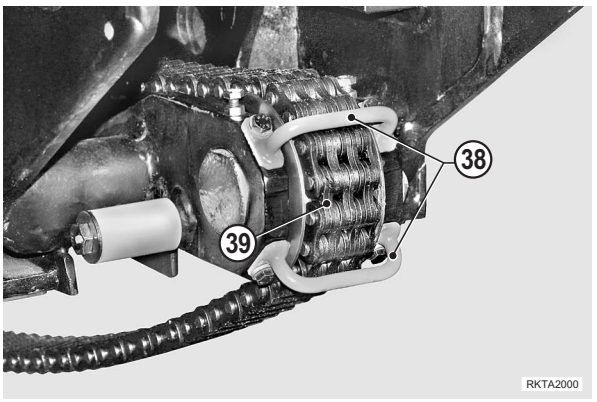
⚠ Do not invert or change the position of the slip clearance adjustment shims.

3 - Disconnect the rods (17) from the extension chains (37).

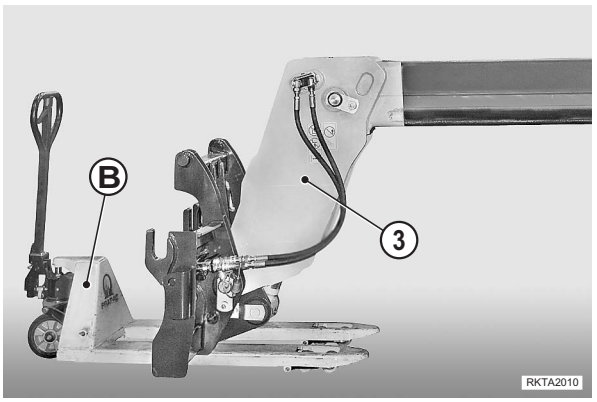


4 - Remove the clevises (38).

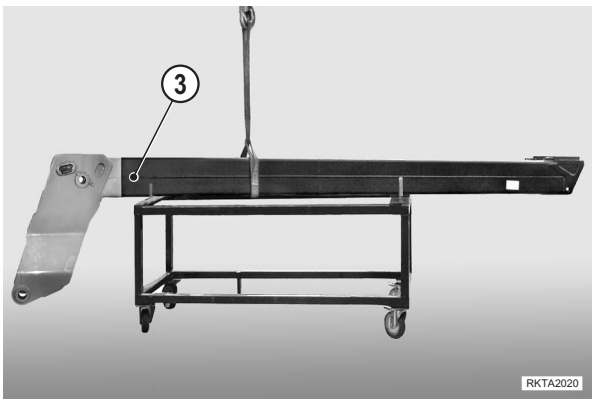
5 - Remove the retraction chain (39).



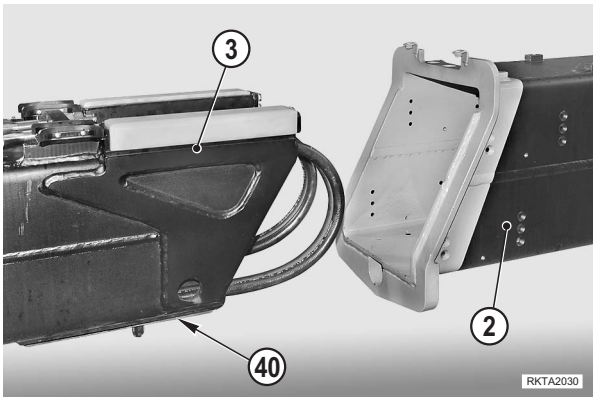
6 - Place a pallet truck (B) under the top boom (3); partially pull out the boom.



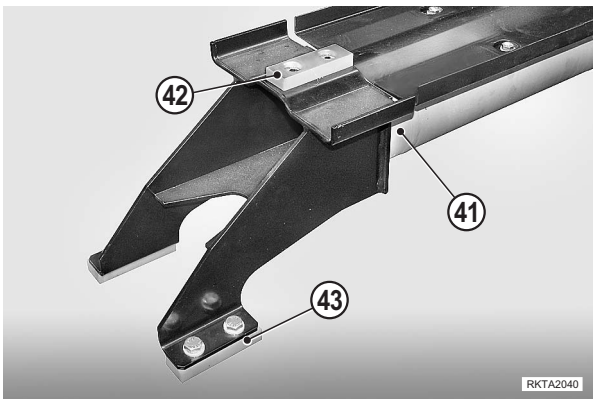
7 - Connect the top boom (3) to a hoist; extract the top boom and rest it on two stands or on a dolly.



8 - Loosen and remove the screws retaining the lower shoes (40) of the intermediate boom (2) and top boom (3) and replace the shoes.



9 - Remove the cylinder (41) from the top boom and replace the worn shoes (42), (43).



10 - Before attempting to reassemble, remove all contaminated grease from the inside of the booms and lubricate the shoe slip surfaces as well as the hose surfaces in the cylinder covers.

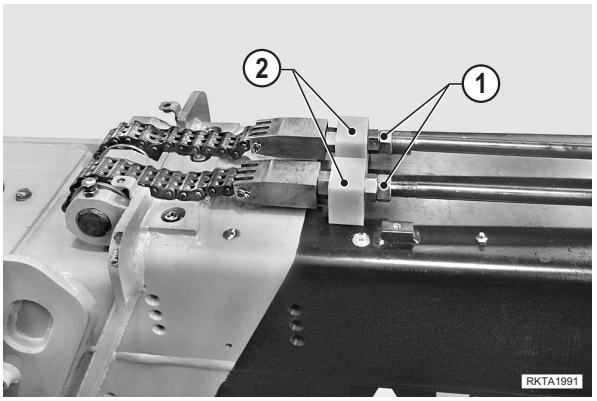
EXTENSION AND RETRACTION CHAINS

(Versions with 3-section boom)

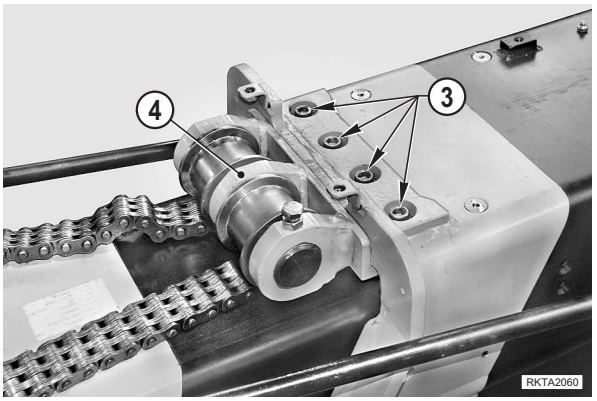
Removal

1 - Remove the intermediate boom complete with top boom.
(For details, see "INTERMEDIATE AND TOP BOOM" until point 19).

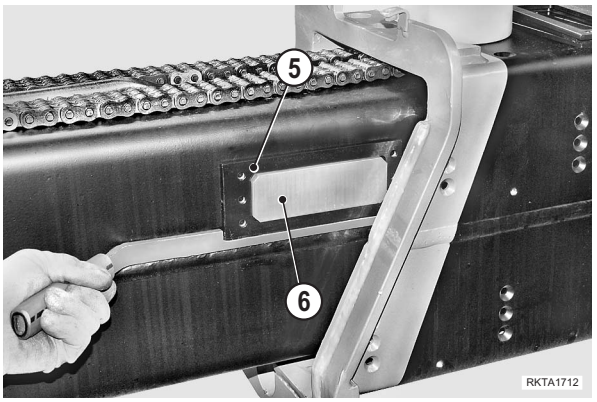
2 - Loosen the nuts (1) and disconnect the rods and guide blocks (2). [*1]



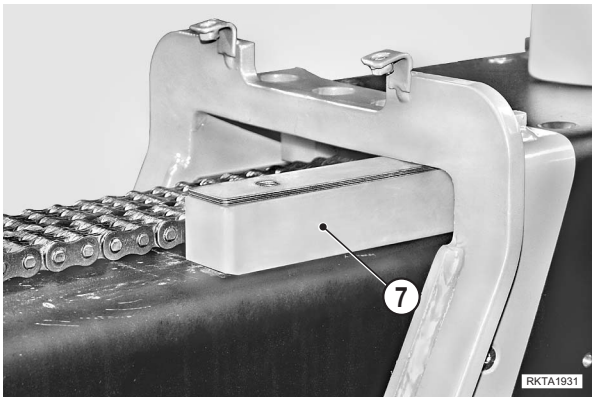
3 - Remove the screws (3) and remove the idler wheel assembly (4) guiding the extension chain.



4 - Loosen and remove the screws; remove the check plates (5) along with the top boom side guide shoes (6) and their respective shims.

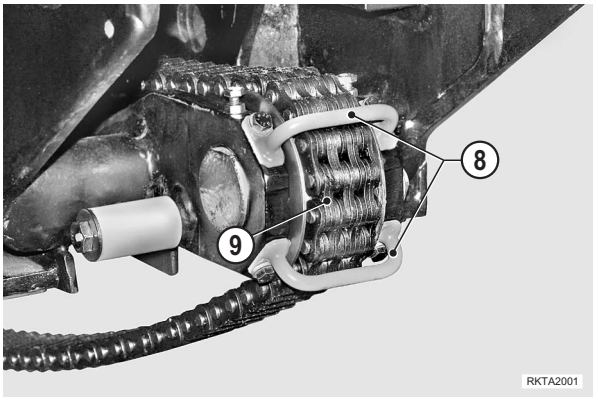


5 - Loosen and remove the screws; remove the top boom vertical guide shoes (7) and their respective shims.

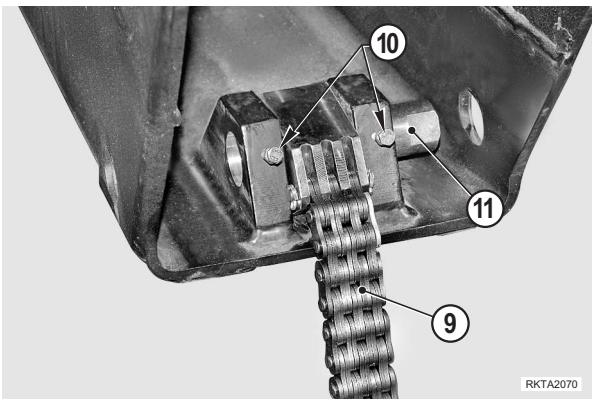


6 -Remove the screws and remove the clevises (8).

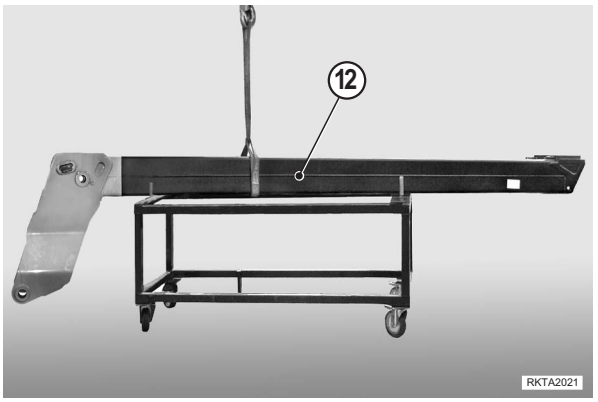
7 -Remove the retraction chain (9).



8 -Loosen the screws (10), remove the pin (11) and disconnect the retraction chain (9).

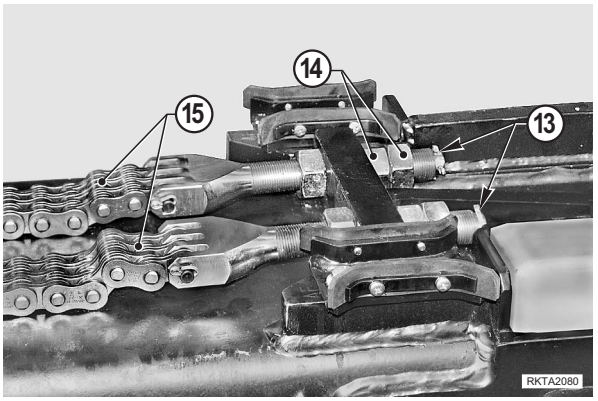


9 -Connect the top boom (12) to a hoist and remove the top boom.



10 -Remove the cotter pins (13) and nuts (14). [*2]

11 -Remove the extension chains (15).

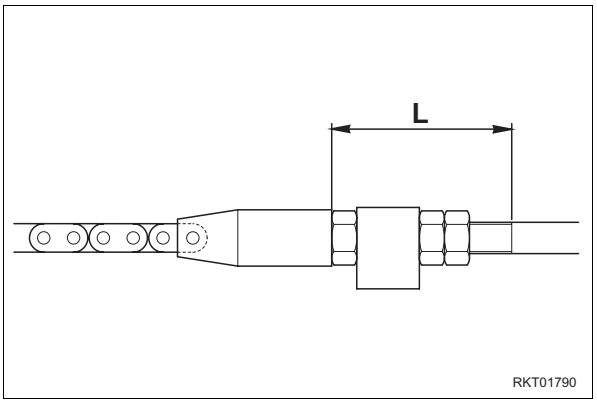


Installation

- To install, reverse the removal procedure.

[*1]

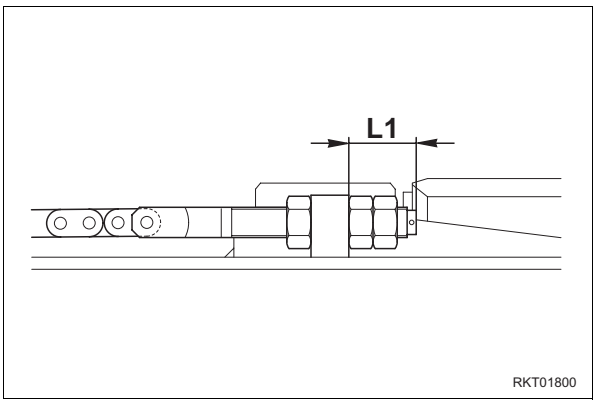
★ Tightening length for rods “**L**”: 115 mm



[*2]

★ Tightening length for attachment:

Model	Length “L1”
WH613	52.5 mm
WH713	54.0 mm
WH714 WH714H	54.0 mm
WH716	65.0 mm



CHAIN RETURN PULLEY PINS AND BUSHINGS

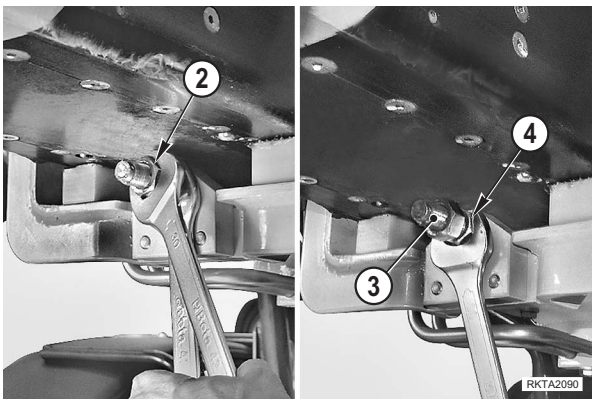
RETRACTION CHAIN PULLEY

Removal

1 -Remove the screws and remove the boom rear cover (1).

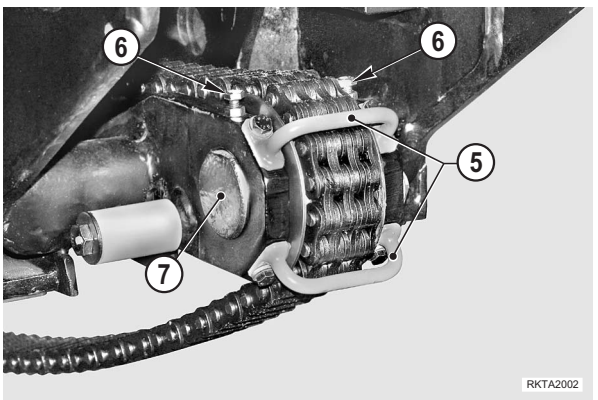
2 -Remove the cotter pin; loosen and remove the check-nut. [*1]

3 -Loosen the nut (4) until it is flush with the rod head, being careful not to cause any rotation of the rod (3).

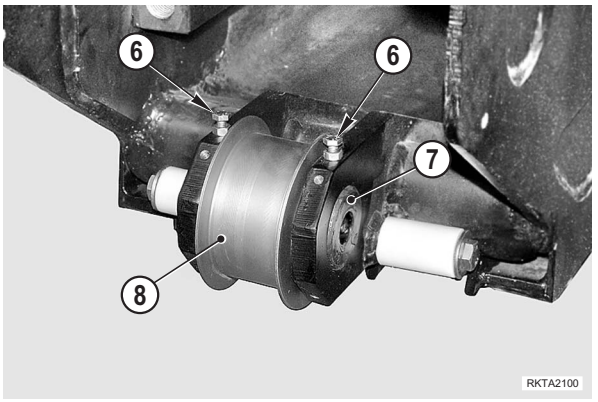


4 -Remove the clevises (5) retaining the chain.

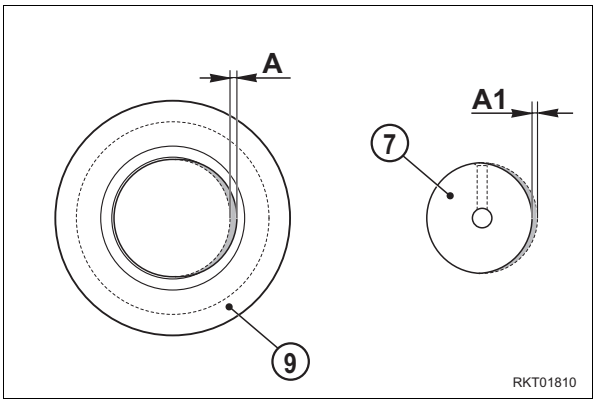
5 -Loosen the nuts and retaining screws (6) until disengaging the pin (7).



6 -Remove the pin (7) and pulley (8).



7 - Inspect pulley bushing (9) and pin (7) wear.
If the total of wear "**A**" plus wear "**A1**" is near or exceeds 1 mm, replace the bushing and pin.



Installation

- To install, reverse the removal procedure.

1 - Perform the bushing lubrication procedure.

Bushings: NLGI 2EP grease

2 - Perform the chain tensioning procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

[*1]

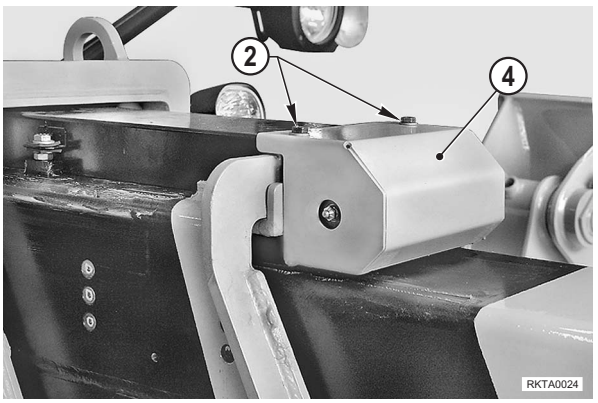
Check-nut: 270 Nm

EXTENSION CHAIN PULLEYS

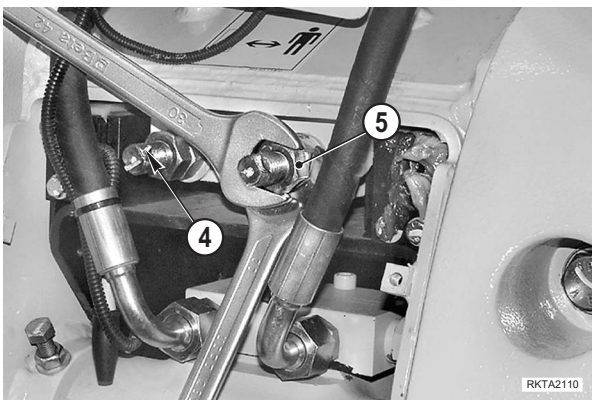
Removal

1 -Remove the screws and remove the boom rear cover (1).

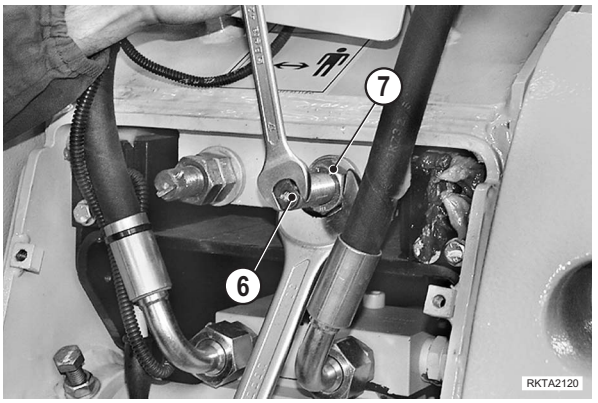
2 -Remove the screws (2) and the grease nipple and remove the extension chain housing (3).



3 -Remove the cotter pins (4); loosen and remove the check-nuts (5).

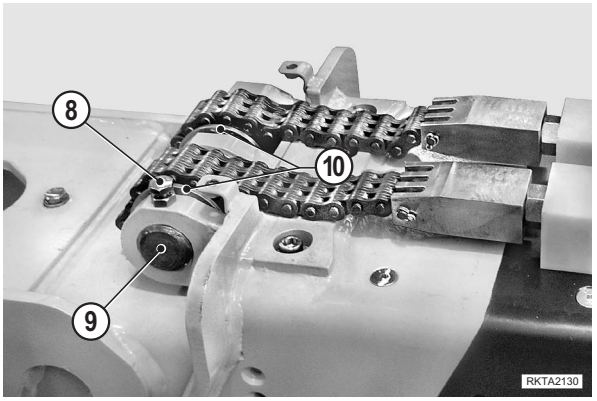


4 -Loosen the nuts (7) in an alternate manner until flush with the rod heads, being careful not to cause any rotation of the rods (6).

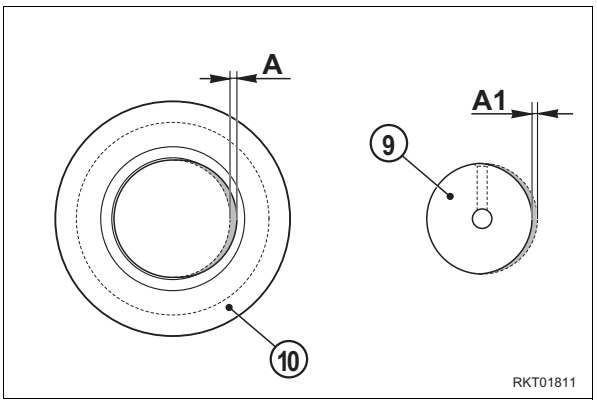


5 - Loosen the nut and screw (8) until disengaging the pin (9).

6 - Remove the pin (10) and pulleys (11).



7 - Inspect pulley bushing (11) and pin (10) wear.
If the total of wear "**A**" plus wear "**A1**" (including for the sole individual coupling) is near or exceeds 1 mm, replace the bushings and the pin.



Installation

- To install, reverse the removal procedure.

1 - Perform the bushing lubrication procedure.

Bushings: NLGI 2EP grease

2 - Perform the chain tensioning procedure.

Chains: SAE 15W-40

3 - Perform the chain tensioning procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

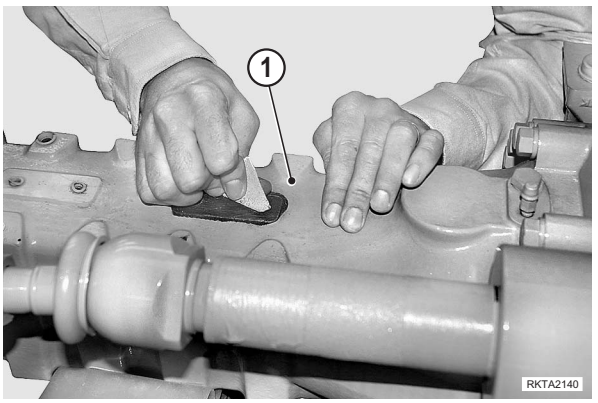
LOAD CELL

Installation

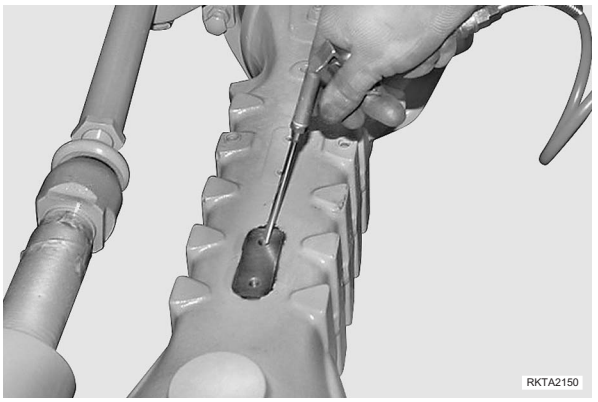
Before attempting to install the load cell, ensure that the sensor output signal (with the cell resting on a surface, i.e. in a free condition) is about 50±1 mA with and average power supply of 12 VDC.

1 - Remove all residues of pre-existing adhesive or protective varnish from the seat provided in the right rear axle shaft (1), and ensure that the surface is free of any deformation due to dents.

2 - To complete the cleaning procedure, rub sandpaper No. 80-120 on the surface making circular movements.



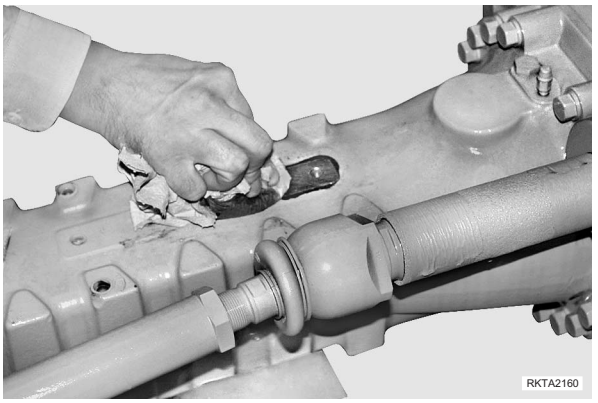
3 - Use compressed air at low pressure to blow out any debris and cleaning residues from the holes provided for the retaining screws.



4 - Degrease the load cell seat using a paper rag previously soaked in a dedicated degreasing agent.

Degreasant: Loctite 7063

Do not use compressed air to dry. Allow the degreasing agent to work until the seat is completely dry.

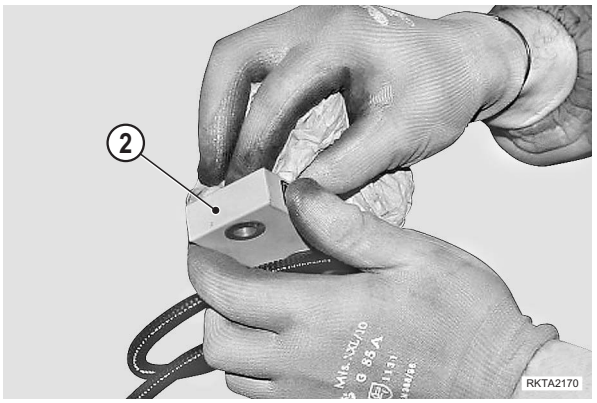


5 - Ensure that the base of the load cell (2) is free from dents.

6 - Degrease the base plates of the load cell using a paper rag previously soaked in a dedicated degreasing agent.

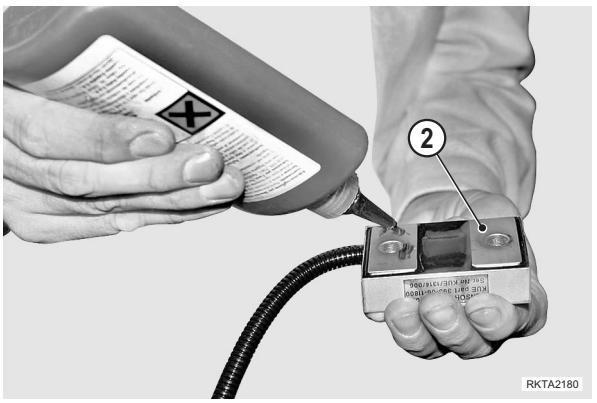
Degreasant: Loctite 7063

Do not use compressed air to dry. Allow the degreasing agent to work until the plates are completely dry.



7 - Apply a thin coat of anaerobic adhesive for coaxial part assembly to the base plates of the load cell.

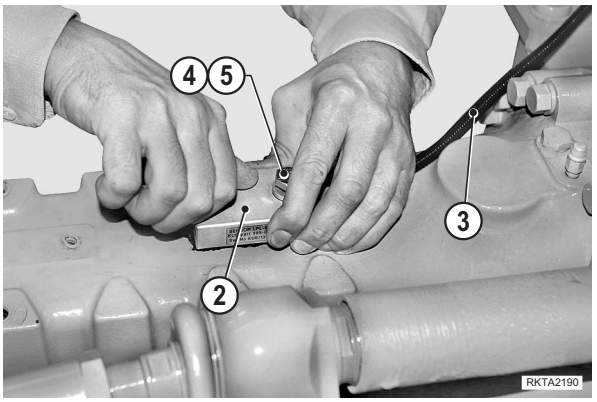
Adhesive: Loctite 638



8 - Position the cell (2) by routing the cable (3) towards the middle of the axle.

9 - Install the screws (4) and special washers (5) while locking the position of the load cell by hand.

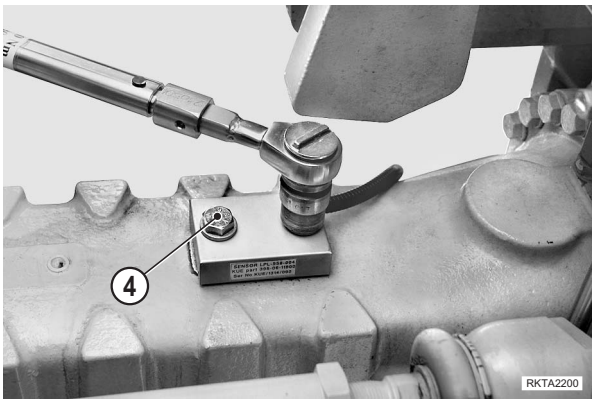
Search for alignment between load cell (2) and axle axis.



10 - While holding the alignment position, tighten the screws (4) using a torque wrench.

Screws: 70 Nm

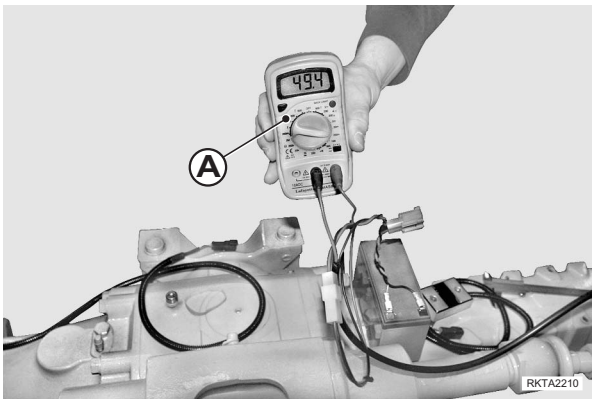
Note down the screw tightening sequence (4).



11 - Use a tester (A) capable of supplying an average of 12V to check (within a couple of minutes) that the cell output signal is between 48 and 55 mA.

⚠ a - If current is not within the prescribed range, loosen the screws you have tightened during step 10, and re-tighten, this time inverting the tightening sequence.

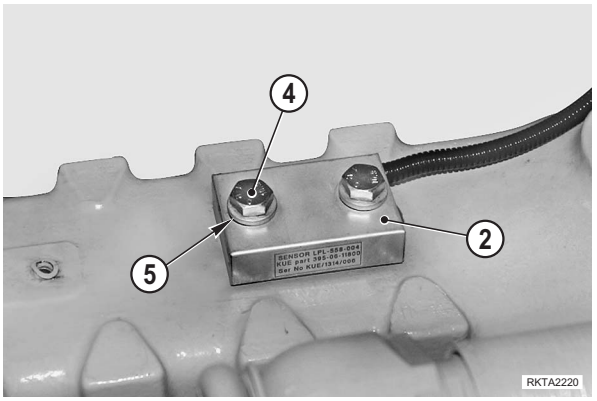
b - If the current is still not within the prescribed range after the operation above, remove the load cell and check the surfaces for being level.



12 - Allow the adhesive to polymerise for about 15 minutes before attempting to install the axle on the machine.

13 - Wait about 12 hours for the adhesive to reach full polymerisation, and then calibrate the overturn prevention system.

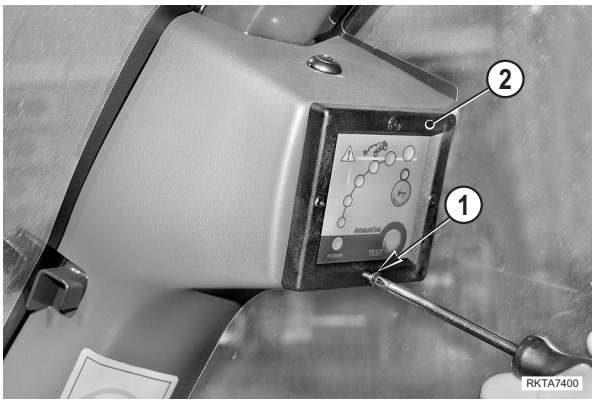
14 - Touch up any painted parts that may have been damaged (if any).



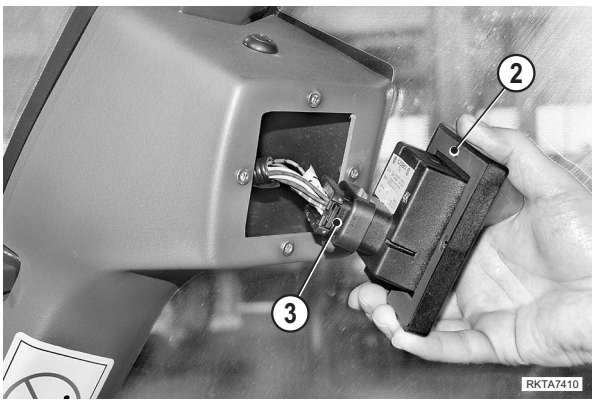
CONTROL UNIT

Removal

1 - Loosen and remove the four (1) screws and detach the device (2). [*1]



2 - Disconnect the connector (3). [*2]



Installation

- To install, reverse the removal procedure.

[*1]

★ Apply sealant to the notches provided for the screwdriver.

Sealant: Black silicone

[*2]

★ Before operating the machine, carry out the device calibration procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

BALLAST

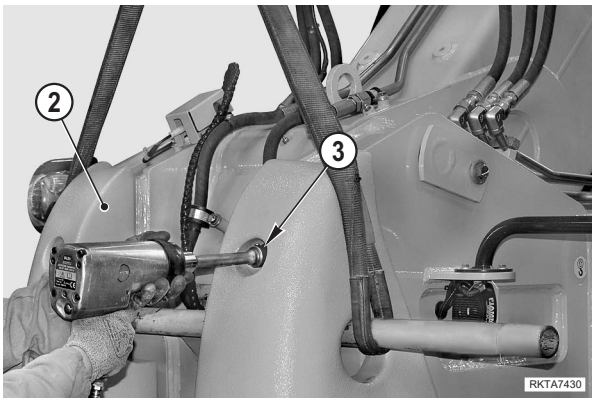
Removal

1 -Remove the screws and remove the telescopic boom rear cover (1).

2 -Connect the ballast (2) to a hoist and slightly tension the rope.

Ballast: 950 kg

3 -Loosen and remove the screws (3); remove the ballast (4). [*1]



Installation

- To install, reverse the removal procedure.

[*1]

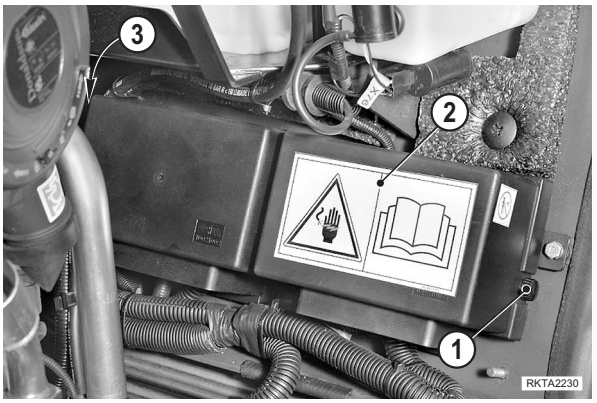
Screws: 585±12 Nm

ENGINE LINE CENTRE

Removal

⚠ Disconnect the cable from the negative (–) battery terminal.

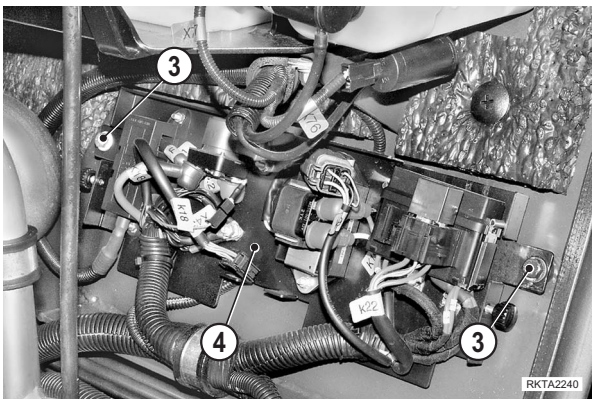
1 - Loosen the knobs (1) (2 knobs) and remove the cover (2).



2 - Disconnect the fuse and relay connectors.

★ Ensure that the wiring harnesses are marked; mark them if necessary.

3 - Loosen and remove the screws (3) together with their respective washers, and remove the complete centre assembly (4).



Installation

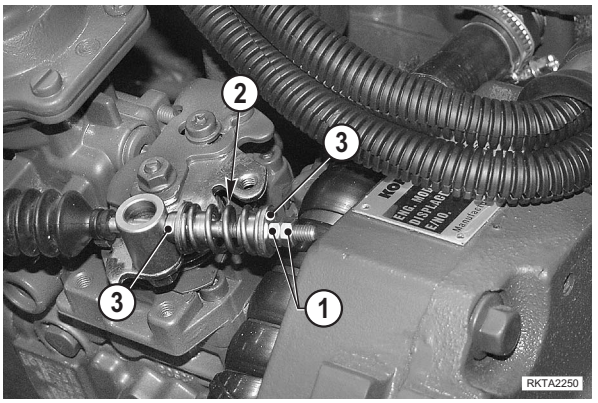
- To install, reverse the removal procedure.

ACCELERATOR CABLE

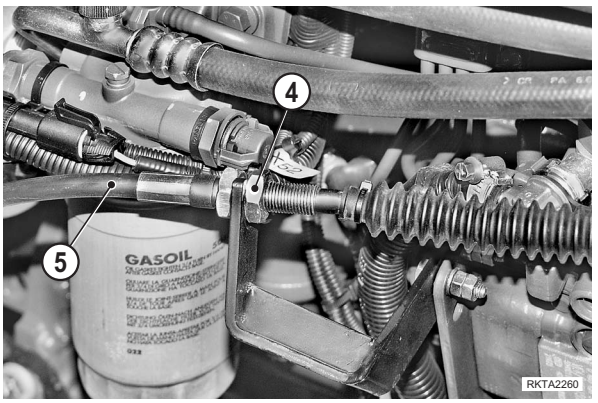
Removal

⚠ Remove the ignition key and apply the parking brakes.

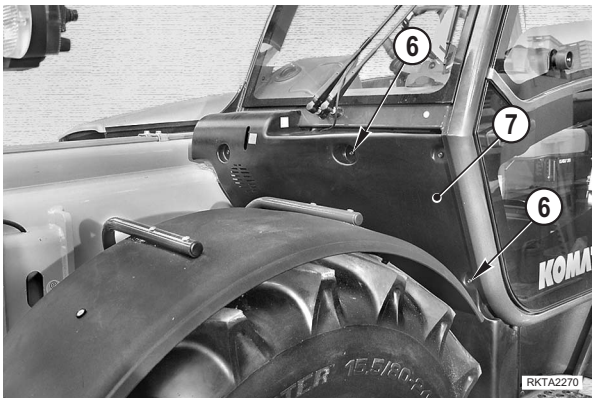
1 -Loosen the check-nut, remove the nuts (1), and recover the spring (2) and spring guides (3).



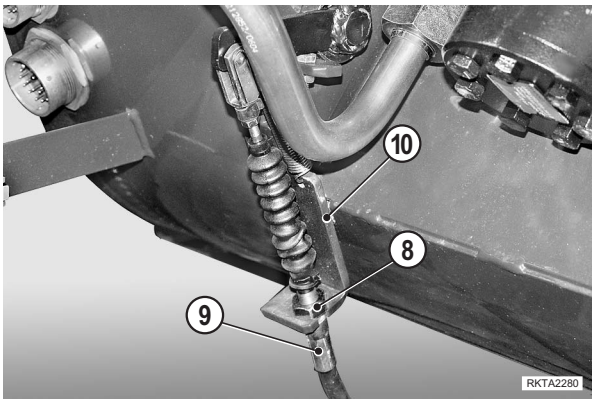
2 -Loosen the nuts (4) and disengage the accelerator cable conduit (5).



3 -Remove the screws (6) and remove the front guard (7).

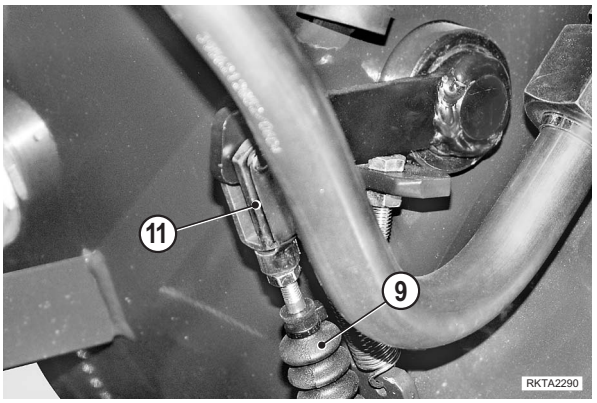


4 -Loosen the nut (8) and disengage the conduit (9) from the support (10).



5 - Remove the safety pin and disconnect the yoke (11) connecting to the accelerator pedal.

6 - Remove the conduit (9).



Installation

- Install the new conduit by inverting the removal procedure.

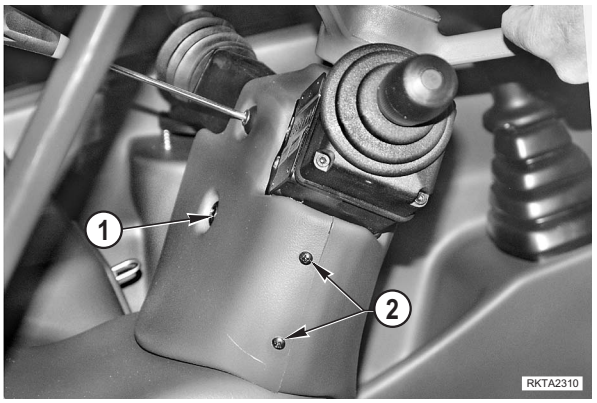
1 - Perform the accelerator cable length adjustment procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

SHIFT-REVERSING GEAR LEVER ASSEMBLY

Removal

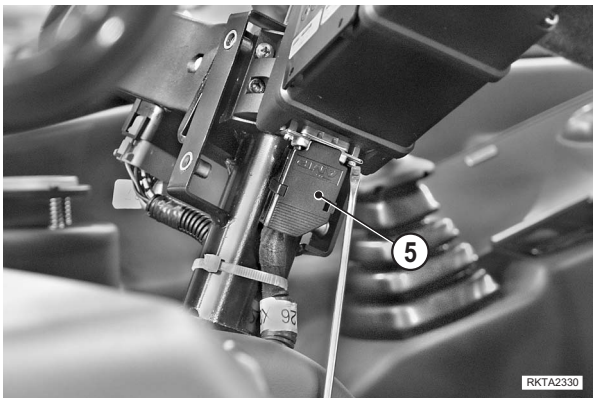
⚠ Disconnect the cable from the negative (–) battery terminal and apply the parking brake.

1 -Loosen and remove the screws (1), (2).

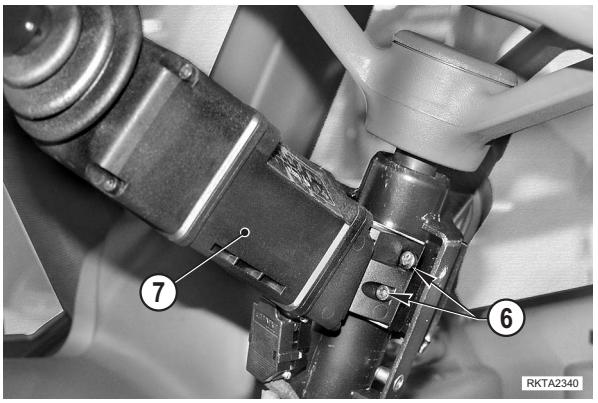


2 -Disconnect and remove both covers (3), (4).

3 -Loosen the screws and disconnect the connector (5).



4 -Loosen and remove the screws (6) and remove the assembly (7).



Installation

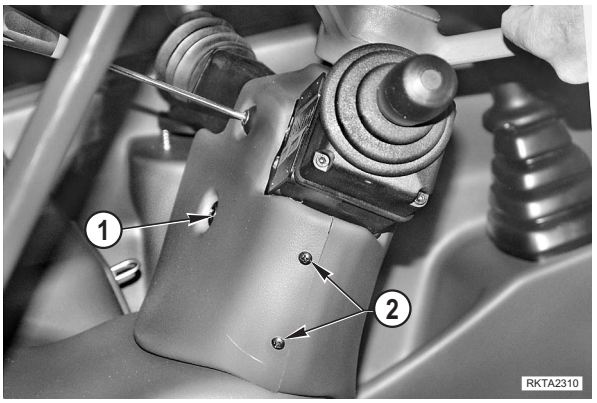
- To install, reverse the removal procedure.

STEERING COLUMN SWITCH UNIT - DIPSWITCH

Removal

⚠ Disconnect the cable from the negative (–) battery terminal and apply the parking brake.

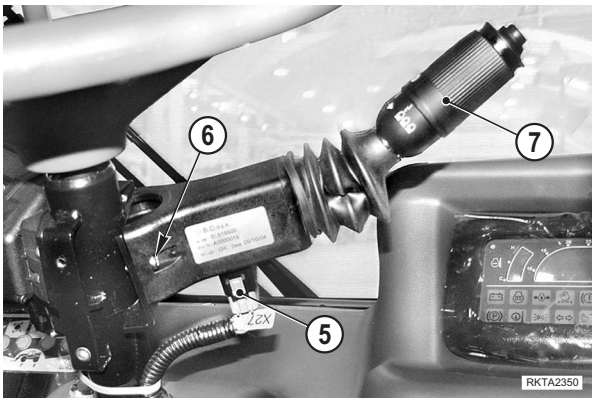
1 - Loosen and remove the screws (1), (2).



2 - Disconnect and remove both covers (3), (4).

3 - Disconnect the connector (5).

4 - Loosen and remove the three screws (6) and remove the steering column switch unit (7).



Installation

- To install, reverse the removal procedure.

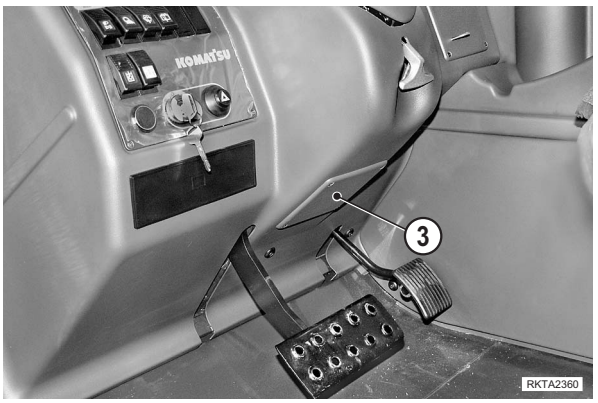
STEERING UNIT

Removal

⚠ Disconnect the cable from the negative (–) battery terminal and apply the parking brake.

1 -Remove the screws (1) and remove the front guard (2).

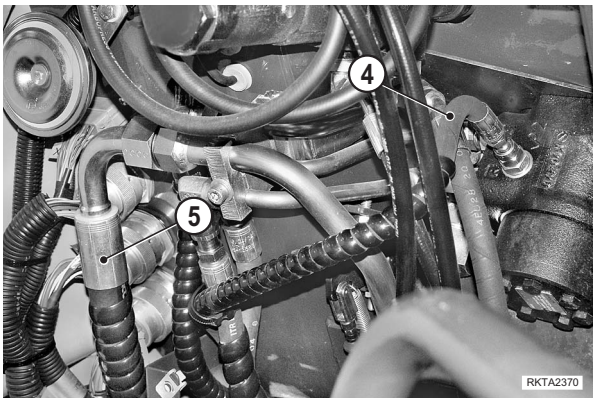
2 -Remove the steering column shield (3).



3 -Disconnect the LS hose (4) from the steering unit.

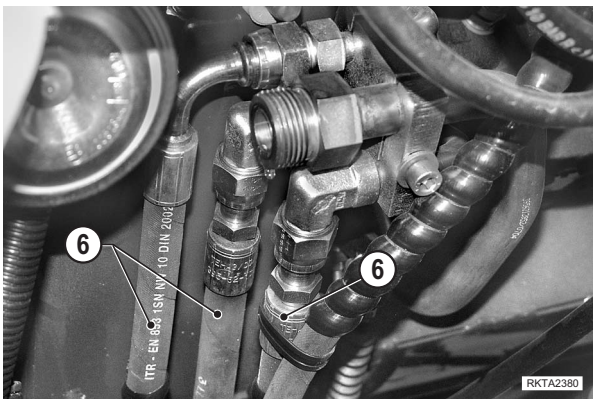
4 -Disconnect the hose (5).

★ Immediately cap the hoses to prevent contaminants from entering the passages.

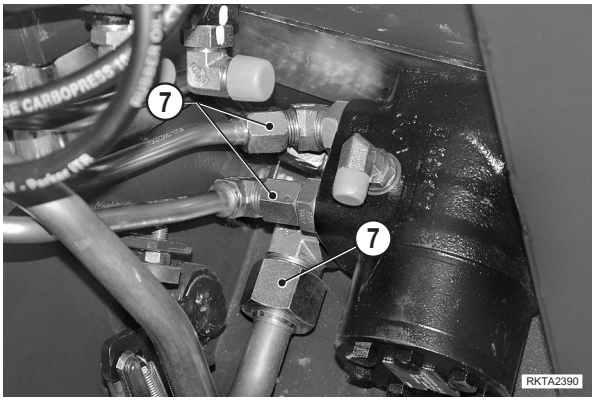


5 -Mark and then disconnect the hoses (6).

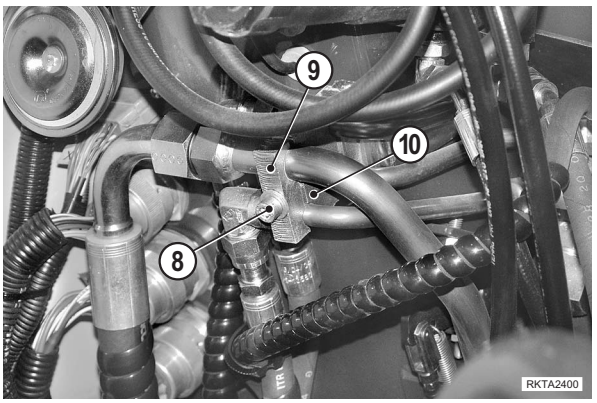
★ Immediately cap the hoses to prevent contaminants from entering the passages.



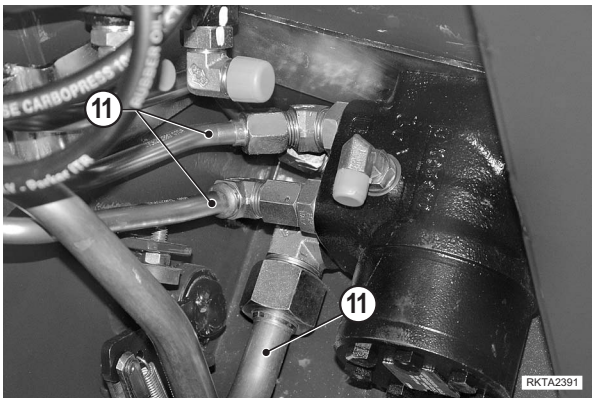
6 - Loosen the four fittings (7) connecting the pipes to the steering unit.



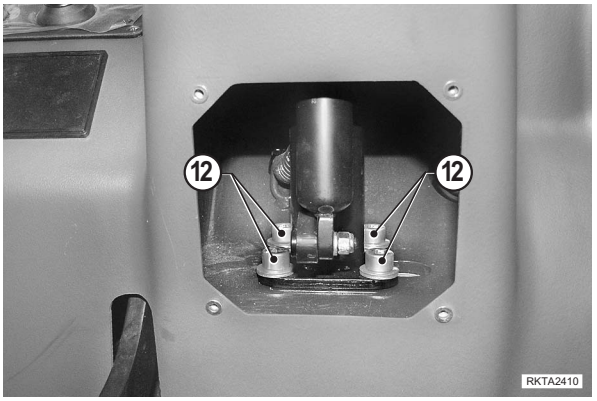
7 - Loosen the screw (8), remove the clamp (9) and the distance piece (10).



8 - Remove the pipes (11).

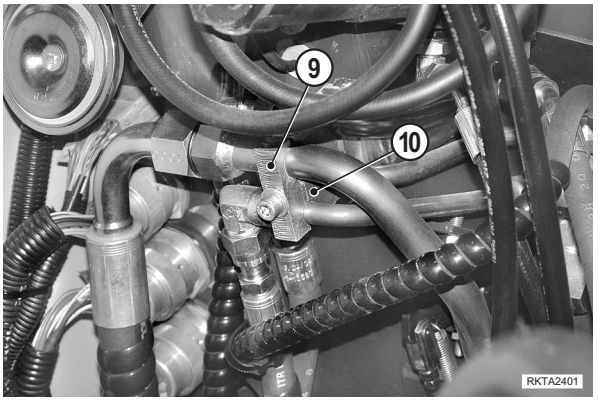


9 - Loosen and remove the screws (12) and their respective washers and remove the steering unit complete with the pipes. [*1]

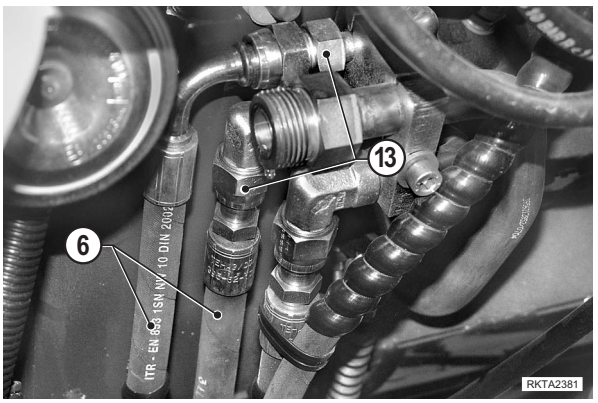


Installation

★ Before attempting to tighten the pipes to the power steering fittings, engage the pipes into the clamps (9) and distance piece (10).



★ First tighten the rear fittings (13) of the lines (6).



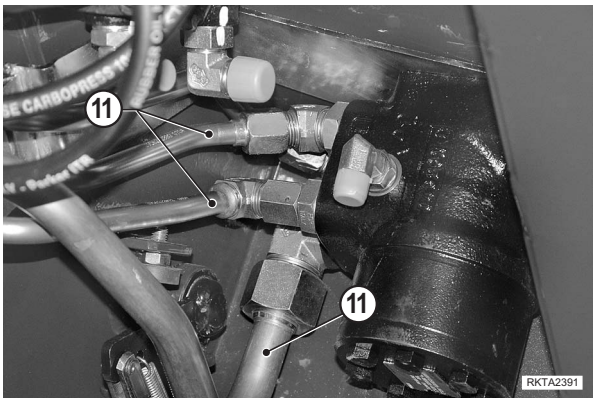
★ Fit the front pipes (11) and tighten the fittings.

• Continue with the installation procedure by reversing the removal procedure.

1 - Start the engine and perform several steering motions in both directions in the crab steering mode (i.e. steering with 4 wheels turning in the same direction) in order to bleed the system.

[*1]

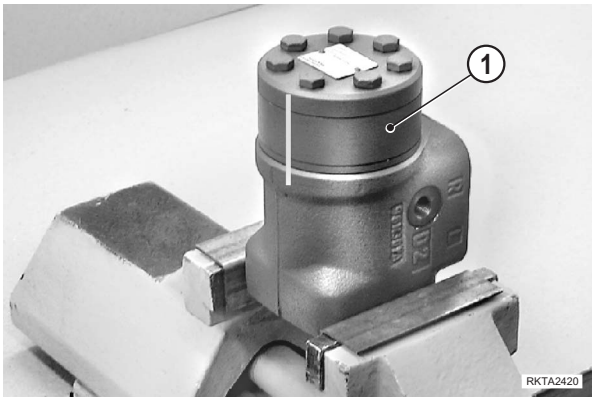
Screws: 63 Nm



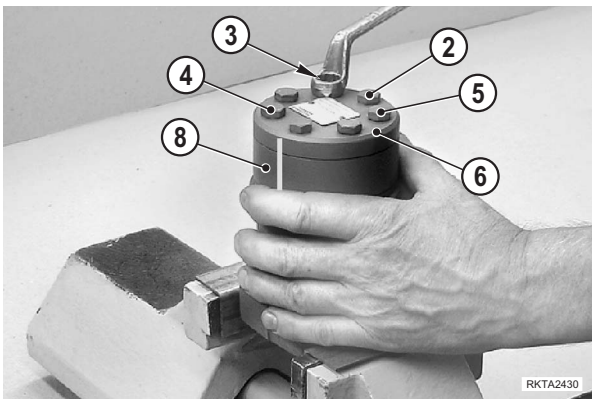
Disassembly

1 - Clamp the complete power steering body (1) in a vice with the screws facing upwards. Use a vice whose jaws are lined with tender material (aluminium or soft steel).

★ Do not tighten the vice excessively, or you will damage the power steering body.

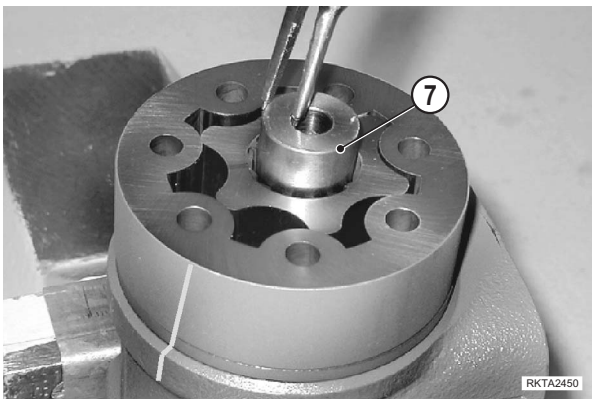


2 - Mark the positions of the screws, cover (6) and metering assembly (8).
Loosen the screws (2), (3), (4), and (5) in a criss-cross manner and remove them.



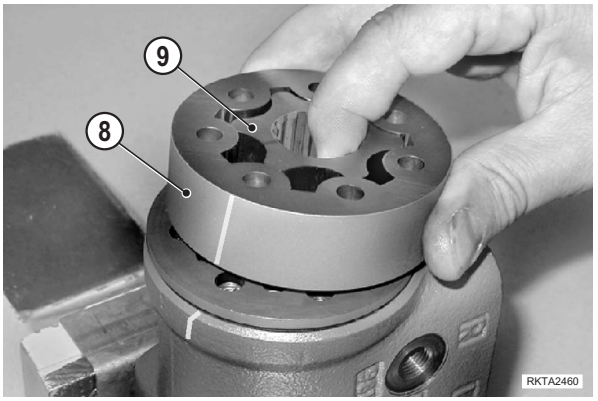
3 - Slide the cover (6) crosswise to remove it.

4 - Using needle nose pliers, remove the bushing (7).

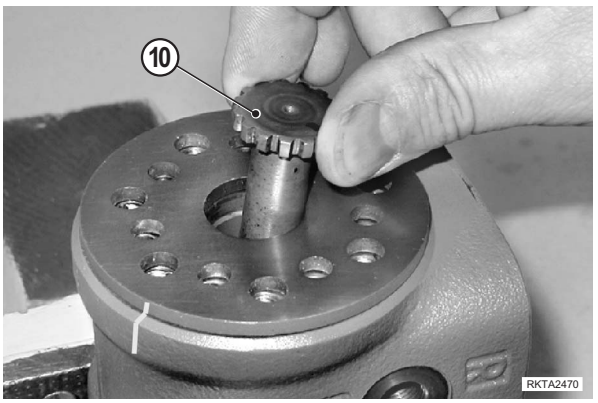


5 - Mark the position between the rotor (9) and the driving shaft (10).
Simultaneously remove the outer ring (8) and rotor (9).

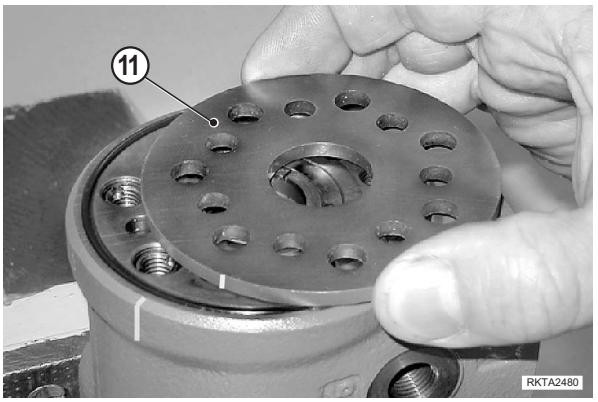
★ To remove, slide the assembly crosswise while simultaneously lifting it.



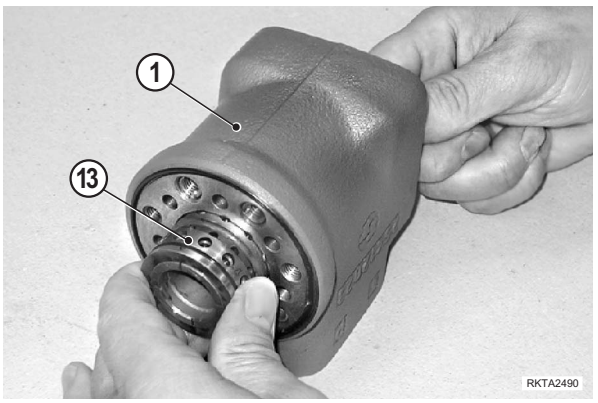
6 - Pull out the driving shaft (10).



7 - Remove the stop disc (11) by sliding it crossways.

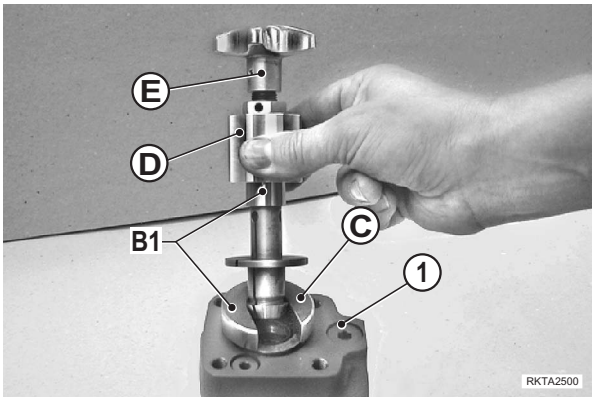


8 - Remove the complete steering unit (1) from the vice and place it in its horizontal position.
Rotate the drive pin (12) into the control valve (13) in its horizontal position and remove the complete control valve without removing the axial bearing (14).

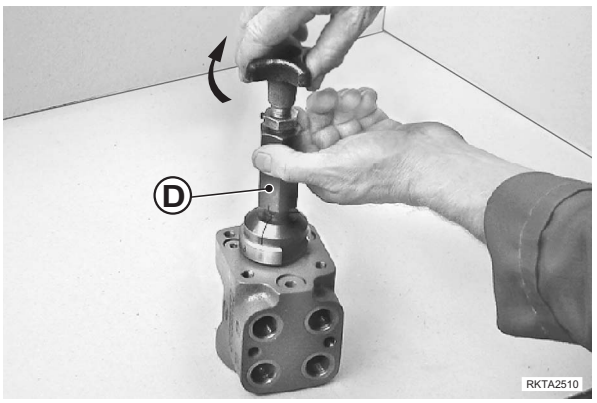


- **Removing the seals**

1 - To remove the inner seal (15), use tool **B1** (code no. 00239496).
Introduce the washer (C) into the power steering body (1) and then install the expander tool (E) in its fully closed position.

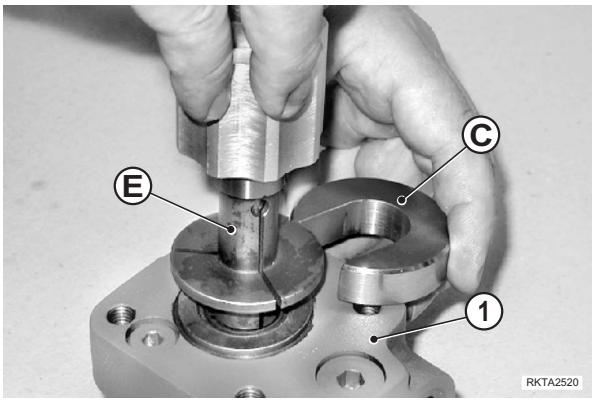


2 - Open the expander tool (E) by rotating the upper knob clock-wise while simultaneously holding the centre check-nut (D).



3 - Remove the washer (C) and push the expander tool (E) towards the inside of the power steering body (1) until the seal (15) has been removed.

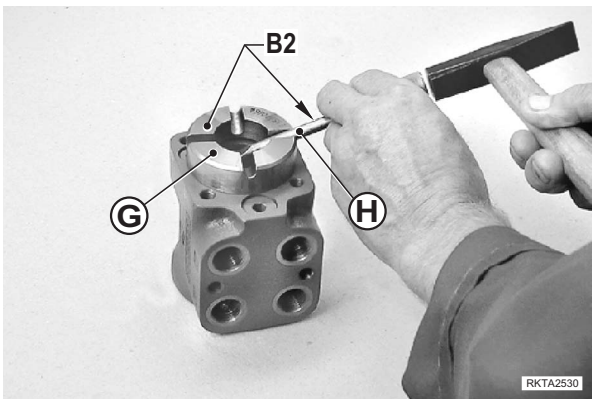
4 - Loosen and remove the expander tool.



- **Removing the wiper ring**

1 - To remove the wiper ring, use tool **B2** (code no. 00239497).
Introduce a ring nut (G) into the power steering body (1) and use a puller (H) and a hammer to remove the wiper ring (16).

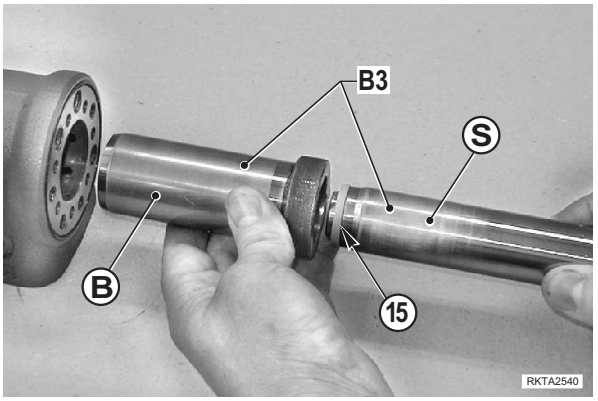
★ Be extremely careful not to damage the seat.



Assembly

• Installing the inner seal (15)

1 - Before installing the inner seal, make sure you thoroughly clean the seat surface, the inside of the steering unit, and the cover from any trace of grease.
Install seal (15) to the driver part (S) of tool **B3** (code no. 00239498) and introduce the driver into the bushing (B) of the tool.

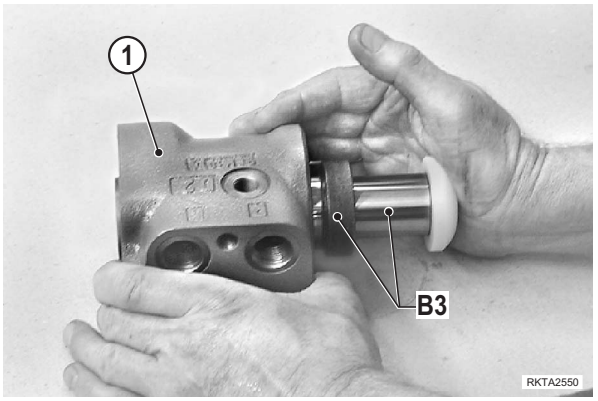


2 - Introduce bushing "**B**", driver "**S**" and seal (15) into the power steering body (1).

3 - Press the bushing and driver as far as they will go.

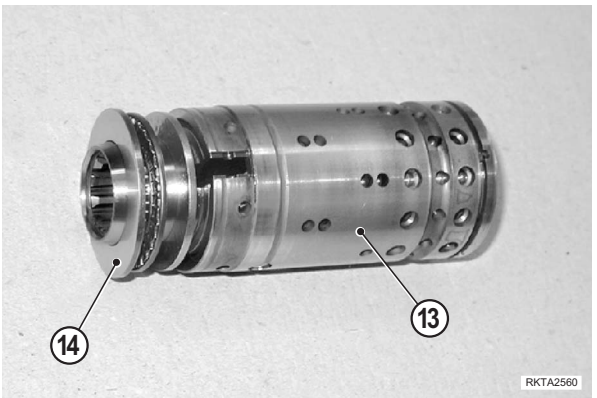
★ After removing tool **B3** (code no. 00239498), thoroughly check for the seal to be properly seated.

4 - Lubricate the grommet with mineral oil.



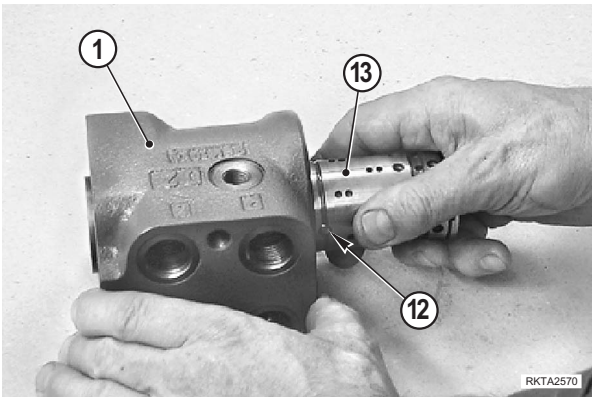
• Installing the control valve

1 - Slightly lubricate the control valve assembly (13) with oil.
Check the bearing (14) for being mounted with the thinner step against the outer bushing of the control valve.



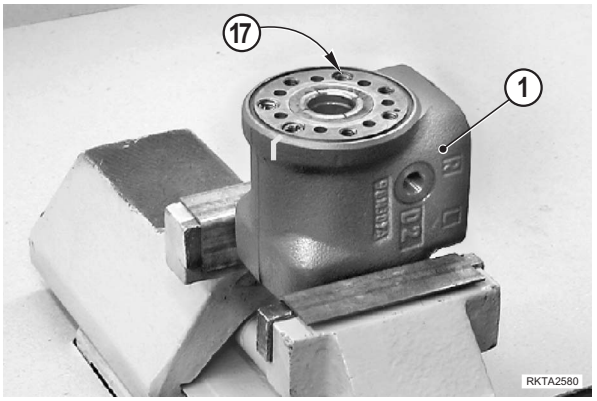
2 - Introduce the control valve (13) into the power steering body (1) starting from the top of the bearing (14) and holding the drive pin (12) in its horizontal position.

★ The control valve should slide into the housing provided in the steering unit without forcing.

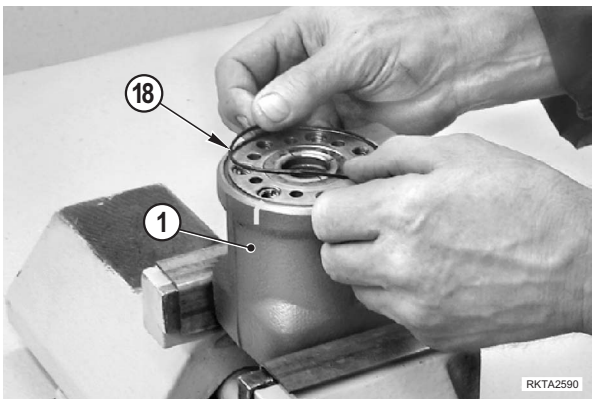


- **Completing the installation procedure**

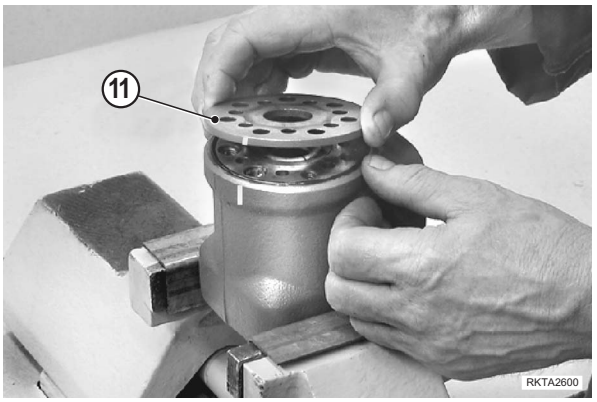
1 - Clamp the steering unit (1) in a vice as shown. Check for proper positioning of the ball (17) (its function is that of a cavitation-prevention valve).



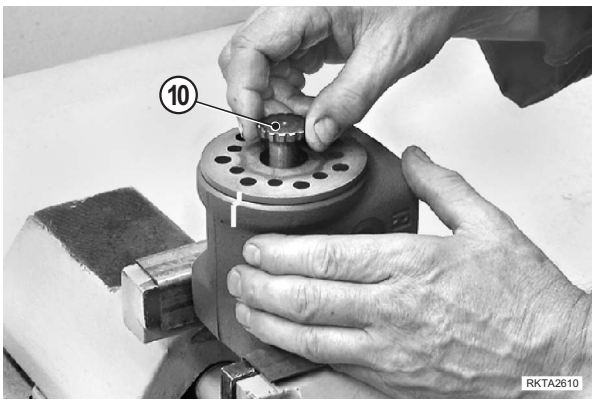
2 - Grease the O-ring (18) and position it on the power steering body (1).



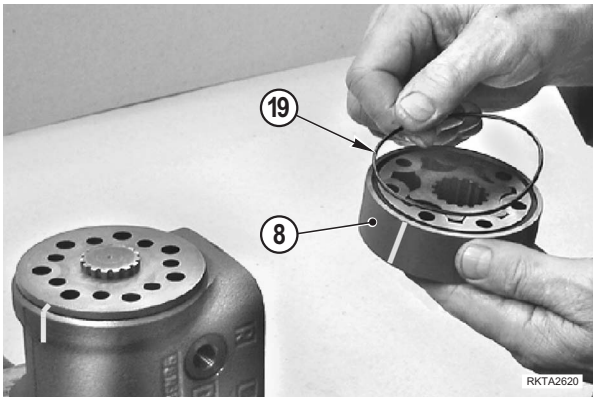
3 - Install the stop disc (11) matching the holes in the disc with those on the power steering body.



4 - Introduce the driving shaft (10) and engage it to the pin (12) of the control valve (13).

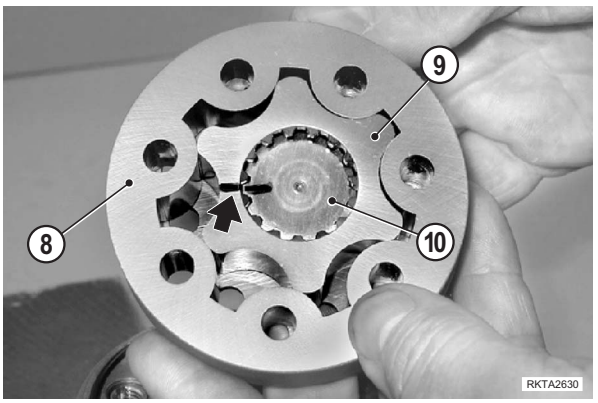


5 - Grease the O-ring (19) and position it on the outer ring (8).

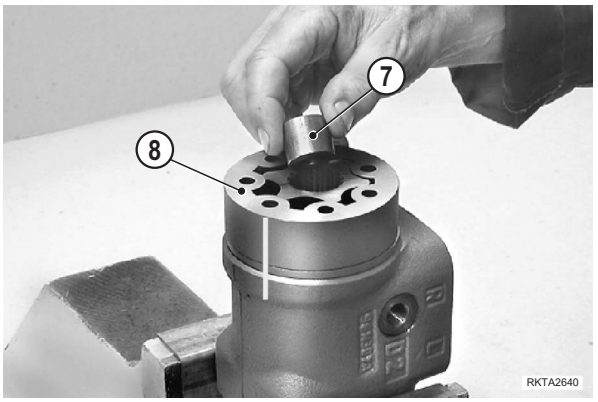


6 - Position the rotor (9) to the driving shaft (10), matching the scribble marks you have made during disassembly.

7 - Position the outer ring (8) by locating the centring position in relation to the power steering body (1) and rotor (9).

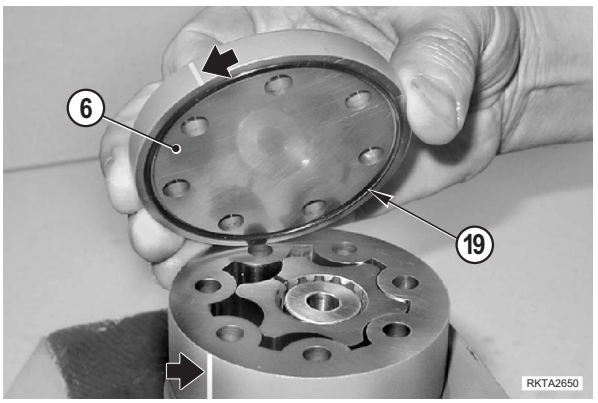


8 - Position the bushing (7).



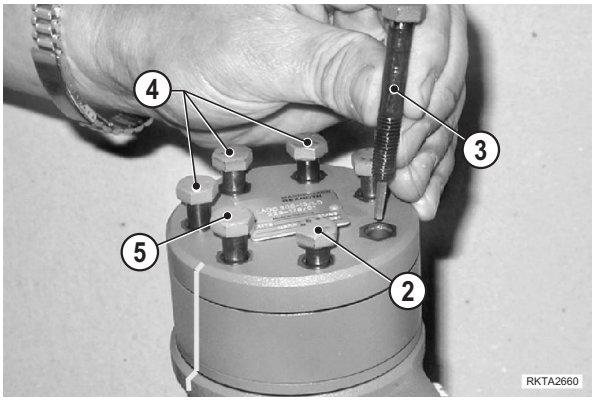
9 - Grease the 2nd O-ring (19) and seat it in the cover (6).

10 - Position the cover (6) to the metering assembly, making sure to match the scribble marks you have made during disassembly.



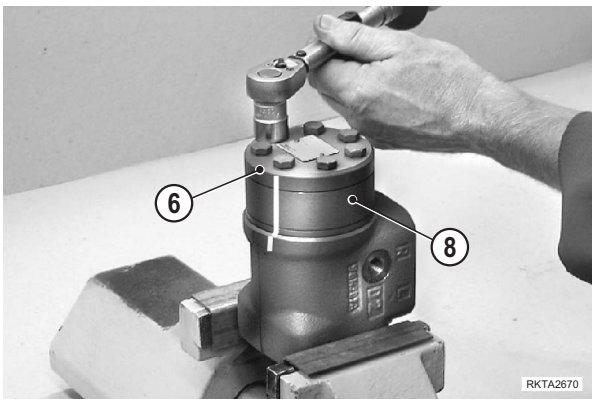
11 - With the help of the exploded view diagram, install the screws (2), (3), (4), and (5) to the correct positions.

★ The screw (3) should be installed to the position corresponding to the cavitation-prevention ball valve (17).

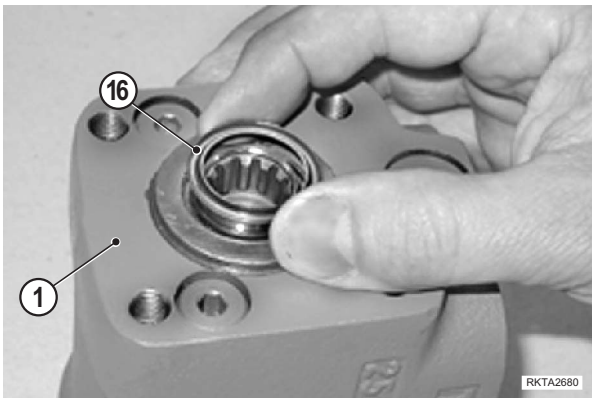


12 - Tighten the screws retaining the cover (6) and the metering assembly (8) using the criss-cross method.

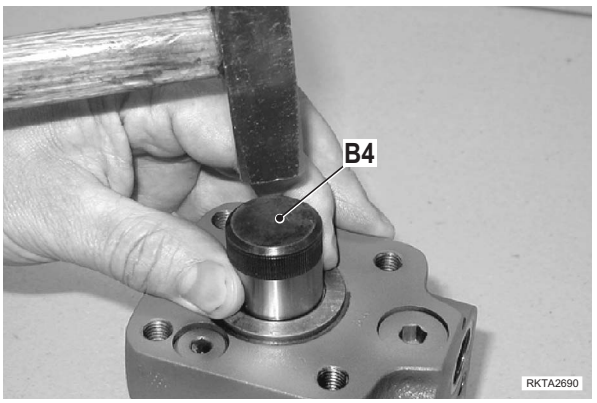
Screws: 30±3 Nm



13 - Turn the steering unit upside down; place the wiper ring (16) to the power steering body (1) with the seal lip facing upwards.



14 - Using tool **B4** (code no. 00239499) and a hammer, introduce the wiper ring as far as it will go without forcing.



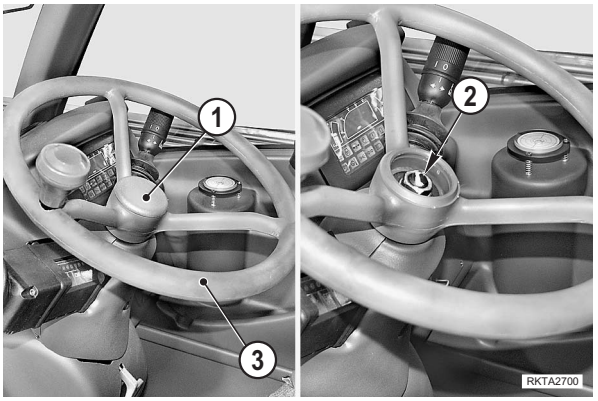
STEERING COLUMN

Removal

⚠ Disconnect the cable from the negative (–) battery terminal and apply the parking brake.

1 - Remove the centre cap (1) and retaining screw (2) from the steering wheel.

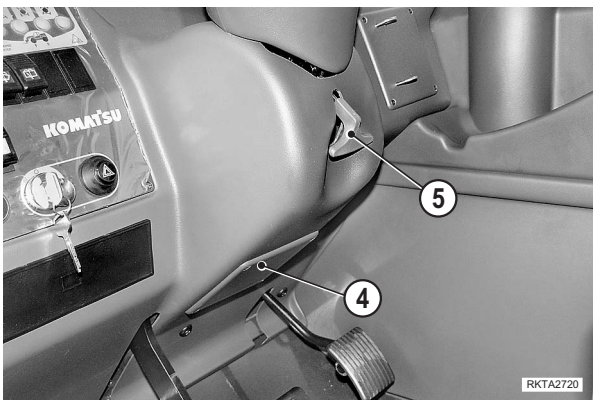
2 - Remove the steering wheel (3).



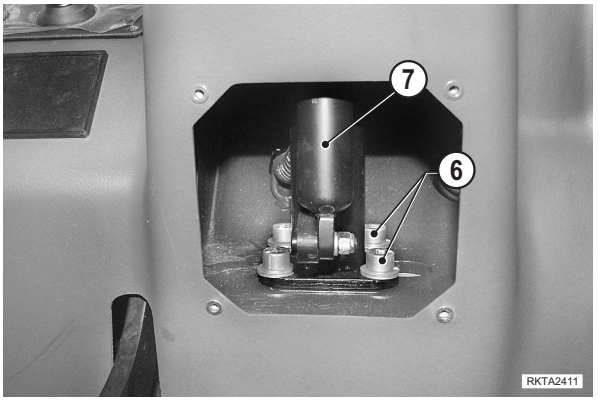
3 - Remove the shift/reversing gear lever and the steering column switch unit/dipswitch assembly.
(For details, see "SHIFT-REVERSING GEAR LEVER ASSEMBLY" e "STEERING COLUMN SWITCH UNIT - DIPSWITCH").

4 - Remove the steering column shield (4).

5 - Remove the steering wheel position adjustment handle (5).



6 - Loosen and remove the screws (6) and their respective washers and slide off the steering column (7) from the top. [*1]



Installation

- To install, reverse the removal procedure.

[*1]

Screws: 63 Nm

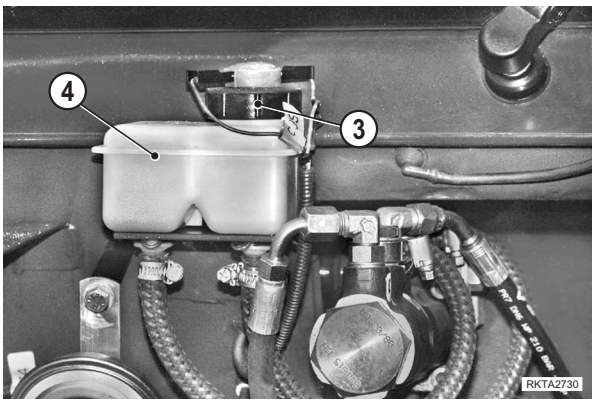
BRAKE PUMPS

Removal

⚠ Disconnect the cable from the negative (–) battery terminal and apply the parking brake.

1 - Loosen and remove the screws (1), and remove the front guard (2).

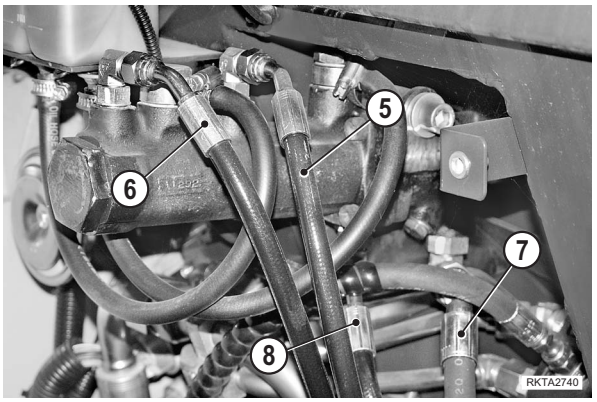
2 - Remove the cover (3) from the reservoir (4) and draw out the oil in it.



3 - Mark and disconnect the service brake feed hoses (5), (6) from the pump. [*1]

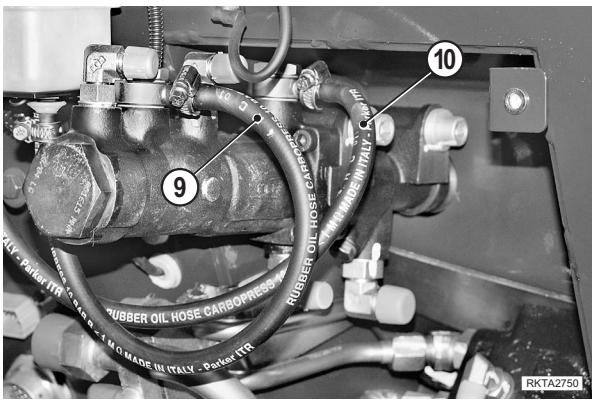
4 - Disconnect the brake booster feed and discharge hoses (7), (8).

★ Immediately cap the hoses to prevent contaminants from entering the passages.

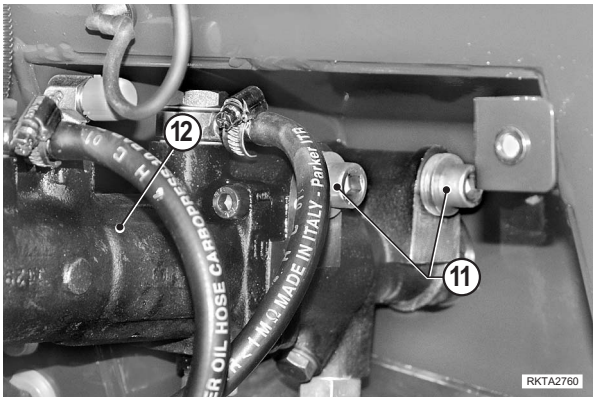


5 - Disconnect the hoses (9), (10) connecting to the brake oil reservoir.

★ Immediately cap the hoses to prevent contaminants from entering the passages.



6 -Loosen and remove the screws (11) and remove the pump (12). [*2]



Installation

- To install, reverse the removal procedure.

[*1]

★ Perform the braking circuit bleed procedure. (For details, see "20 TESTING AND ADJUSTMENTS").

[*2]

★ Ensure that the thrust arm centres the piston seat.

★ When bleeding is complete, check the pedal pretravel and check the position of the microswitch. (For details, see "20 TESTING AND ADJUSTMENTS").

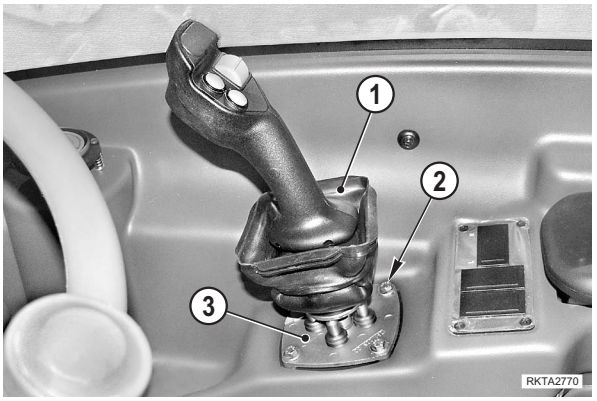
PPC VALVE

Removal

1 - Position the machine on level ground with the boom fully lowered and retracted.

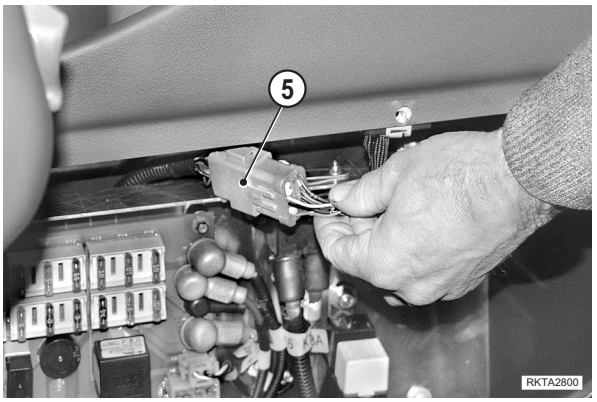
2 - Stop the engine, remove the ignition key and apply the parking brakes.

3 - Raise the rubber boot (1) and remove the screws (2) retaining the PPC valve (3).

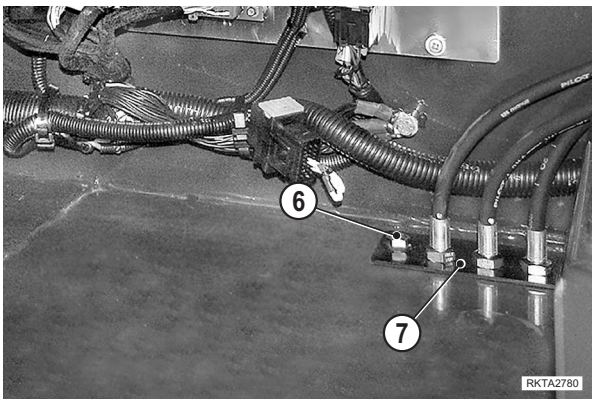


4 - Remove the screws and remove the fuse centre cover (4).

5 - Disconnect the connector (5) supplying the extension potentiometer, the auxiliaries pushbuttons and transmission release.



6 - Loosen and remove the screws (6) securing the feedthrough plate (7).

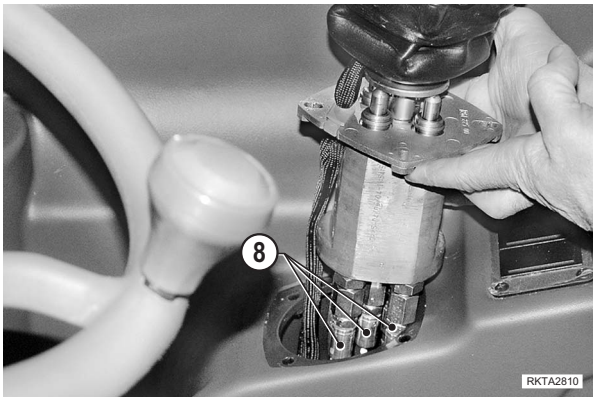


7 -Remove the PPC valve (3) and disconnect the hoses (8). [*1]

★ Mark the hoses to avoid mixing them up during installation.

★ Immediately cap the hoses to prevent contaminants from entering the passages.

⚠ If slack is noticed at the control lever, make the necessary adjustments to the assembly.
(For details, see "20 TESTING AND ADJUSTMENTS").

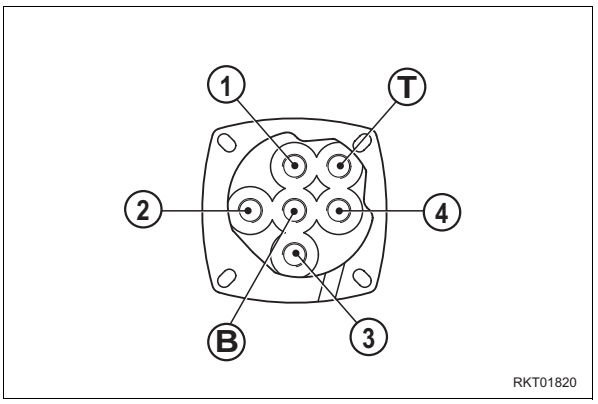


Installation

• To install, reverse the removal procedure.

[*1]

★ Thoroughly check for proper hose connection:
P= Pressure
T= Discharge
1= Boom lift
2= Equipment curl
3= Boom lowering
4= Equipment dump



1 -Start the engine to allow the oil to circulate and to check the seals.

LEVEL

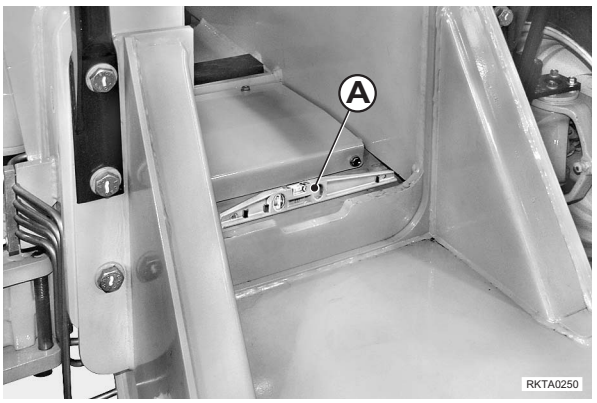
Removal

1 - Position the machine on firm, perfectly level ground with the boom fully lowered and retracted.

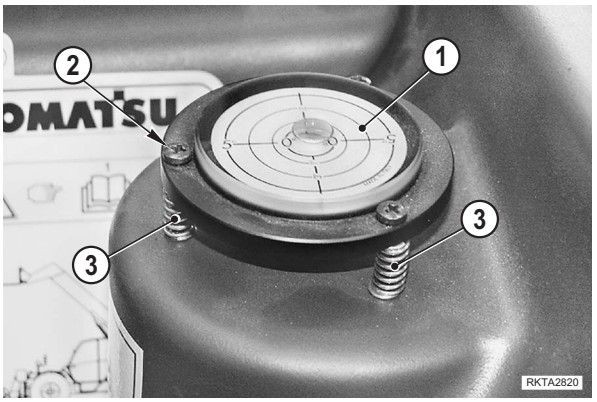
⚠ Check that the forks are not resting on the ground, and then stop the engine.

2 - Ensure that the tires are inflated to the proper pressure.

3 - Level the frame crosswise using an electronic level or a 40 cm. spirit level (A) placed on the front part of the frame or on the outrigger support (if equipped).



4 - Remove the level (1) to be replaced by loosening the screws (2) in a gradual and alternate manner.



Installation

- Install the new level by reversing the sequence of the removal procedure and finish off by compressing the springs (2) by 3 mm. approximately.

1 - Perform the calibration procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

WIPER MOTORS

Removal

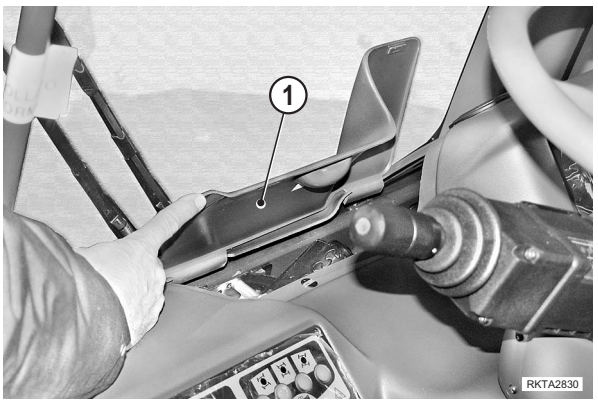
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

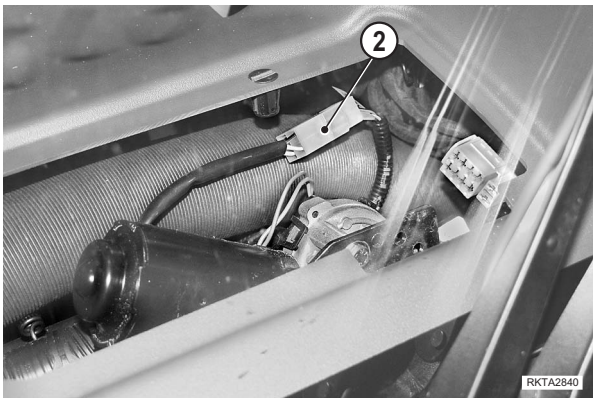
3 - Stop the engine and remove the ignition key.

- **Front wiper motor**

1 - Remove the centre compartment cover (1).



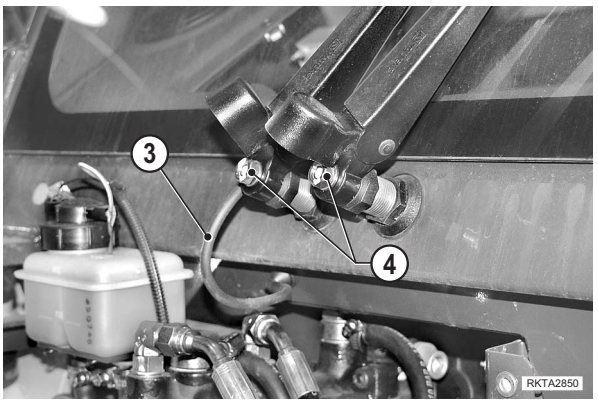
2 - Disconnect the wiper motor connector (2).



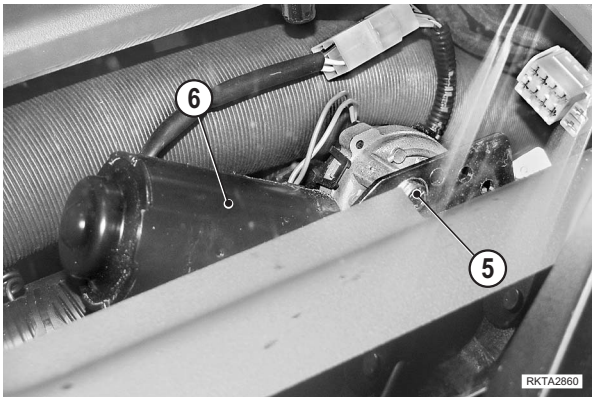
3 - Disconnect the washer fluid hose (3).

4 - Remove the nuts (4) and the wiper arm complete with washers and spacers.

★ Note down the installation sequence.

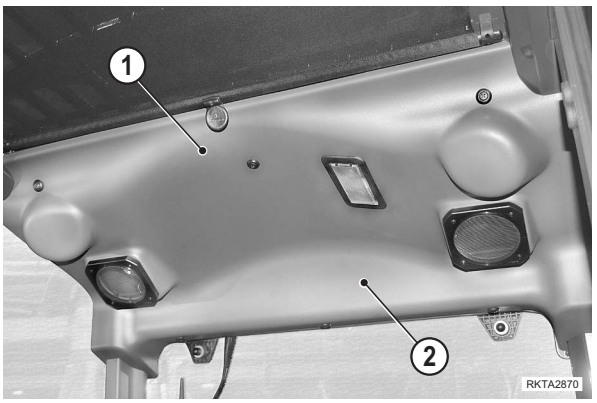


5 - Loosen and remove the screws (5) and remove the motor (6).



- **Rear wiper motor**

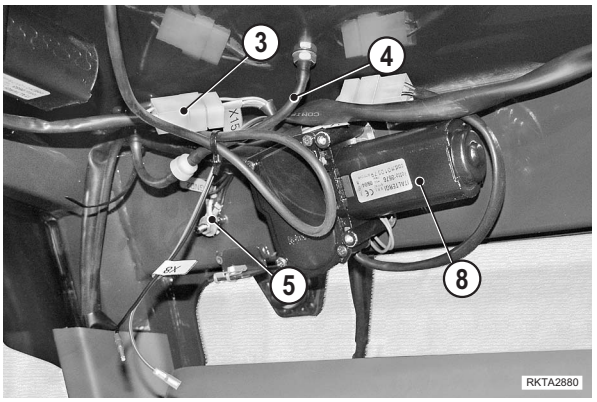
1 - Remove the screws (7) and remove the cab headliner (2).



2 - Disconnect the connector (3).

3 - Disconnect the washer fluid hose (4).

4 - Disconnect the ground cables (5).

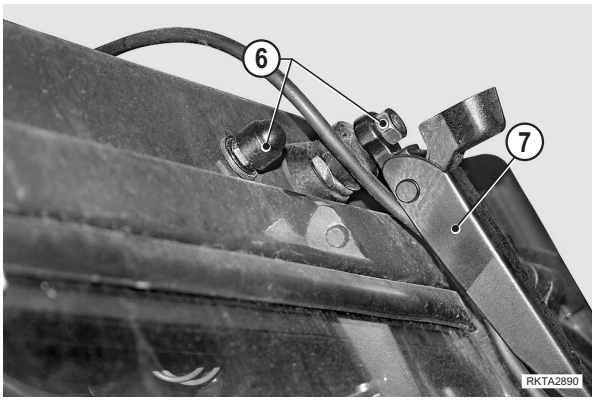


5 - Remove the nuts (6) and the wiper arm (7) complete with washers and spacers.

★ Note down the assembly sequence.

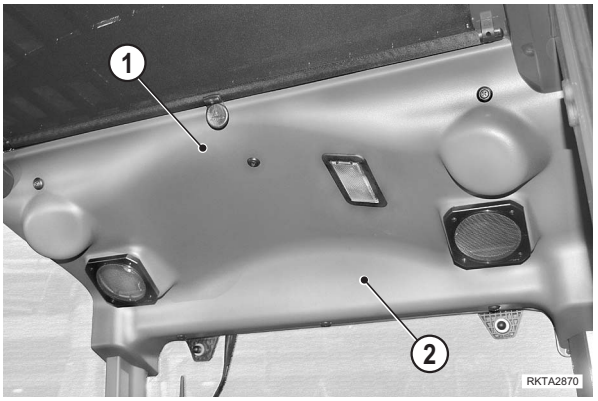
6 - Remove the motor (8).

★ Note down the seal assembly sequence.



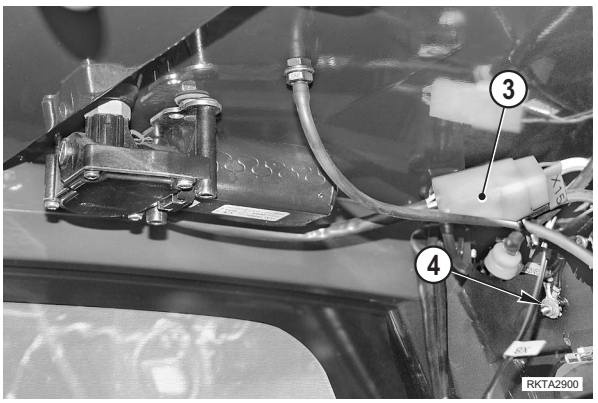
- **Upper wiper motor**

1 -Remove the screws (1) and remove the cab headliner (2).



2 -Disconnect the connector (3).

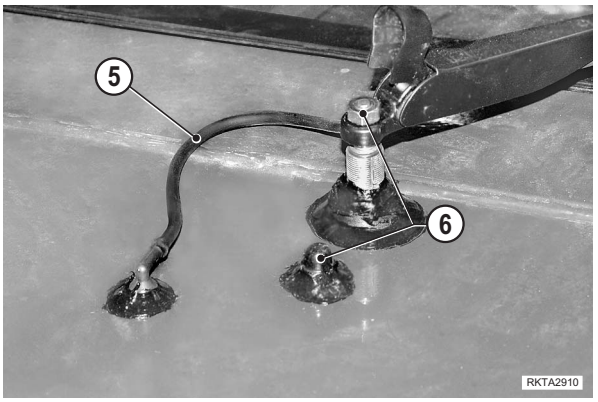
3 -Disconnect the ground cables (4).



4 -Disconnect the washer fluid hose (5).

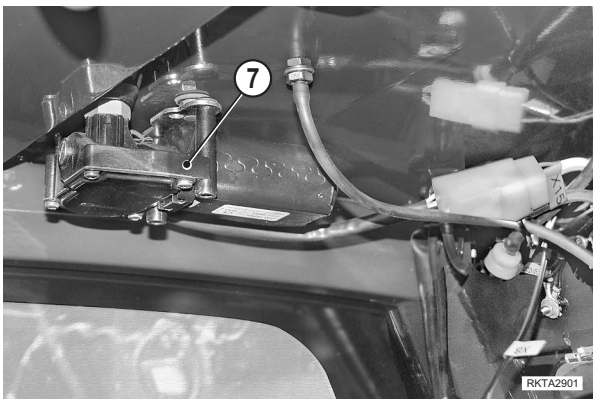
5 -Remove the adhesive; remove the nuts (6) and the wiper arm complete with washers and spacers. [*1]

★ Note down the assembly sequence.



6 -Remove the motor (7).

★ Note down the seal assembly sequence.



Installation

- To install, reverse the removal procedure.

[*1]

Sealant: Acetic silicone

PARKING BRAKE CABLE

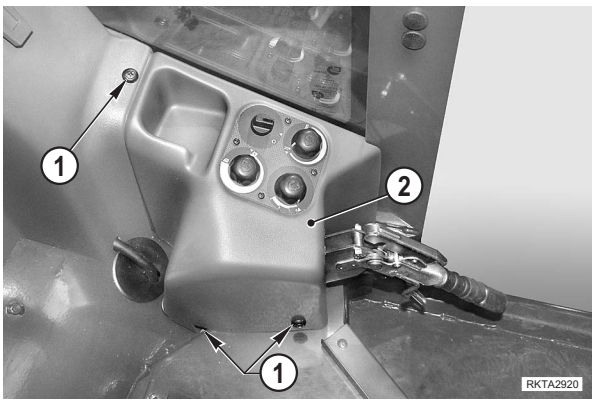
Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

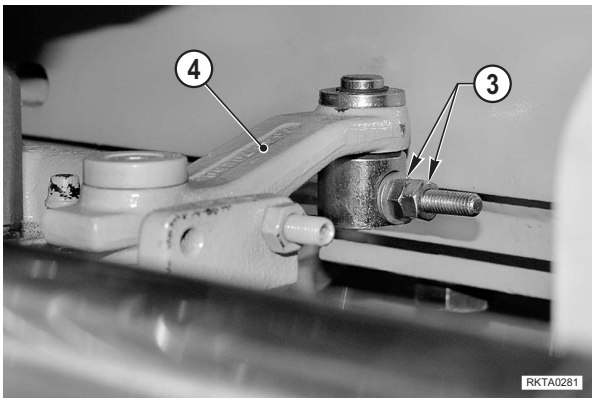
2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

3 - Stop the engine and remove the ignition key.

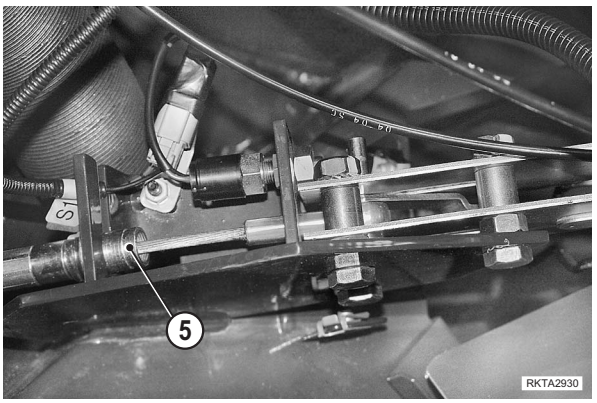
4 - Remove the seat, remove the three screws (1), and remove the cover (2).



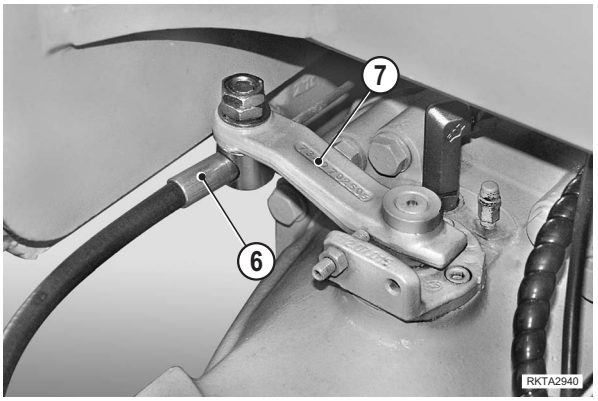
5 - Loosen and remove the nuts (3), disengage the cable from the axle levers (4).



6 - Disconnect the cable (5) from the brake apply lever.



7 - Disengage the conduit (6) from the axle lever (7) and slide off the whole transmission.



Installation

- To install, reverse the removal procedure.

1 - Adjust cable tension.
(For details, see "20 TESTING AND ADJUSTMENTS").

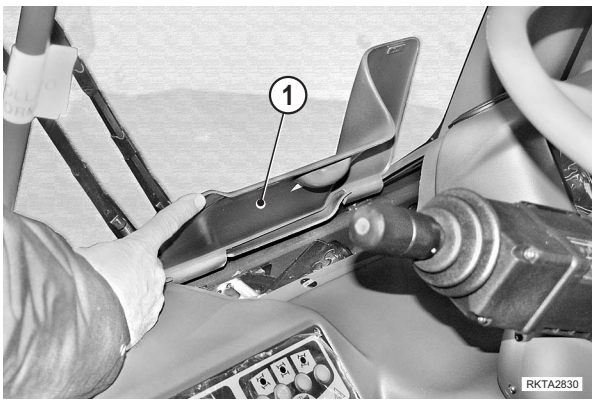
DASH / INSTRUMENT PANEL

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted and the parking brakes applied.

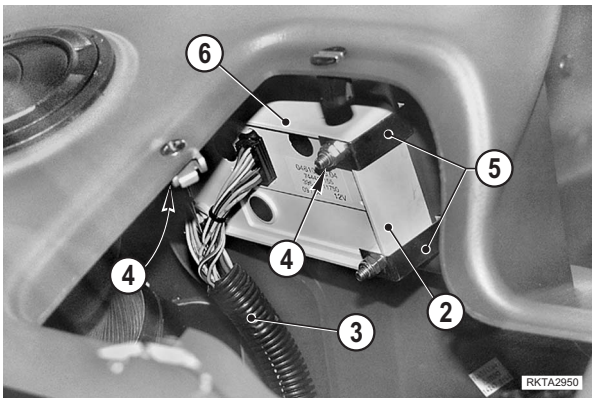
2 - Stop the engine and remove the ignition key.

3 - Remove the instrument panel top centre cover (1).



4 - Disconnect the wiring harness (3) from the dash (2).

5 - Loosen and remove the four self-locking nuts (4), remove the retaining brackets (5) and the complete dash (6).



Installation

- To install, reverse the removal procedure.

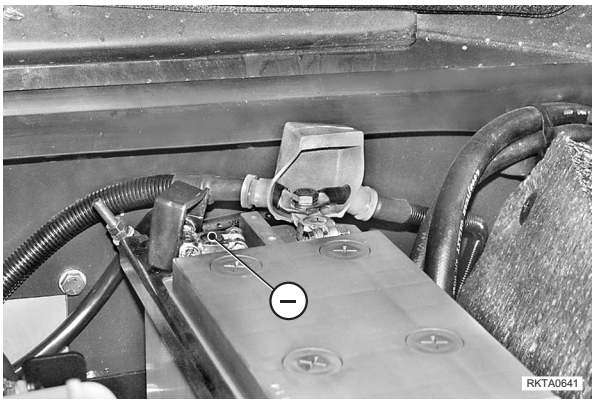
CONTROL PANEL

Removal

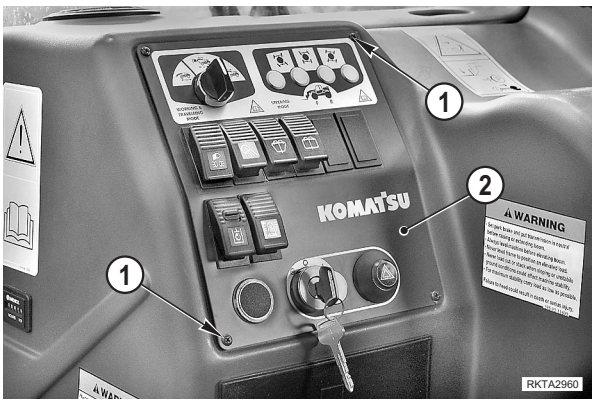
1 - Position the machine on firm, level ground with the boom fully lowered and retracted and the parking brakes applied.

2 - Stop the engine and remove the ignition key.

3 - Disconnect the cable from the negative (-) battery terminal.

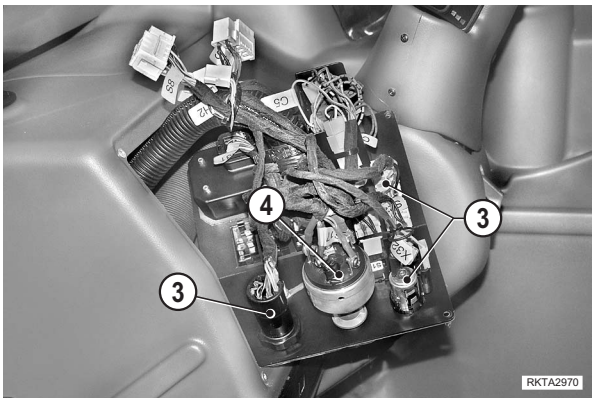


4 - Loosen and remove the screws (1); remove the panel (2).



5 - Disconnect the connectors (3) from the switches, pushbuttons and selector switches.

6 - Mark and then disconnect the cables from the ignition lock cylinder (4); remove the complete panel.



Installation

- To install, reverse the removal procedure.

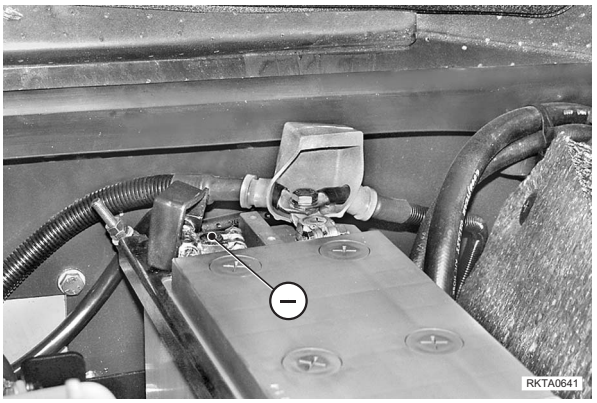
FUSE AND RELAY CENTRE

Removal

1 - Position the machine on firm, level ground.

2 - Apply the parking brakes and remove the ignition key.

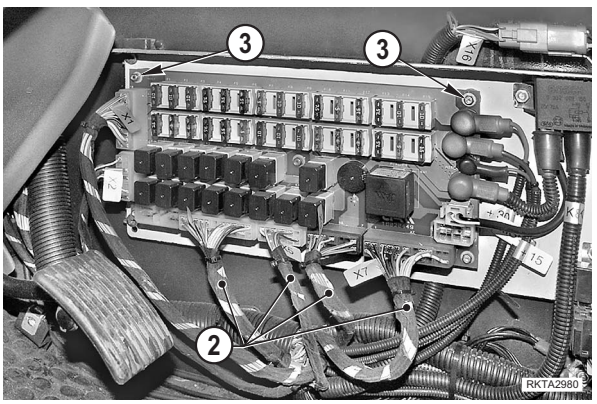
3 - Disconnect the cable from the negative (-) battery terminal.



4 - Loosen the screws and remove the panel (1).

5 - Disconnect all wiring harnesses (2), ensuring that they are all marked.

6 - Loosen and remove the four self-locking nuts (4) and remove the complete circuit board.



Installation

- To install, reverse the removal procedure.

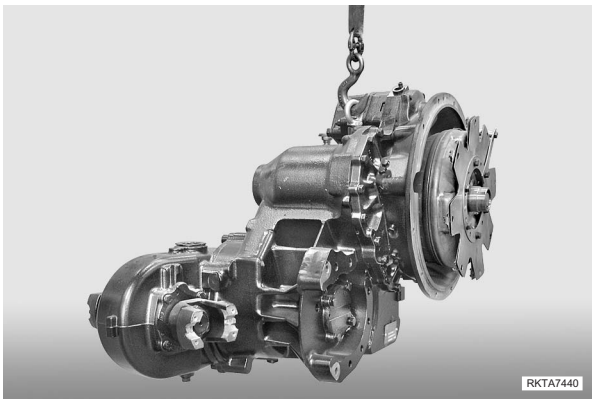
PROPELLER SHAFT

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

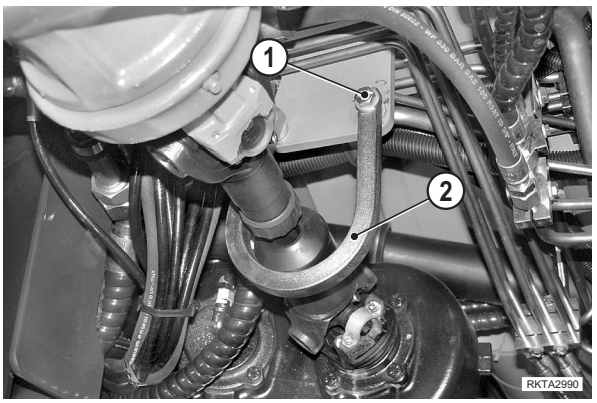
2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

3 - Stop the engine, apply the parking brakes and remove the ignition key.

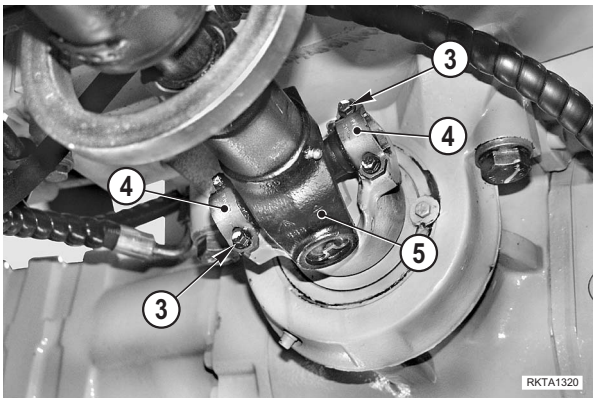


- **Front cardan shaft**

1 - Loosen and remove the screws (1) together with their respective washers, and remove the guard (2).



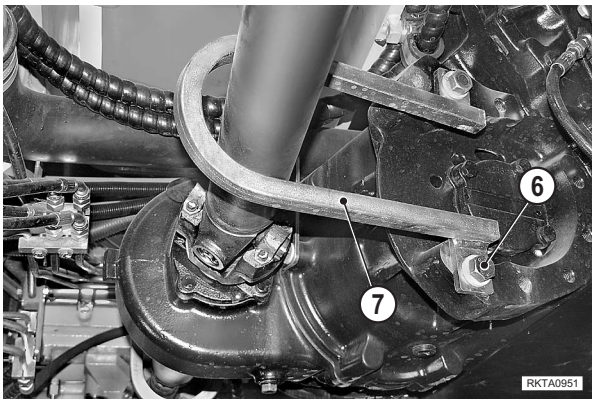
2 - Remove the screws (3), remove the collars (4) from both sides and remove the cardan shaft (5).



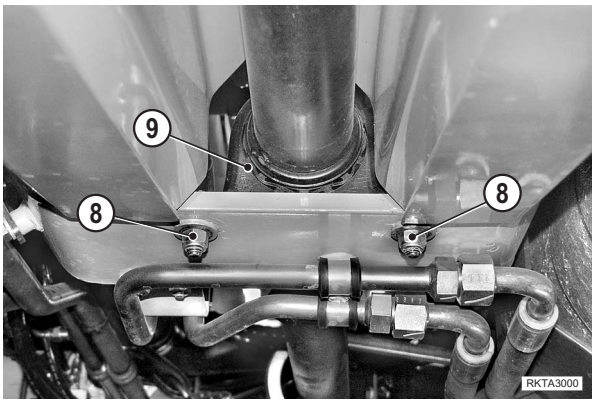
- **Rear cardan shaft**

1 - Loosen the screws (6) and washers retaining the guard (7).

★ Leave the screws and guard in position to ease removal.

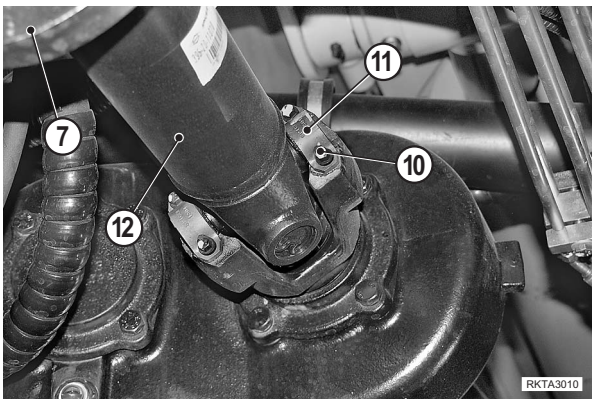


2 - Loosen and remove the self-locking nuts (8) and the centre support screws (9).



3 - Remove the screws (10) and remove the collars (11) from both cardan shaft ends.

4 - Remove the guard (7) and slide off the cardan shaft (12).



Installation

- To install, reverse the removal procedure.

FUEL TANK

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

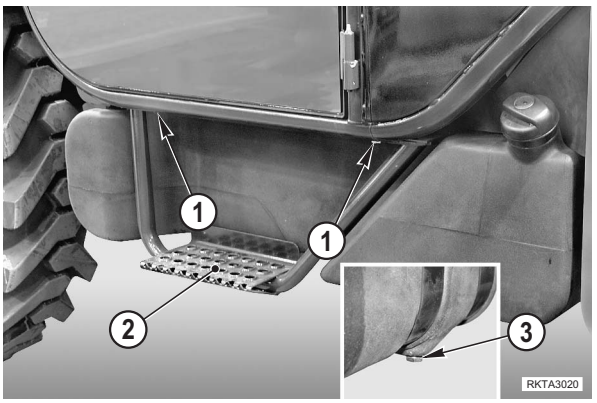
2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

3 - Stop the engine, apply the parking brakes and remove the ignition key.

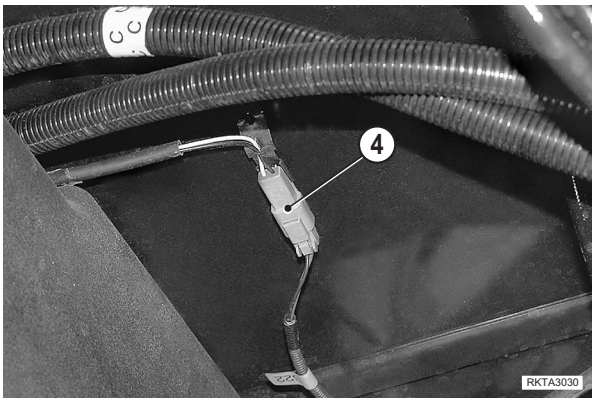
4 - Loosen and remove the screws (1) and remove the cab assist step (2).

5 - Unscrew the drain cap (3) and recover the fuel.

Fuel: max. 130 ℓ

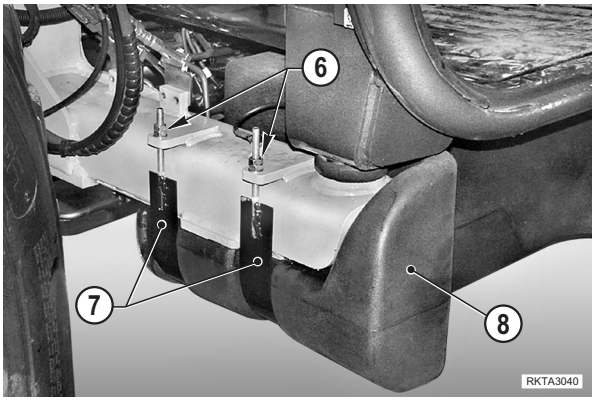


6 - Disconnect the fuel level indicator connector (4) and remove it from its support.



7 - Remove the screws and remove the front cover (5).

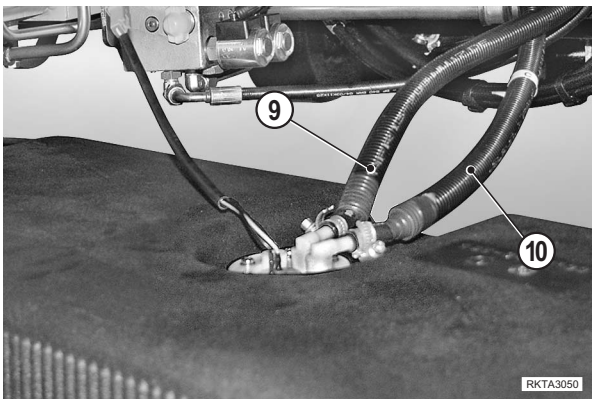
8 - Loosen the support band front and rear nuts (6) and lower the tank (8) as much as possible.



9 - Loosen the clamps and disconnect the fuel inlet and return hoses (9), (10).

★ Mark the hoses to avoid swapping during installation.

10 - Remove the tank (8).



Installation

- To install, reverse the removal procedure.

HYDRAULIC OIL TANK

Removal

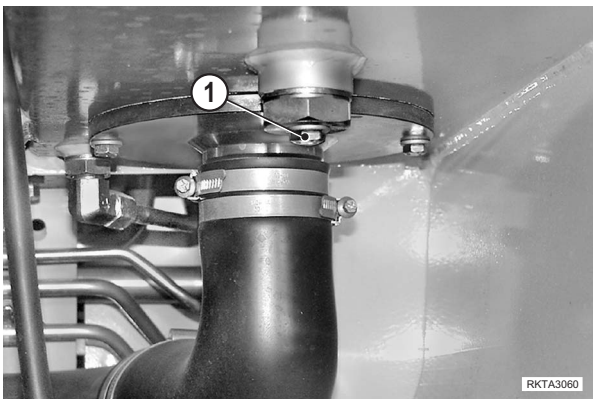
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

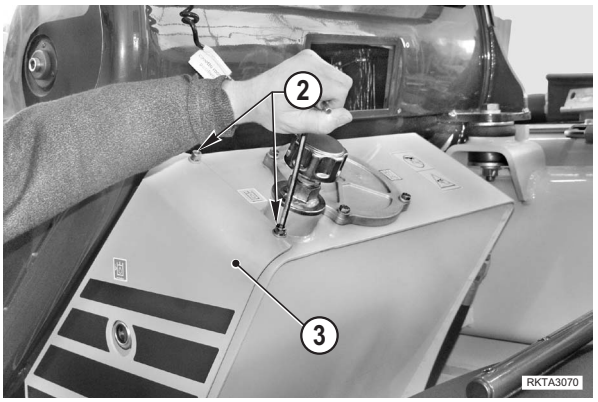
3 - Stop the engine, apply the parking brakes and remove the ignition key.

4 - Loosen the cap (1) and completely drain the hydraulic oil.

Hydraulic oil: max. 95 ℓ



5 - Loosen and remove the four screws (2) and remove the cover (3).

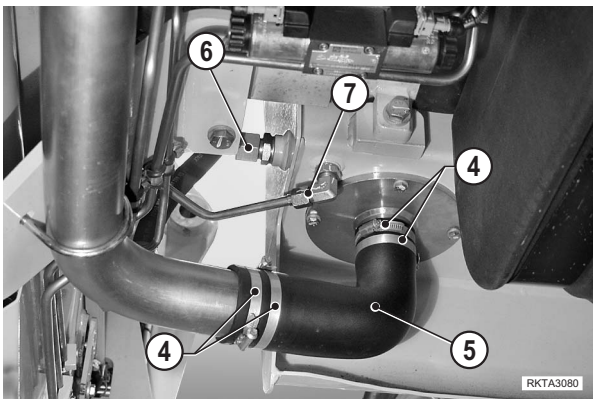


6 - Loosen the clamps (4) and remove the inlet sleeve (5).

7 - Disconnect the steering unit discharge line (6).

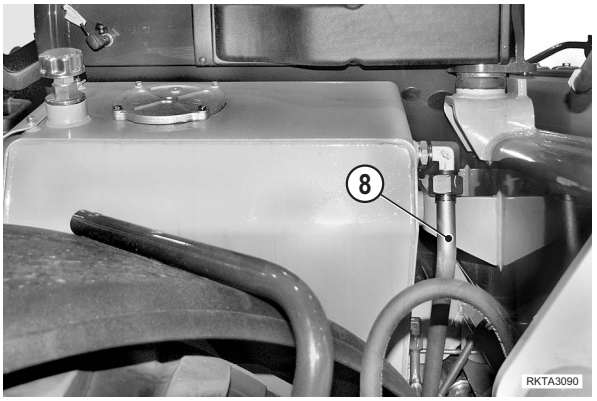
8 - Disconnect the servocontrol discharge pipe (7).

★ Cap the hoses and pipes and plug the holes to prevent contaminants from entering the passages.



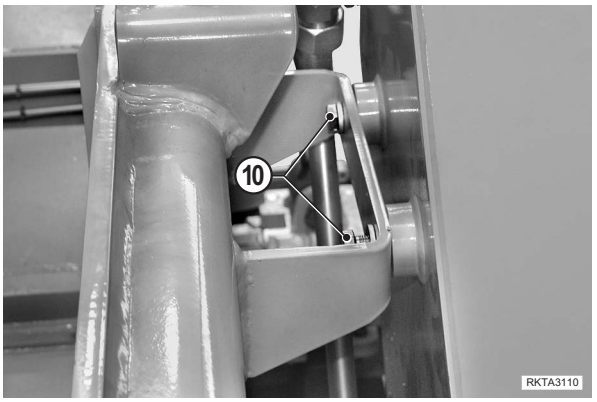
9 - Disconnect the main discharge line from the tank (8).

★ Cap the line and plug the hole to prevent contaminants from entering the passages.

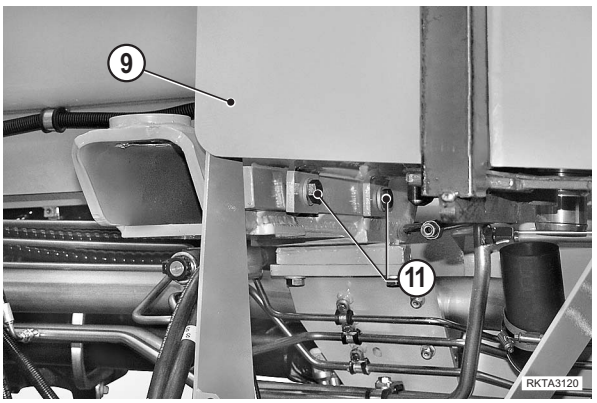


10 - Connect the tank (9) to a hoist and slightly tension the ropes.

11 - Loosen and remove the screws (10) securing the tank to the frame.



12 - Loosen and remove the screws (11); remove the tank (9) complete with filters.



Installation

- To install, reverse the removal procedure.

FRAME LEVELLING CYLINDER

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers (if equipped) to the ground in order to prevent any rotation of the frame.

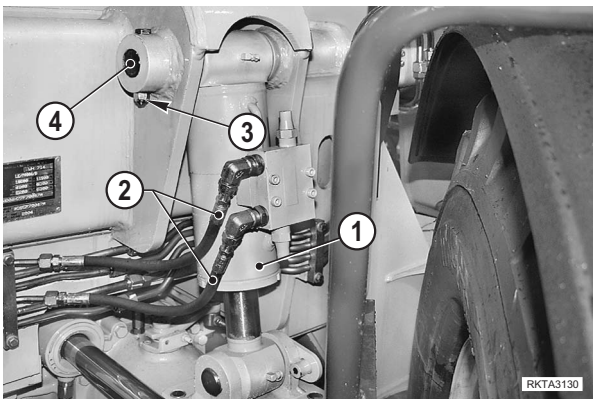
3 - If the machine is not provided with outriggers, place wedges under the rear wheels and force two stands (A) under the sides of the front frame to prevent any rotation.

4 - Turn the front wheels all the way to the right; stop the engine and remove the ignition key.

5 - Disconnect the hoses (2) from the cylinder (1).

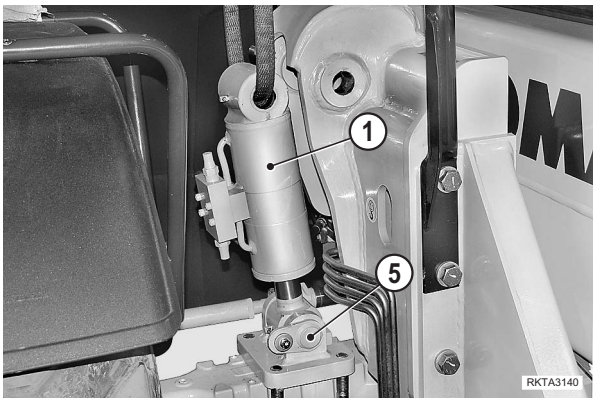
★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.

6 - Loosen and remove the screw (3) and remove the upper pin (4).



7 - Connect the cylinder (1) to a hoist, remove the screw and remove the pin (5) and the cylinder.

Cylinder: WH613 28.7 kg
WH713 28.7 kg
WH714 28.7 kg
WH716 28.7 kg



Installation

• To install, reverse the removal procedure.

1 - Perform the pin and bushing lubrication procedure.

2 - Start the engine and perform full frame-tilt manoeuvres in both directions to bleed the circuit.

FRAME SWING LOCKING ROD
(WH609 and WH613 only)
Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers (if equipped) to the ground in order to prevent any rotation of the frame.

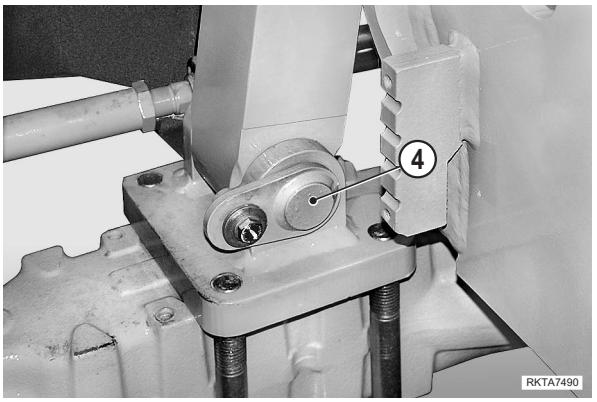
3 - If the machine is not provided with outriggers, place wedges under the rear wheels and force two stands (A) under the sides of the front frame to prevent any rotation.

4 - Turn the front wheels all the way to the right; stop the engine and remove the ignition key.

5 - Remove the screw (1) and then remove the upper pin (2) and spacers (3). [*1]

6 - Connect the rod to a hoist; remove the screw and the lower pin (4). [*1]

Rod: 32.6 kg



Installation

- To install, reverse the removal procedure.

[*1]

1 - Perform the coupling lubrication procedure.

Pins and bushings: NLGI 2EP grease

AXLE LOCKING CYLINDER

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers (if equipped) to the ground.

3 - Turn the rear wheels all the way to the left.

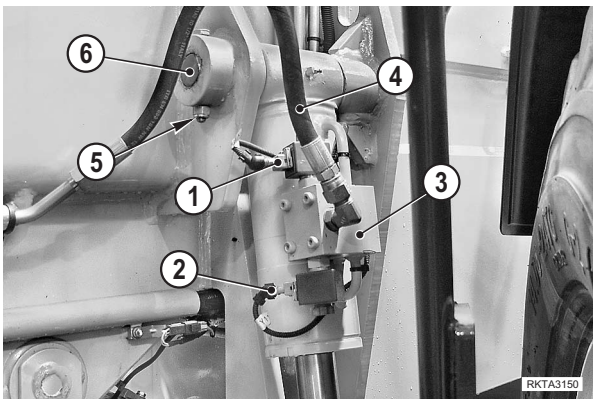
4 - Stop the engine and remove the ignition key.

5 - Disengage the wiring from the wire harness straps and disconnect the connectors (1), (2) from the solenoid valves.

6 - Disconnect the hose (4) from the valve (3).

★ Cap the line and plug the hole to prevent contaminants from entering the passages.

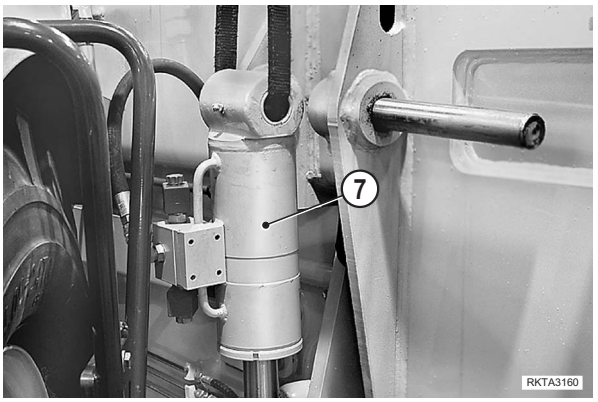
7 - Remove the screw (5) and remove the upper pin (6).



8 - Start the engine and turn the rear wheels all the way to the right; stop the engine and remove the ignition key.

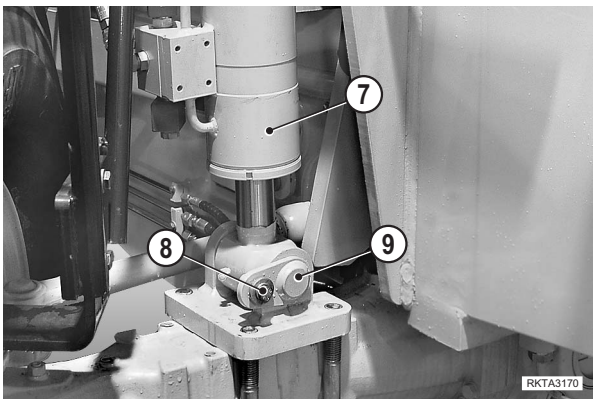
9 - Connect the cylinder (7) to a hoist.

Cylinder: WH613 35.0 kg
WH713 35.0 kg
WH714 35.0 kg
WH716 35.0 kg



10 - Remove the screw (8) and the pin (9).

11 - Remove the cylinder (7).



Installation

- To install, reverse the removal procedure.

1 - Perform the pin and bushing lubrication procedure.

2 - Lift the boom by more than 30° in order to activate and bleed the circuit.

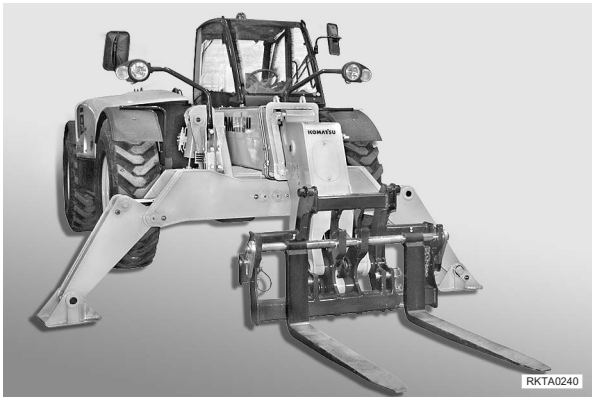
STABILIZER CYLINDERS (If equipped)

Removal

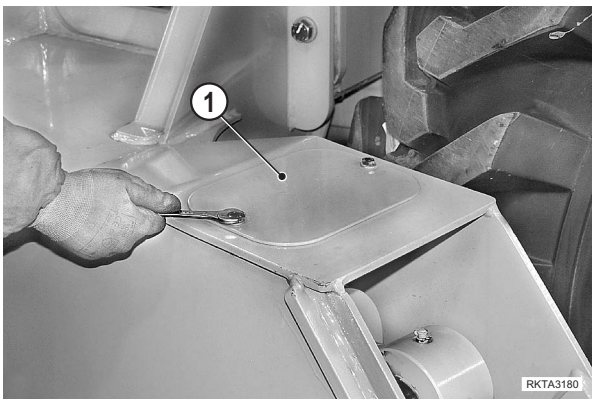
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers to the ground without forcing and place wedges under the rear wheels.

3 - Stop the engine, apply the parking brakes and remove the ignition key.

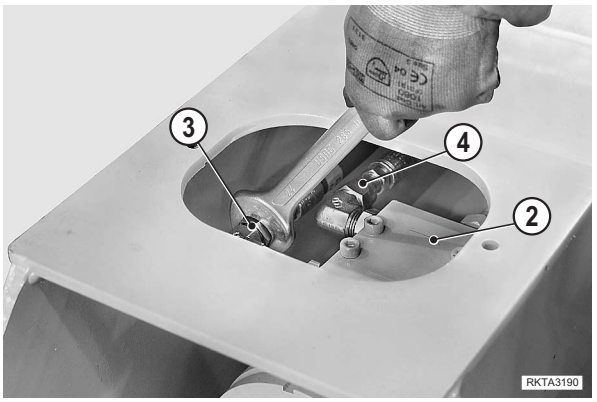


4 - Remove the upper cover (1) giving access to the safety valve.

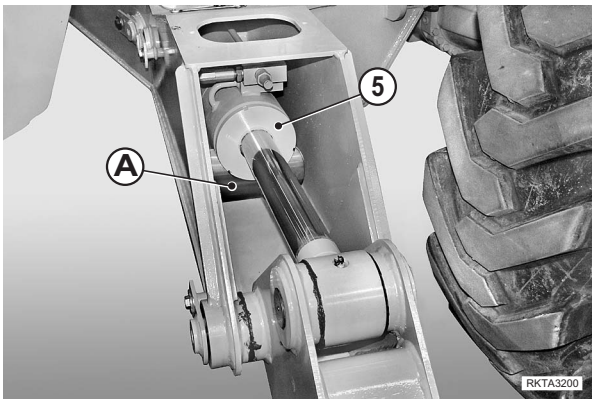


5 - Disconnect the lines (3), (4) from the valve (2).

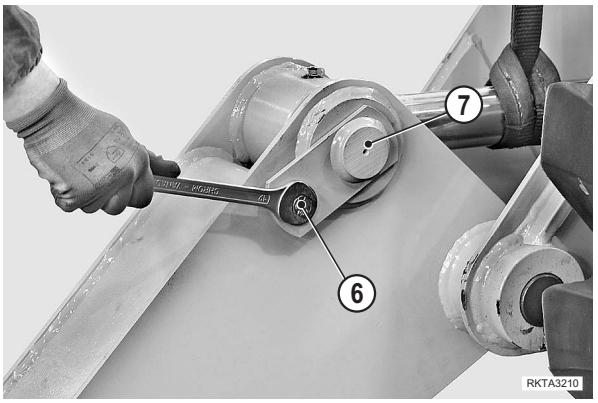
★ Immediately cap the lines and plug the holes to prevent contaminants from entering the passages.



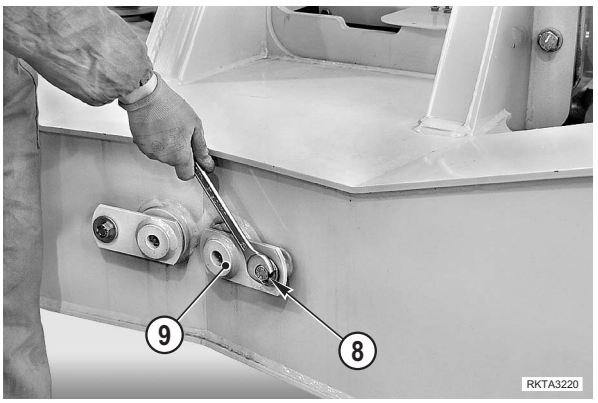
6 - Place a support roller (A) under the cylinder (5).



7 - Remove the screw (6), and then remove the pin (7) providing the attachment to the outrigger.

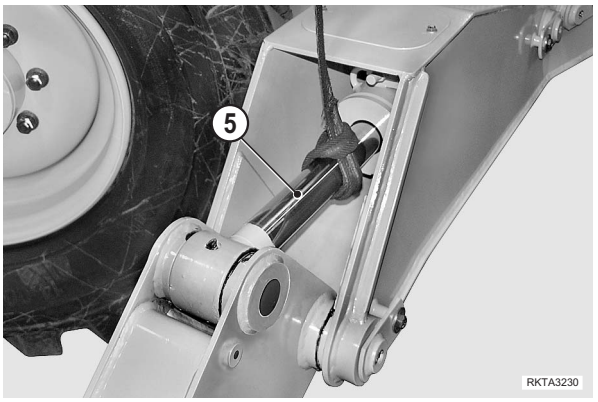


8 - Remove the screw (8) and the pin (9) providing the attachment for the cylinder.



9 - Partially remove the cylinder (5) by sliding it on the support roller (A).

10 - Connect the cylinder (5) to a hoist and remove it from the frame.

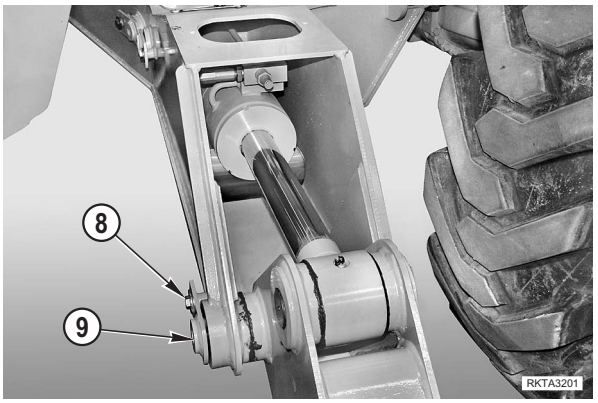


Installation

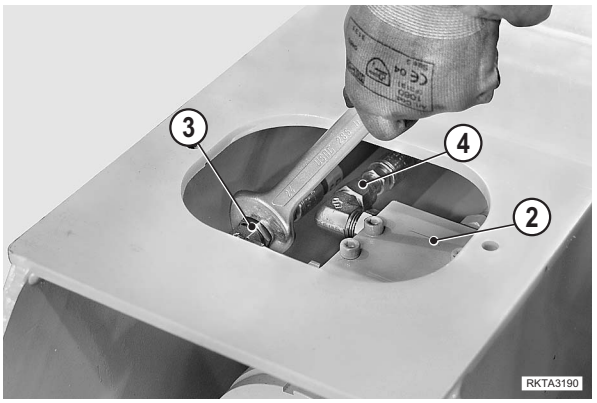
- To install, reverse the removal procedure.

1 - Introduce the cylinder into the frame and engage it with the pin (9) previously locked with the screw (8).

⚠ To install, reverse the removal procedure.



2 - Connect the lines (3), (4) to the valve (2).

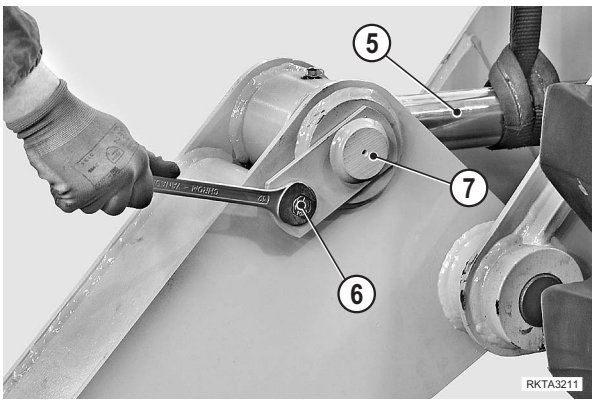


3 - Start the engine and slowly extend the piston (5) until the mating holes between the outrigger and rod are centred.

4 - Introduce the pin (7) and lock it with the screw (6).

5 - Perform the pin and bushing lubrication procedure.

6 - Perform several motions until the outriggers reach their fully extended position in order to bleed the air from the circuit.



EQUIPMENT HOLDER

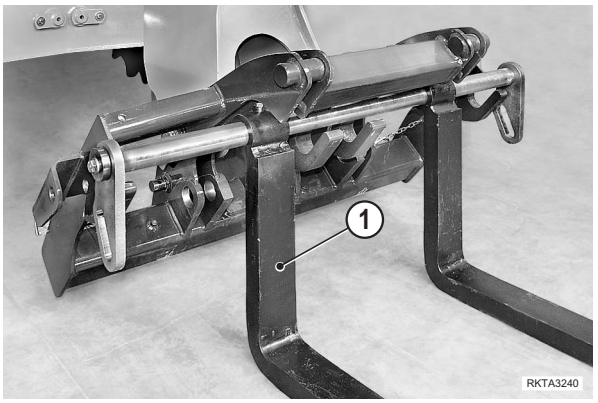
Removal

1 -Remove the equipment (1) in use.

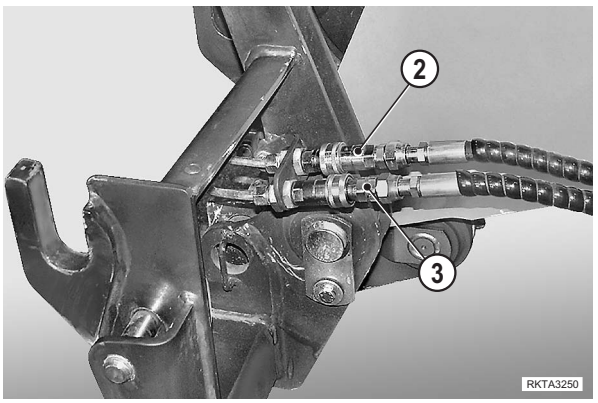
2 -Position the machine on firm, level ground with the boom fully lowered and retracted and with the equipment holder resting on the ground.

3 -Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

4 -Stop the engine and remove the ignition key.

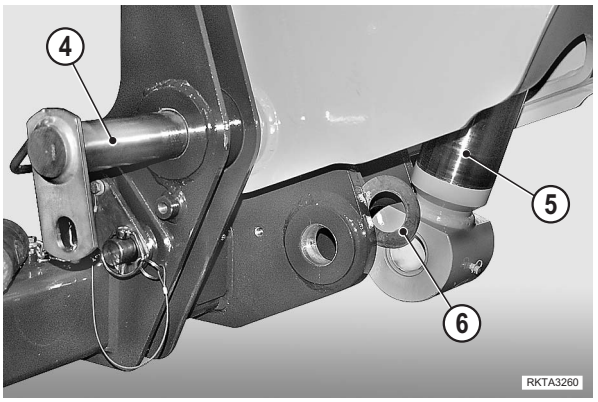


5 -**Hydraulic connection bucket and fork holders only**
Disconnect the hoses (2), (3).

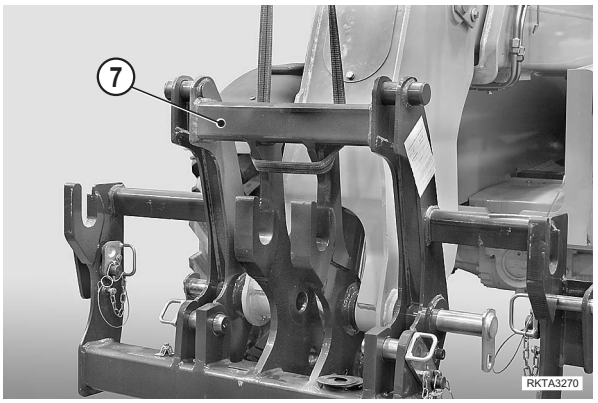


6 -Remove the screw and then remove the pin (4) providing the attachment for the piston (5).

★ Recover the shims (6) and note down the installation side.

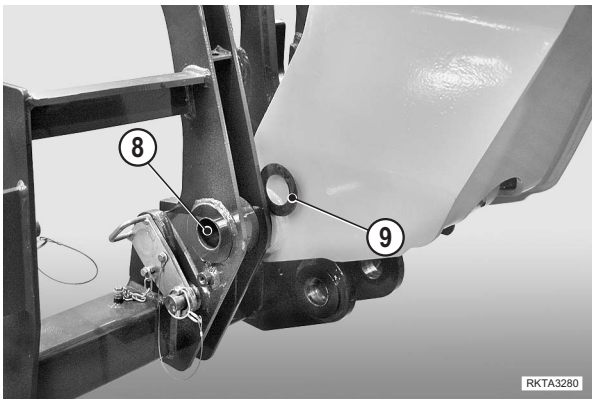


7 -Connect the equipment holder (7) to a hoist and slightly tension the rope.



8 - Remove the screw, and then remove the pin (8) providing the attachment to the boom.

★ Recover the shims (9) and note down the installation side.



Installation

- To install, reverse the removal procedure.

⚠ Check the resulting side clearance between the boom and the fork holder, and at the rod eye, for being less than 1 mm.

1 - Lubricate the pins you have previously removed, before attempting to start the machine.

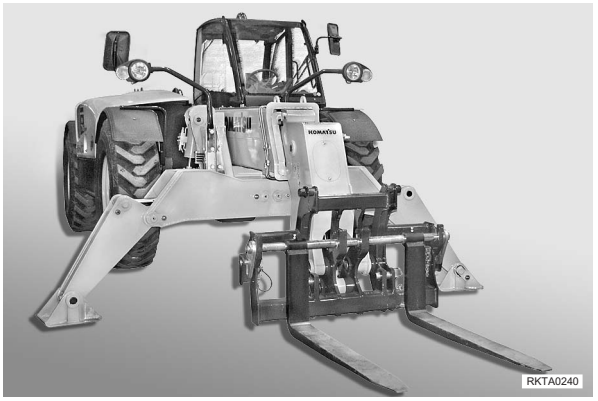
EQUIPMENT MOTION CYLINDER

Removal

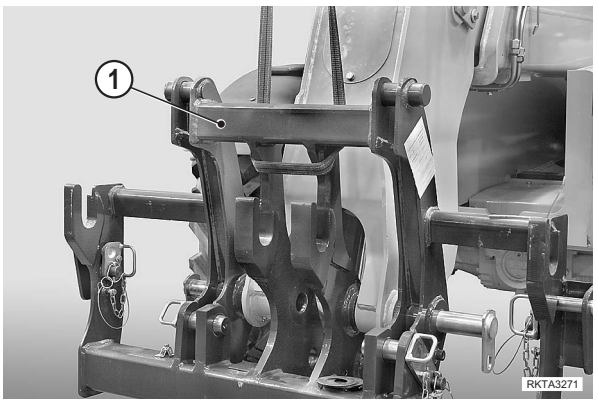
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

3 - Stop the engine and apply the parking brakes.



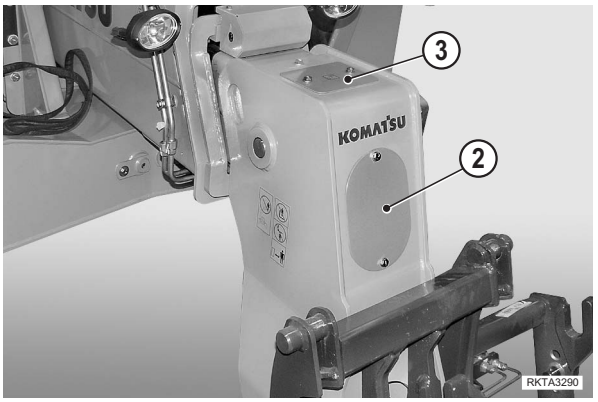
4 - Remove the equipment holding assembly (1).



5 - Loosen the screws and remove the front and top covers (2), (3).

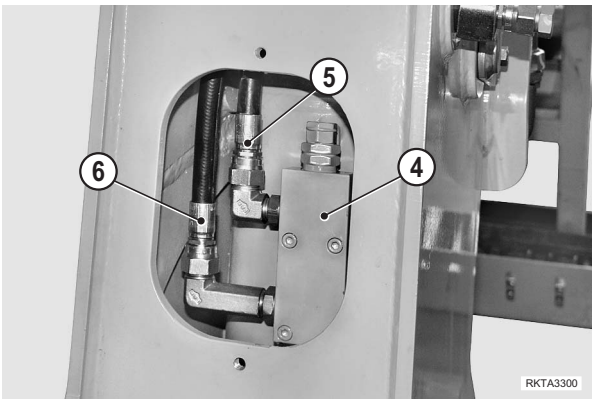
6 - Start the engine; lift the boom about 60 cm off the ground and fully retract the piston of the cylinder responsible for moving the equipment.

★ Position a safety block between the boom and the frame.



7 - Stop the engine and remove the ignition key.

8 - Disconnect the hoses (5), (6) from the valve (4).



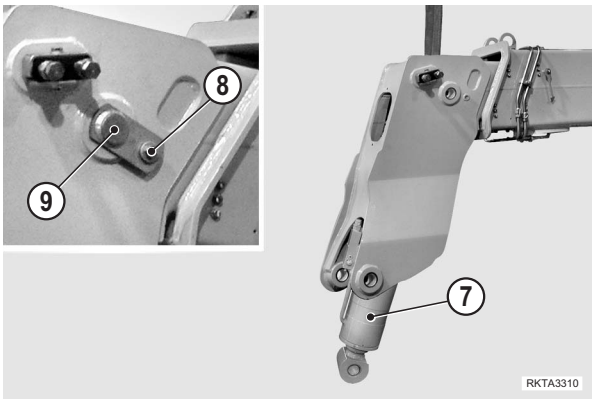
9 - Connect a hoist to the cylinder (7) working through the top compartment.

★ Use a rope and the upper hose from the safety valve to connect the cylinder to the hoist.

10 - Slightly tension the rope.

11 - Remove the screw (8) and the pin (9).

12 - Lower the hoist and slide off the cylinder (7) from the boom lower side.



Installation

• To install, reverse the removal procedure.

1 - Lubricate the pins you have previously removed before attempting to start the machine.

2 - Start the engine and perform some full travels in order to bleed the air from the circuit.

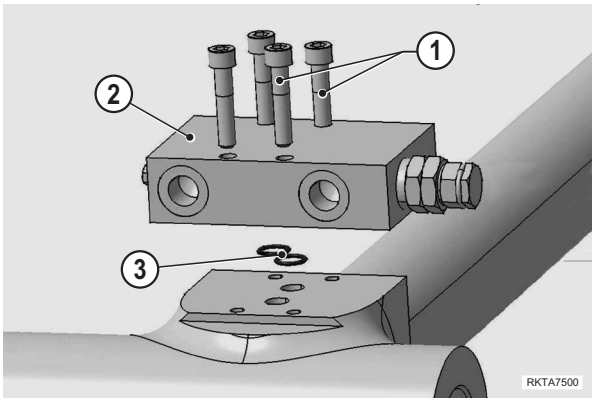
CYLINDERS

Disassembly

1 - Loosen and remove the screws (1), remove the safety valve (2), and the O-rings (3).

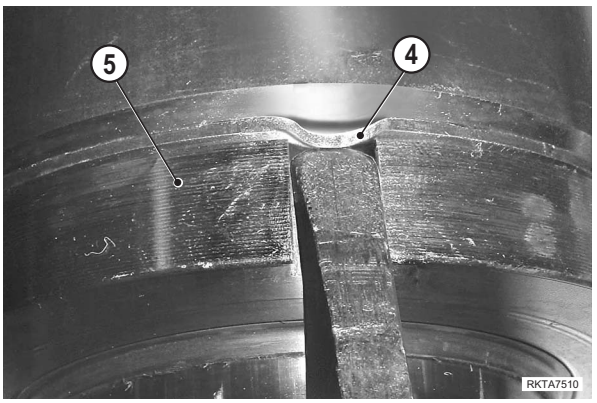
★ Note down the orientation of the valve prior to removal.

★ Replace the O-rings at each disassembly.



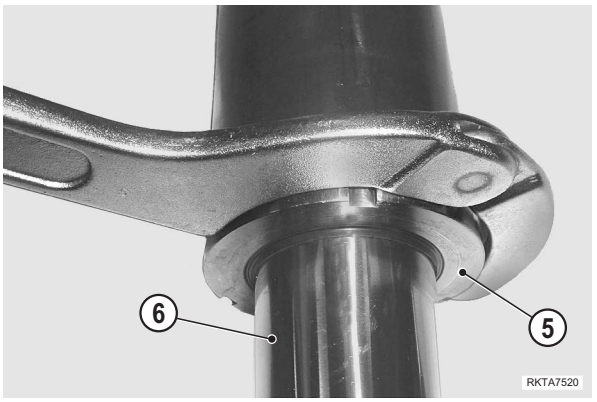
2 - Clamp the cylinder in one or more vices with soft grips.

3 - Lift the caulking of the retainer ring (4). Using a spanner, loosen and remove the cylinder head (4) and the complete piston.

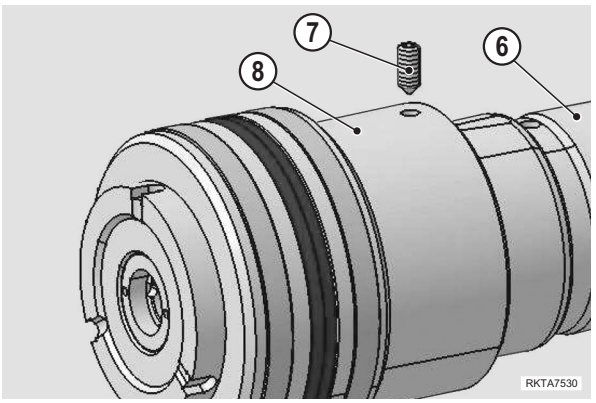


4 - Clamp the piston in one or more vices with soft grips.

5 - Using a spanner, loosen the cylinder head (5) and the braking bush, if installed.
Remove the complete piston rod (6).

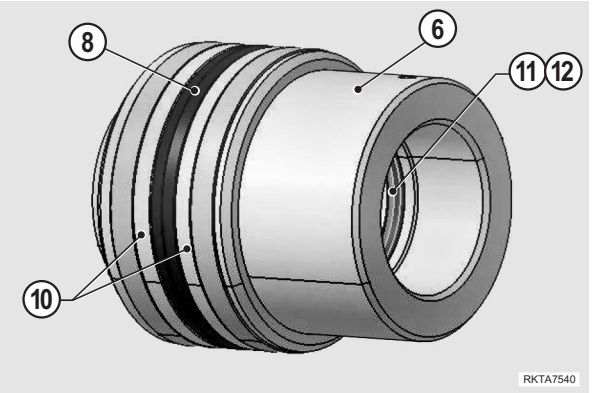


6 - Loosen and remove the retaining screw (7) from the complete piston rod (6)
Remove the piston (8).



7 - Using a round-bladed screwdriver, remove the seals (9), guide rings (10) and the inner O-rings (11 and 12) from the piston (8).

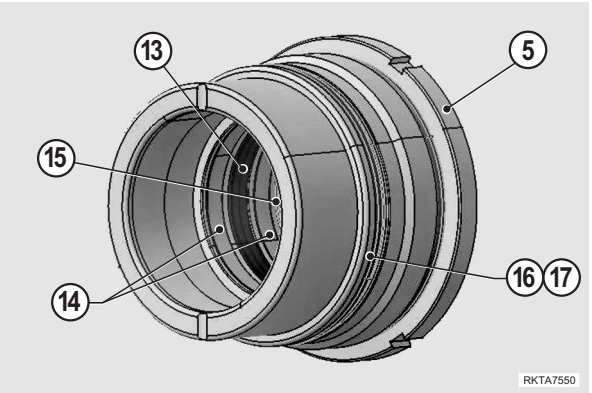
★ Be extremely careful not to damage the seal grooves.



8 - Using the same type of screwdriver previously used on the piston, remove the seals (13), guide rings (14), scraper ring (15), O-ring (16), anti-extrusion ring (17) and O-ring (18) from the cylinder head (5).

★ Be extremely careful not to damage the seal grooves.

9 - Thoroughly clean all components with a mild solvent.

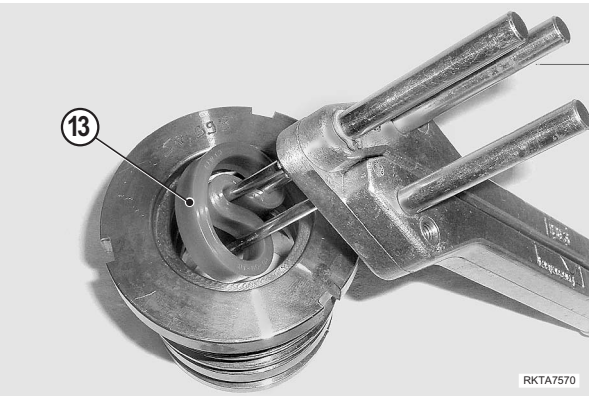


Assembly

1 - Using a a pair of pliers, install the inner seal (13) to the cylinder head (5).

★ Thoroughly check for proper orientation.

2 - Install the guide rings (14).

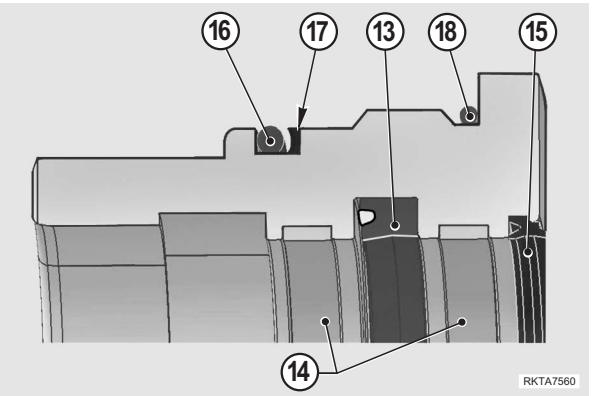


3 - Install the anti-extrusion ring (17) and O-ring (16).

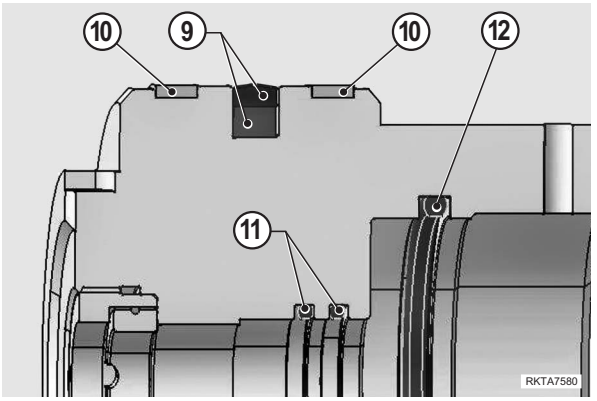
★ Check for proper orientation of the anti-extrusion ring.

4 - Install the O-ring (18).

5 - Install the scraper ring (15).



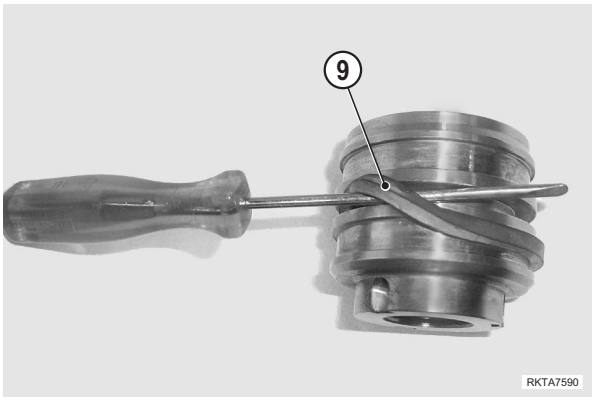
6 - Install the O-rings (11) and ring (12) to the piston (8).



7 - Install the seal (9) to the piston.

★ The seal consists of two rings of rectangular cross-section which require installation by means of a rounded edge tool; pay attention to ensure that the central line on the outer ring remains visible.

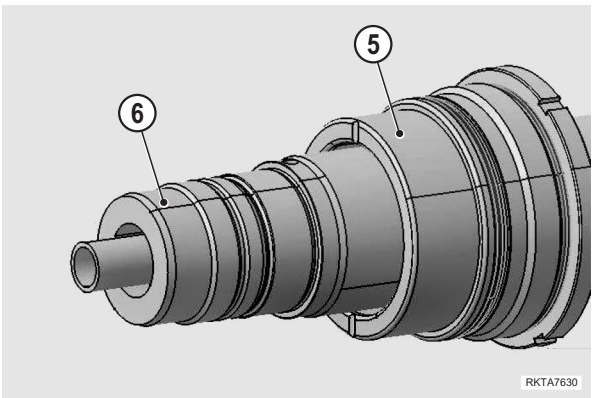
8 - Install the guide rings (10).



9 - Check the parts for being thoroughly clean, and then install the cylinder head (5) to the piston rod (6).

★ Lightly lubricate the rod.

Rod: hydraulic oil



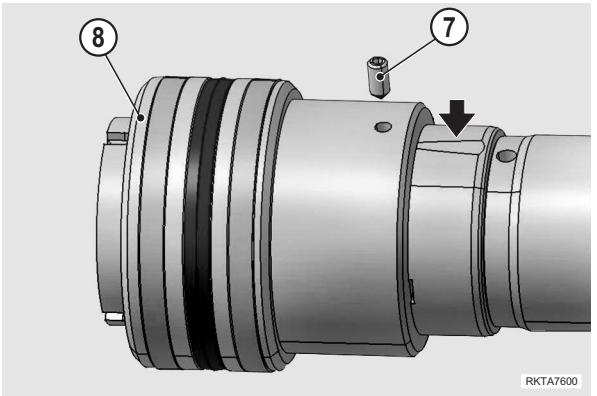
10 - Clamp the piston rod (6) in one or more vices with soft grips.

11 - If equipped, install the braking bush and ensure that bush orientation matches that in the illustration.

12 - Install the piston (8) complete with seals.

★ Tighten the piston to the rod.

Piston: hydraulic oil



13 - Tighten the piston to the rod.

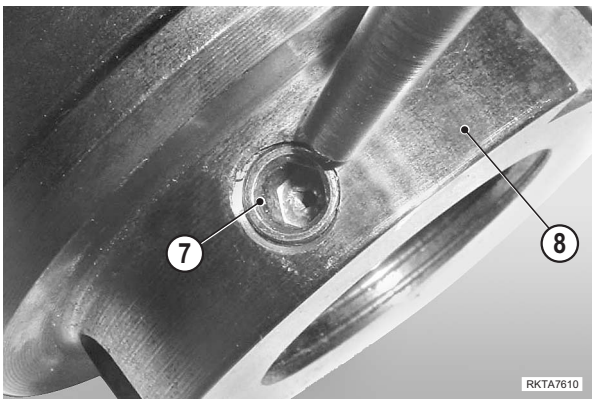
Lift piston:
WH609: 1000±200 Nm
WH613: 950–1000 Nm
WH7: 1100±220 Nm
Offset piston: 385±75 Nm
Extension piston: 900±180 Nm
Equipment control piston: 1000±200 Nm
Outrigger piston: 900±180 Nm
Levelling piston: 700±140 Nm
Axle locking piston: 700±140 Nm

14 - Apply a coat of sealant to the retaining screw threads (7) and install the screw to the piston (8).

Screw: Loctite 243

Screw: 20 Nm

15 - Caulk the edge of the screw to prevent screw rotation.



16 - Check the cylinder, piston (6) and cylinder head (5) for being thoroughly clean.

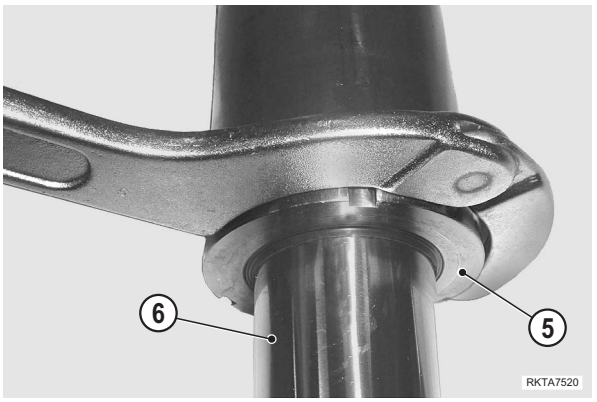
17 - Lubricate cylinder head and piston seals.

Seals: hydraulic oil

18 - With the cylinder in its horizontal position, introduce the piston (6) and the cylinder head (5).

★ Keep cylinder and piston perfectly aligned.

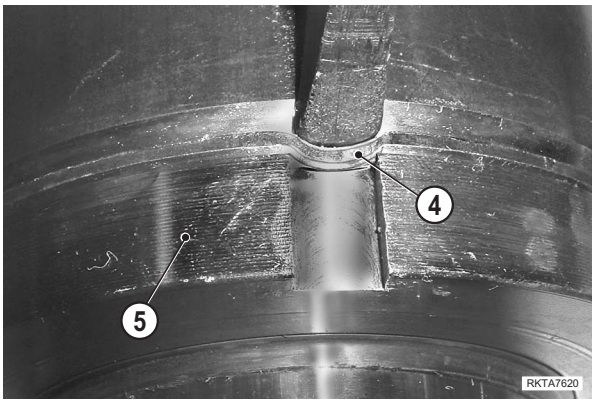
★ Be extremely careful not to damage the seals.



19 - Using a spanner, tighten and lock the cylinder head (5).

Lift piston: 450–500 Nm
Offset piston: 250–300 Nm
Extension piston: 450–500 Nm
Equipment control piston: 450–500 Nm
Outrigger piston: 450–500 Nm
Levelling piston: 450–500 Nm
Axle locking piston: 450–500 Nm

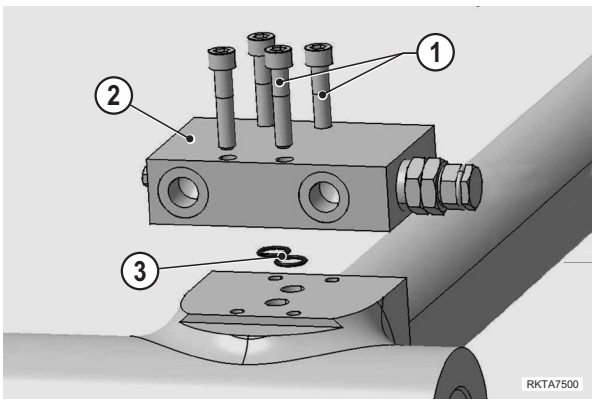
20 - Caulk the retainer ring (4) at one slot only.



21 - Position the O-rings (3) to the valve seats (2); install the valve to the cylinder and check for proper orientation.

22 - Lock the valve by tightening the screws (1) using the criss-cross tightening method.

Screws: 20 Nm



EQUIPMENT QUICK-LOCK ASSEMBLY

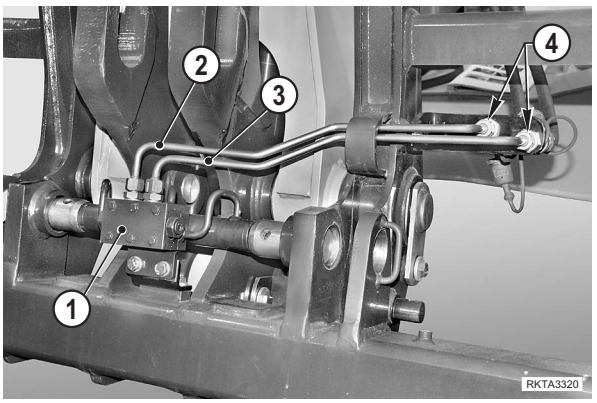
Removal

1 - Remove the equipment in use.

2 - Position the machine on firm, level ground with the boom fully lowered and retracted and with the equipment holder resting on the ground.

3 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

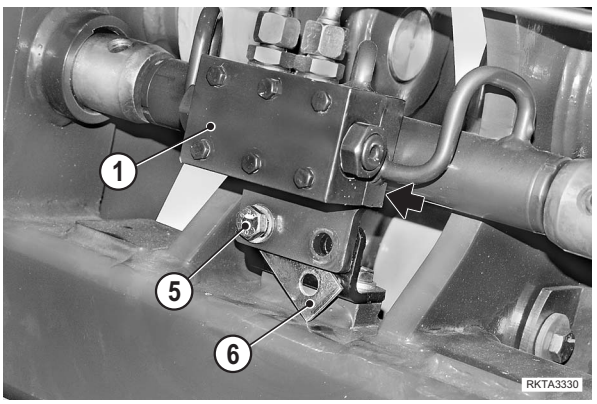
4 - Stop the engine, remove the ignition key and apply the parking brakes.



5 - Disconnect the pipes (2), (3) from the cylinder (1).

★ Immediately cap the lines and plug the holes to prevent contaminants from entering the passages.

★ To ease removal, loosen the fittings (4) as well.



6 - Loosen and remove the screws (5).

★ Recover the shims (6) used for pin centring.

7 - Push the cylinder (1) to the left, tilt it outwards, and then remove it.

Installation

• To install, reverse the removal procedure.

1 - Start the engine and perform several motions in order to bleed the circuit.

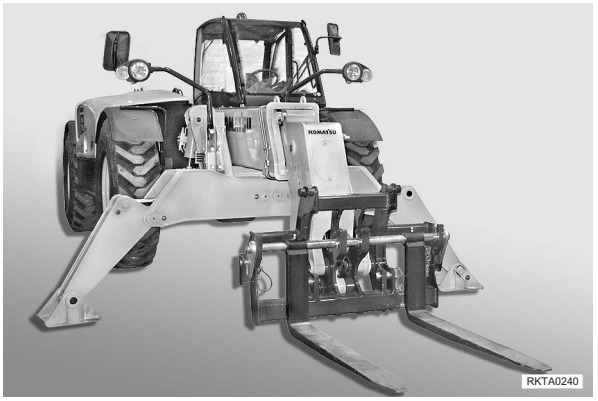
AIR CONDITIONER FANS

Removal

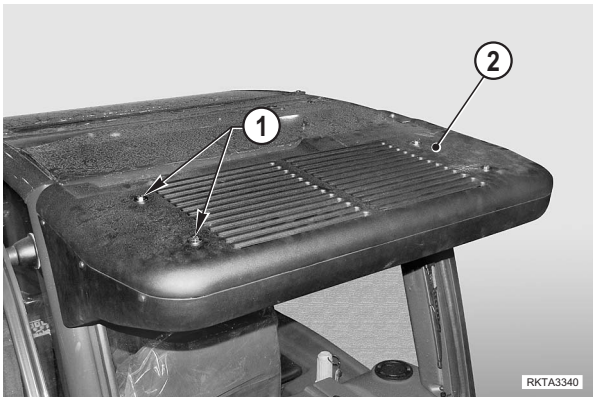
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

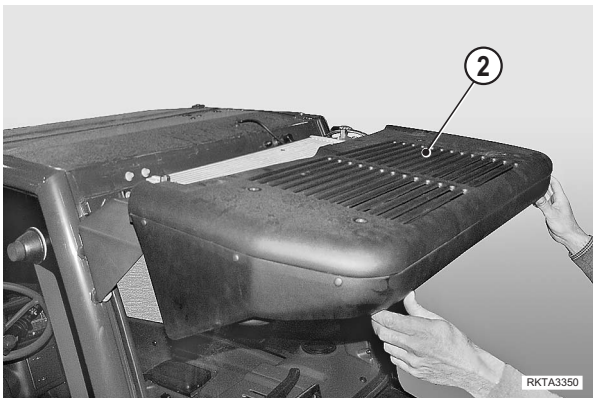
3 - Stop the engine and apply the parking brakes.



4 - Loosen and remove the four screws (1) retaining the fan cover (2).

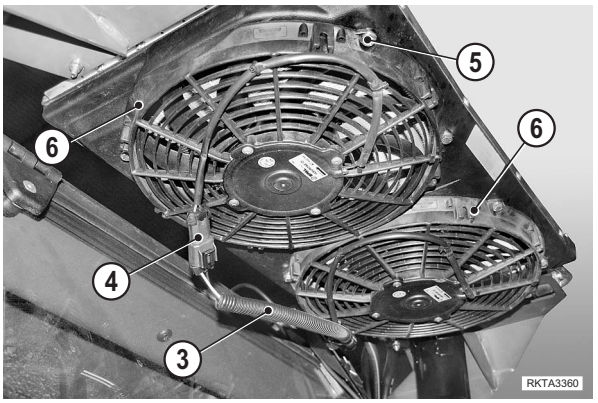


5 - Remove the fan cover (2).



6 - Disconnect the connector (4) of the fan to be replaced from the wiring harness (3).

7 - Loosen the screws (5) and remove the fan (6).



Installation

- To install, reverse the removal procedure.

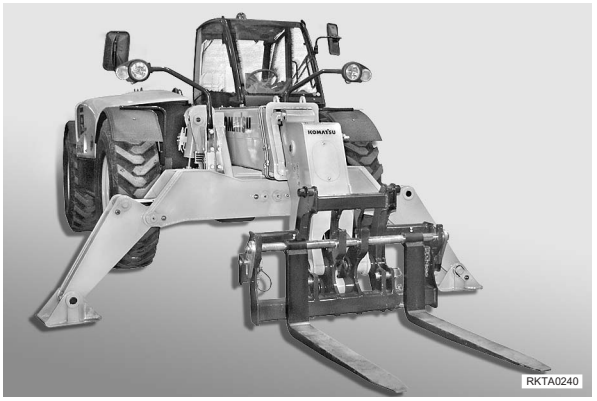
AIR CONDITIONER CONDENSER ASSEMBLY

Removal

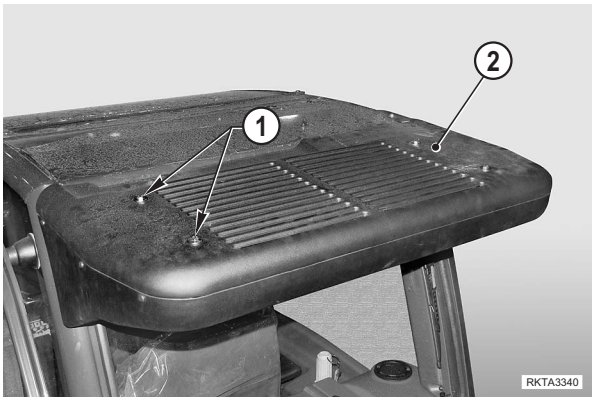
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

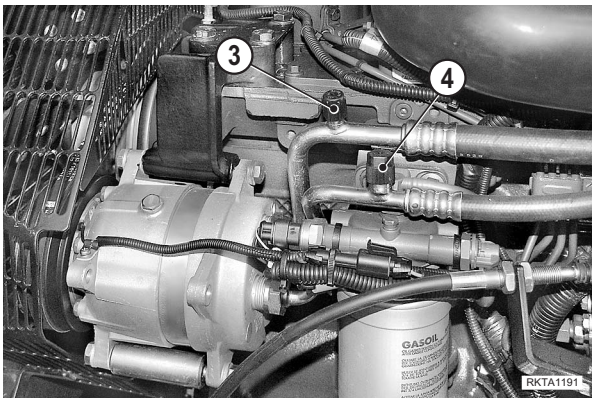
3 - Stop the engine and apply the parking brakes.



4 - Loosen and remove the four retaining screws (1) and remove the cover (2).

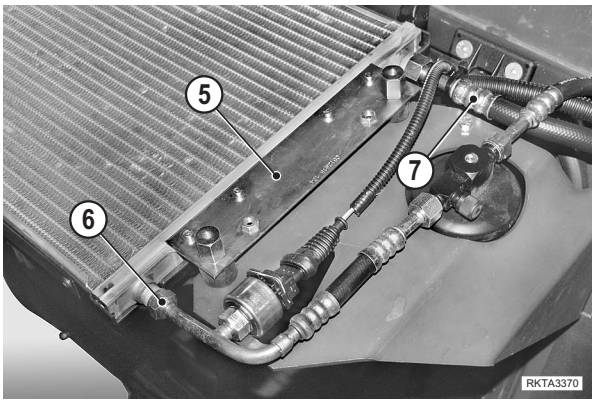


5 - Connect the maintenance station to the connections (3), (4) and drain the coolant fluid off the air conditioning system.
(For details, see "20 TESTING AND ADJUSTMENTS").

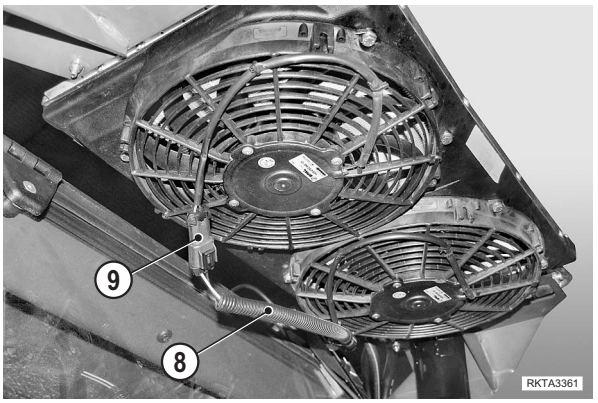


6 - Disconnect the lines (6), (7) from the condenser (5). [*1]

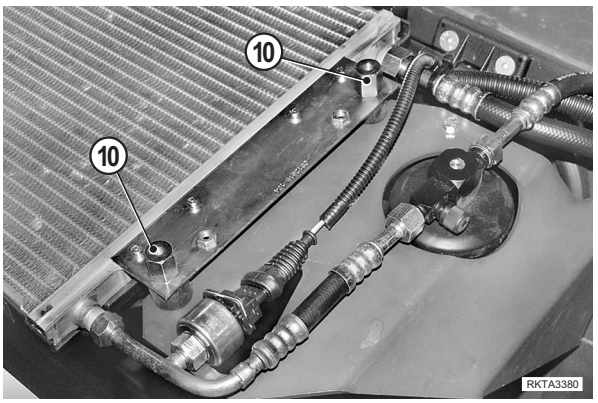
★ Immediately cap the lines and the condenser to prevent contaminants from entering the air conditioning circuit.



7 -Disconnect the connectors (9), from the wiring (8).



8 -Loosen and remove the four nuts (10) and remove the complete assembly.



Installation

- To install, reverse the removal procedure.

[*1]

★ Ensure that the O-rings are undamaged.

Fittings and O-rings: antifreeze:

1 -Carry out the air conditioning system filling procedure. (For details, see "20 TESTING AND ADJUSTMENTS".

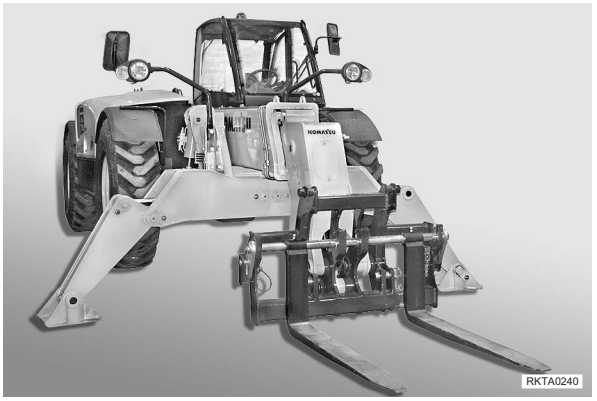
DEHUMIDIFYING FILTER

Removal

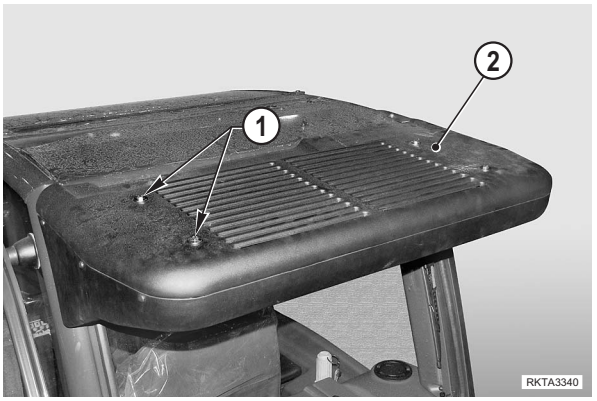
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

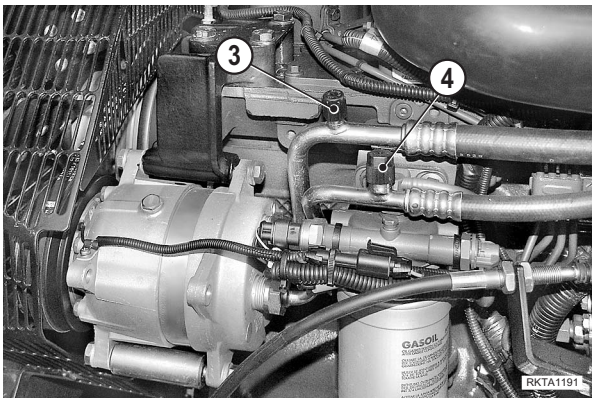
3 - Stop the engine and apply the parking brakes.



4 - Loosen and remove the retaining screws (1) and remove the cover (2).

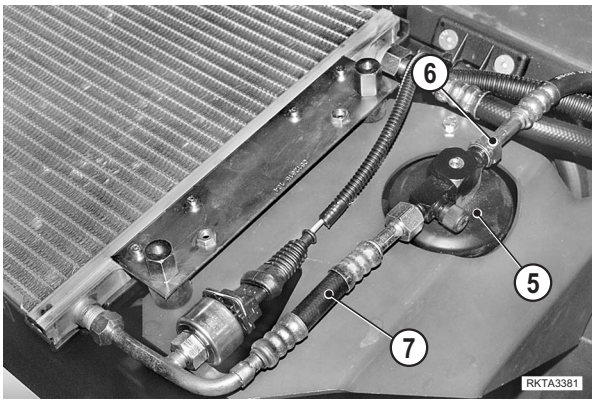


5 - Connect the maintenance station to the connections (3), (4) and drain the coolant fluid off the air conditioning system.
(For details, see "20 TESTING AND ADJUSTMENTS").



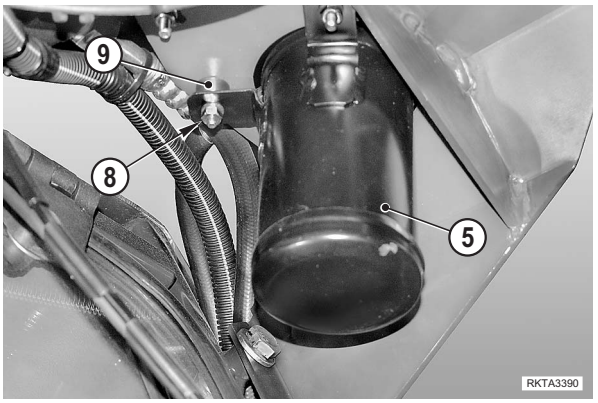
6 - Disconnect the lines (6), (7) from the filter (5). [*1]

★ Immediately cap the lines and plug the holes to prevent humidity from entering the circuit.



7 -Remove the nuts (8) and washers; remove the screws and spacers (9).

8 -Remove the filter (5).



Installation

- To install, reverse the removal procedure.

[*1]

★ Ensure that the O-rings are undamaged.

Fittings and O-rings: antifreeze:

1 -Carry out the system filling procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

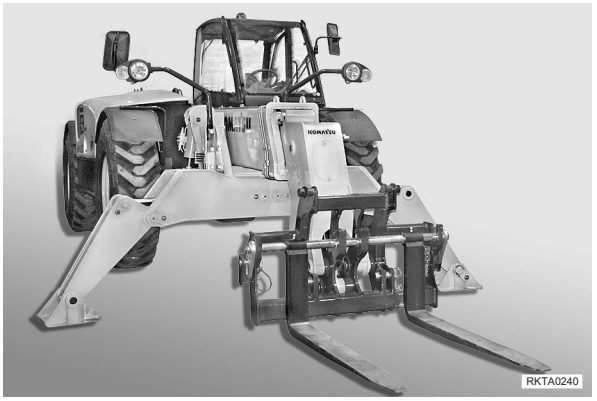
PAIR CONDITIONING SYSTEM PRESSURE SWITCH

Removal

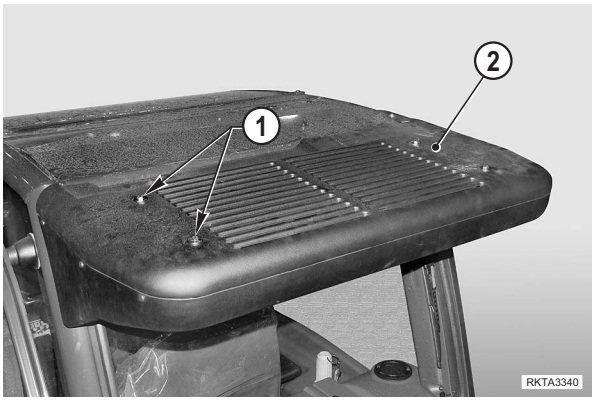
1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

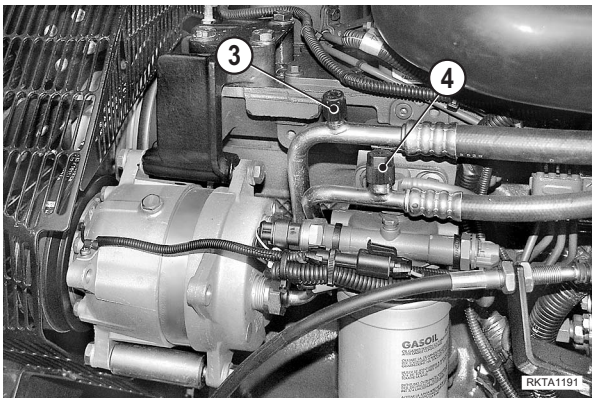
3 - Stop the engine and apply the parking brakes.



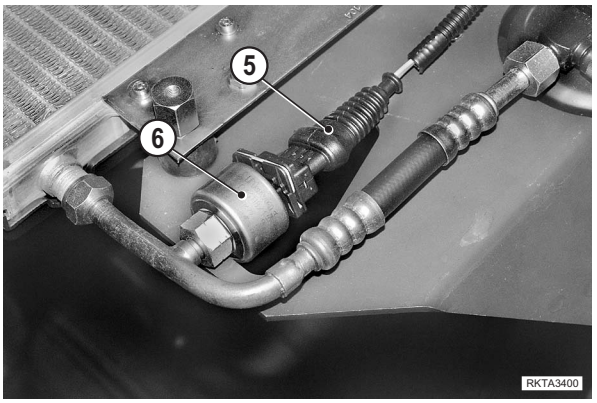
4 - Loosen and remove the retaining screws (1) and remove the cover (2).



5 - Connect the maintenance station to the connections (3), (4) and drain the coolant fluid off the air conditioning system.
(For details, see "20 TESTING AND ADJUSTMENTS").



6 - Disconnect the connector (5) and remove the pressure switch (6).



Installation

- To install, reverse the removal procedure.

1 - Carry out the system filling procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

CAB

Removal

1 - Position the machine on firm, level ground with the boom fully lowered and retracted.

2 - Lower the outriggers, if equipped. If the machine is not equipped with outriggers, place wedges under the rear wheels.

3 - Stop the engine and apply the parking brakes.

4 - Disconnect the cable from the negative (-) battery terminal.

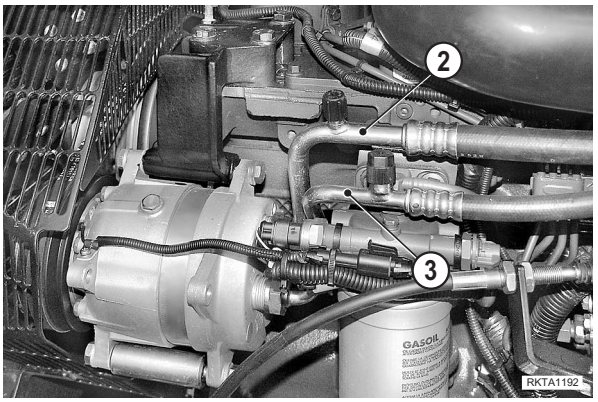
5 - Drain the coolant liquid. [*1]

Coolant liquid: 20 ℓ approx.

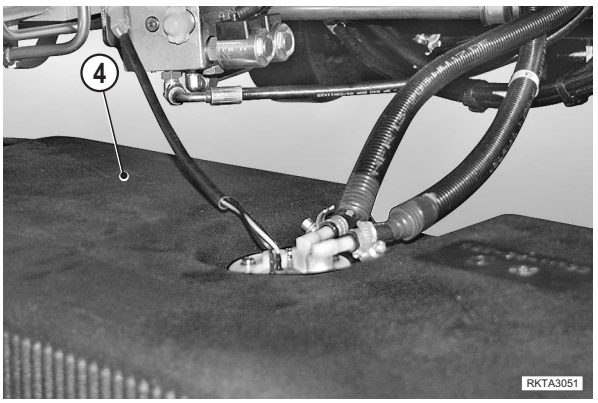
6 - Remove the screws and remove the front cover (1).

7 - **Only if equipped with air conditioning system.**
Drain the coolant fluid and disconnect the hoses (2) and (3) from the compressor.

★ Immediately seal the hoses and holes to prevent humidity from entering the passages.
(For details, see "20 TESTING AND ADJUSTMENTS").



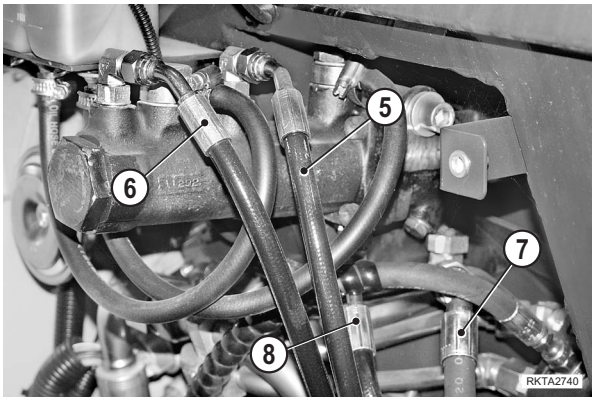
8 - Remove the fuel tank (4).
(For details, see "FUEL TANK").



9 - Mark and disconnect the service brake feed hoses (5), (6) from the brake pump. [*1]

10 - Disconnect the brake booster feed and discharge hoses (7), (8) from the brake pump.

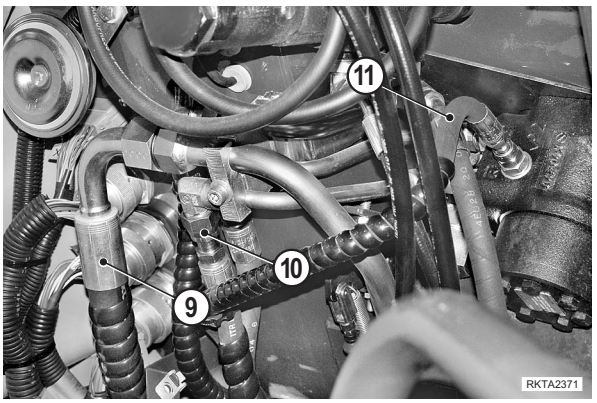
★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.



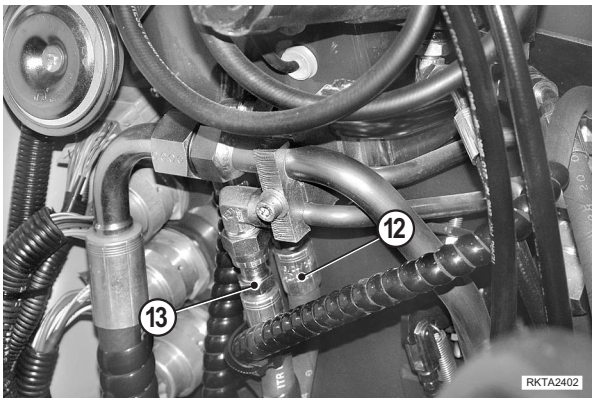
11 - Disconnect the hoses (9), (10).

12 - Disconnect the Load Sensing hose (11) from the steering unit.

★ Immediately cap the hoses and plug the holes to prevent contaminants from entering the passages.

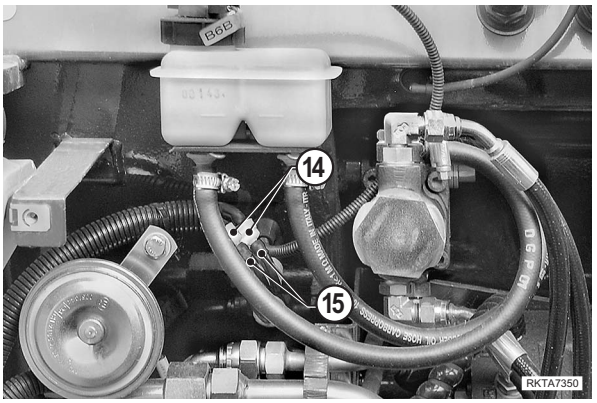


13 - Mark and disconnect the rear hoses (12), (13).

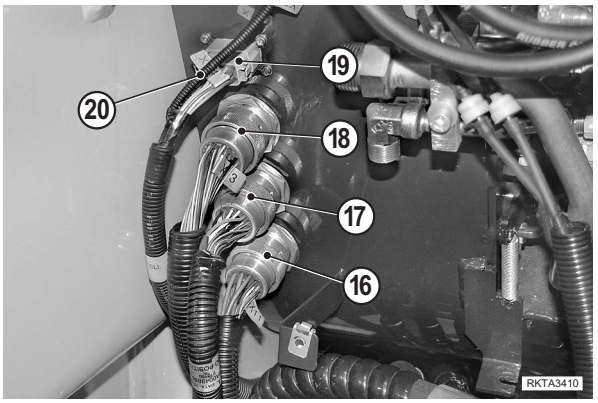


14 - Disconnect the washer fluid hoses (14) from the check valves.

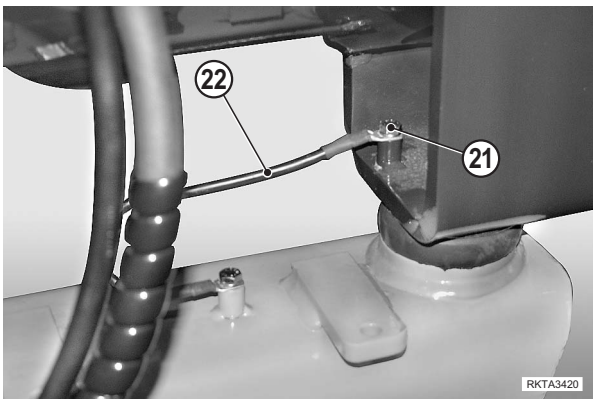
★ Disconnect the hoses at the check valve output.



15 - Disconnect connectors (16), (17), (18), (19), and the horn wiring harness (20).

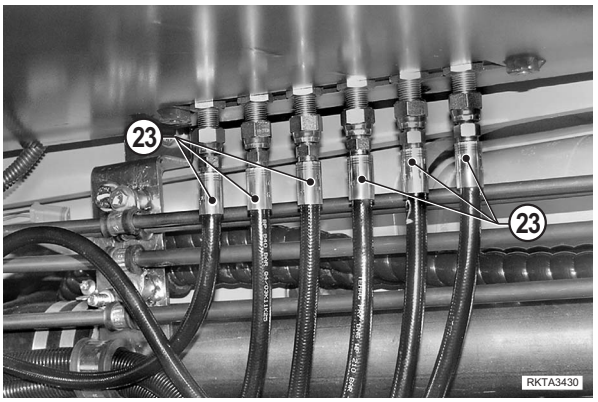


16 - Remove the screw (21) and disconnect the ground cable (22).



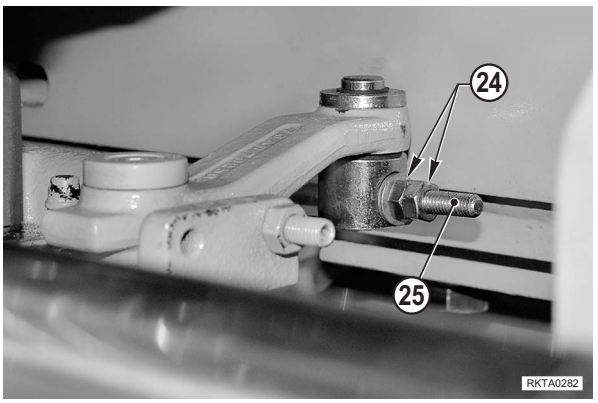
17 - Mark and disconnect the hoses (23) connecting to the PPC valve.

★ Immediately cap the hoses and fittings to prevent contaminants from entering the passages.



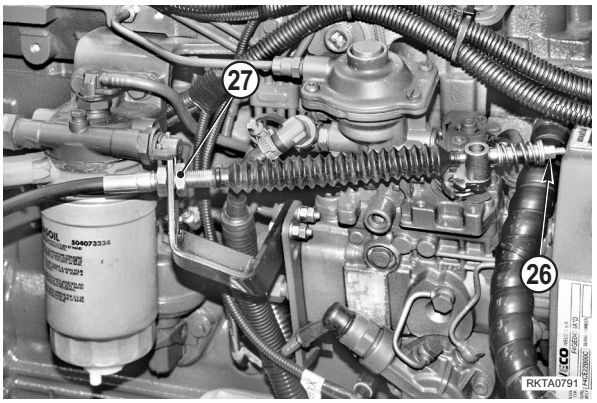
18 - Remove the nuts (24) and disconnect the parking brake control cable (25) from the front axle.

[*2]



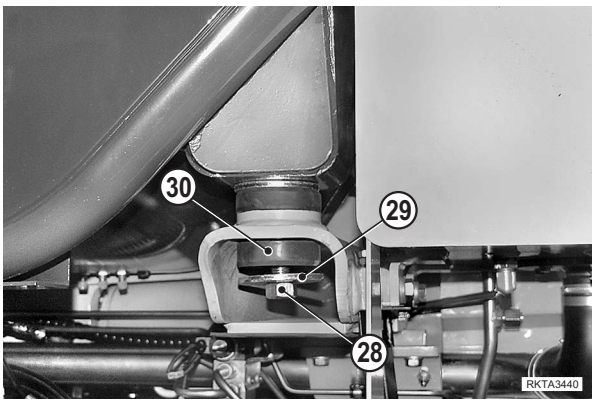
19 - Loosen and remove the nuts (26), the spring and spring guide.

20 - Loosen the nut (27) and disengage the accelerator cable and conduit.



21 - Loosen and remove the cab mounting nuts (28) and washers (29) along with the elastic pad (30).

[*3]

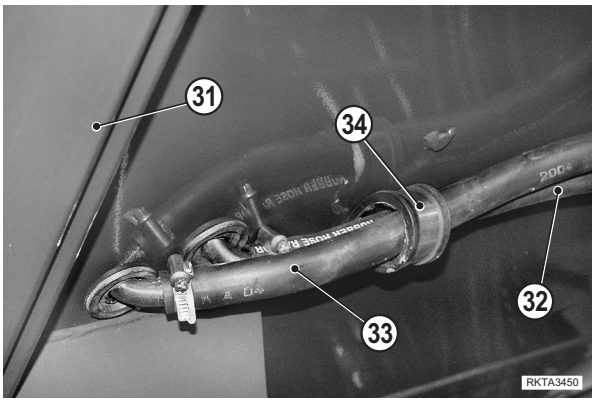


22 - Connect the cab (31) to a hoist and lift it by 30 cm. approximately.

Cab: 476.0 kg approx.

23 - Mark and disconnect the cab heating hoses (32), (33); slide them off the clamp (34).

★ Immediately cap the hoses to prevent contaminants from entering the passages.



24 - Remove the cab (31).

★ Place the cab on firm supports placed under the four free corners of the cab floor.

Installation

- To install, reverse the removal procedure.

[*1]

★ Perform the braking circuit bleed procedure.
(For details, see "20 TESTING AND ADJUSTMENTS").

★ Carry out the coolant liquid fill procedure.


Coolant liquid: 20 ℓ approx.

[*2]


Cab mounting nuts: 270±20 Nm

[*3]

★ Adjust the parking brake cable length.
(For details, see "20 TESTING AND ADJUSTMENTS").

1 - Start the engine and perform several lift and braking manoeuvres in order to bleed the air from the control circuits.

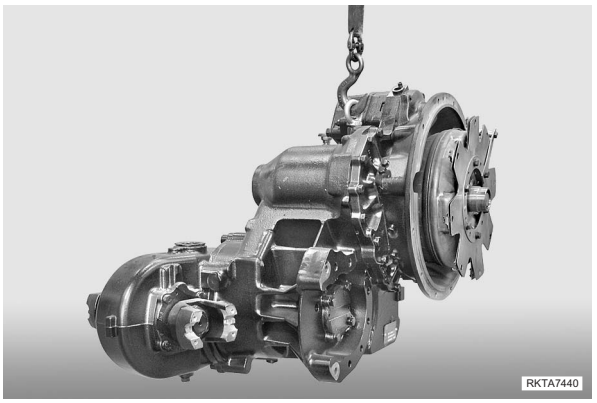
2 - Stop the engine and check the seals on the parts you have previously removed.

TRANSMISSION

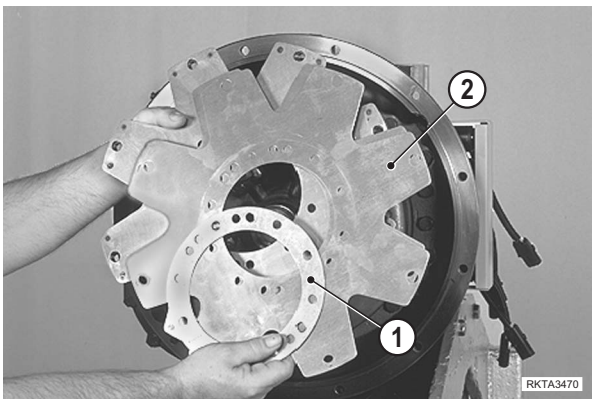
TRANSMISSION ASSEMBLY

Disassembly

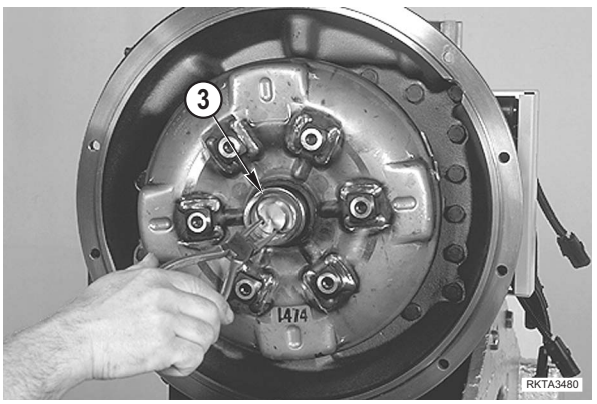
1 - Front and rear view of transmission.

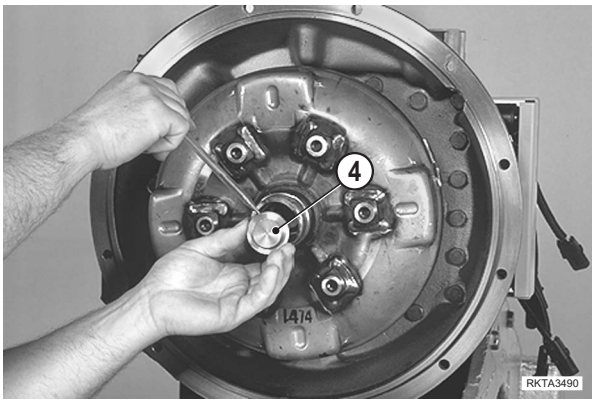


2 - Remove the drive plate screws and washers. Remove the backing ring (1) and drive plates (2). [*1]

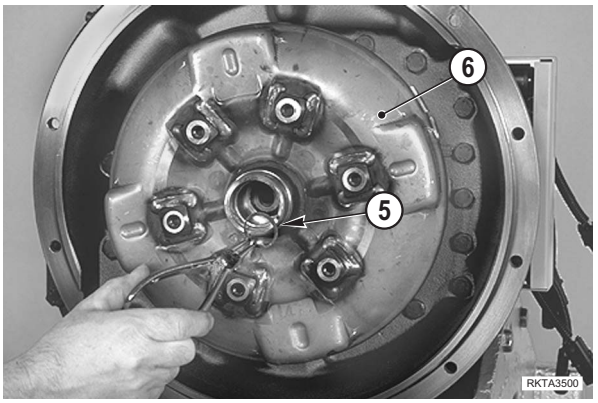


3 - Remove the plug retainer ring (3), the plug (4) and the O-ring.

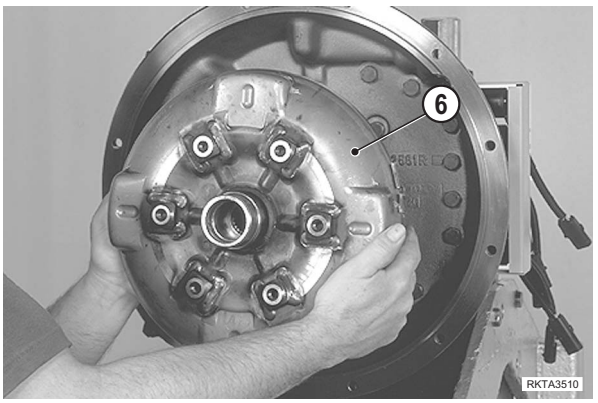




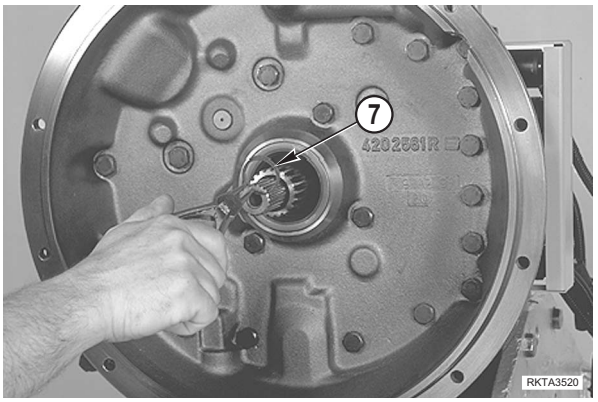
4 -Remove the ring (5) retaining the hydrodynamic coupling (6) to the shaft.



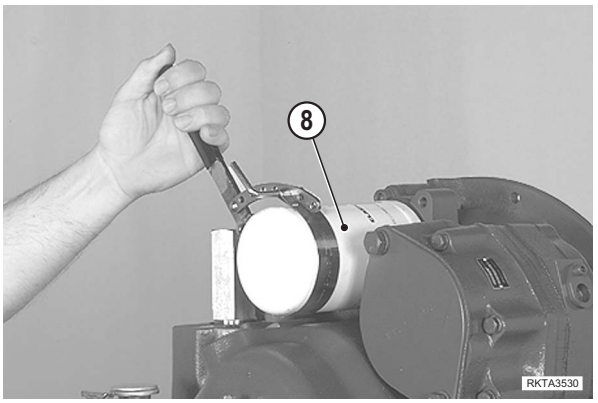
5 -Remove the hydrodynamic coupling (6).



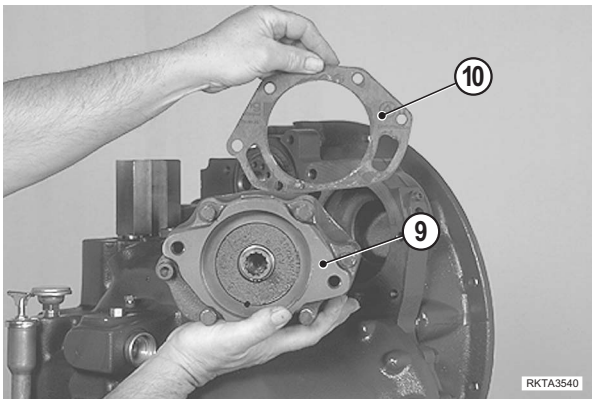
6 -Remove the coupling to turbine shaft backing ring (7).



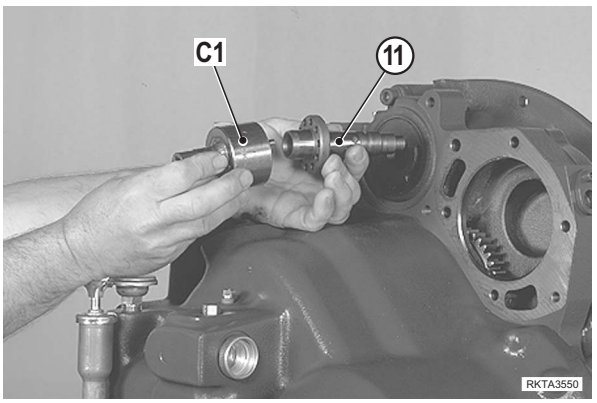
7 -Remove the filter (8). [*2]



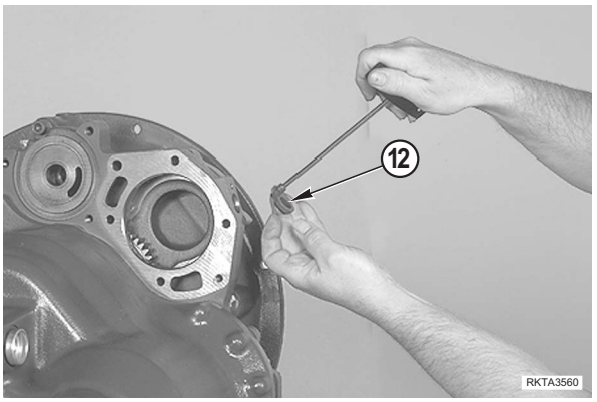
8 - Remove the pump mounting screws and washers. Remove the pump (9) and gasket (10). [*3]



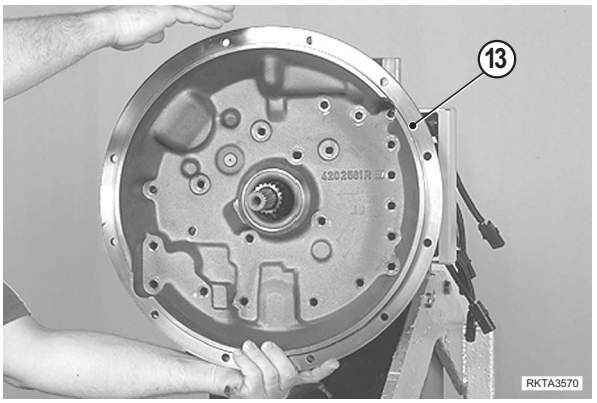
9 - Using tool **C1** (code no. ATR201501)remove the pressure regulator assembly (11). [*4]



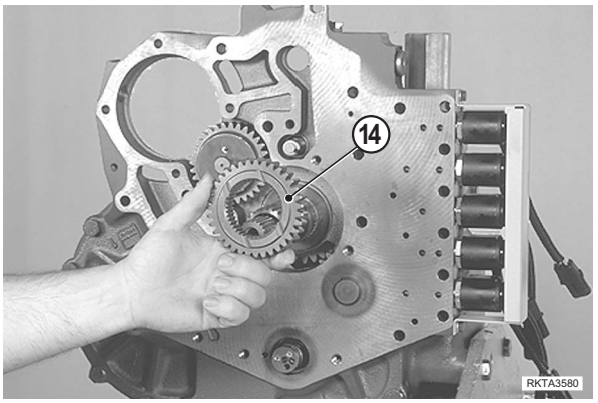
10 - Remove the pressure sensor plug (12).



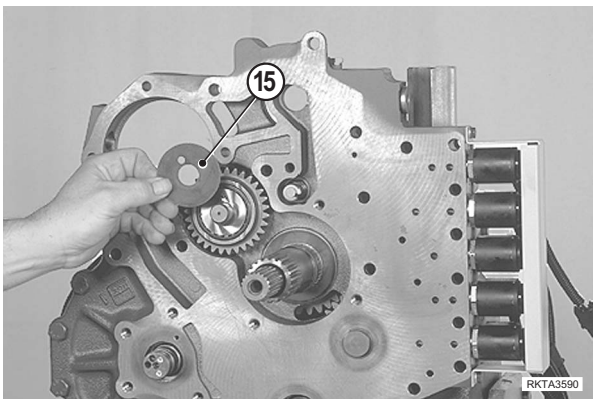
11 - Remove the 18 screws and washers retaining the flange (13) connecting to the engine. Remove the flange and gasket. [*5]

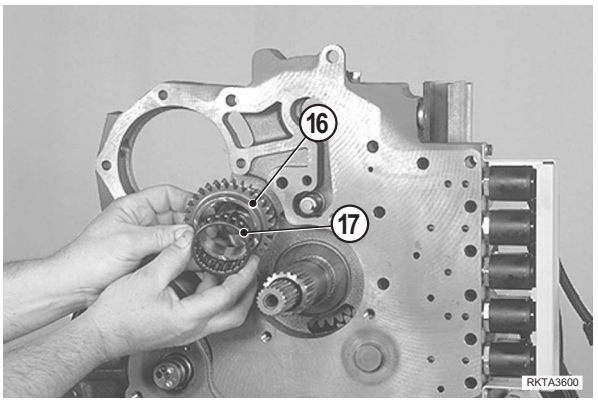


12 -Remove the pump drive gear (14) from the hub.

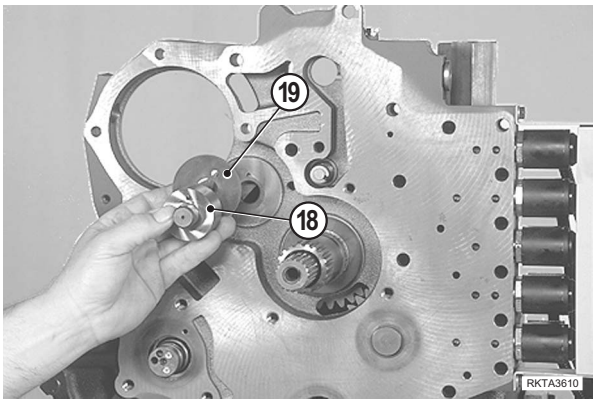


13 -Remove the backing washer (15), the intermediate gear (16) and bearing (17).

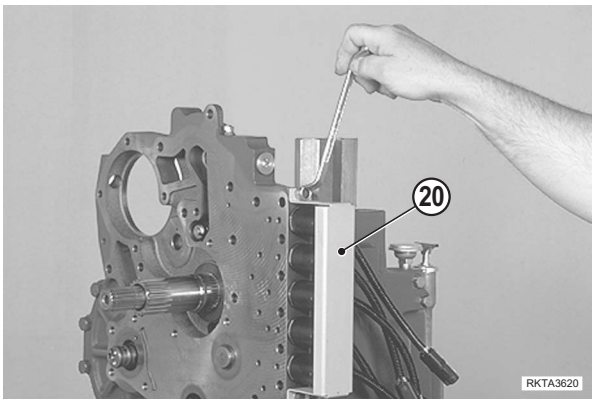


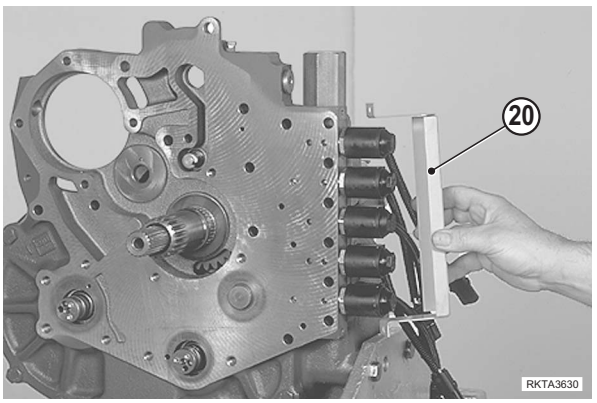


14 -Remove the intermediate shaft (18) and backing washer (19).

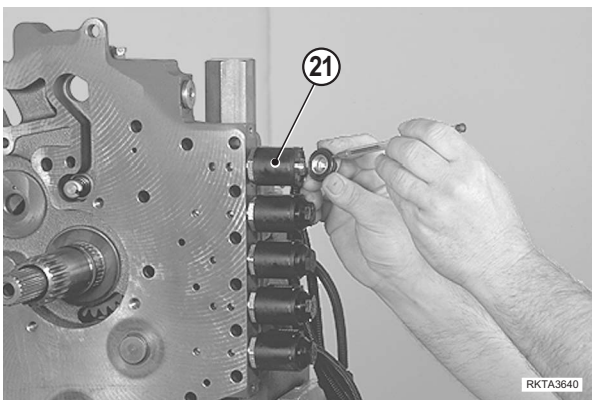


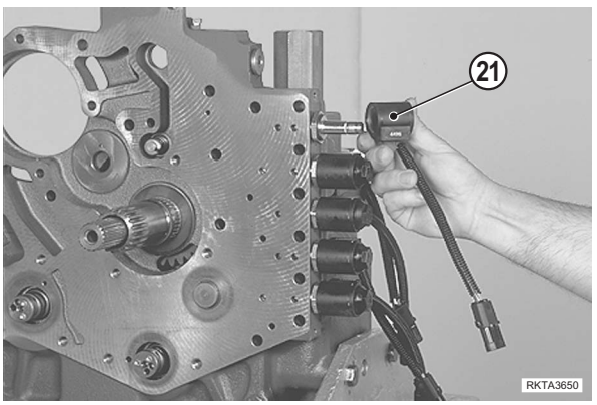
15 - Remove the solenoid protection cover (20). [*6]



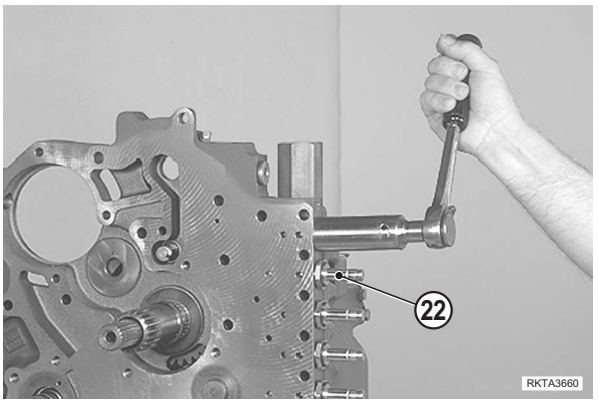


16 - Remove the solenoid coils (21) and O-rings. [*7]

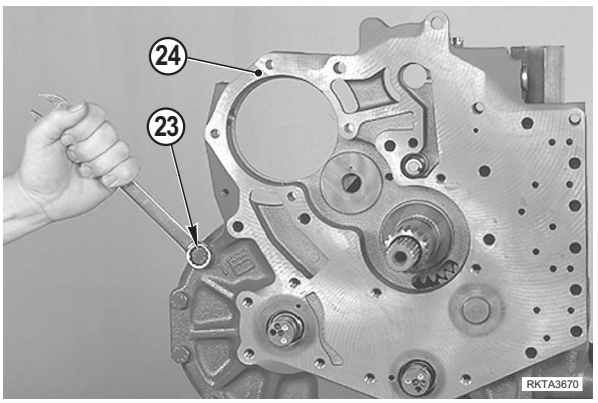




17 -Remove the valve spools (22) and O-rings.

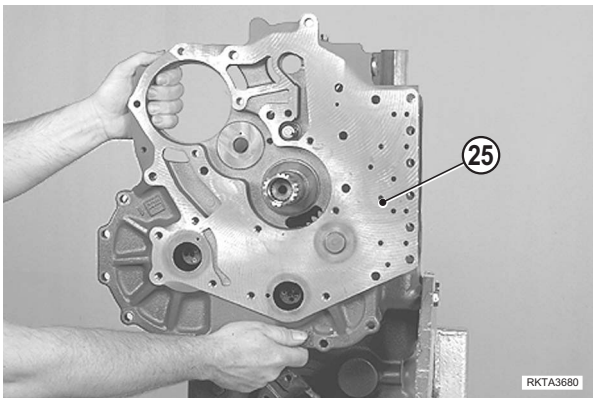


18 -Remove the screws (23) retaining the transmission spacer plate (24).

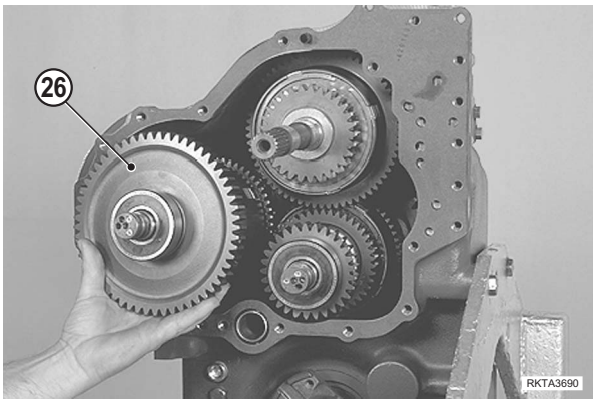


19 -Remove the spacer plate (25) and gasket. [*8]

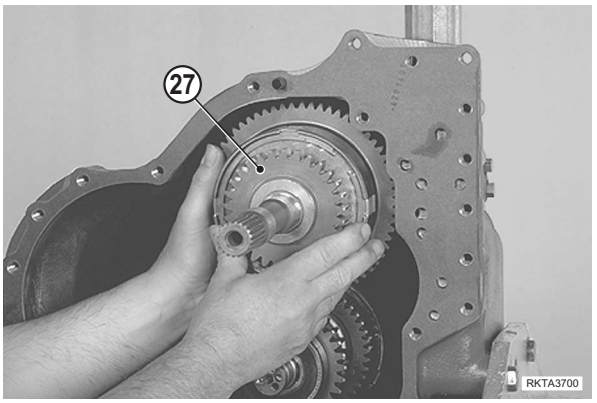
⚠ To remove, pry the plate close to the dowel pins.



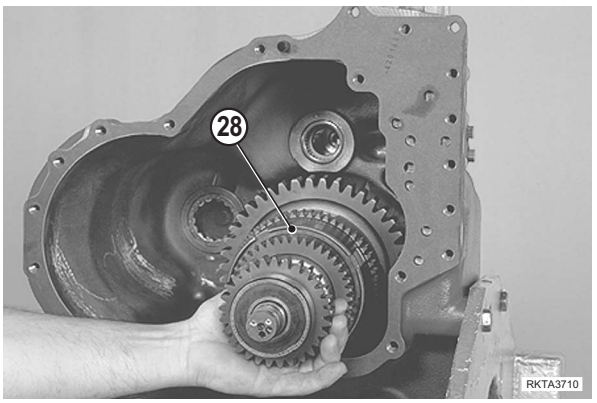
20 -Remove the 1st and 2nd clutch assembly (26).



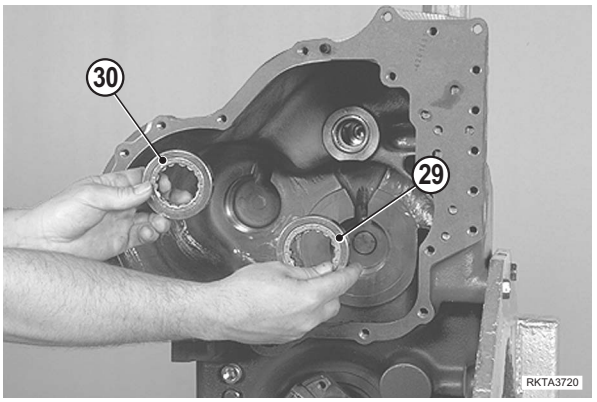
21 - Remove the forward and reverse clutch assembly (27).



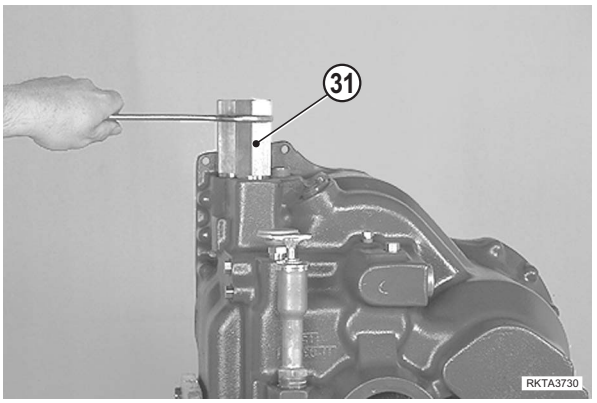
22 - Remove the 3rd and 4th clutch assembly (28).



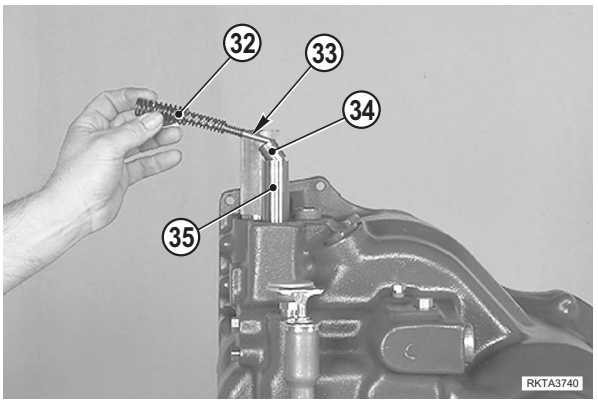
23 - Remove clutch assembly rear bearings (29) and (30).



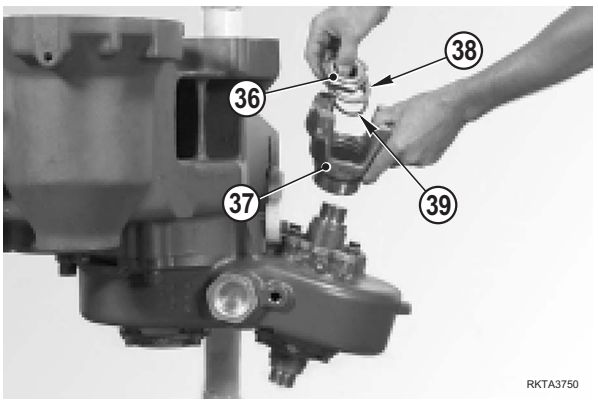
24 - Remove the modulator valve housings (31).



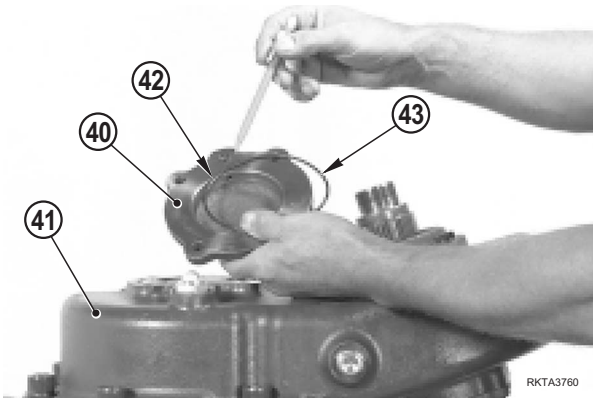
25 - Remove the spring assembly (32), stop pin (33), first spool (34) and cartridge (35).



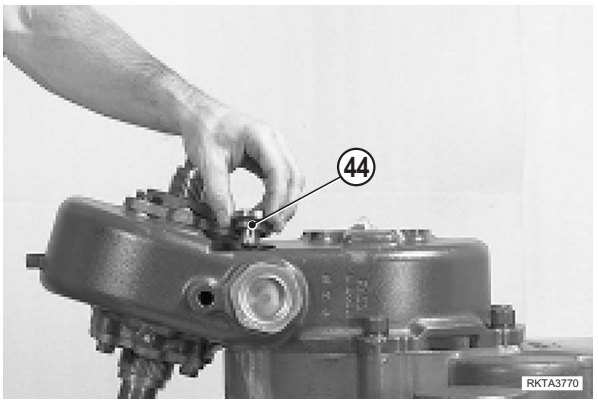
26 - Using a pneumatic impact wrench, loosen and remove the nuts (36) retaining the flanges (37), washers (38) and O-rings (39). [*9]



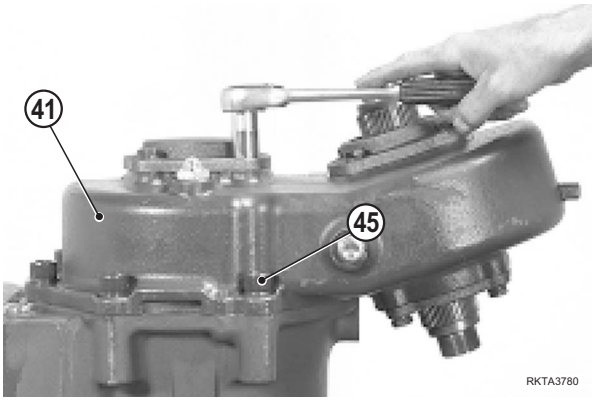
27 - Remove the screws and washers. Remove the rear flange (40) of the drop box (41), O-ring (42) and O-ring (43). [*8]



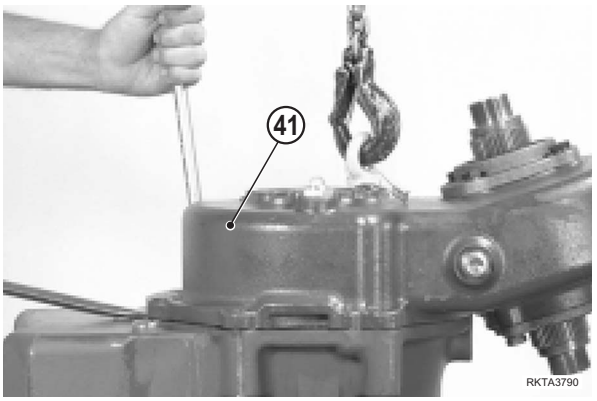
28 - Remove the fill plug (44).



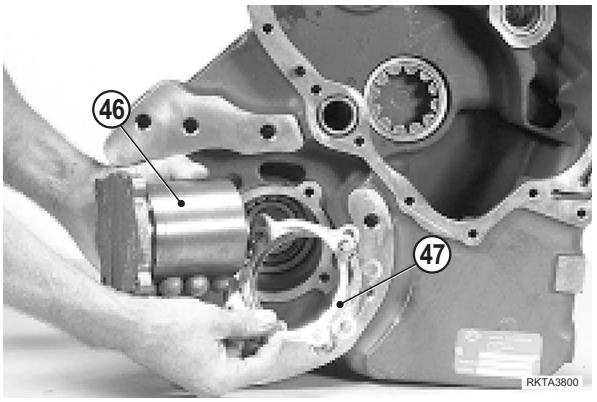
29 - Loosen the screws (45) retaining the drop box (41). [*10]



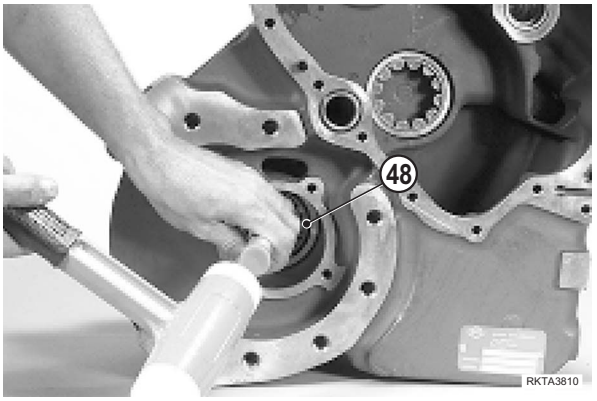
30 - Connect the drop box (41) to a hoist. Tension the chain or rope. Pry the drop box (41) from the transmission housing.



31 - Remove screws and washers; remove the flange (46) and shim pack (47). [*8]

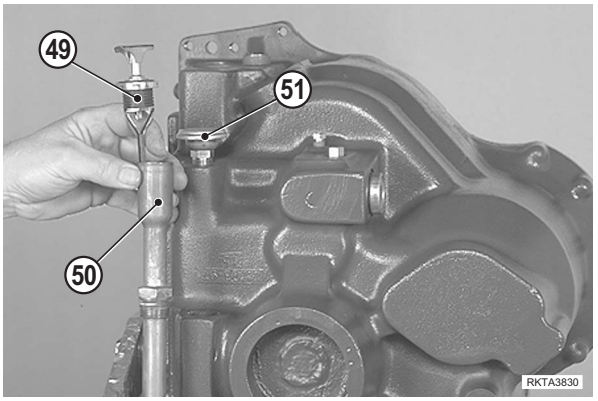


32 - Using a suitable driver, disengage the drop box main shaft (48) from the front bearing.



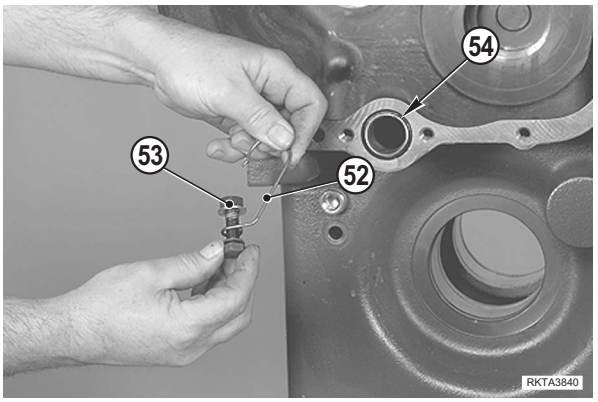
33 -Remove the main shaft assembly (48).

34 -Remove the dipstick (49), dipstick tube (50) and air breather (51).

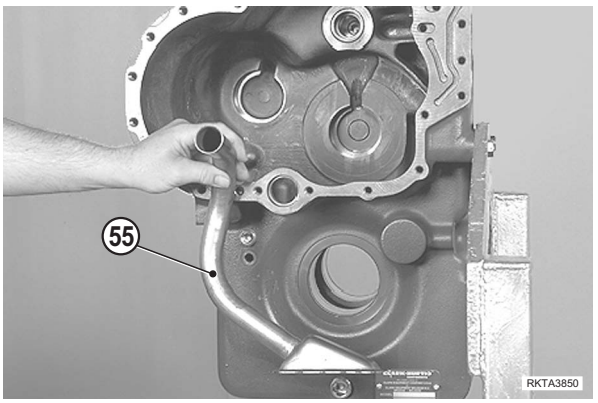


35 -Remove the retainer (52), screw (53), O-ring seal and O-ring (54) from the supply tube (55).

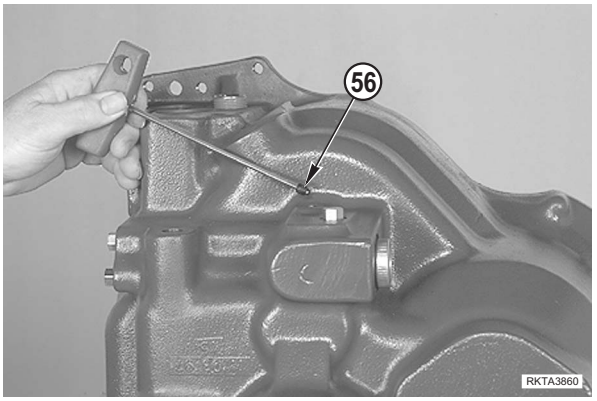
[*11]



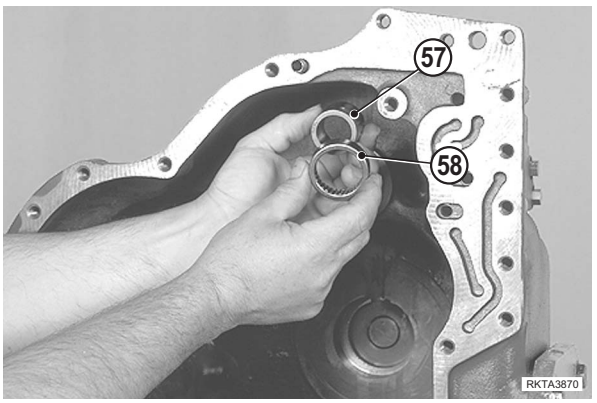
36 -Remove the supply tube (55).



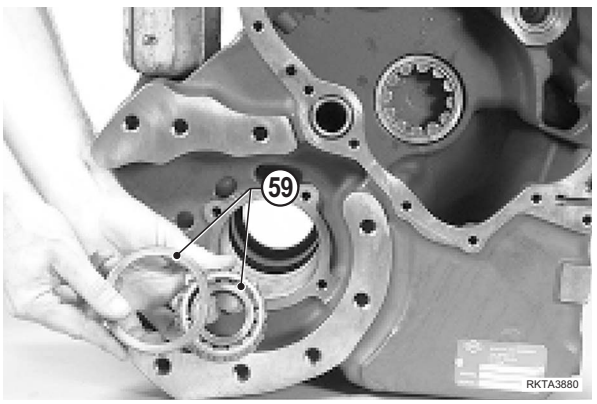
37 - Remove the forward and reverse clutch shaft bushing retaining screw (56). [*12]



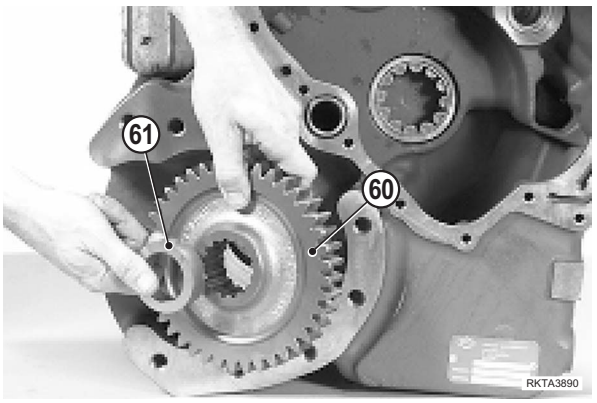
38 - Using a hammer puller, remove the control valve sleeve (57) and bearing (58).



39 - Remove the front tapered bearing (59).



40 - Remove the gear (60) and spacer (61).



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

Screws: 35 – 39 Nm

[*2]

Filter: 27 – 34 Nm

[*3]

Screws: 35 – 41 Nm

[*4]

Regulator assembly: 61 – 68 Nm

[*5]

Position two studs to ease the centring of clutch shafts and sealing elements.
Do not use screws to force the installation.

Screws: 40 – 50 Nm

[*6]

Screws: 5 – 7 Nm

[*7]

Nuts: 22 – 27 Nm

[*8]

Screws: 40 – 50 Nm

[*9]

Nuts: 389– 407 Nm

[*10]

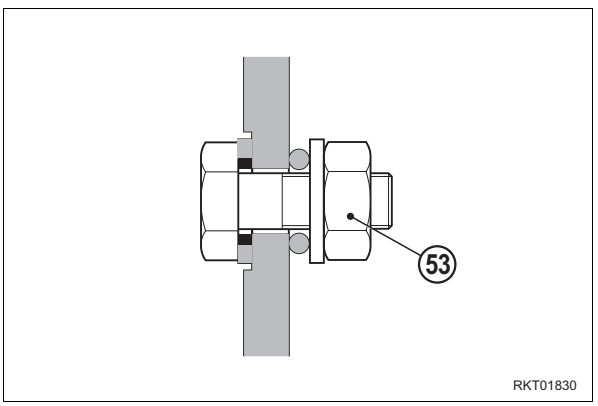
Screws: 170 – 190 Nm

[*11]

Nut: Loctite 270

[*12]

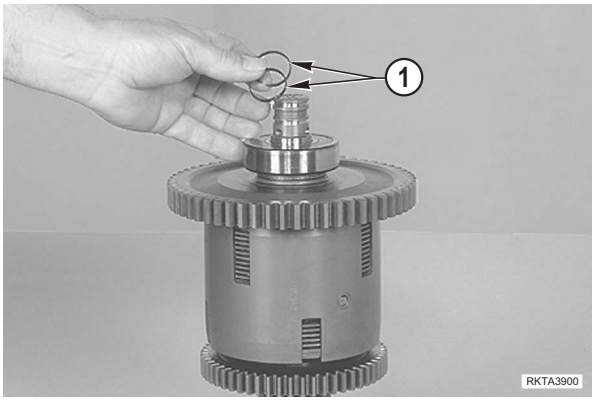
Screw: Loctite 243



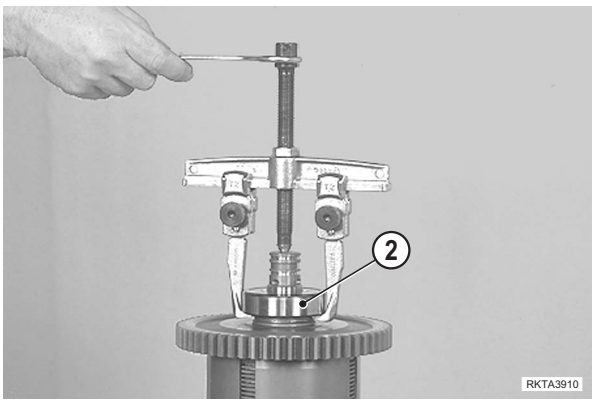
1st CLUTCH

Disassembly

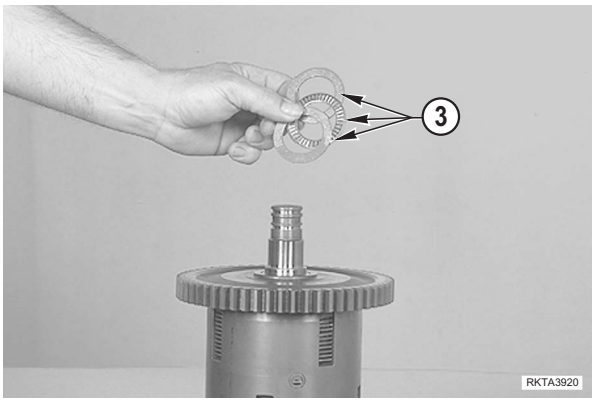
1 -Remove the sealing elements (1).



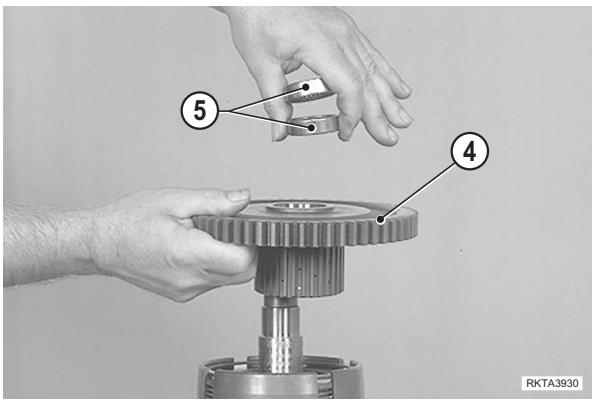
2 -Remove the front bearing (2).



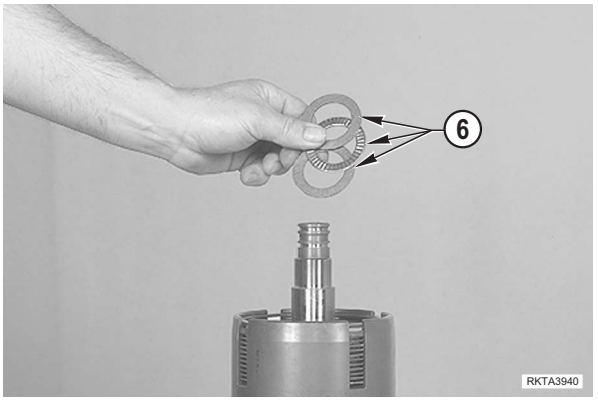
3 -Remove the outer thrust bearing (3).



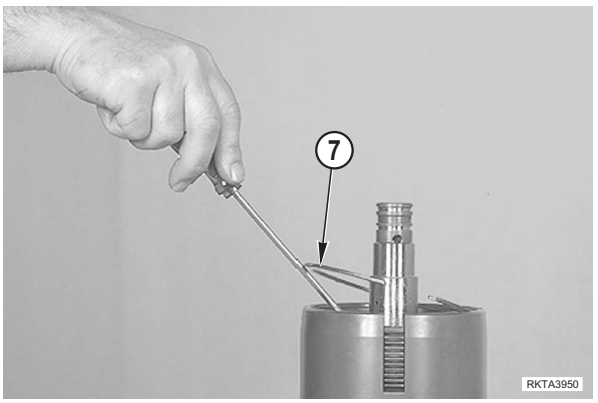
4 -Remove the gear (4) and bearings (5).



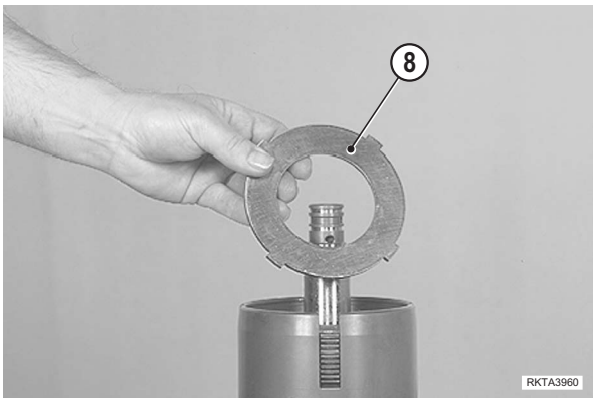
5 -Remove the inner thrust bearing (6).



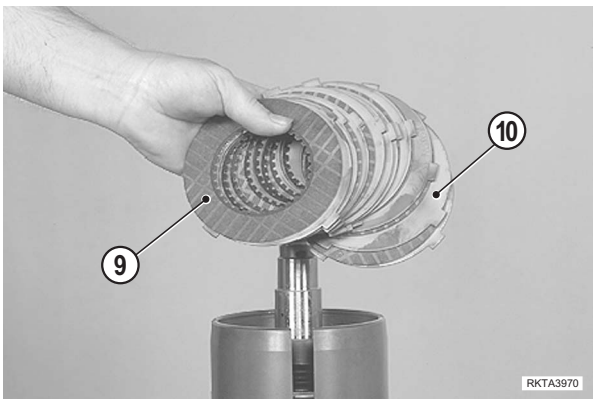
6 -Remove the clutch disc inner retainer ring (7).



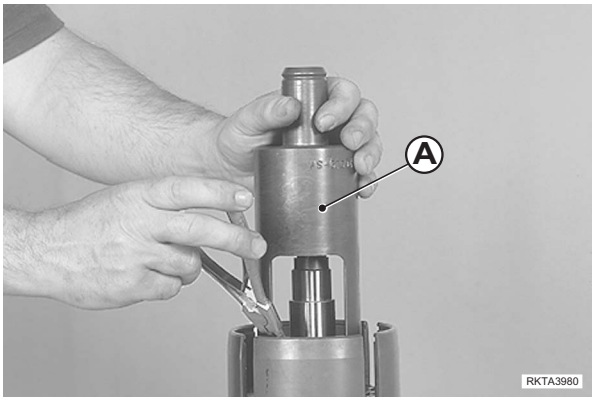
7 -Remove the end plate (8).



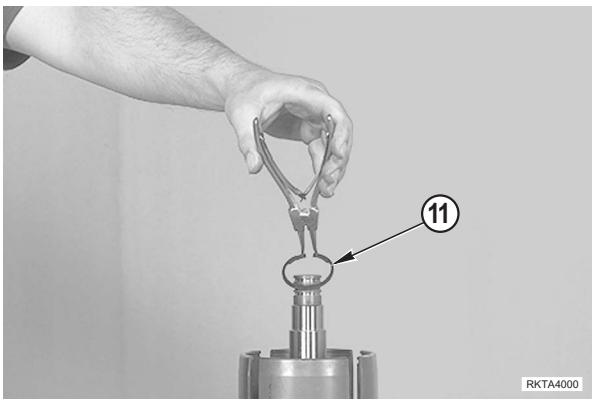
8 -Remove the clutch discs (9) and (10). [*1]



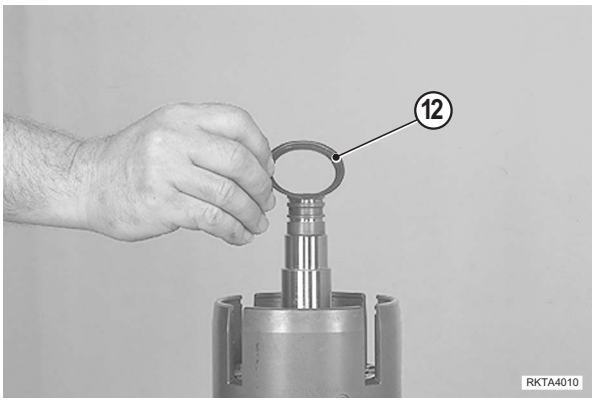
9 - Using a puller (A), compress the disc springs to disengage the retainer ring. [*2]



10 - Remove the retainer ring (11).

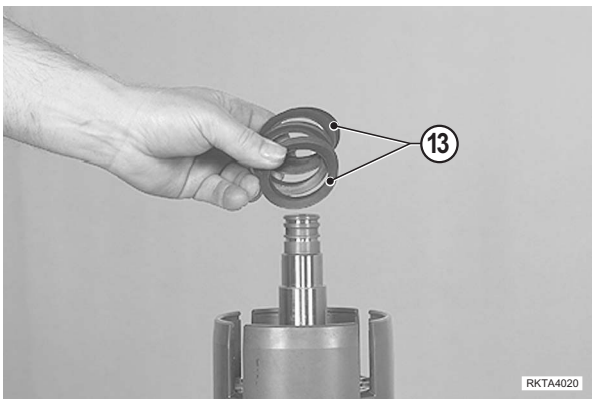


11 - Remove the spring locating ring (12).

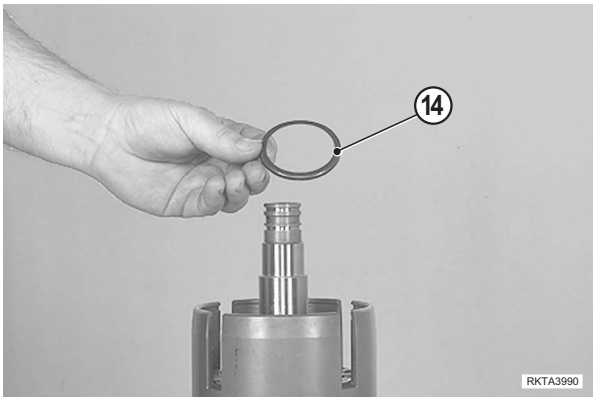


12 - Remove the disc springs (13). [*3]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.



13 -Remove the inner spring locating ring (14).



14 -Turn the clutch over and tap the clutch on a block of soft material to remove the piston (15). [*4]

★ Note down the seals assembly sequence.

Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Start clutch disc installation by placing a steel disc (10) first.

★ Install 10 + 10 clutch discs in total.

[*2]

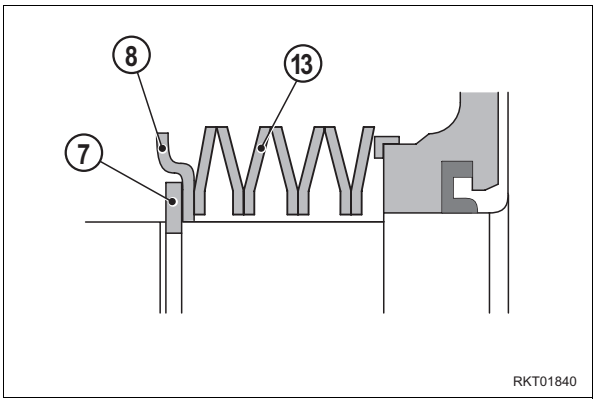
★ After installing the snap ring, turn the assembly over and check clearance between piston and steel ring for being between 2.03 and 3.43 mm.
If clearance is greater than 3.43 mm, remove the snap ring (7) and end plate (8) and add a steel disc.

[*3]

★ Orient the springs (13) as shown to the side.

[*4]

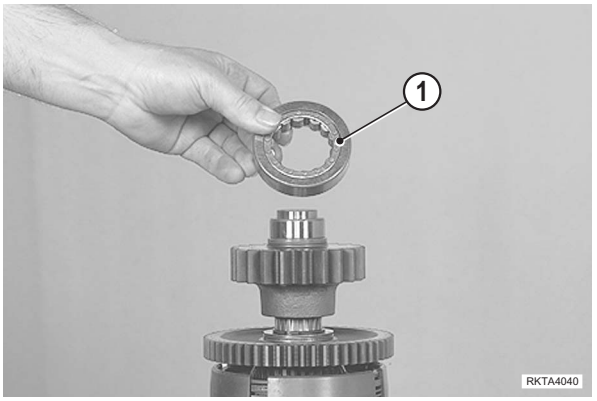
★ The inner retainer ring should be extended to reach the size of the shaft. This is done by rolling the seal lip on a refaced piece of round steel.



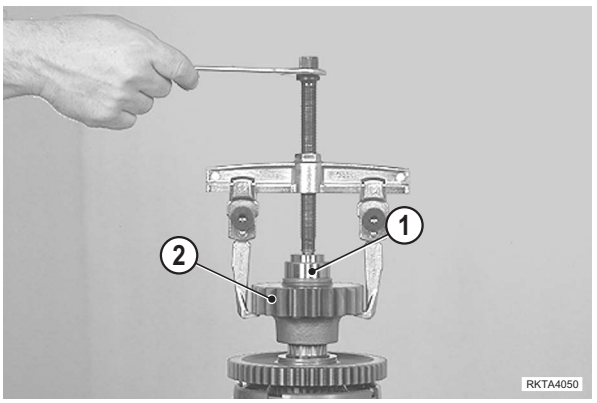
2nd CLUTCH

Disassembly

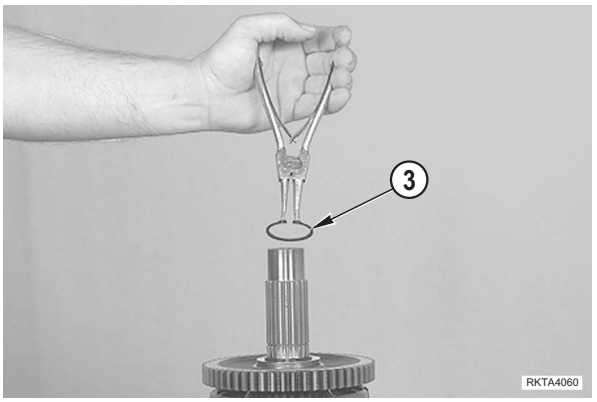
1 - Remove the shaft bearing outer race (1).



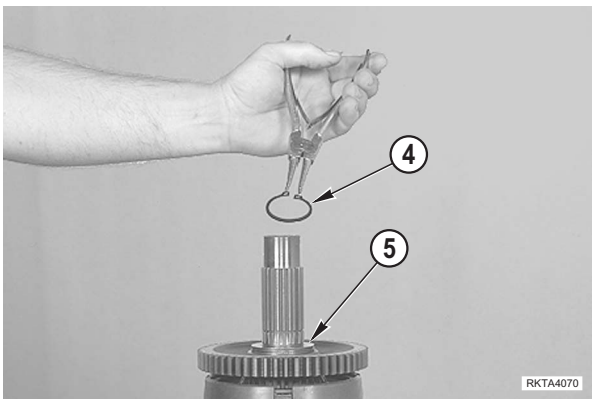
2 - Using a gear puller, remove the gear (2) and bearing inner race (1).



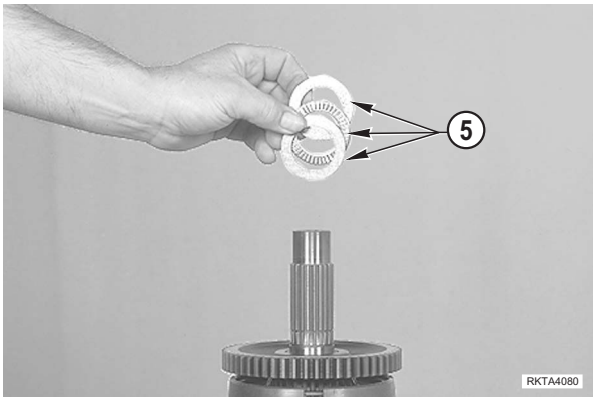
3 - Remove the ring (3) stopping the gear (2).



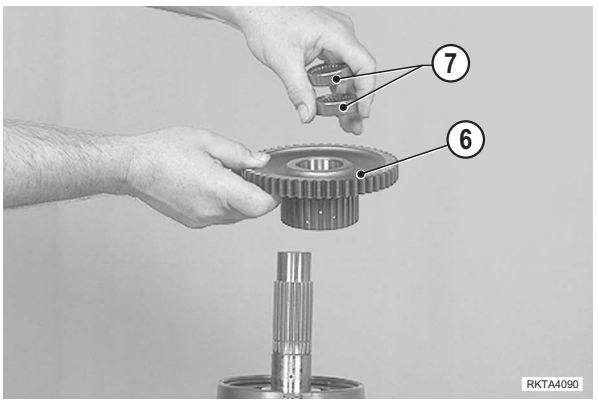
4 - Remove the ring (4) retaining the thrust bearing (5).



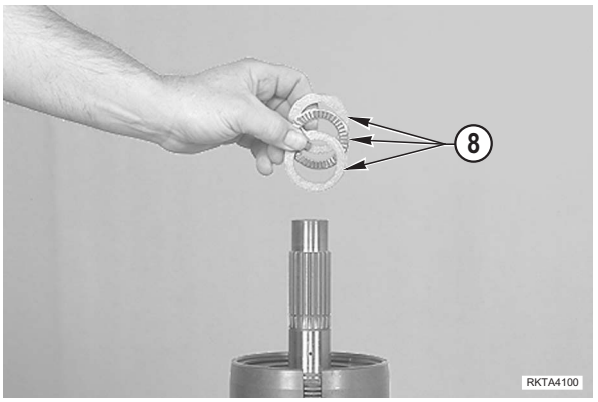
5 -Remove the outer thrust bearing (5).



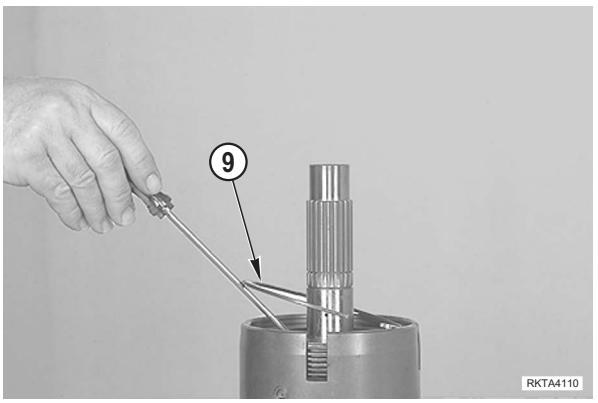
6 -Remove the gear (6) and bearings (7).



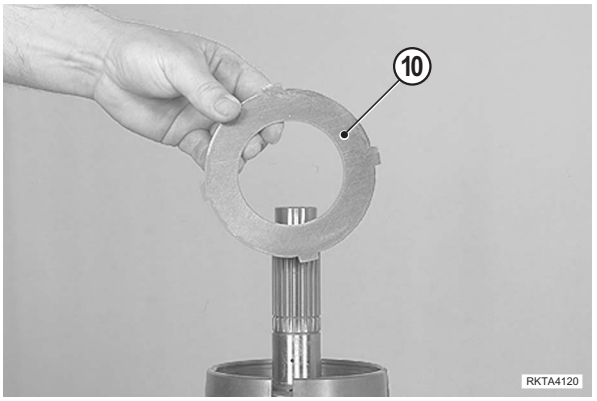
7 -Remove the inner thrust bearing (8).



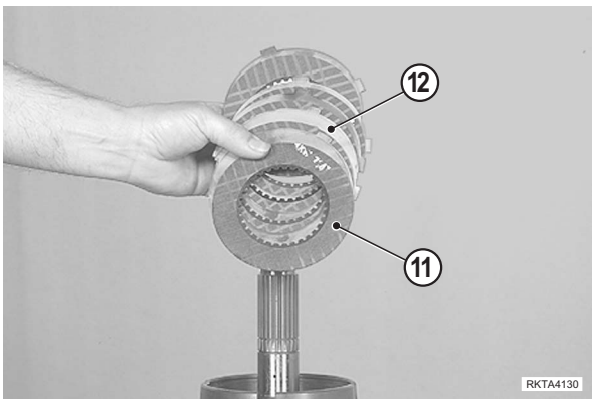
8 -Remove the clutch disc inner retainer ring (9).



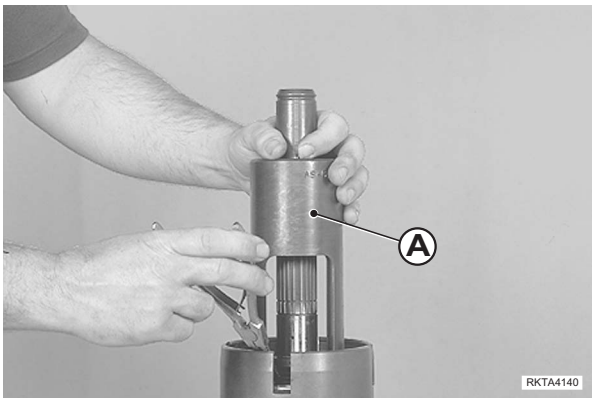
9 - Remove the end plate (10).



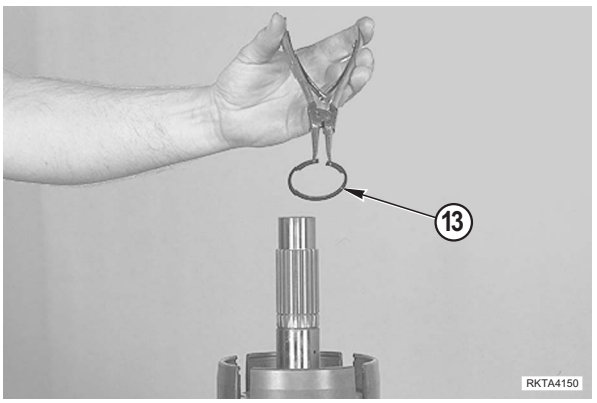
10 - Remove the clutch discs (11) and (12). [*1]



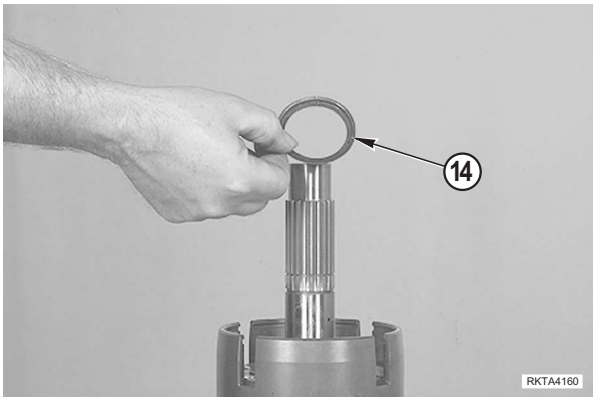
11 - Using a puller (A), compress the disc springs to disengage the retainer ring.



12 - Remove the retainer ring (13).

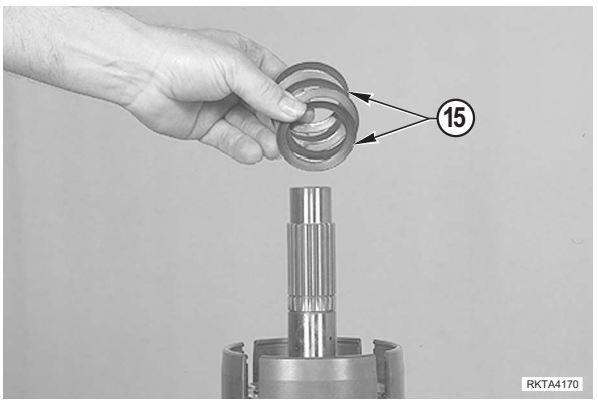


13 -Remove the spring locating ring (14).

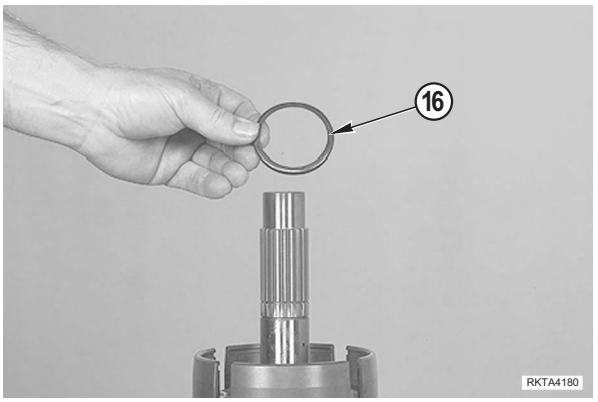


14 -Remove the disc springs (15). [*2]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.

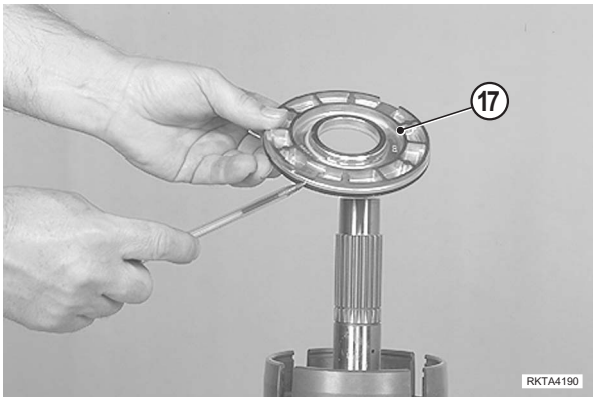


15 -Remove the inner spring locating ring (16).



16 -Turn the clutch over and tap the clutch on a block of soft material to remove the piston (17). [*3]

★ Note down the seals assembly sequence.



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Start clutch disc installation by placing a steel disc first.

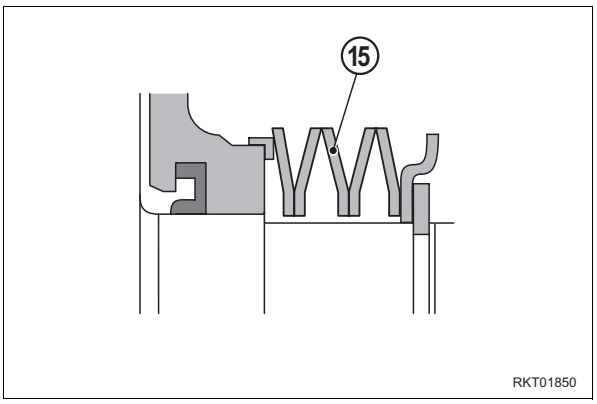
★ Install 5 + 5 clutch discs in total.

[*2]

★ Orient the springs (15) as shown to the side.

[*3]

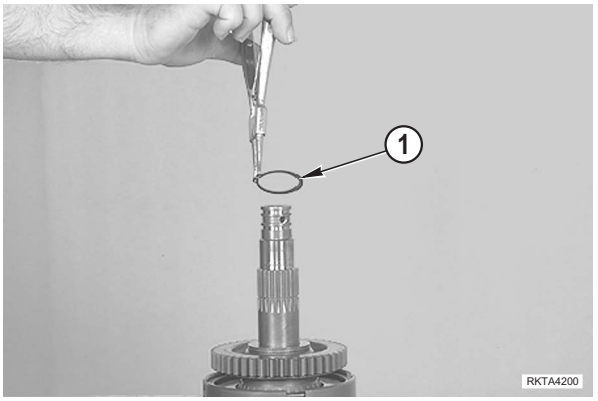
★ The inner retainer ring should be extended to reach the size of the shaft. This is achieved by rolling the seal lip on a refaced piece of round steel.



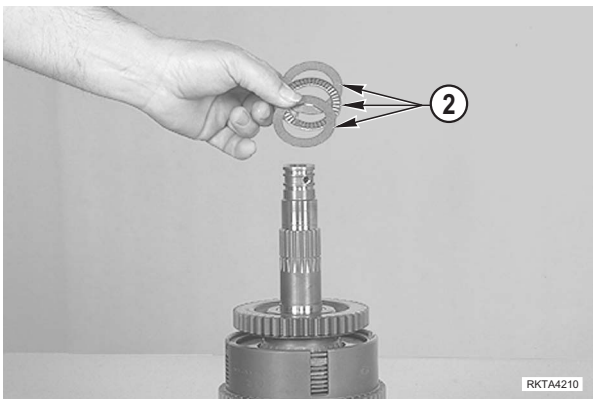
4th CLUTCH

Disassembly

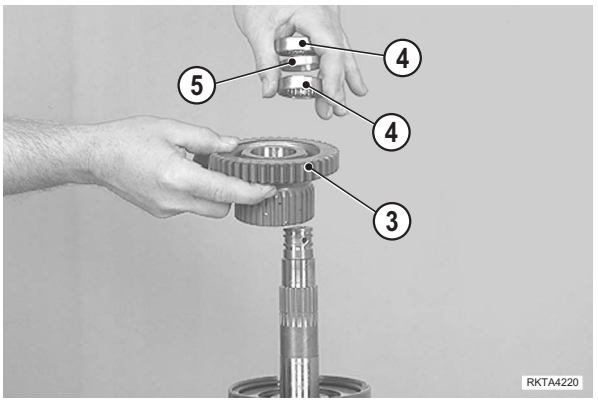
1 -Remove the retainer ring (1).



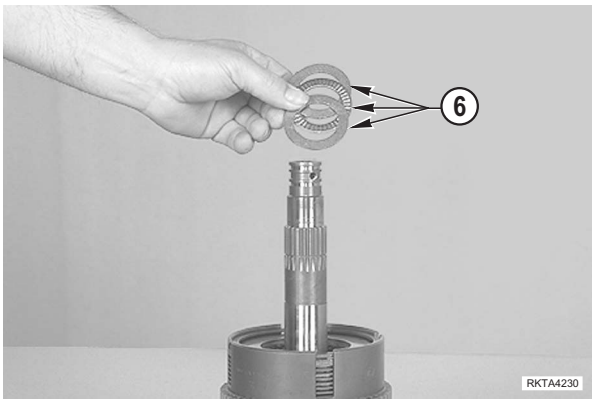
2 -Remove the outer thrust bearing (2).



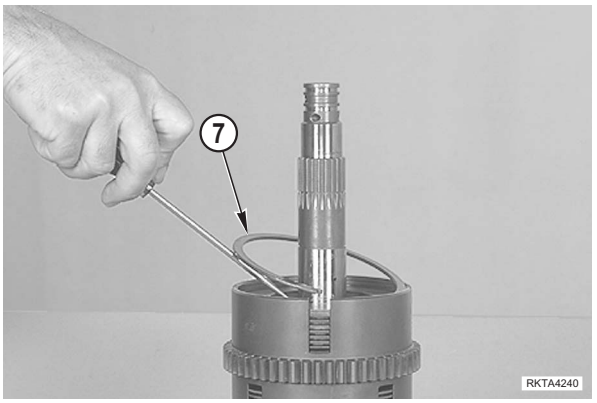
3 -Remove the gear (3), bearings (4), and spacer (5).



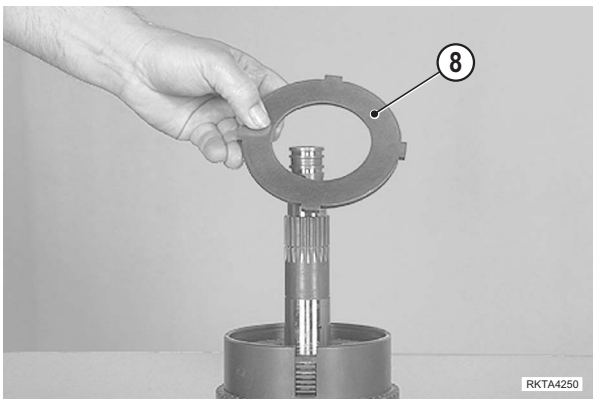
4 -Remove the inner thrust bearing (6).



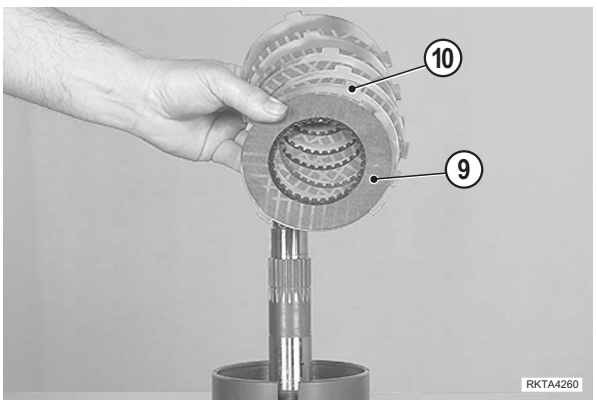
5 - Remove the clutch disc inner retainer ring (7).



6 - Remove the end plate (8).

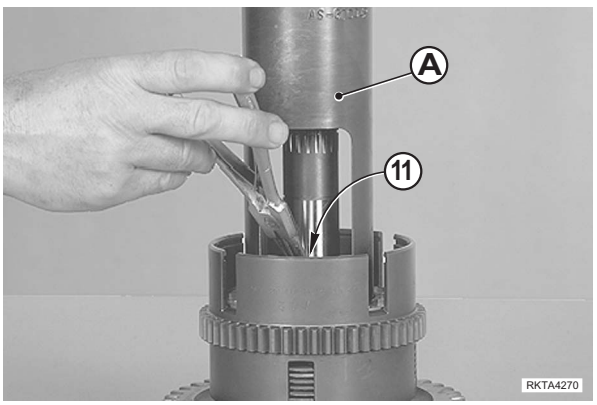


7 - Remove the clutch discs (9) and (10). [*1]

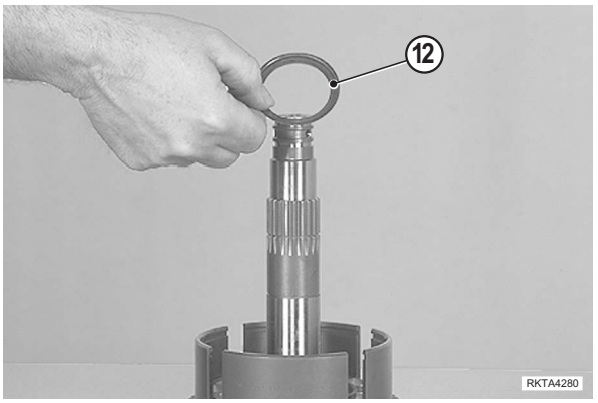


8 - Using a puller (A), compress the disc springs to disengage the retainer ring.

9 - Remove the retainer ring (11).

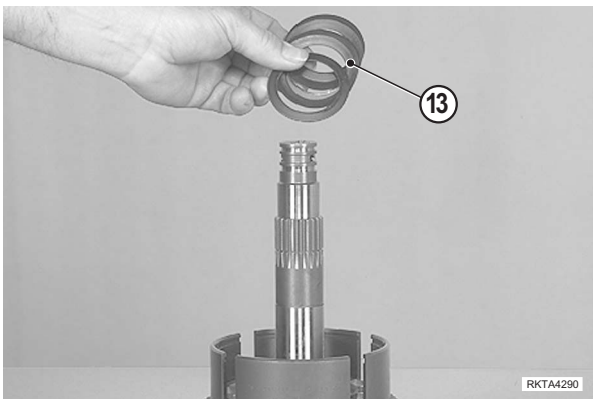


10 -Remove the spring locating ring (12).

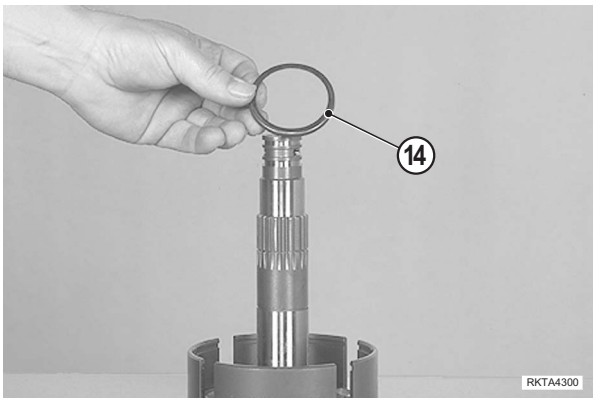


11 -Remove the disc springs (13). [*2]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.

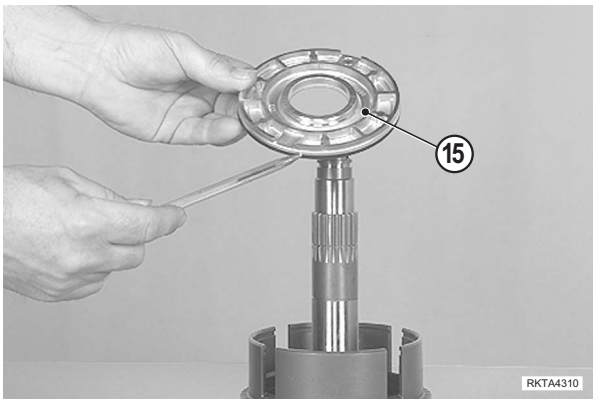


12 -Remove the inner spring locating ring (14).



13 -Turn the clutch over and tap the clutch on a block of soft material to remove the piston (15). [*3]

★ Note down the seals assembly sequence.



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Start clutch disc installation by placing a steel disc first.

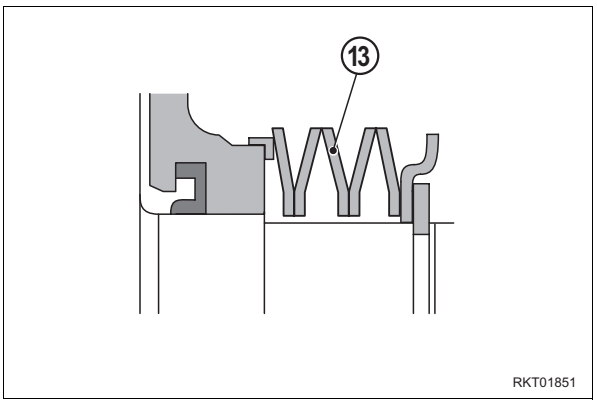
★ Install 6 + 6 clutch discs in total.

[*2]

★ Orient the springs (13) as shown to the side.

[*3]

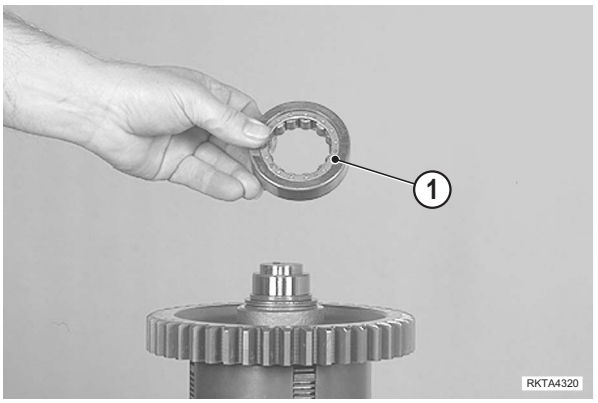
★ The inner retainer ring should be extended to reach the size of the shaft. This is achieved by rolling the seal lip on a refaced piece of round steel.



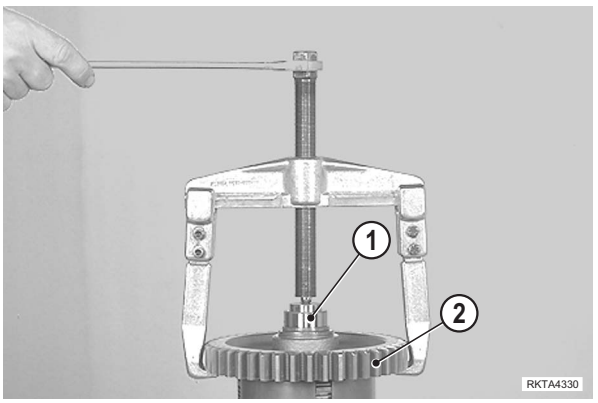
3rd CLUTCH

Disassembly

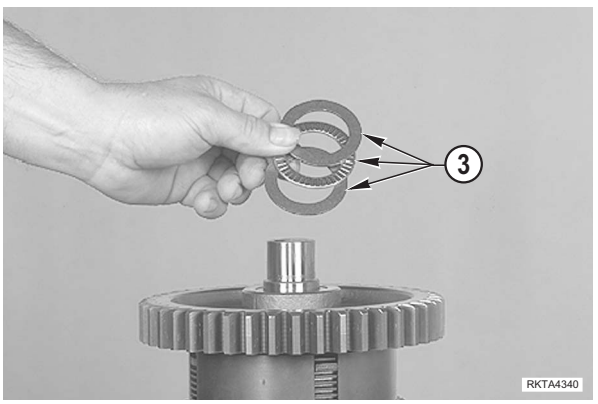
1 -Remove the bearing outer race (1).



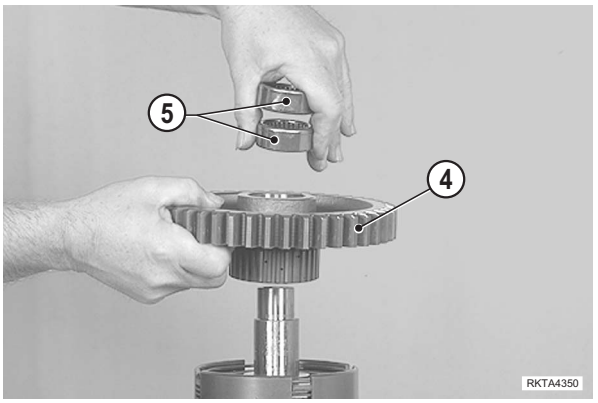
2 -Using a gear puller, remove the gear (2) and bearing inner race (1).



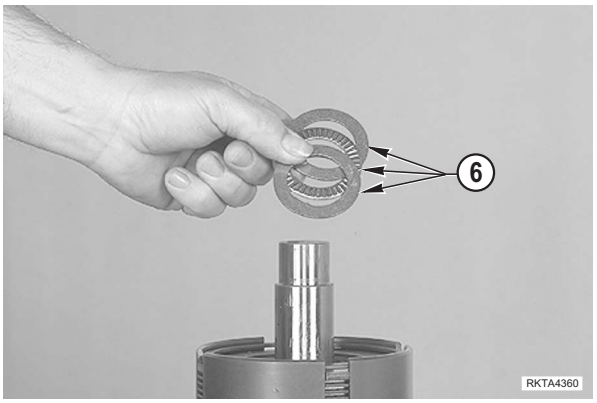
3 -Remove the thrust bearing (3).



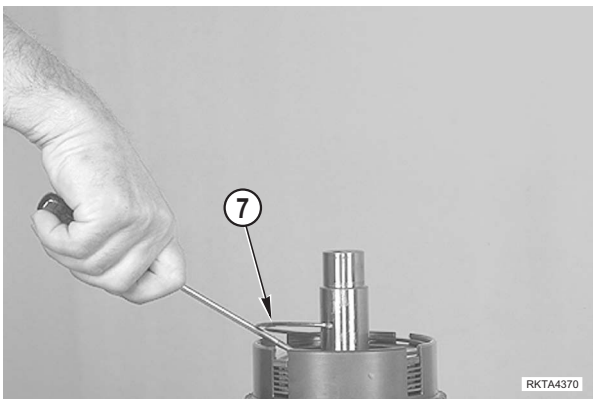
4 -Remove the bearings (5) from the gear (4).



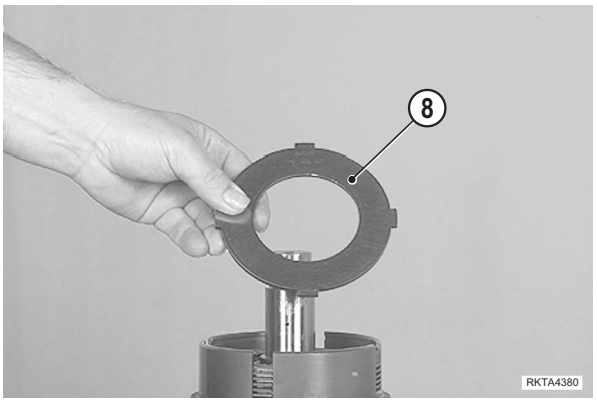
5 -Remove the thrust bearing (6).



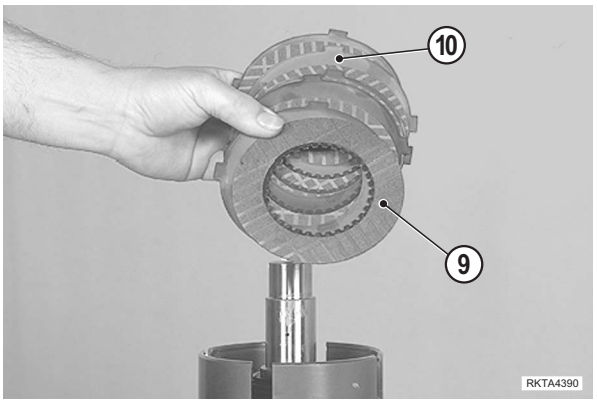
6 -Remove the clutch disc inner retainer ring (7).



7 -Remove the end plate (8).

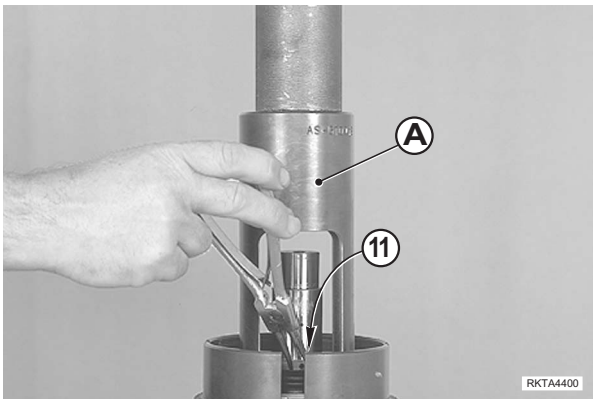


8 -Remove the clutch discs (9) and (10). [*1]

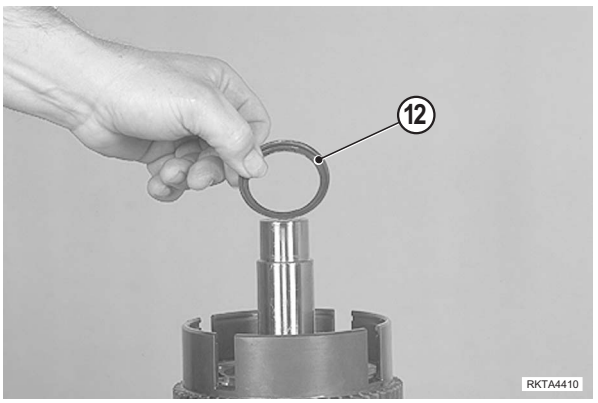


9 - Using a puller (A), compress the disc springs to disengage the retainer ring.

10 - Remove the retainer ring (11).

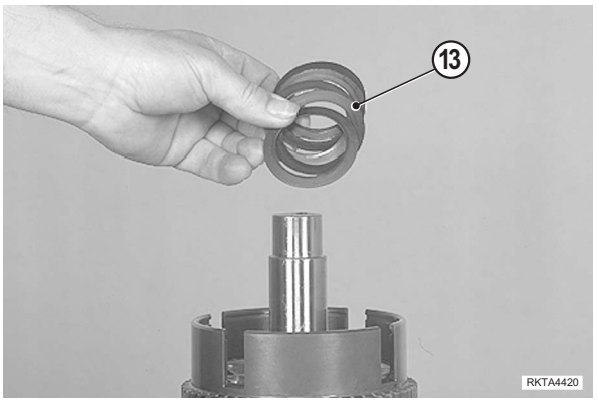


11 - Remove the spring locating ring (12).

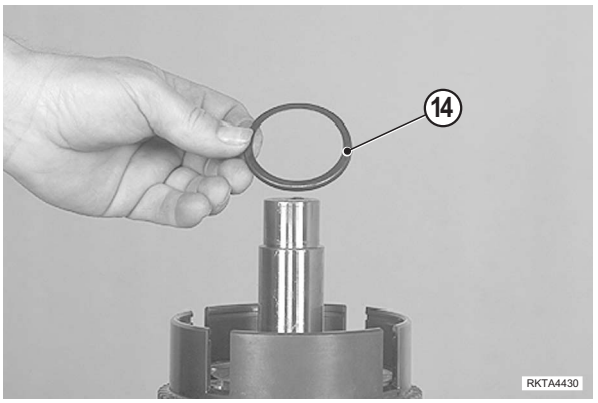


12 - Remove the disc springs (13). [*2]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.

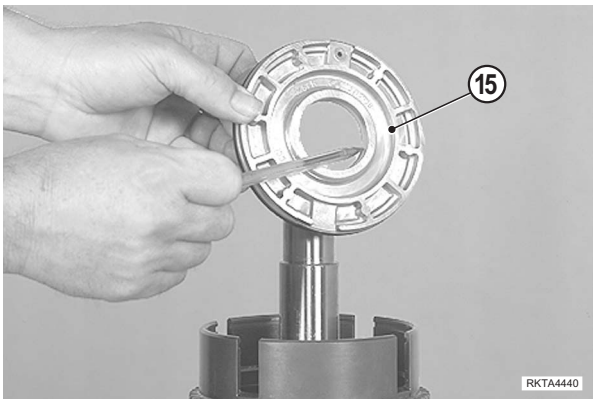


13 - Remove the inner spring locating ring (14).



14 - Turn the clutch over and tap the clutch on a block of soft material to remove the piston (15). [*3]

★ Note down the seals assembly sequence.



Assembly

- To assemble, reverse the disassembly procedure.

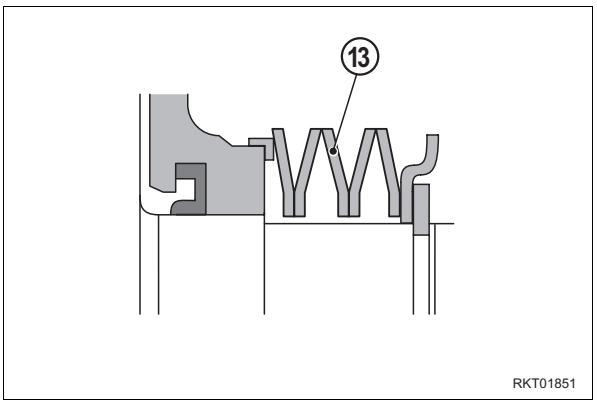
[*1]

★ Start clutch disc installation by placing a steel disc first.

★ Install 5 + 5 clutch discs in total.

[*2]

★ Orient the springs (13) as shown to the side.



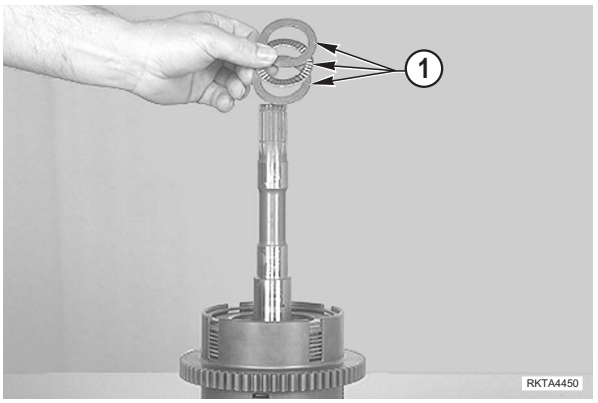
[*3]

★ The inner retainer ring should be extended to reach the size of the shaft. This is achieved by rolling the seal lip on a refaced piece of round steel.

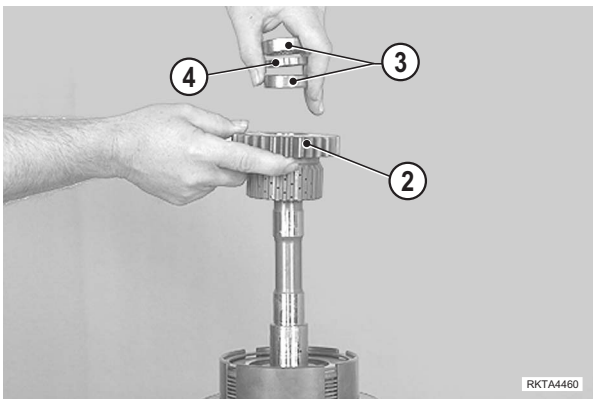
REVERSE CLUTCH

Disassembly

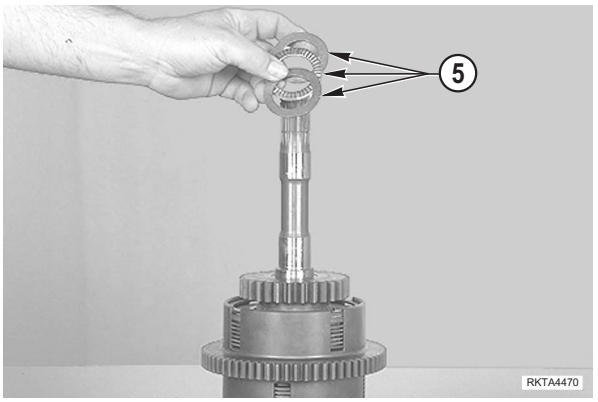
1 -Remove the thrust bearing (1).



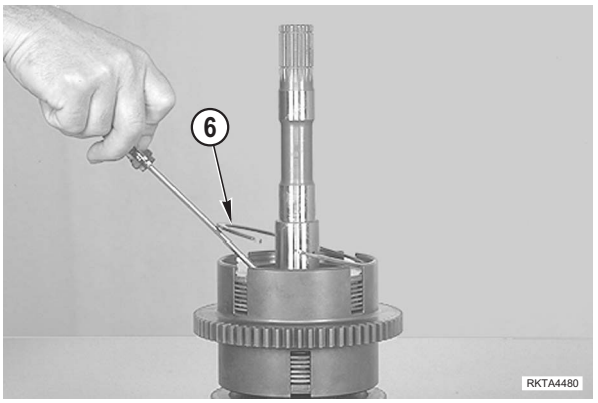
2 -Remove the gear (2), bearings (3), and spacer (4).



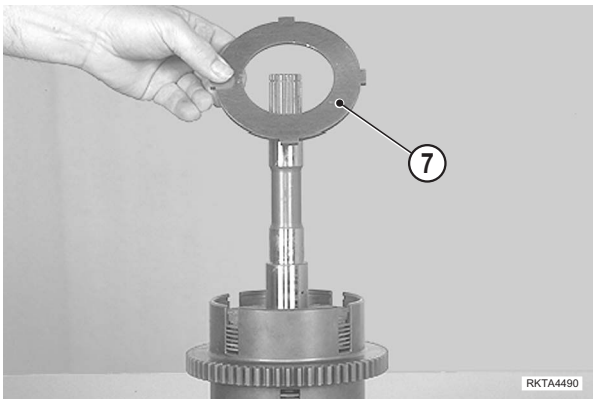
3 -Remove the thrust bearing (5).



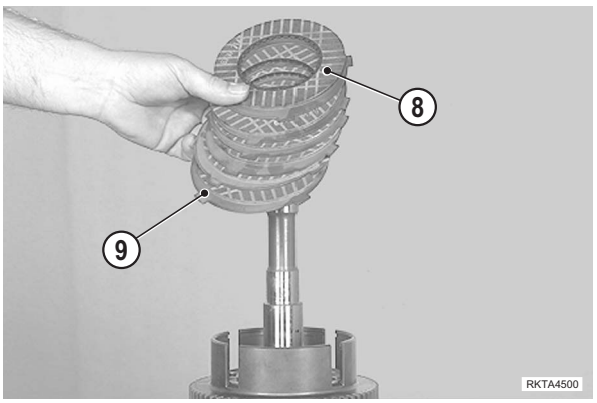
4 -Remove the clutch disc inner retainer ring (6). [*1]



5 - Remove the end plate (7).

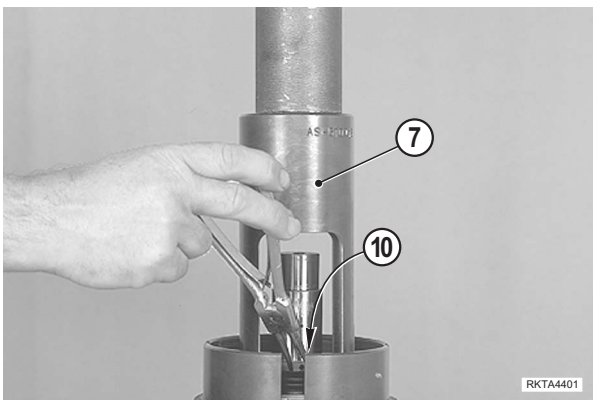


6 - Remove the clutch discs (8) and (9). [*2]

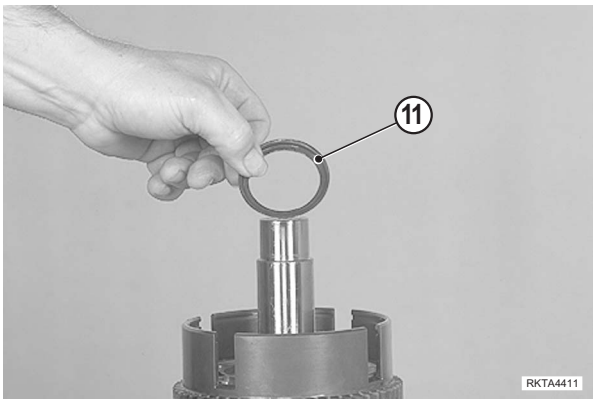


7 - Using a puller (A), compress the disc springs to disengage the retainer ring.

8 - Remove the retainer ring (10).

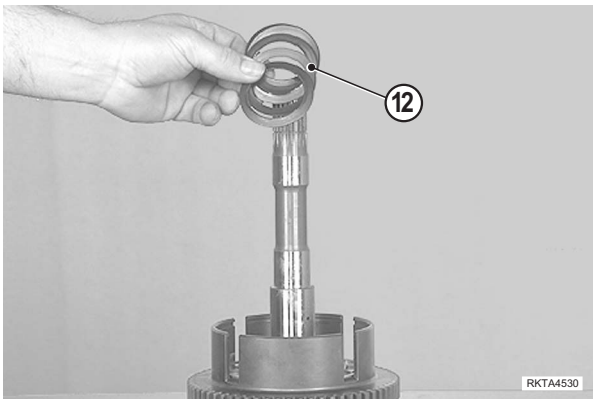


9 - Remove the spring locating ring (11).

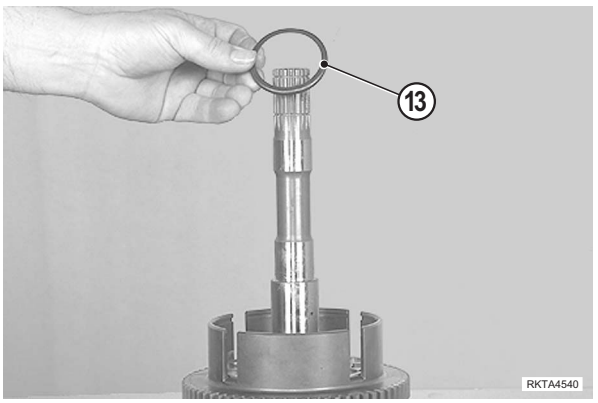


10 -Remove the disc springs (12). [*3]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.

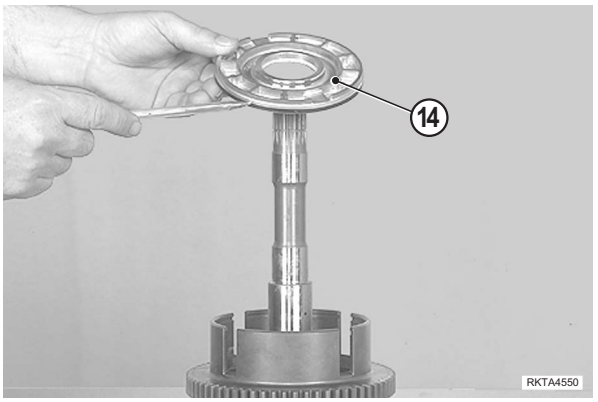


10 -Remove the inner spring locating ring (13).



11 -Turn the clutch over and tap the clutch on a block of soft material to remove the piston (14). [*4]

★ Note down the seals assembly sequence.



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Start clutch disc installation by placing a steel disc first.

★ Install 6 + 6 clutch discs in total.

[*2]

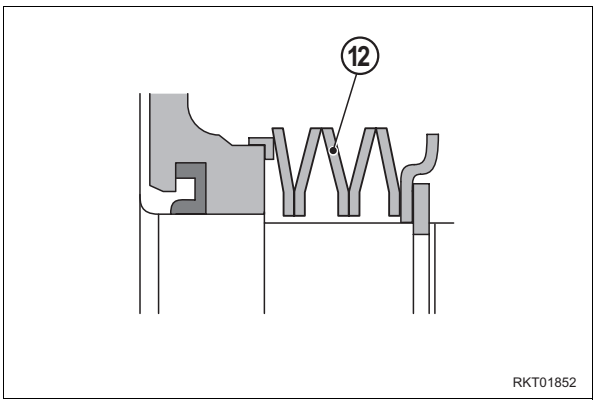
★ After installing the snap ring, turn the assembly over and check clearance between piston and steel ring for being between 1.22 and 2.74 mm.
If clearance is greater than 2.74 mm, remove the snap ring (6) and end plate (7) and add a steel disc.

[*3]

★ Orient the springs (12) as shown to the side.

[*4]

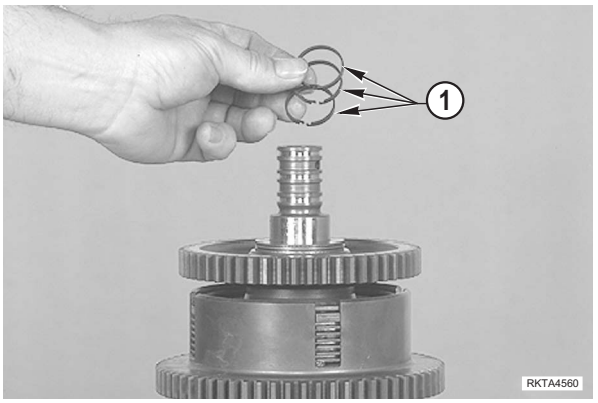
★ The inner retainer ring should be extended to reach the size of the shaft. This is achieved by rolling the seal lip on a refaced piece of round steel.



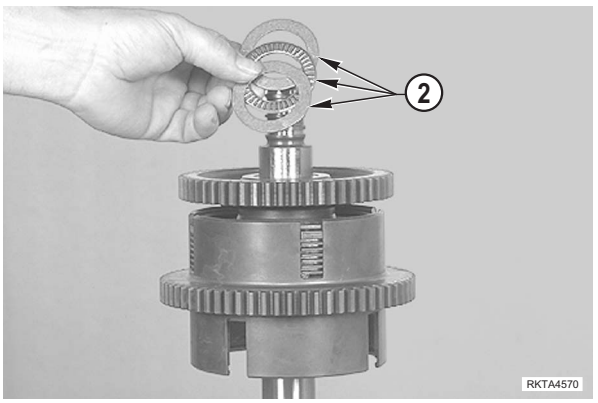
FORWARD CLUTCH

Disassembly

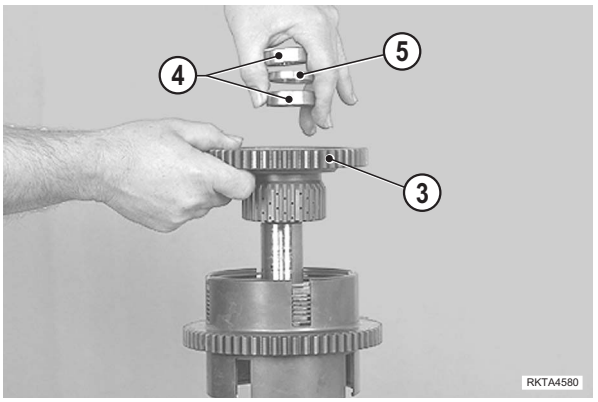
1 -Remove the sealing elements (1).



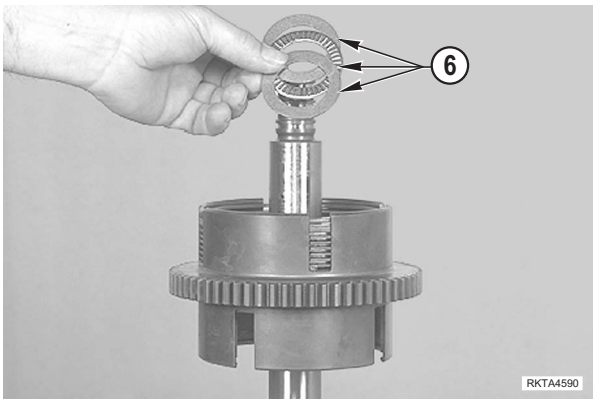
2 -Remove the thrust bearing (2).



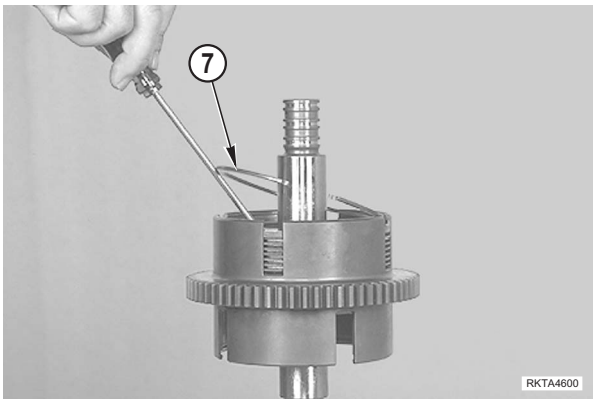
3 -Remove the gear (3), bearings (4), and spacer (5).



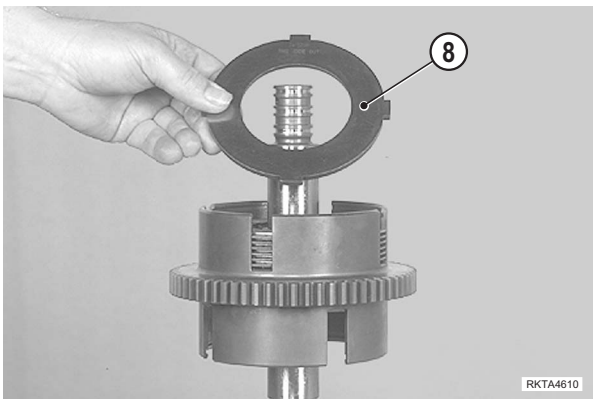
4 -Remove the thrust bearing (6).



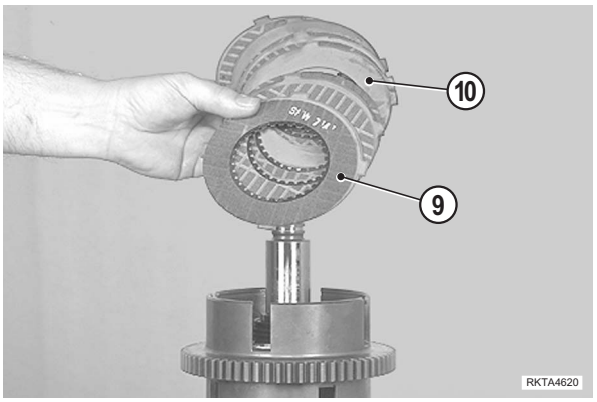
5 - Remove the clutch disc inner retainer ring (7). [*1]



6 - Remove the end plate (8).

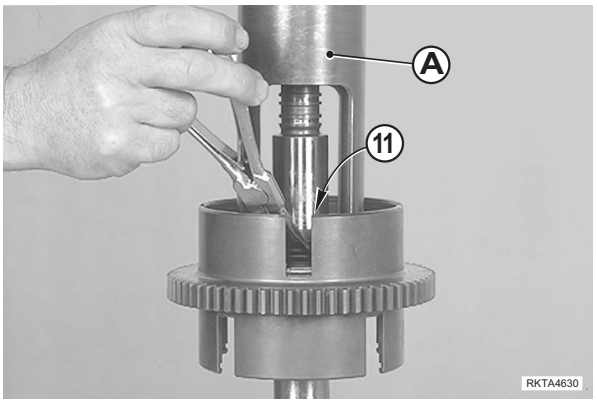


7 - Remove the clutch discs (9) and (10). [*2]

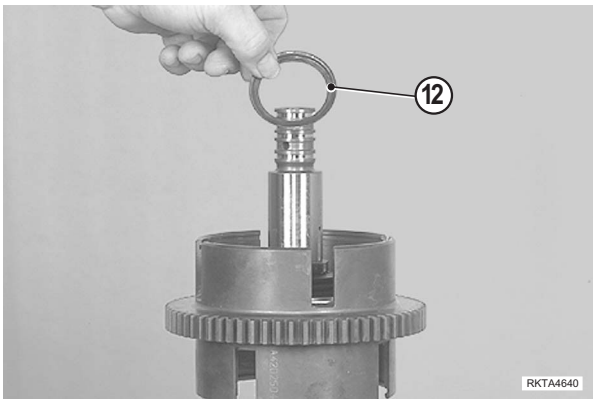


8 - Using a puller (A), compress the disc springs to disengage the retainer ring.

9 - Remove the retainer ring (11).

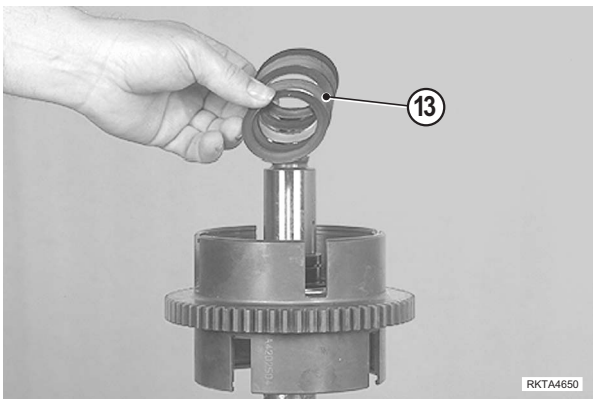


9 -Remove the spring locating ring (12).

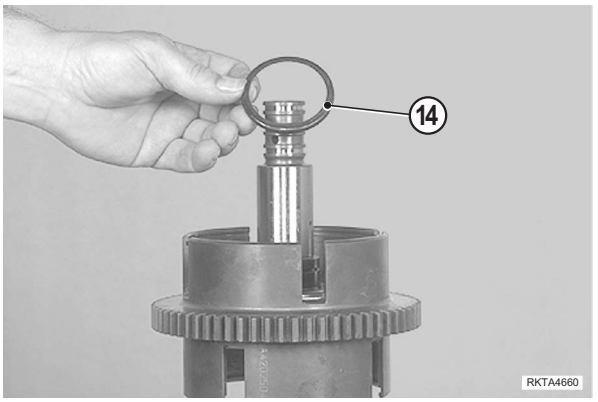


10 -Remove the disc springs (13). [*3]

NOTE
Disc springs are specific for each clutch. Their sequence of installation should never be inverted.
Spare springs are supplied as a pack and are already in their sequence of installation.

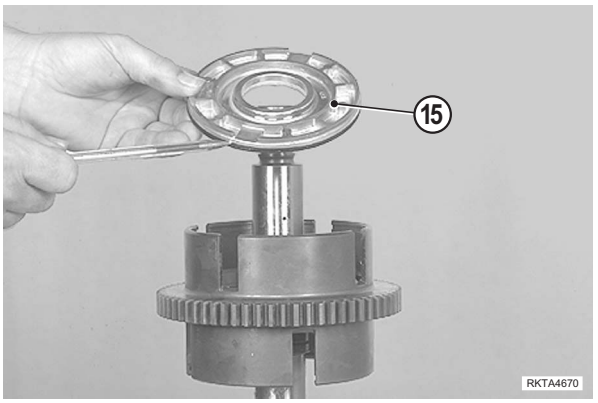


11 -Remove the inner spring locating ring (14).



12 -Turn the clutch over and tap the clutch on a block of soft material to remove the piston (15). [*4]

★ Note down the seals assembly sequence.



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Start clutch disc installation by placing a steel disc first.

★ Install 6 + 6 clutch discs in total.

[*2]

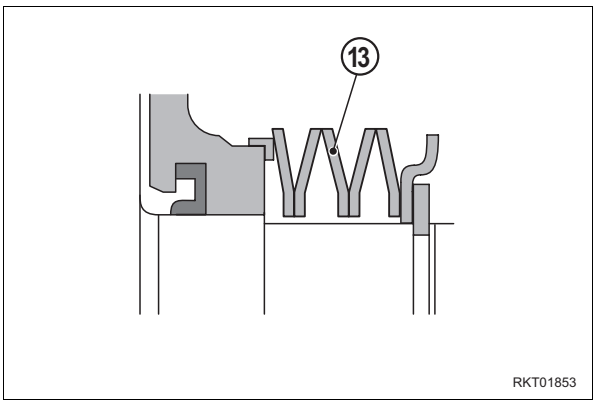
★ After installing the snap ring, turn the assembly over and check clearance between piston and steel ring for being between 1.22 and 2.74 mm.
If clearance is greater than 2.74 mm, remove the snap ring (7) and end plate (8) and add a steel disc.

[*3]

★ Orient the springs (13) as shown to the side.

[*4]

★ The inner retainer ring should be extended to reach the size of the shaft. This is achieved by rolling the seal lip on a refaced piece of round steel.

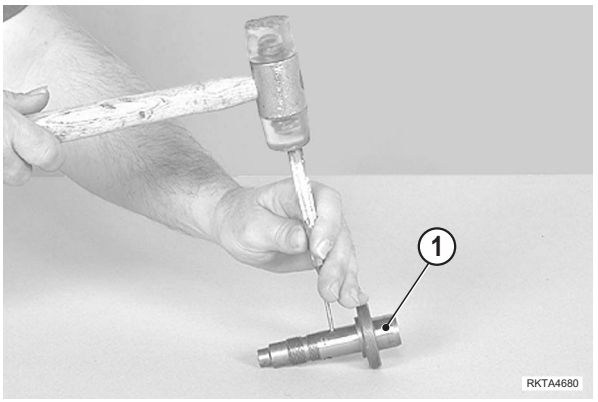


PRESSURE REGULATOR VALVE

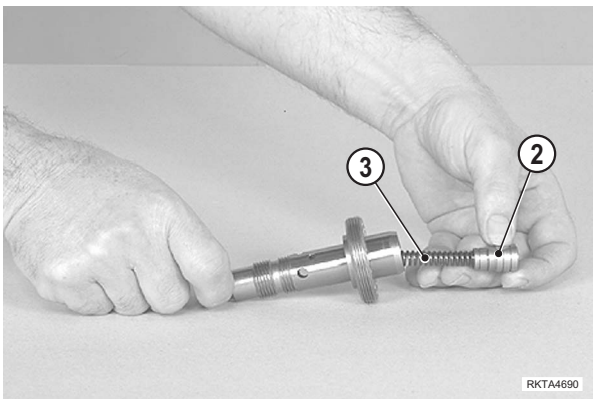
Disassembly

1 -Remove the pin from the valve (1).

★ Use caution as valve spool is under spring pressure.



2 -Remove piston (2) and spring (3) from the valve. Perform a thorough cleaning procedure.



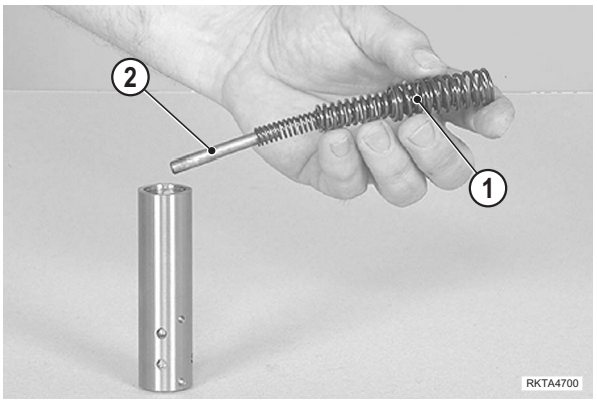
Assembly

- To assemble, reverse the disassembly procedure.

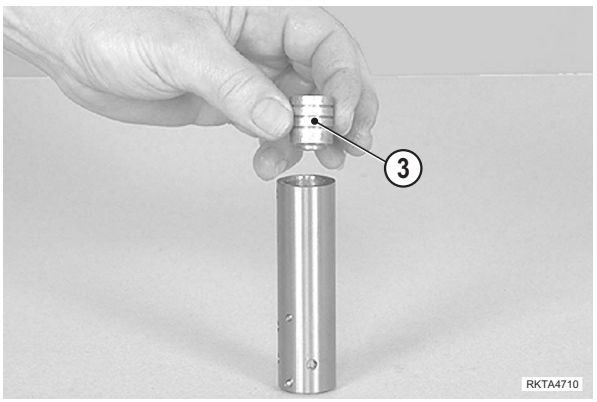
MODULATED VALVE

Disassembly

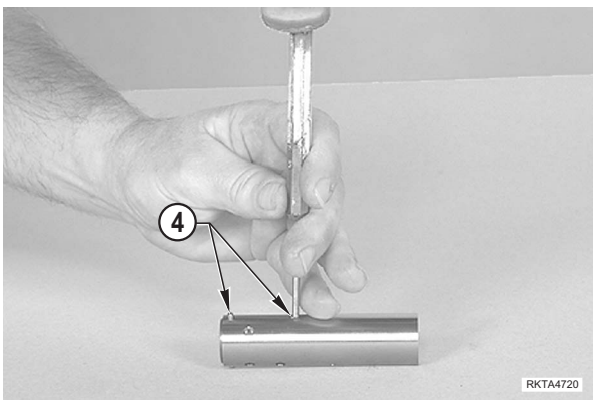
1 - Remove the spring assembly (1) and pin (2) from the housing sleeve.



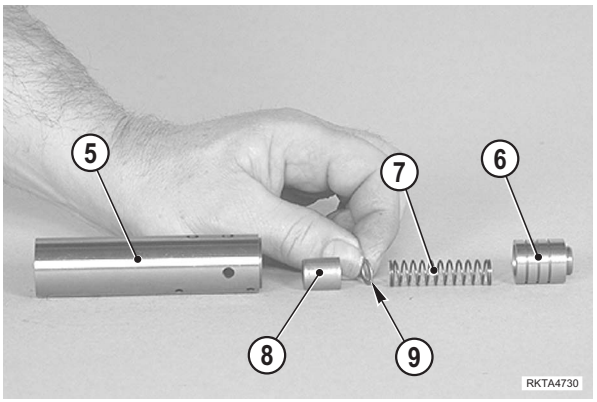
2 - Remove the second spool (3).



3 - Remove the pins (4).



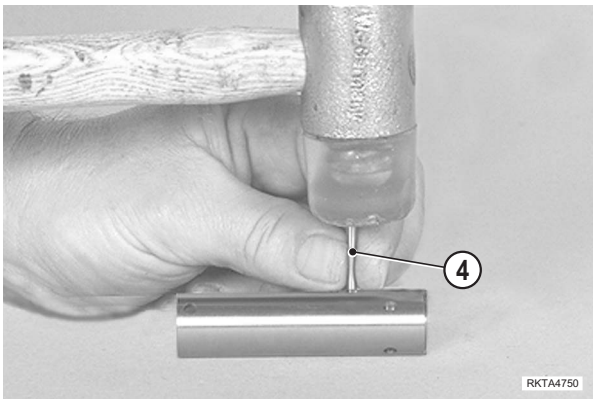
4 - Remove the spool (6), spring (7), spring guide (8) and shim (9) from the housing sleeve (5).



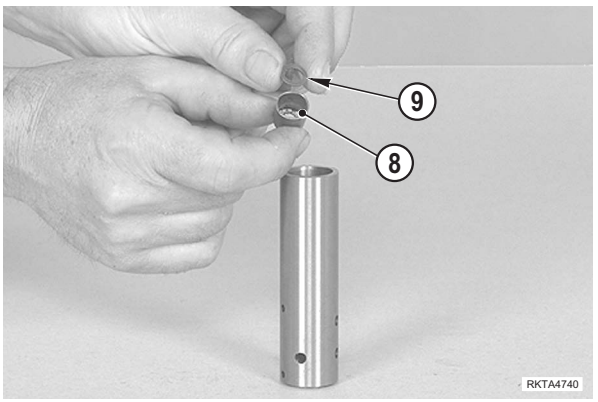
Assembly

1 - Install the pin (4).

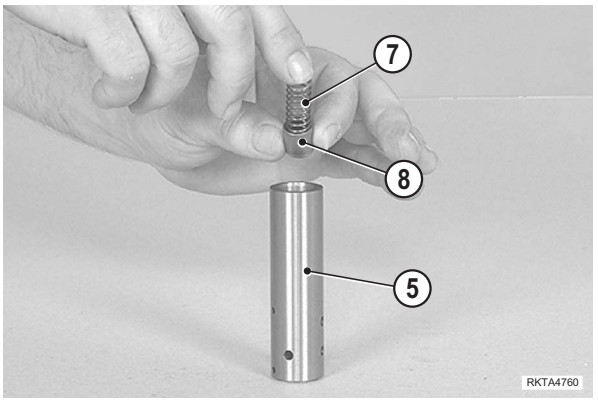
NOTE
On units with pins of different length, install the shortest pin.



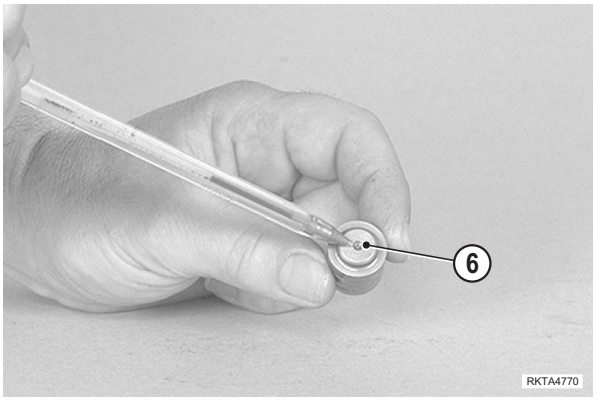
2 - Introduce the shim (9) into the spring guide (8).



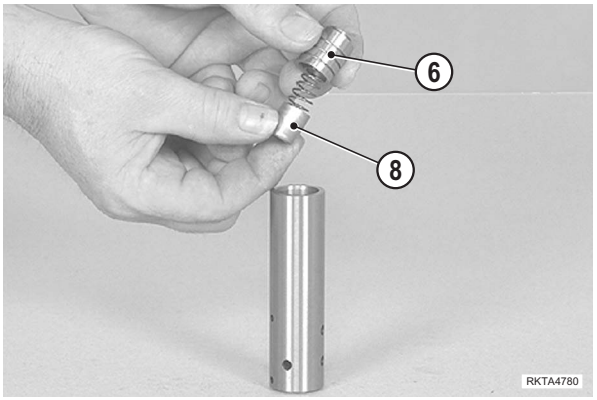
3 - Install the spring (7).



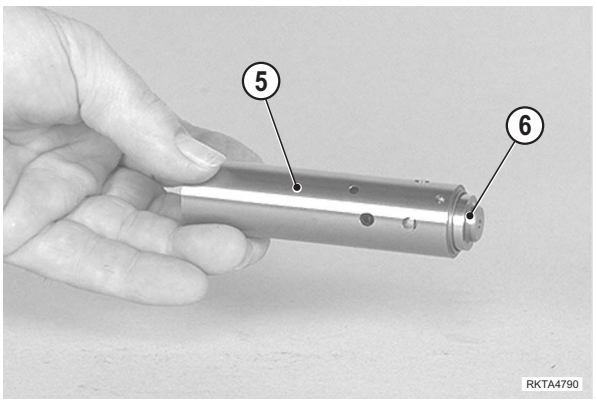
4 - Check the orifice in the spool (6) to be free and clear of any foreign material.



5 - Install the spool (6) and install the assembly with the spring guide (8) facing the lower pin.

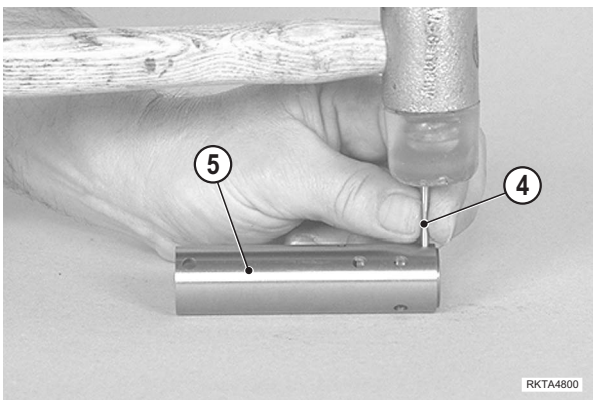


6 - Introduce the spool (6) and complete assembly into the sleeve (5).



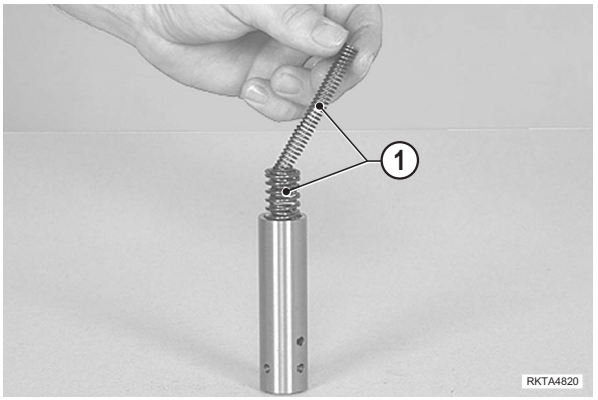
7 - Push the spool (6) inside and install the pin (4).

NOTE
On units with pins of different length, install the longest pin.

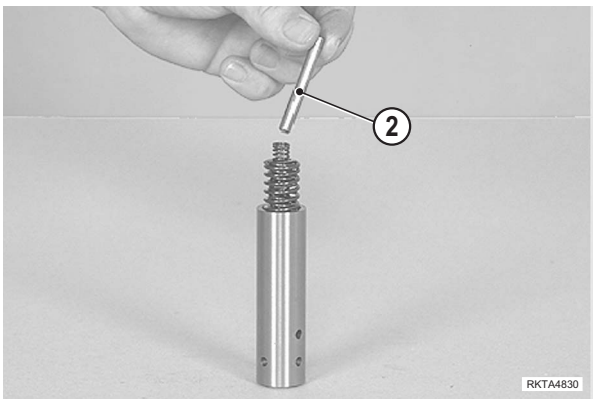


8 - Install the first spool (3).

9 -Install the spring assembly (1).



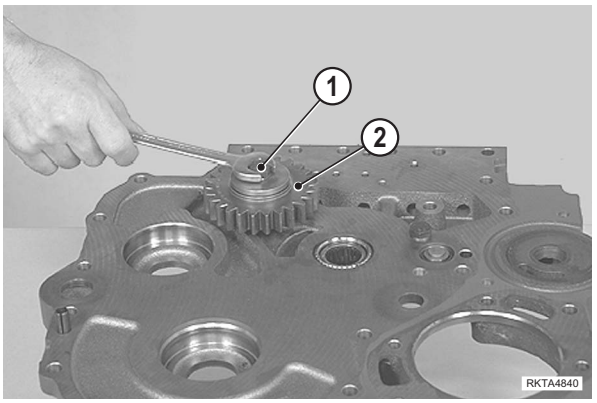
10 -Install the stop pin (2).



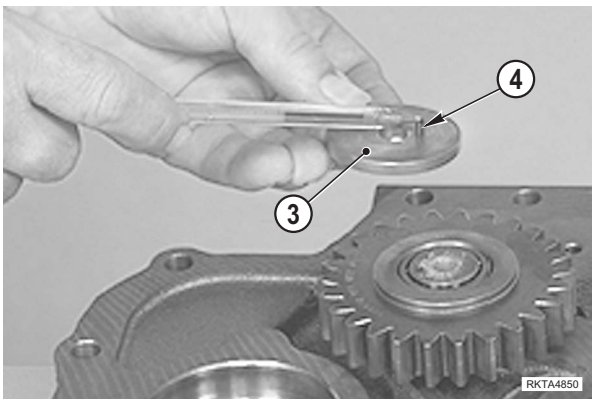
SPACER PLATE

Disassembly

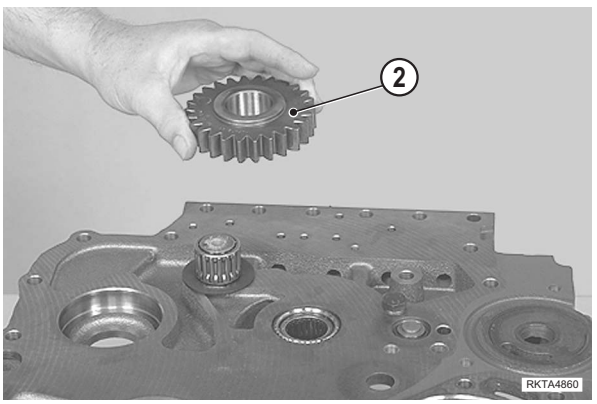
1 - Remove the screw (1) and the washer retaining the idler gear (2).



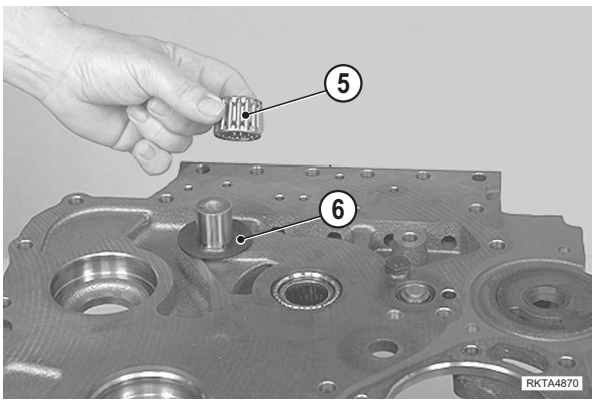
2 - Remove the end plate (3) and dowel pin (4).



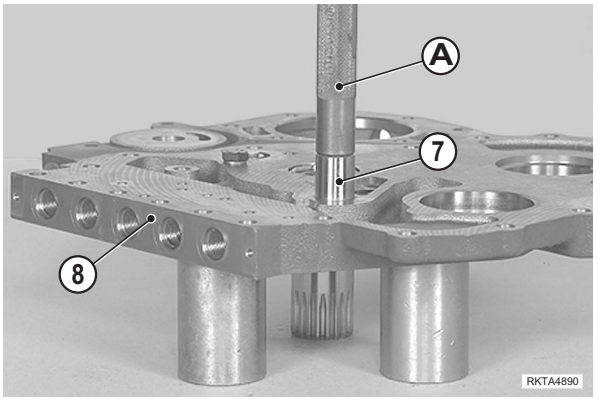
3 - Remove the idler gear (2).



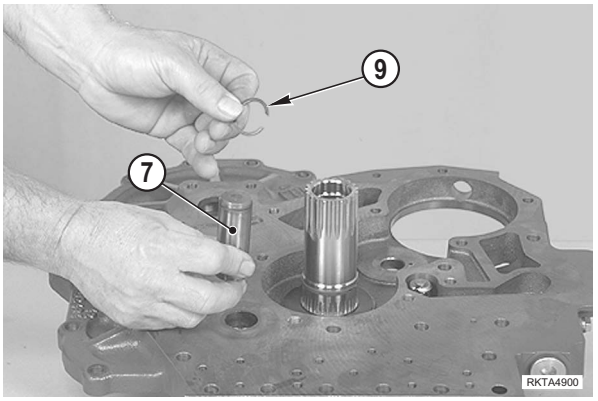
4 - Remove the bearing cage (5) and inner plate (6).



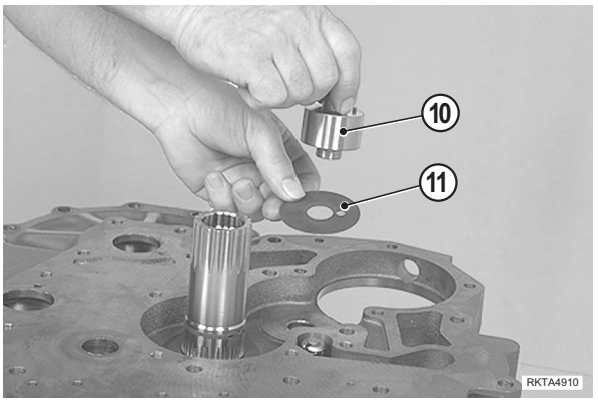
5 - **If you need to replace the shaft** (7) of the idler gear (2), turn the spacer plate (8) upside down and place it on supports, and then pull out the shaft using a puller (A) and a press.



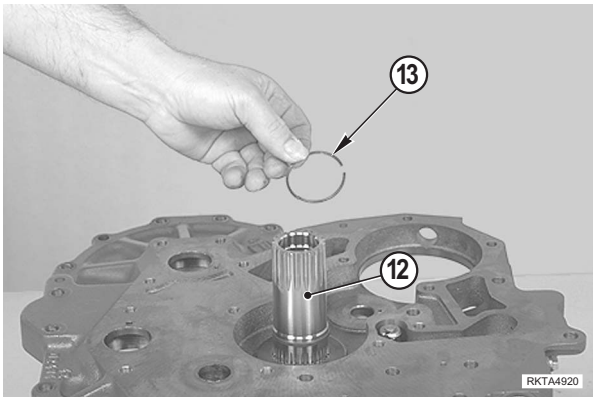
6 - Remove the snap ring (9) from the shaft (7).



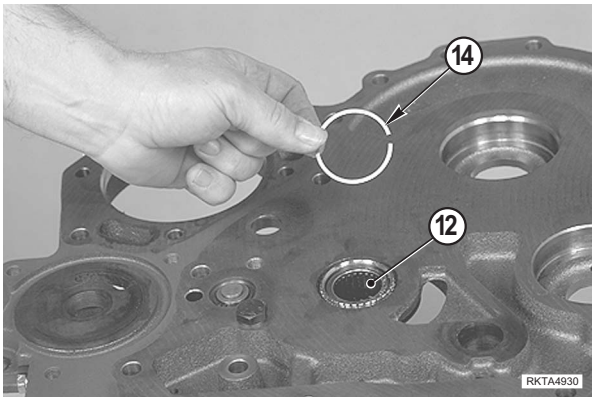
7 - Using a puller, remove the pump idler shaft (10) and washer (11).



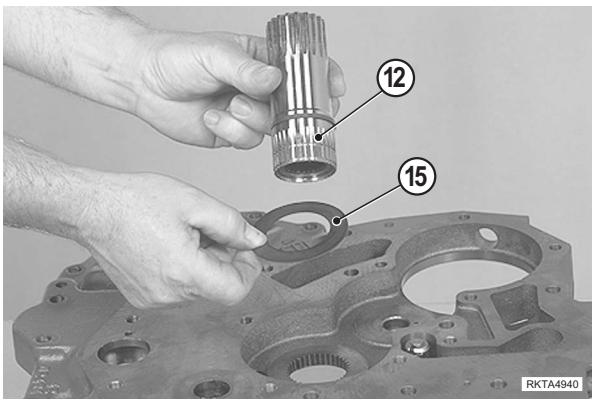
8 - Remove the retainer ring (13) from the stator spline shaft (12).



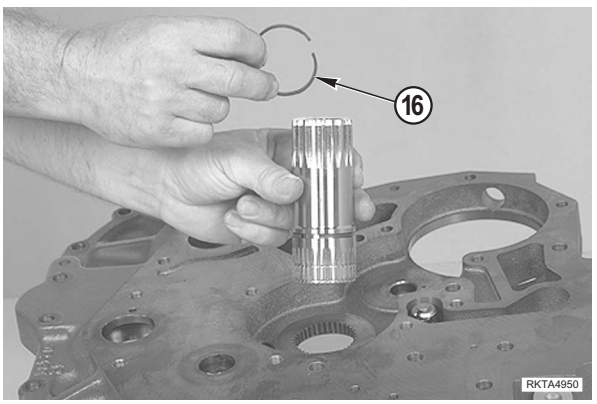
9 - Push the spline shaft (12) far enough to expose the retainer ring (14); remove the retainer ring.



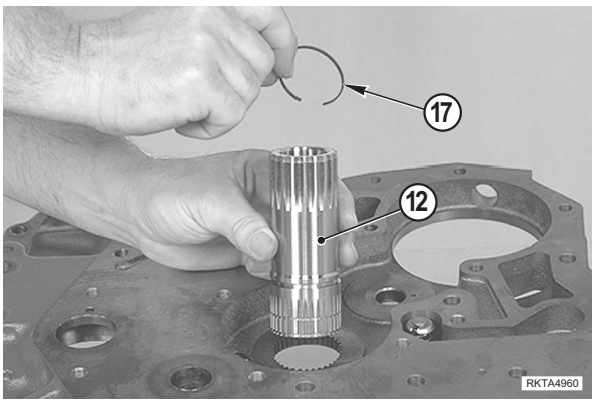
10 - Remove the shaft (12) and backing washer (15).



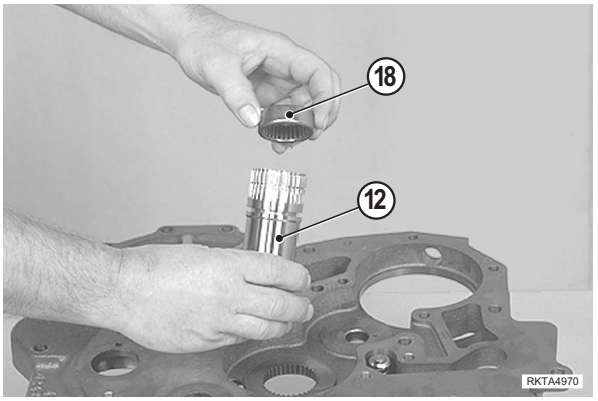
11 - Remove the sealing ring (16). [[*1]



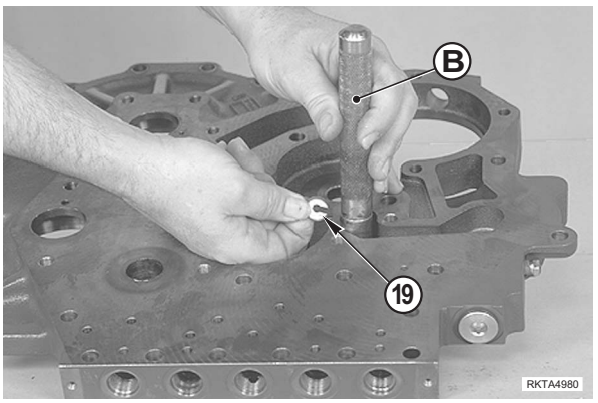
12 - Remove the expander ring (17).



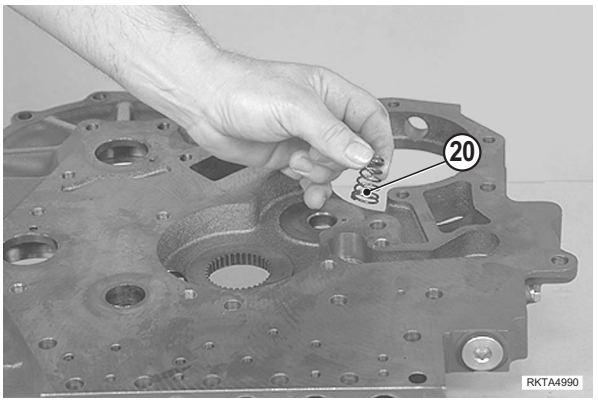
13 - If the shaft bearing (18) is to be replaced, remove bearing from shaft (12).



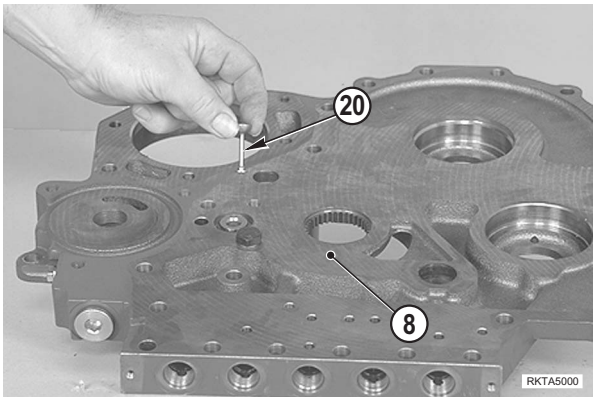
14 - Using a puller (B), compress the safety valve spring and remove the retaining washer (19).



15 - Remove the spring (20).



16 - Turn the plate (8) upside down and remove the poppet valve (21).

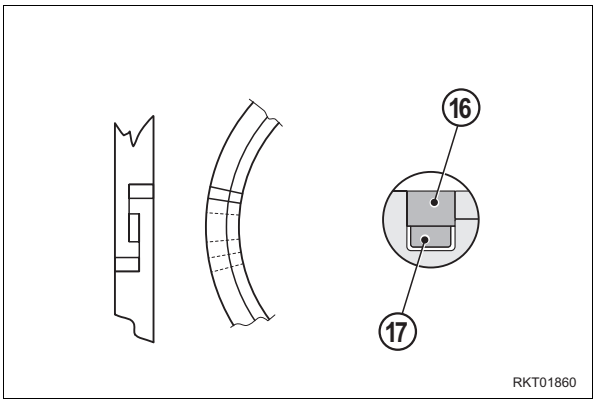


Assembly

- To assemble, reverse the disassembly procedure.

[*1]

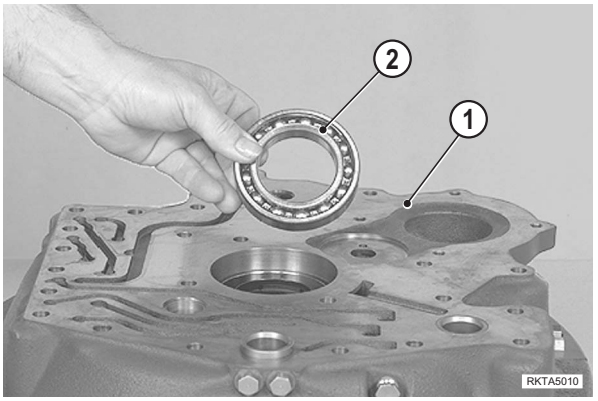
★ Install the expander valve (17) and the segment (16) as shown to the side.



CONVERTER HOUSING

Disassembly

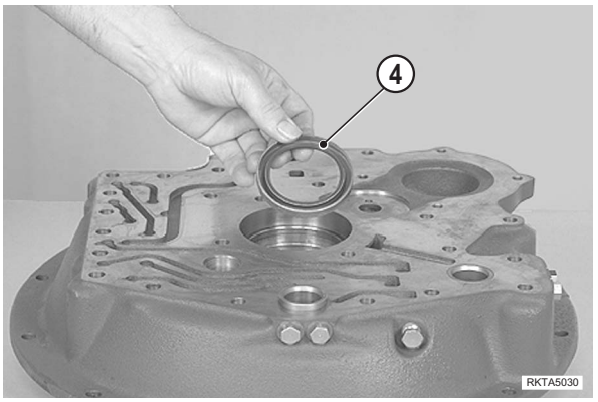
1 -Remove the bearing (2) from the converter housing (1).



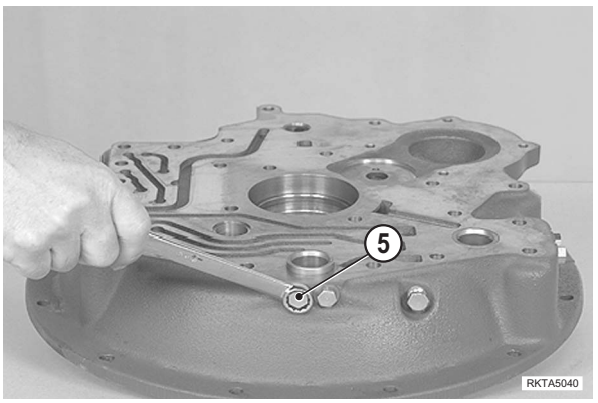
2 -Remove the oil control valve ring (3).

3 -Remove the oil seal (4). [*1]

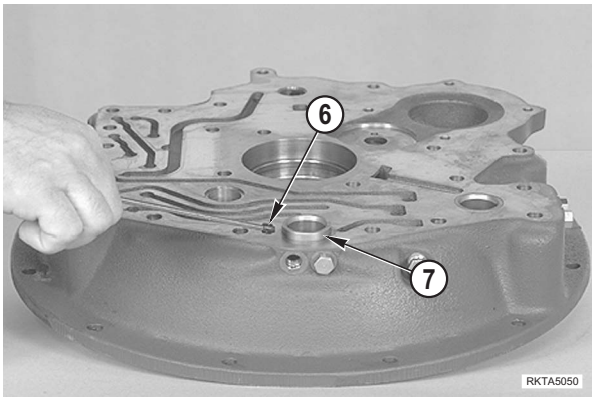
★ Note down direction of assembly.



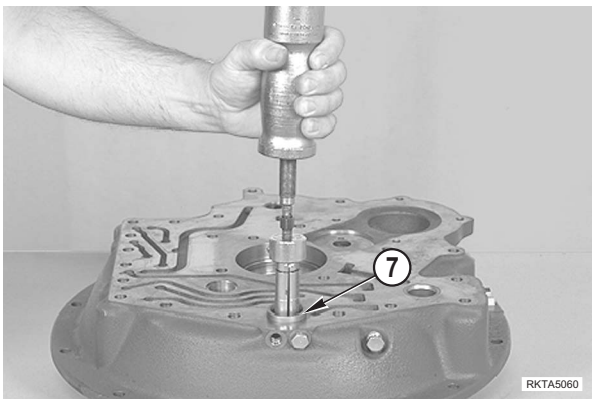
4 -Remove the plug (5).



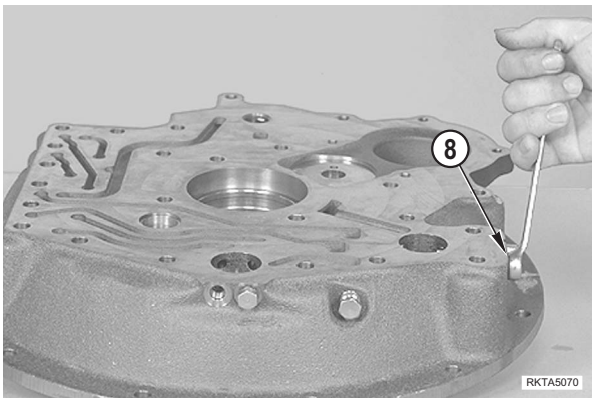
5 - Remove the screw (6) retaining the sleeve (7). [*2]



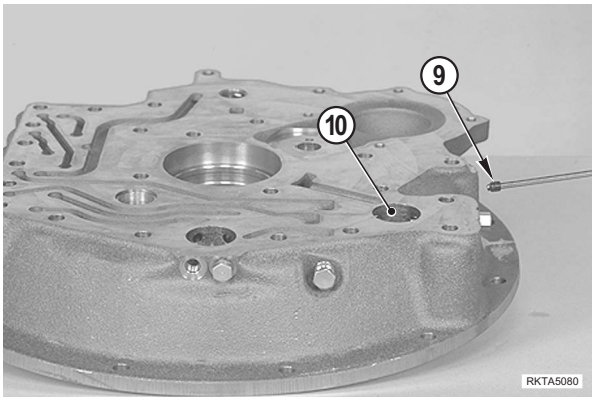
6 - Using a hammer puller, remove the sleeve (7). [*3]



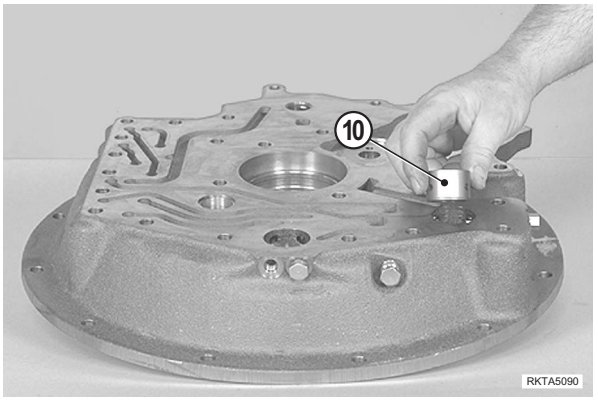
7 - Remove the plug (8).



8 - Remove the screw (9) retaining the sleeve (10). [*2]



9 -Using a hammer puller, remove the sleeve (10). [*3]



Assembly

- To assemble, reverse the disassembly procedure.

[*1]

★ Apply a thin coat of sealant to the outer diameter of the oil seal.

Oil seal: Loctite 641

[*2]

Retaining screw: Loctite 243

[*3]

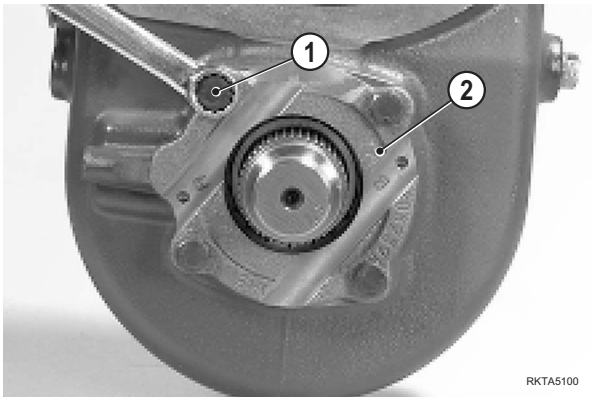
★ Install the sleeve with the chamfer facing up.

DROP BOX ASSEMBLY

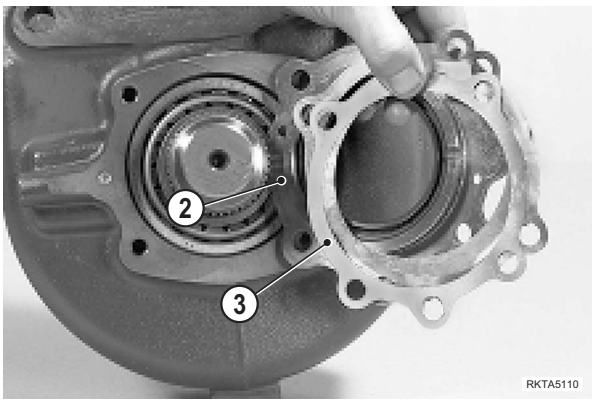
Disassembly

- **Complete drop box assembly**

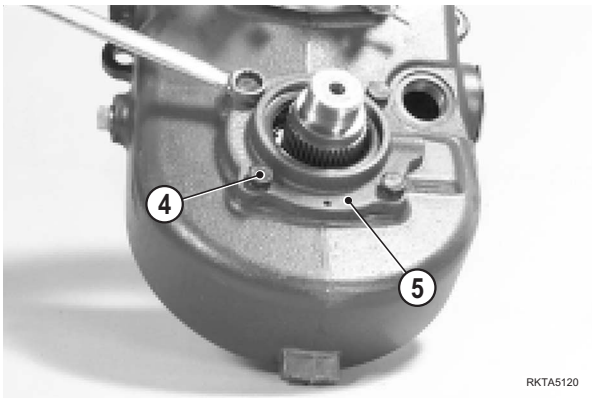
1 - Remove the retaining screws (1) and lockwashers from the front flange (2).



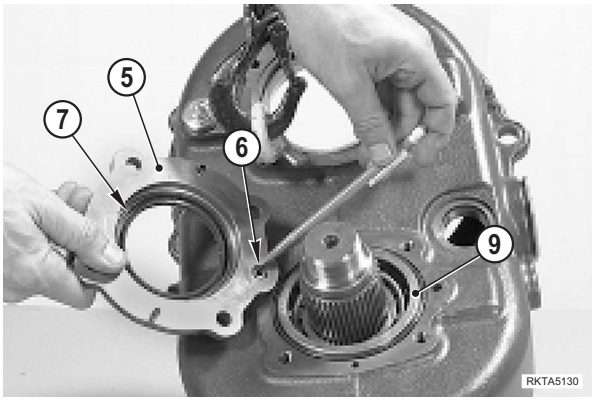
2 - Remove the flange (2) and shim pack (3).



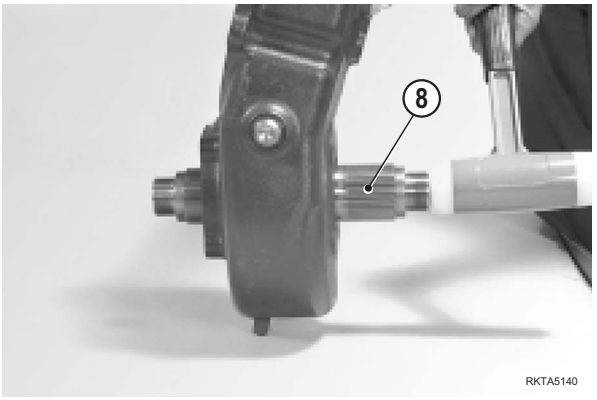
3 - Remove the retaining screws (4) and lockwashers from the rear flange (5).



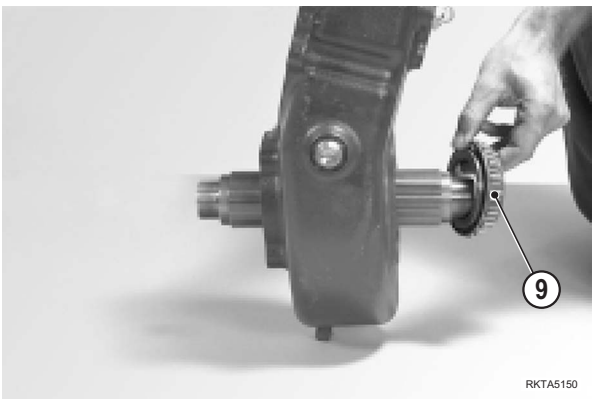
4 - Remove the rear flange (5), O-rings (6) and seal rings (7).
Also, remove the bearing outer race (9).



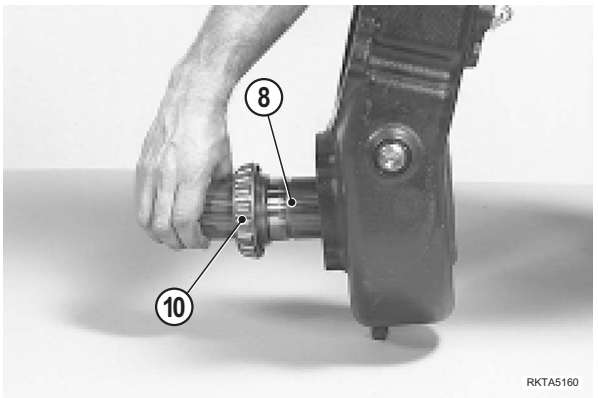
5 - Using a soft hammer, disengage the output shaft (8) from the rear bearing (9).



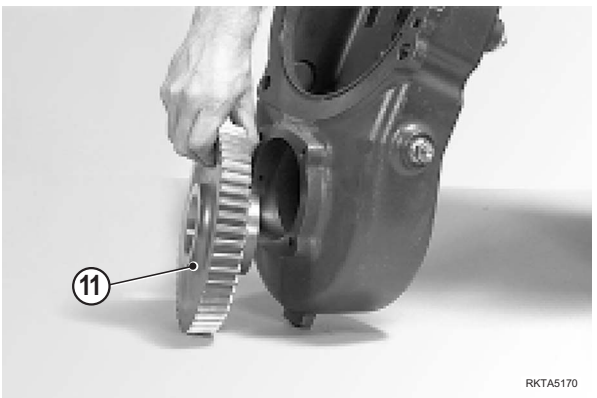
6 - Remove the bearing inner race (9).



7 - Remove the output shaft (8) complete with front bearing inner race (10).

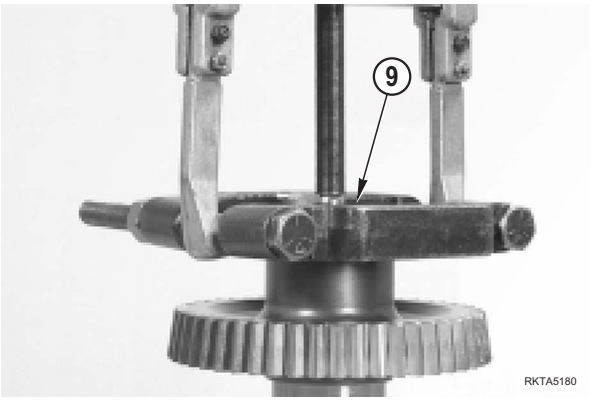


8 - Remove the driven gear (11).



- **Input shaft**

1 - Using a puller, remove the rear bearing outer race (9).



2 - Remove the retainer ring (12).

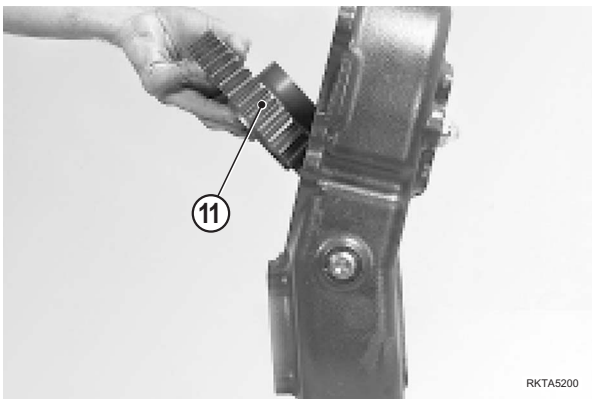
Assembly

- **Input shaft**

- To assemble, reverse the disassembly procedure.

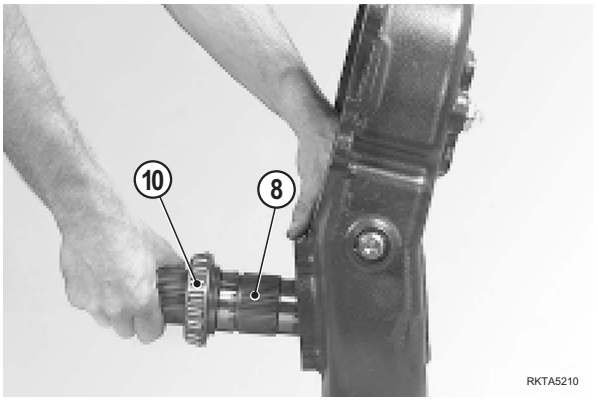
- **Complete drop box assembly**

1 - Install the gear (11) into the drop box housing.



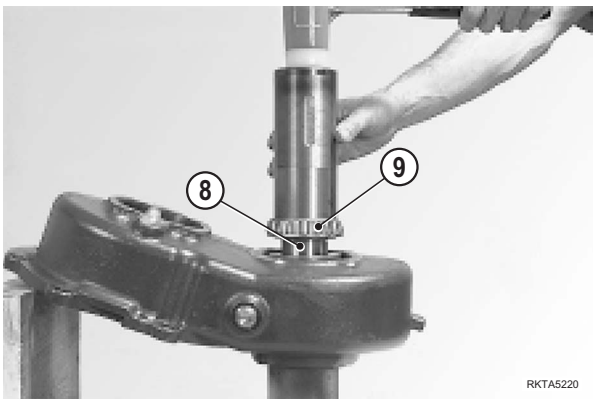
2 - Install the output shaft (8) and front bearing inner race (10).

⚠ To assist installation, heat the bearing inner race at 135±15 °C.

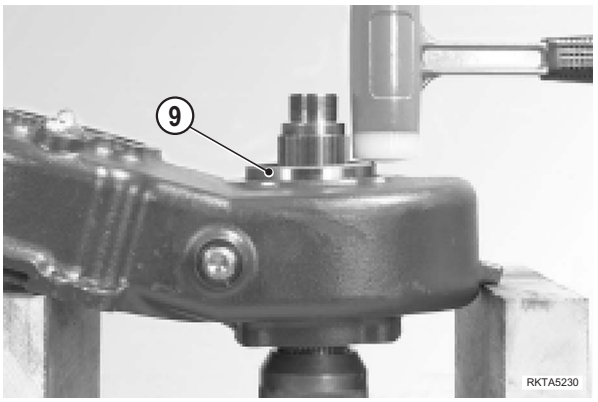


3 - Turn the assembly upside down; place the shaft (8) on a support block and install the inner race (9) to the rear output of the shaft (8).

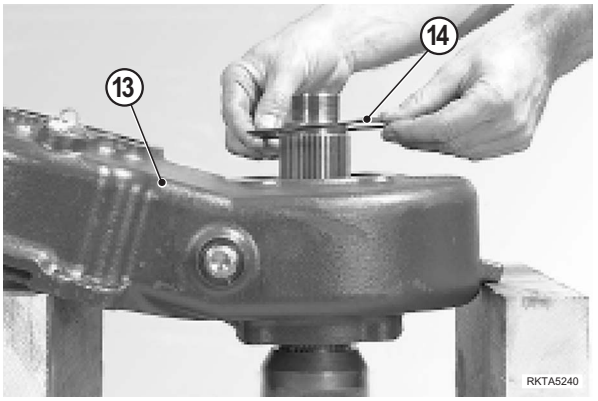
⚠ The bearing can be best fit after heating it at 135±15 °C.



4 - Install the bearing outer race (9) and tap it in place using a plastic hammer.



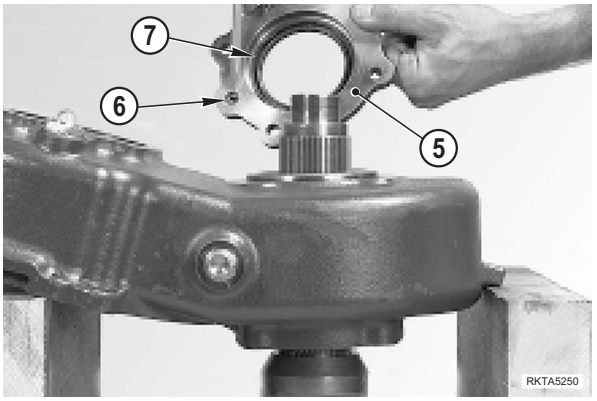
5 - Install the O-ring (14) to the drop box housing (13).



6 - Coat the outside of the seal ring (7) with sealant and install it to the flange (5).

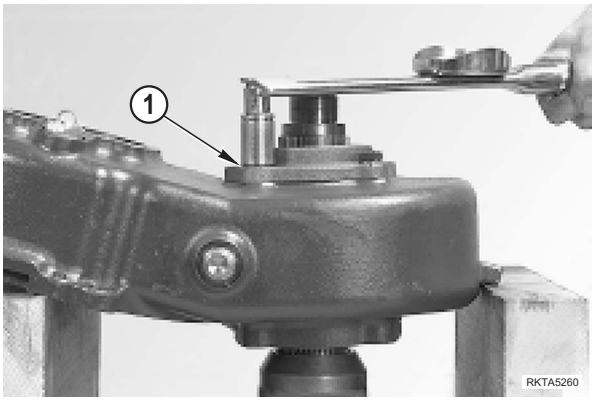
Seal ring: Loctite 641

7 - Install the front output flange (5) and O-ring (6).

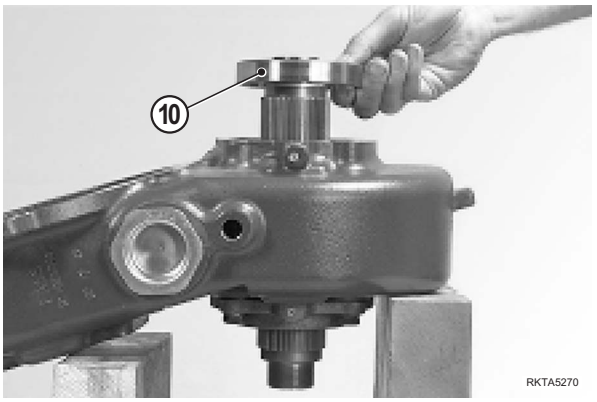


8 - Lock the flange with screws (1) and washers.

Screws: 40 – 50 Nm



9 - Turn the assembly upside down and install the bearing outer race (10).



10 - Using a centesimal microgauge, measure flange thickness at worked areas “**A**” and “**B**”.

★ If necessary, remove all paint or dents (if any) from the worked areas.

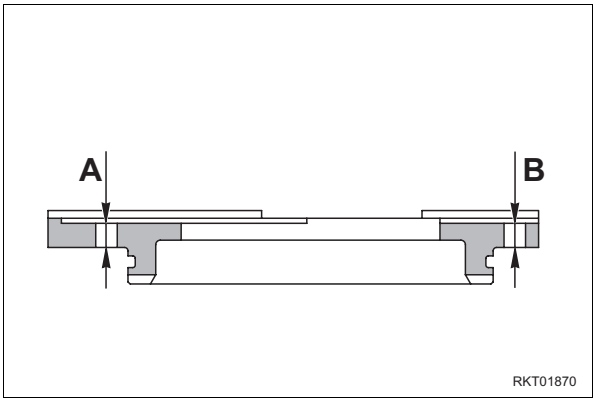
11 - Add the two thickness values to each other and then divide by 2 to obtain the average base measurement “**D**”.

Example:

- Measurement in **A** = 6.990 mm
- Measurement in **B** = 7.000 mm

6.990+7.000 = 13.990 mm

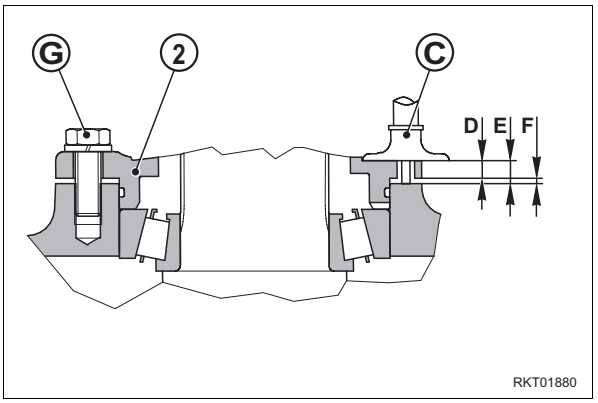
13.990: 2 = 6.995 mm = Measure **D**



12 - Lubricate the front flange (2) and install it to the assembly, ensuring that it slides freely in its seat.

13 - Secure the flange (2) with screws (G) and tighten using the criss-cross and alternate method to 9.5 – 13.6 Nm.

★ While tightening the screws, rotate the shaft several times in both directions to set the bearings.

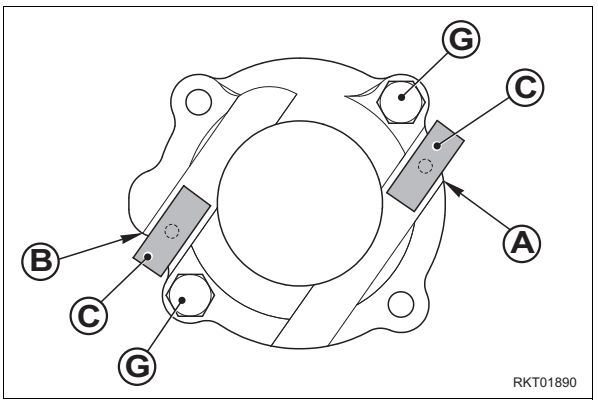


14 - Remove two screws leaving only the ones shown (G) in place.

15 - Using a torque wrench, increase screw tightening torque (for G screws) up to 1.13 Nm and perform some shaft rotations in order to set the bearings.

16 - Increase the screw tightening torque by increments of 0.56 Nm until a final torque of 5.65 Nm is obtained.

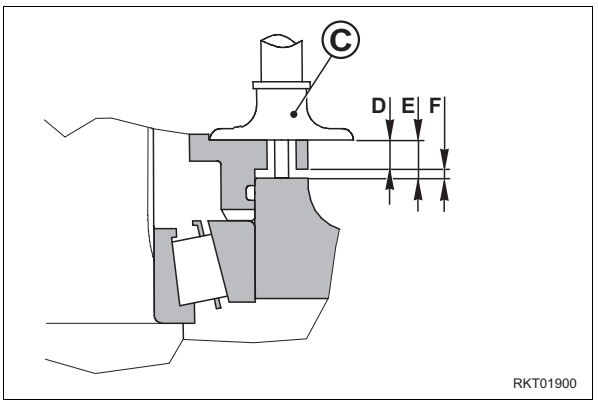
⚠ At each torque increment, carry out measurements in “A” and “B” and, if the difference exceeds 0.127 mm, repeat steps from 12 on.



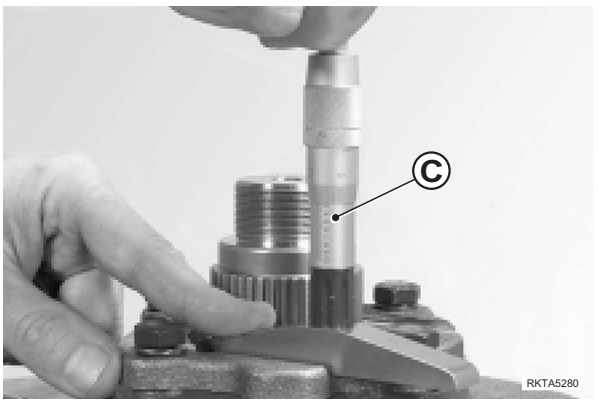
17 - Using a depth microgauge (C), measure “**E**” on surfaces “**A**” and “**B**” and calculate the average.
Example:
E = 7.457 mm

18 - Detract base size “**D”** from “**E**” to obtain the “**F**” size, i.e. the size of the shim pack to be mounted.

19 - Refer to the parts catalogue and choose among the available shims. Make up the shim pack keeping tolerance between 0 and –0.05 mm.



20 - Remove the flange (2).

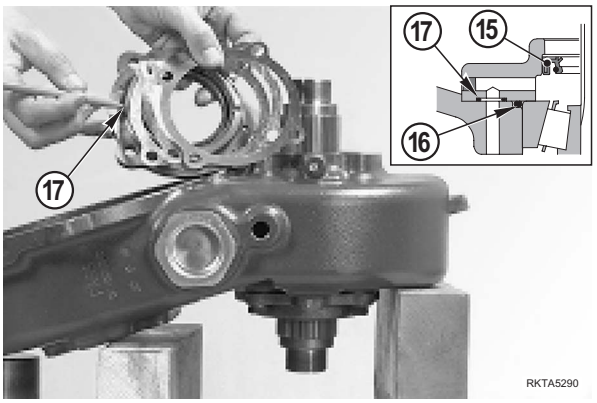


21 - Coat the outside of the seal ring (15) with sealant and install it to the flange (2).

Seal ring: Loctite 641

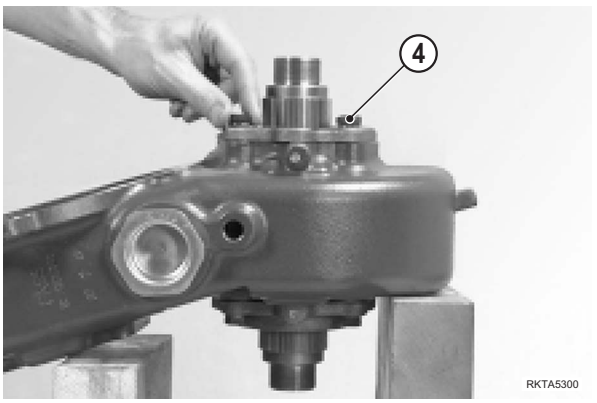
22 - Install the O-ring (16) and the lubrication hole O-ring (17).

23 - Position the shim pack and flange.



24 - Install the screws (4) and washers and lock the flange.

Screws: 40 – 50 Nm

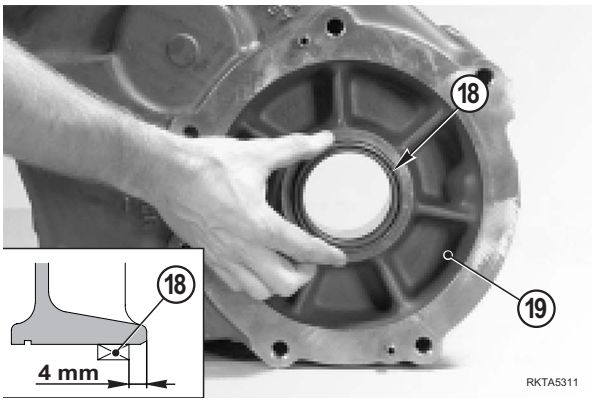


25 - Coat the outside of the oil seal (18) with sealant and install it into the drop box body (19).

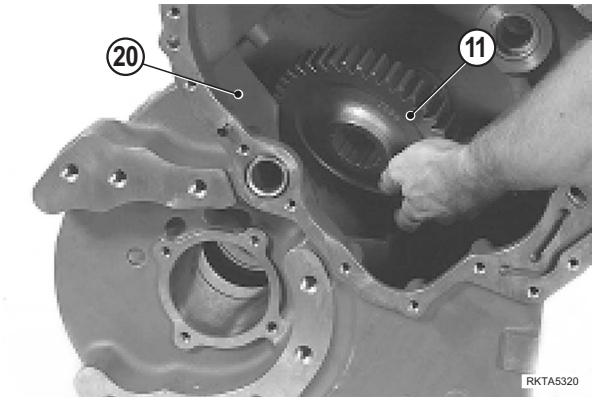
Oil seal: Loctite 641

Push the oil seal far enough to obtain the “M” size specified below:

★ M” size: 4 mm

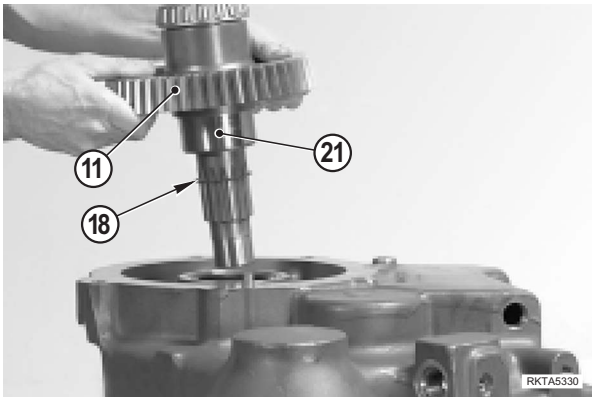


26 - Position the drive gear (11) into the transmission case (20).



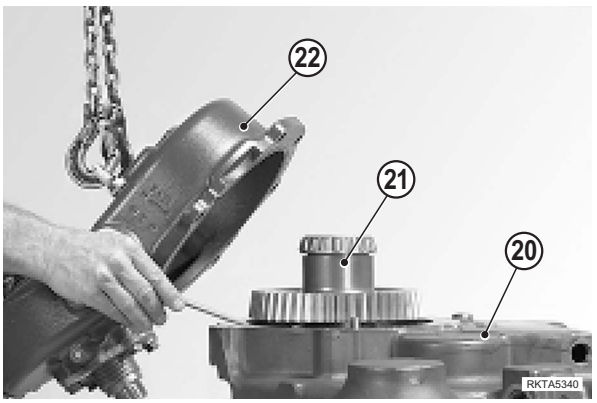
27 - Install and engage the complete input shaft (21) into the drive gear (11).

★ Be extremely careful not to damage the seal ring (18).



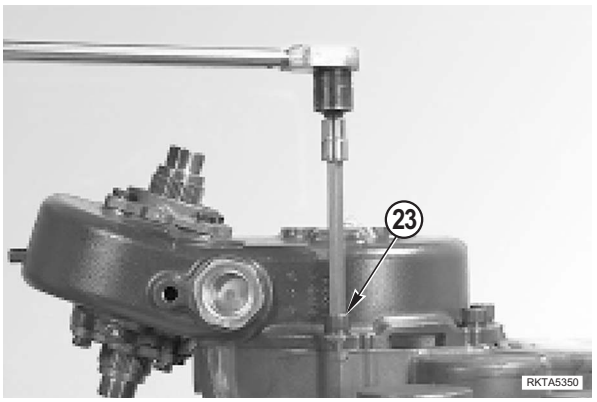
28 - Coat the transmission case (20) with sealant and install the drop box assembly (22).

Transmission case: Loctite 5205

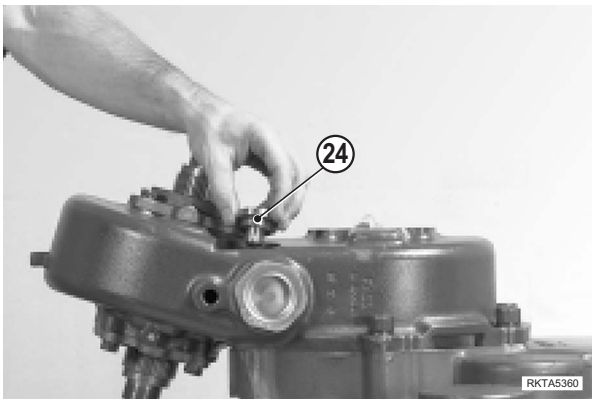


29 - Secure the drop box with screws (23) and self-locking washers.

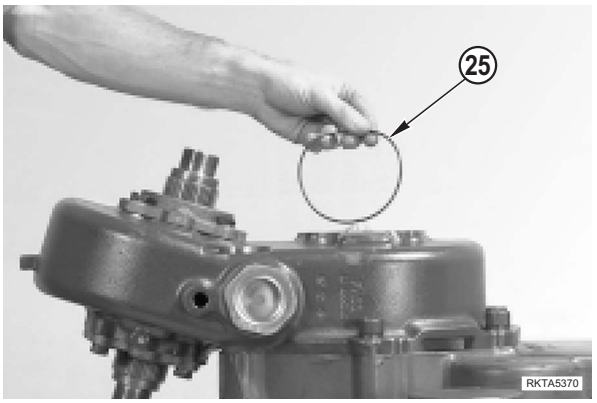
Screws: 275 – 290 Nm



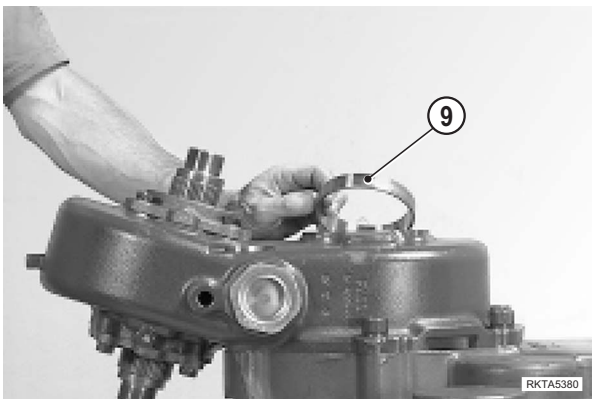
30 - Install the fill plug (24) and O-ring.



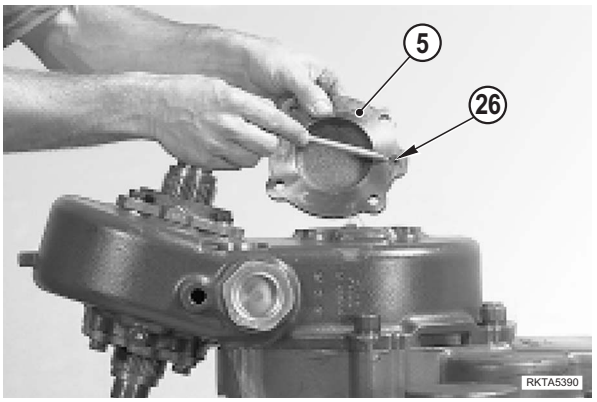
31 - Install the O-ring (25) retaining the flange (5).



32 - Install the bearing outer cup (9).

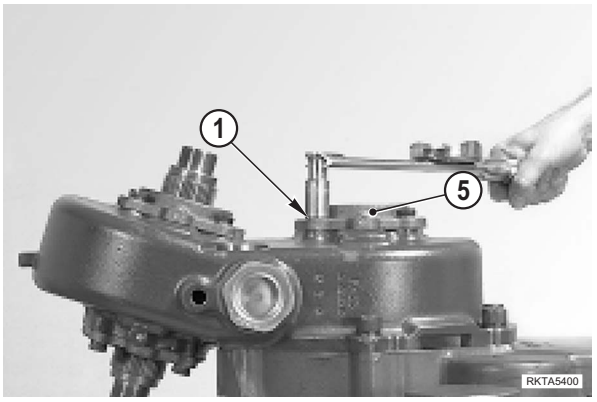


33 - Install the lubrication hole O-ring (26) into the flange (5).

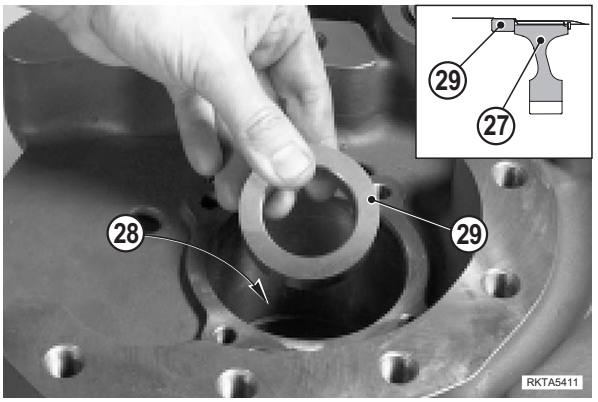


34 - Install the flange (5) and lock it with screws (1).

Screws: 40 – 50 Nm

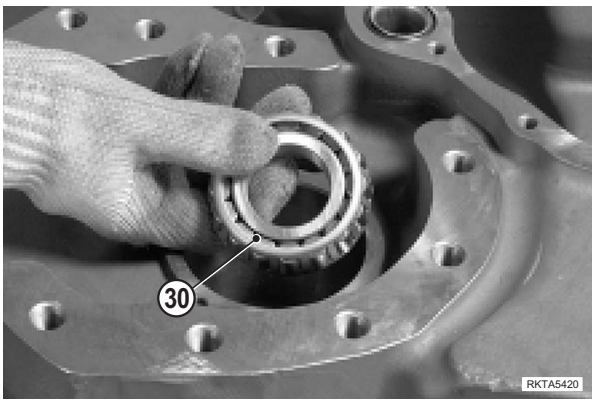


35 - Ensure that the drive gear (27) is seated against the stop ring of the main shaft (28), and then install the spacer ring (29).

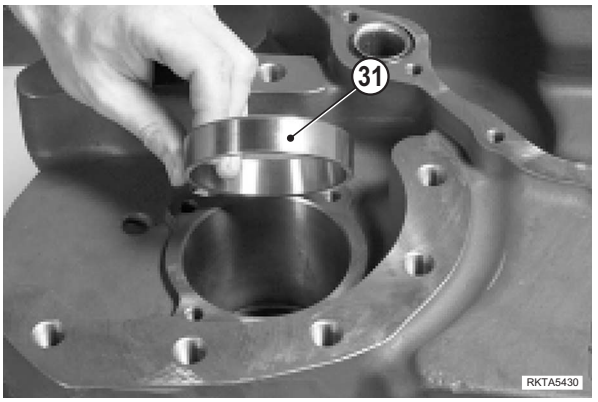


36 - Heat the bearing inner race (30) to 135±14 °C and install the race to the main shaft (28).

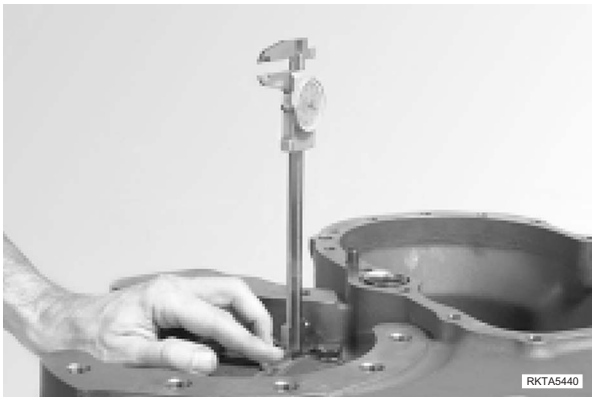
⚠ Ensure that the bearing is well seated against the spacer ring.



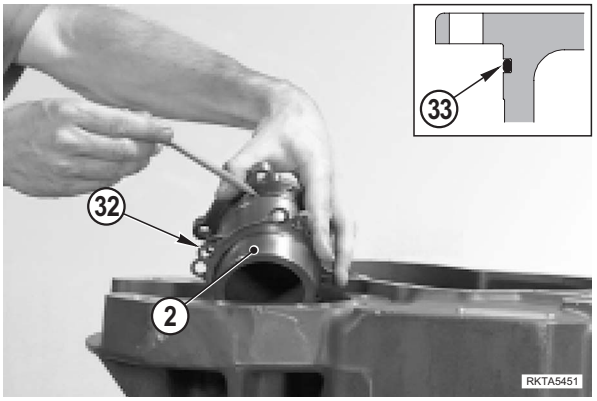
37 - Install the bearing outer race (31).



38 - Using the procedure described in steps 10-20, calculate the shim pack (32) to be mounted under the flange (2).



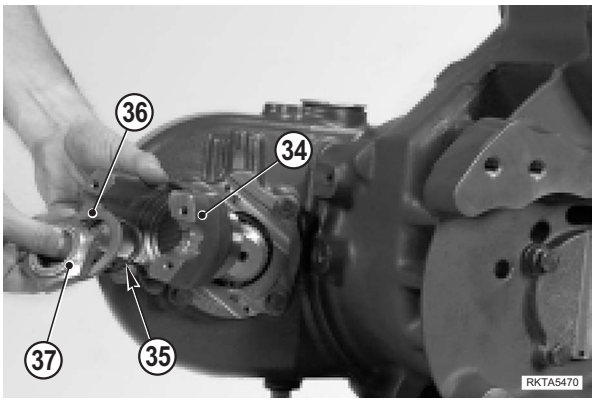
39 - Install the shim pack (32) and O-ring (33) to the flange (2).



40 - Install the flange (2) to the transmission and lock it with screws and washers.

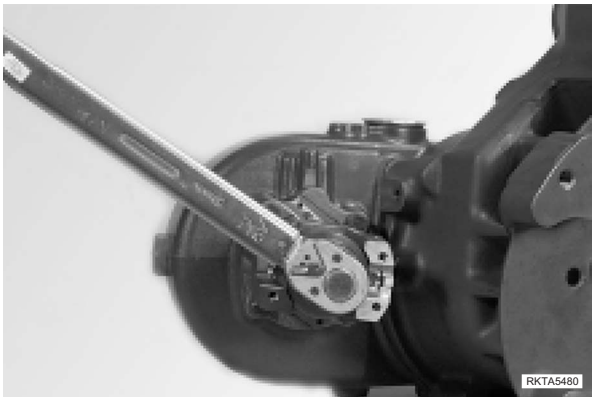
Screws: 40 – 50 Nm

41 - Install the attachment yokes (34), O-rings (35), washers (36) and nuts (37) to the output shaft.



42 - Tighten the nuts (37).

Nuts: 389 – 407 Nm



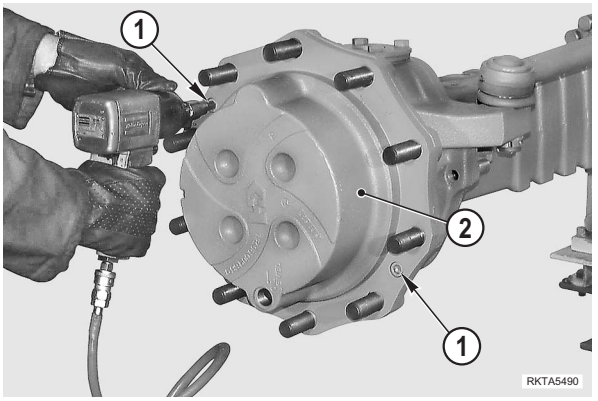
AXLES

NOTE: Some parts may be different in shape but procedures remain the same.

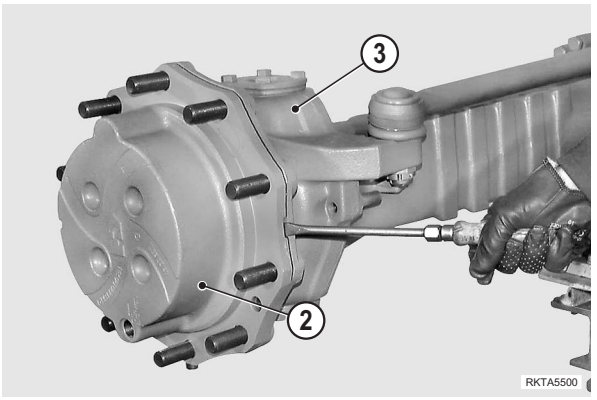
Disassembly

- **Planetary reduction**

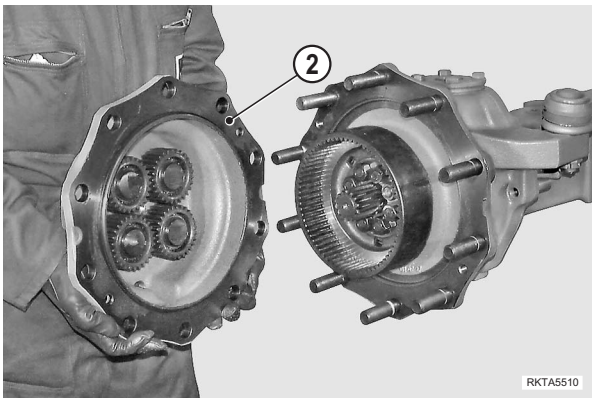
1 - Remove the securing screws (1) from the planetary carrier cover (2).



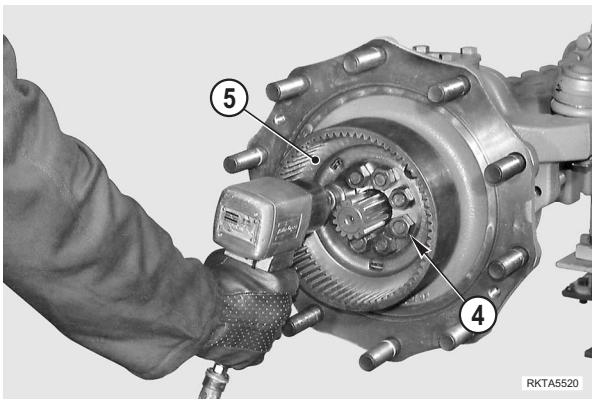
2 - Disjoint the planetary carrier cover (2) from the steering case (3) by alternatively forcing a screwdriver into the appropriate slots.



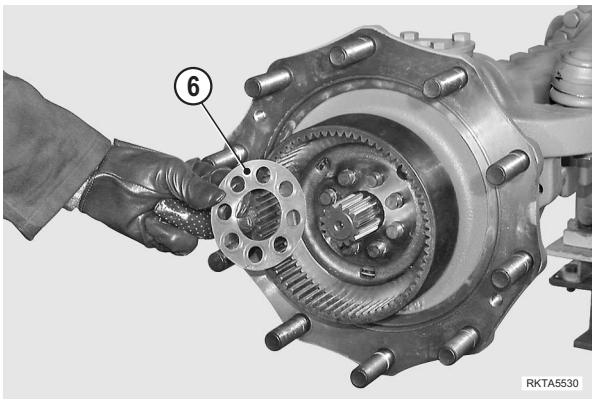
3 - Remove the complete planetary carrier cover (2).



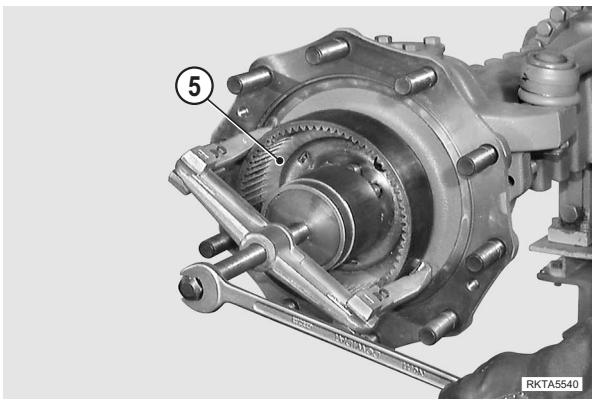
4 - Unloose and remove the tightening nuts (4) from the crown flange (5).



5 - Remove the safety flange (6).

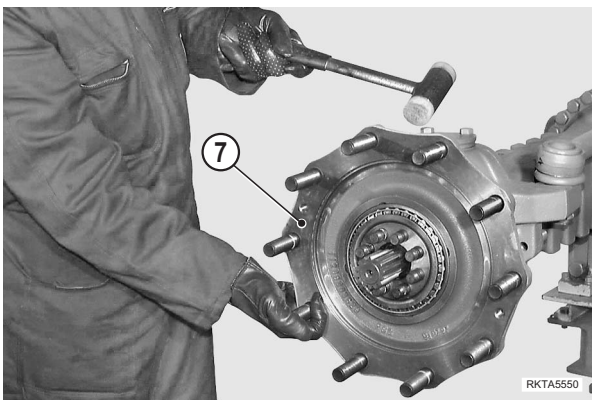


6 - Using a puller, remove the complete crown flange (5) by acting on the stud bolts.

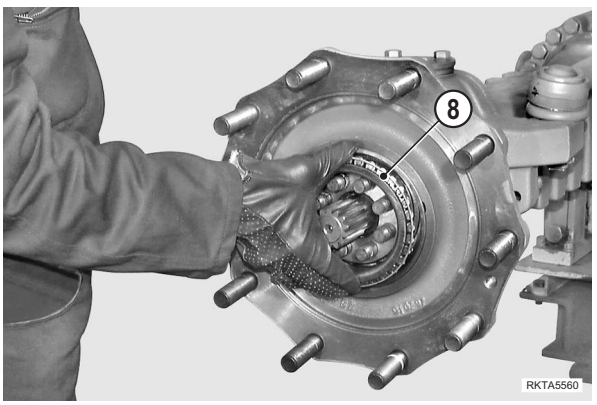


7 - Partially extract the hub (7) using a plastic hammer.

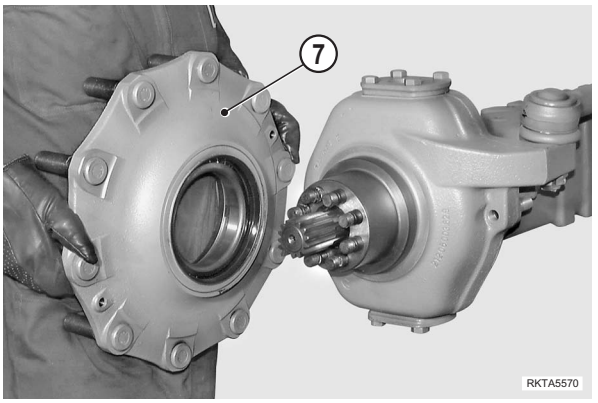
★ Alternately hammer on several equidistant points.



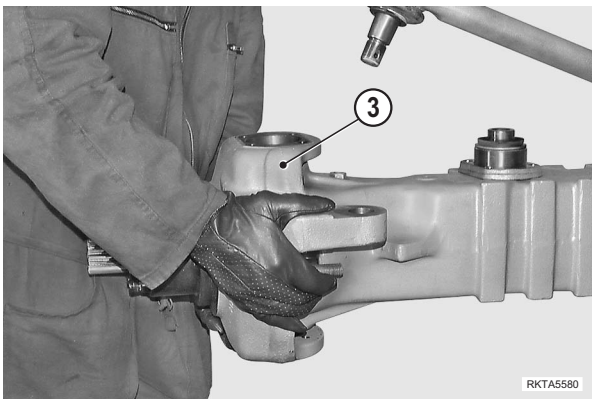
8 - Remove the external bearing (8).



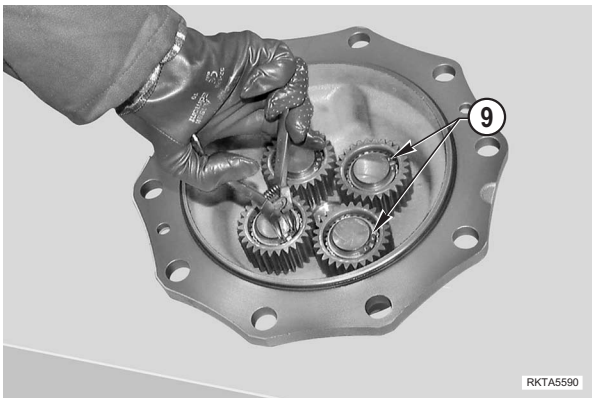
9 -By hand remove the complete hub (7).



10 -Remove the pins and remove the steering case (3).
(For details, see "Steering case").

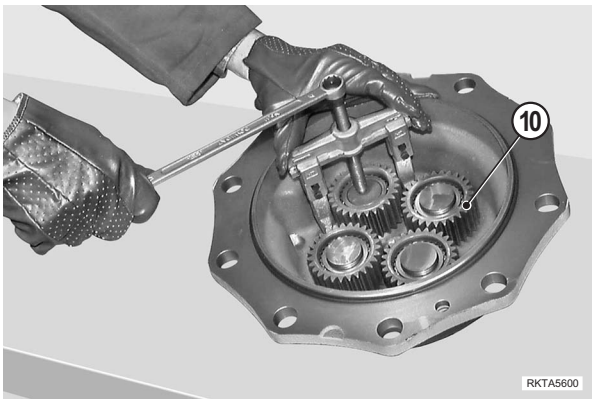


11 -Remove the snap rings (9).

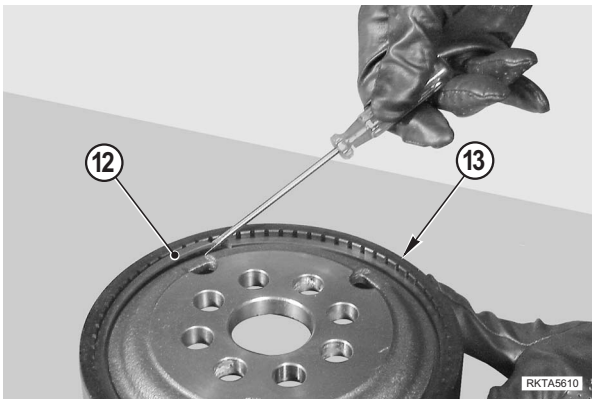


12 -With the help of a puller, remove the planet wheel gears (10).

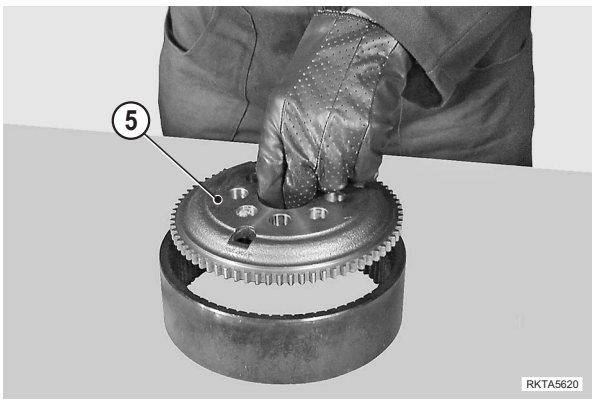
★ Note down the assembly side of planet wheels.



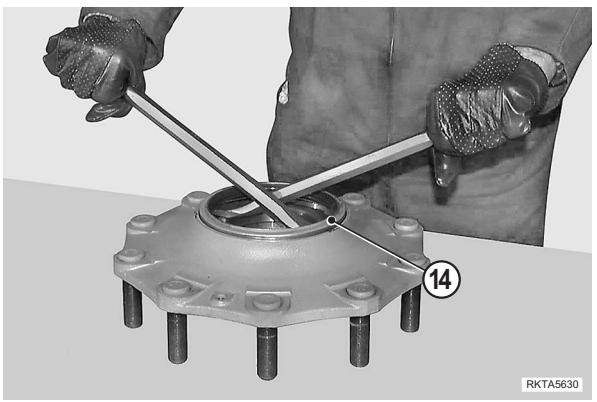
13 -Remove the snap ring (12) from the crown (13).



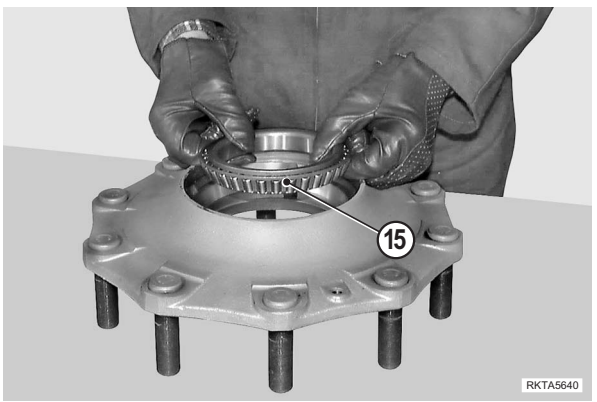
14 -Remove the crown flange (5).



15 -Remove the sealing ring (14) from the hub (7).

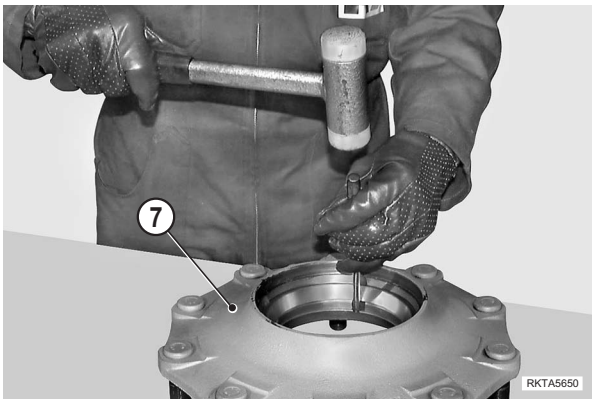


16 -Remove the internal bearing (15).



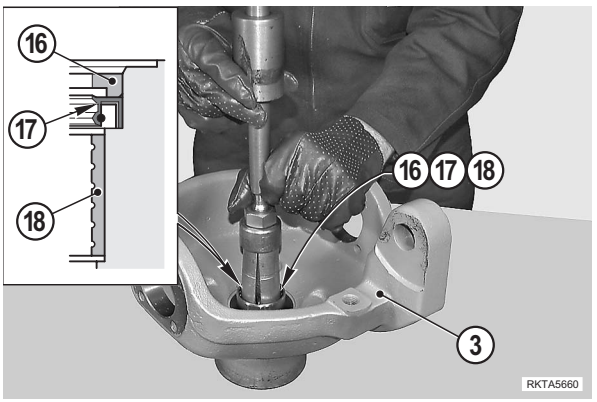
17 - Remove the external thrust blocks from the bearings (8) and (15) forcing a pin-driver into the appropriate slots on the hub (7).

★ Hammer in an alternate way so as to avoid crawling or deformation of the thrust blocks.



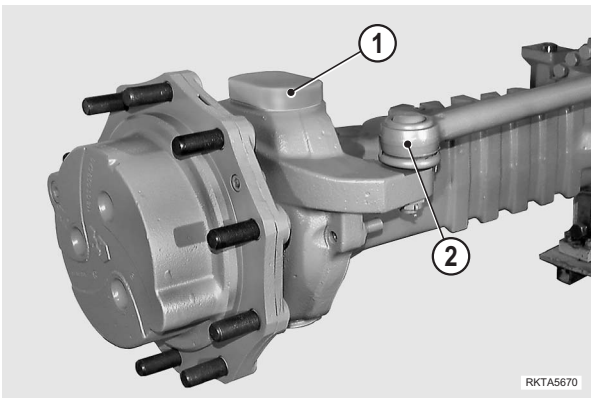
18 - Use a puller to remove the centring ring (16), the sealing ring (17) and the bearing (18) from the steering case (3).

★ Note down the orientation of both centring ring (16) and sealing ring (17).

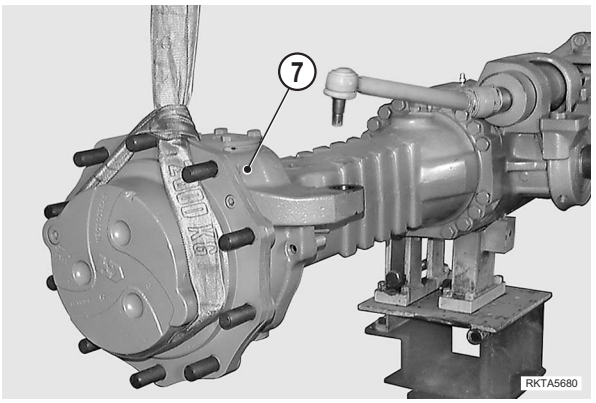


- **Steering case**

1 - Remove the guard (1) and disconnect the articulation pin (2).
(For details, see "Removal of steering cylinder").

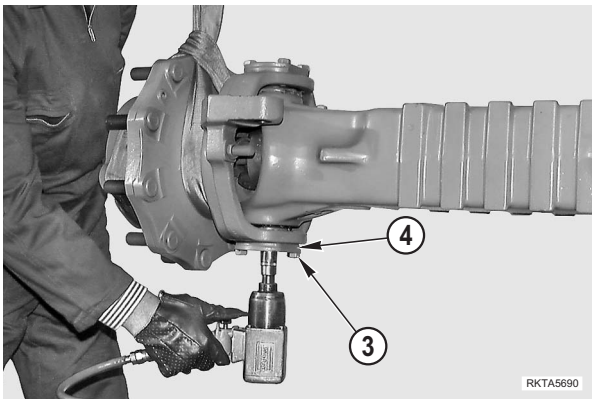


2 - Sling the entire unit (7) and connect it to the hoist, putting the rod under light tension.

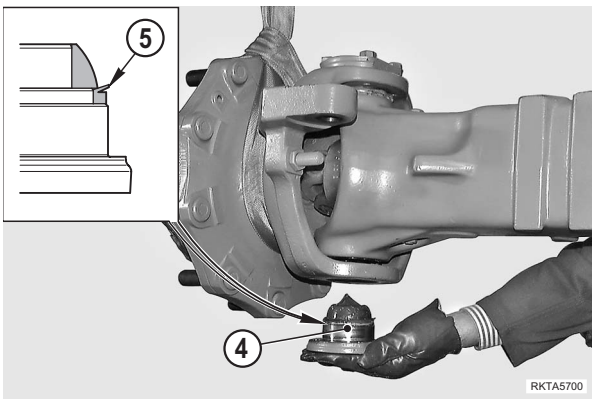


3 - Unloose and remove the fitting screws (3) from the bottom articulation pin (4).

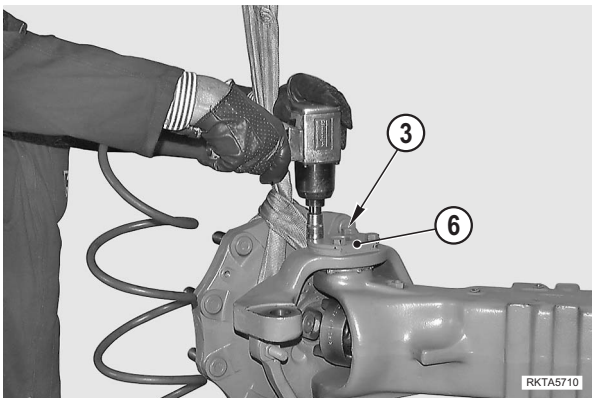
★ Screws cannot be re-used.



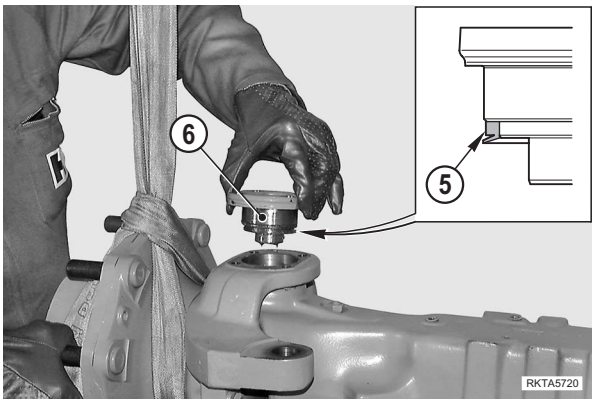
4 - Remove the bottom articulation pin (4) complete with front sealing ring (5).



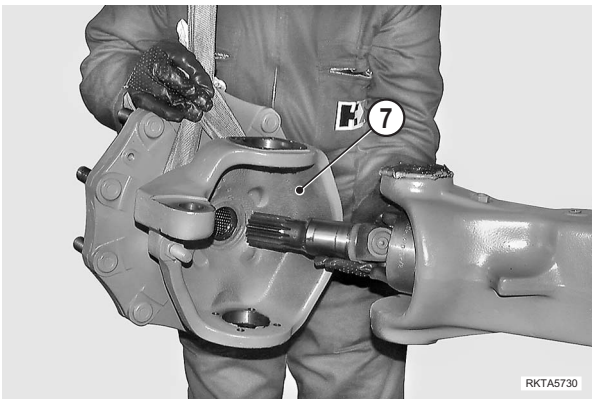
5 - Unloose and remove the fittin screws (3) from the top articulation pin (6).



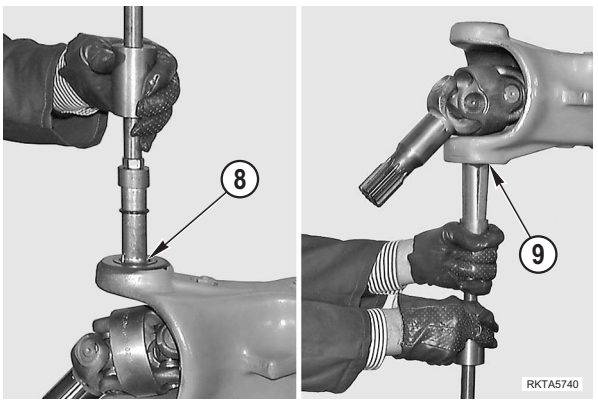
6 - Using two levers, remove the top articulation pin (6) complete with front seal (5).
Pay attention not to damage the surfaces.



7 - Remove the complete steering case (7).

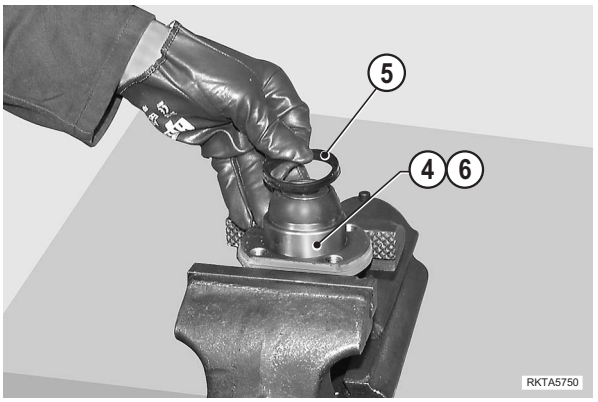


8 - Using a puller for inner parts, remove the top bush (8) and the bottom ball-bush (9).

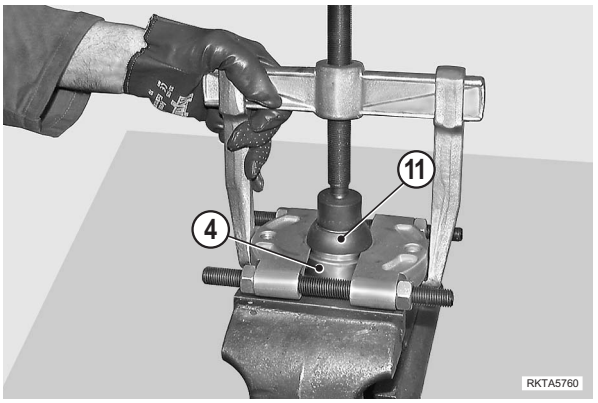


9 - Remove the articulation pins (4) and (6) and the front sealing rings (5).

★ Note down the side for assembly.



10 - If the ball cover (11) needs replacing, remove it from the bottom articulation pin (4).

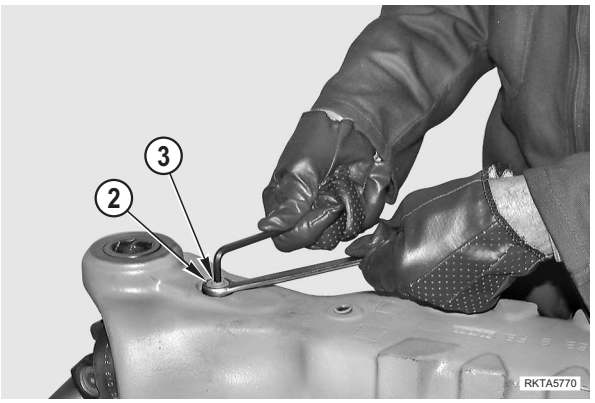


- **Cardan shaft**

1 - Remove the steering case.
(For details, see "Steering case").

★ For front axle: introduce compressed air (approx. 7 bar) in the braking circuit.

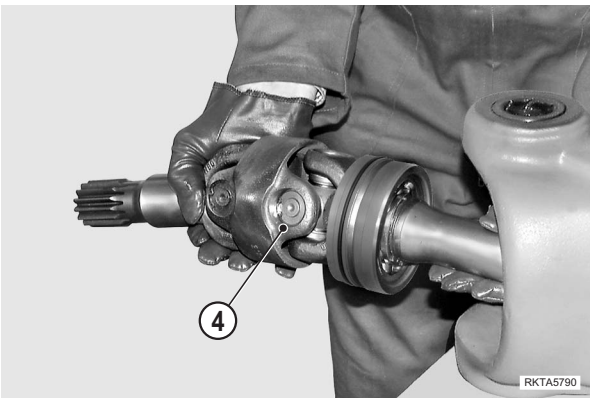
2 - Unloose and remove the top and bottom check nuts (2) from the dowels (3).



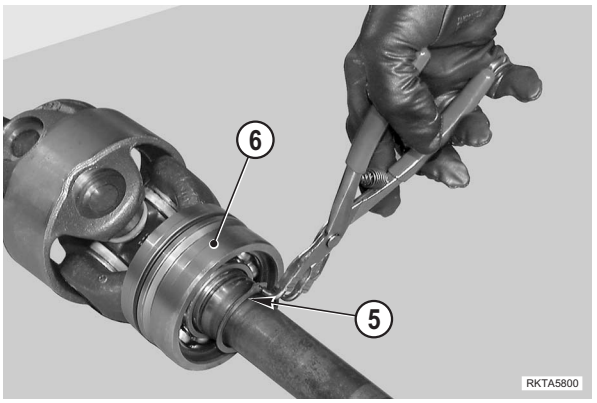
3 - Remove top and bottom check dowels (3).

4 - Remove the u-joint (4).

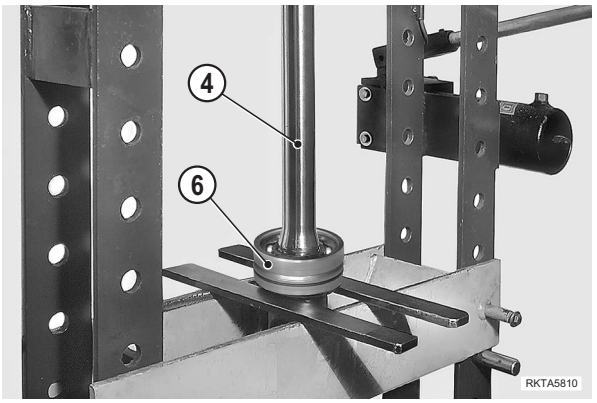
★ To remove the u-joint use, if necessary, a plastic hammer or a lever.



5 - Remove the snap ring (5) from the bushing unit (6).



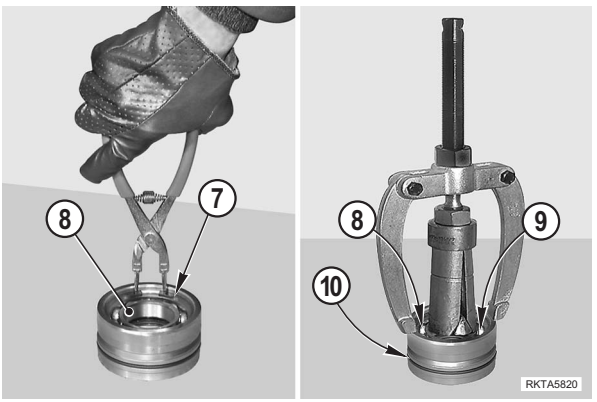
6 - Position the entire u-joint (4) under a press and remove the complete bush (6).



7 - Remove the snap ring (7) from the bearing (8).

8 - Use a puller to remove the bearing (8), the sealing ring (9) and the O-ring (10).

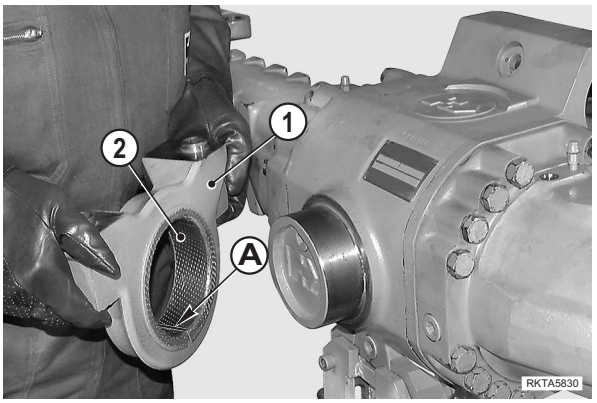
★ Note down the assembly side of the ring (9).



- **Brakes**

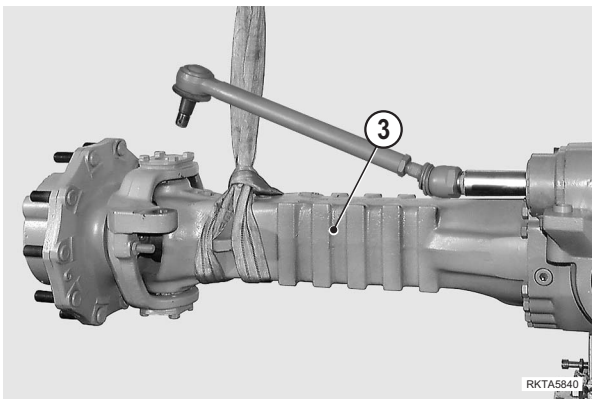
1 - Remove the swinging support (1) on the side opposite the drive.

★ If the bushing (2) is worn and needs replacing, note down the assembly side of the connection notch "**A**".

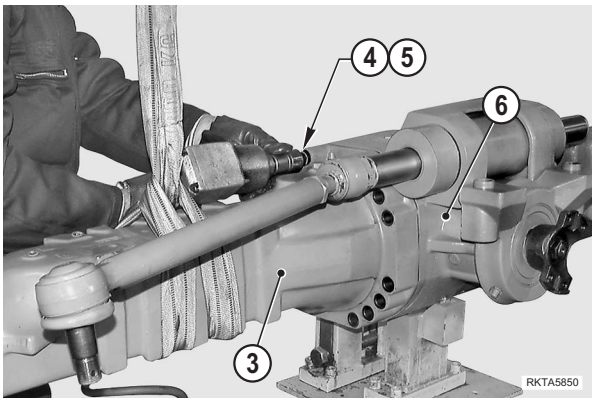


2 - Disconnect the pins of the steering bars from the steering case.
(For details, see "Removal of steering cylinder").

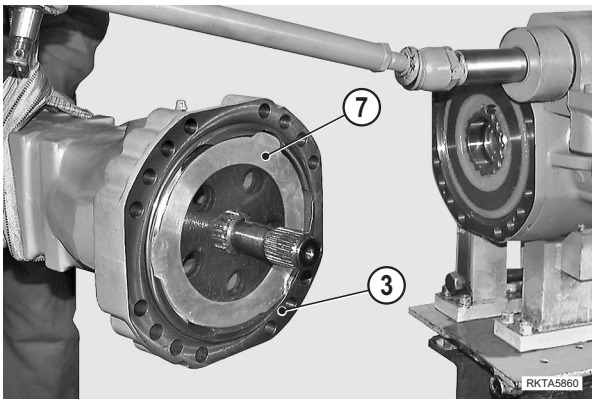
3 - Sling the arm (3) to be removed and put the rod under slight tension.



4 - Unloose and remove the screws (4) and the washers (5) that fix the arm (3) to the central body (6).



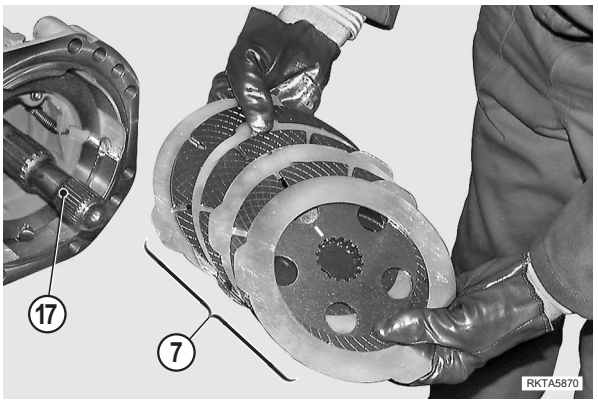
5 - Remove the arm (3) together with the pack of the braking disks (7). Place the arm on a bench.



6 - Remove the braking disks (7) and note down their order of assembly.

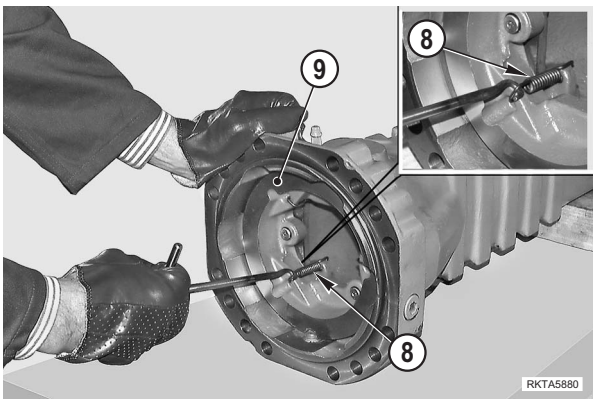
★ If the disks do not need replacing, avoid switching their position.

7 - Extract the u-joint (17).
(For details, see "Cardan shaft").



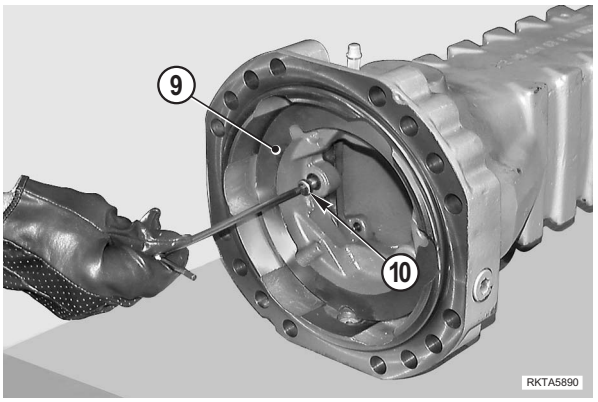
8 - Remove the reversal springs (8) from the piston (9).

★ If the springs (8) are weak or deformed they must be replaced.



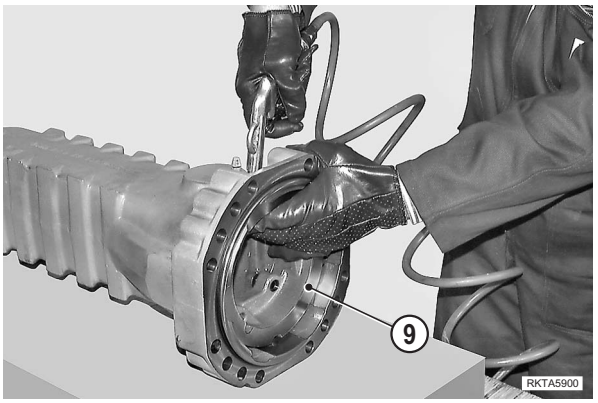
9 - Remove the pin screws (10) guiding the piston (9).

⚠ If the screws are to be replaced, note down the different colours for the different brake gap.
(For details, see "Brakes").



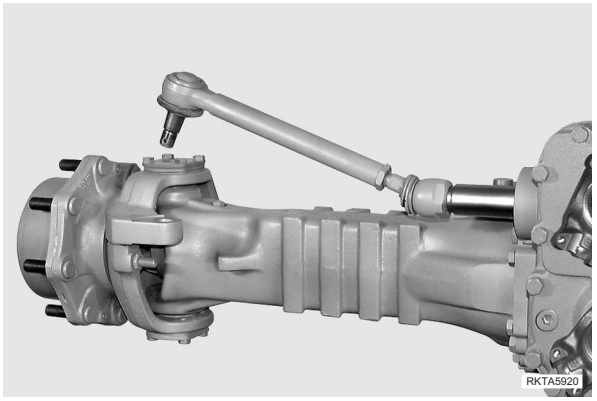
10 - Slowly introduce compressed air through the connection of the braking circuit in order to extract the entire piston.

⚠ Hold on to the piston as it may be suddenly ejected and damaged.

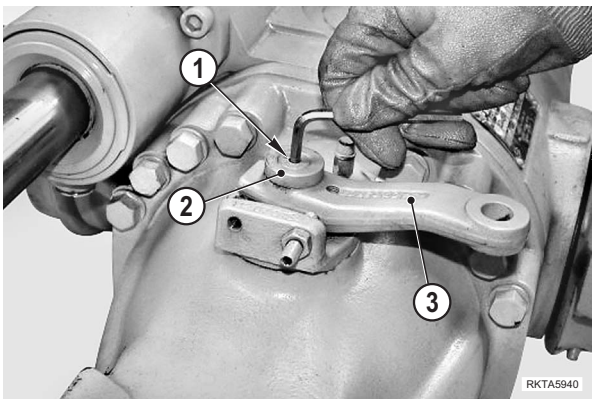


- **Parking brake assembly (front axle)**

1 - Disconnect the steering rod from the housing and remove the axle shafts.
(For details, see "Removal of steering cylinder").

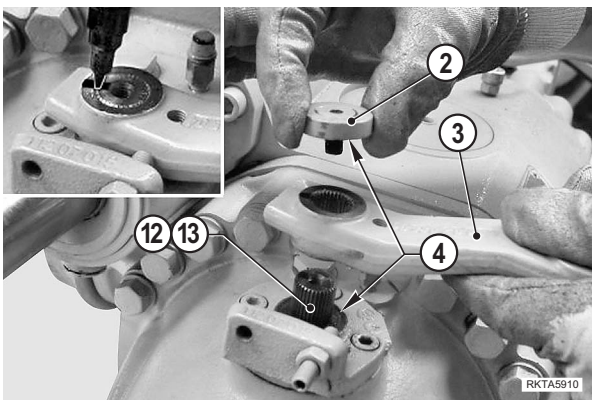


2 - Remove the screw (1) retaining the washer (2) retaining the lever (3).

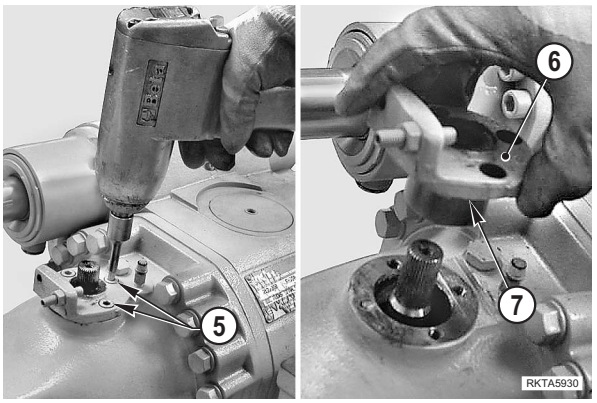


3 - Remove the washer (2), lever (3) and O-rings (4).

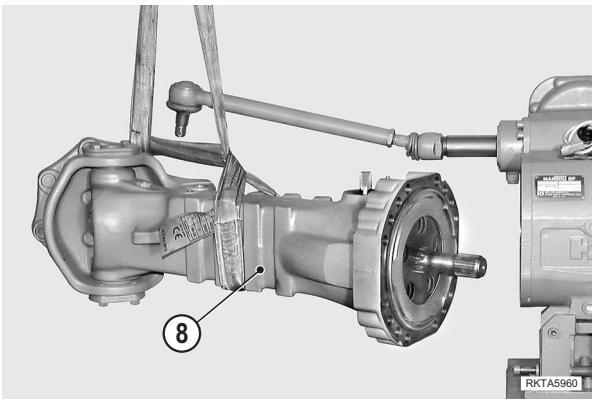
★ Mark the positions of the levers (3) in relation to the thrust levers (12 and 13).



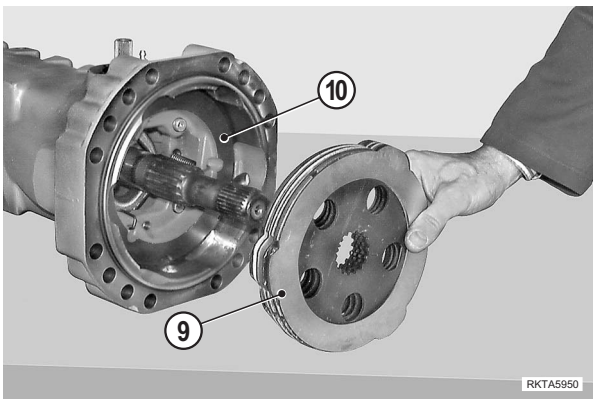
4 - Loosen and remove the screws (5); remove the bushing (6) together with the O-ring seal (7).



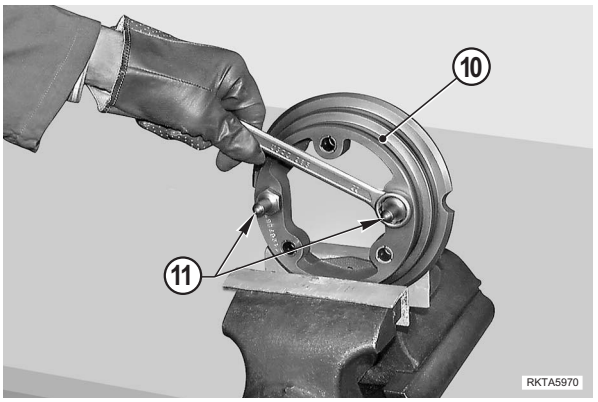
5 - Connect the complete axle shaft (8) to a hoist and slightly tension the rope.
Remove the complete axle shaft.
(For details, see "Brakes").



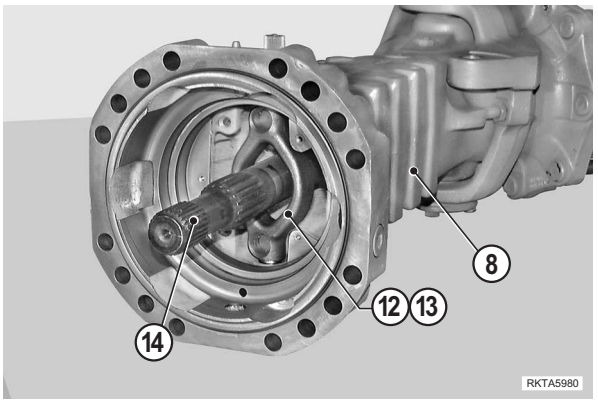
6 - Remove the brake rotors (9) and the complete piston (10).
(For details, see "Brakes").



7 - If the points (11) are to be replaced, clamp the piston (10) in a vice with soft grips and remove the points.

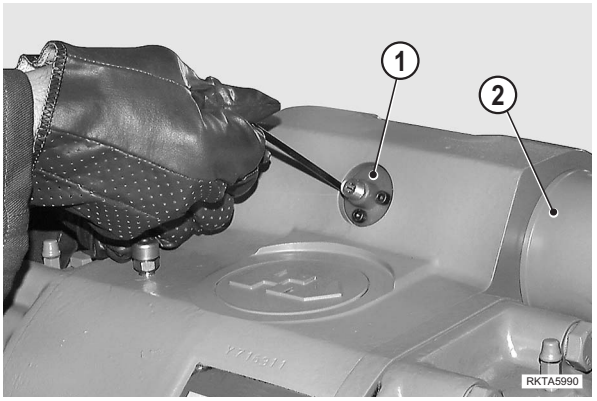


8 - If the thrust levers (12 and 13) are to be replaced, remove the U-joint (14) before removing the axle shafts (8).



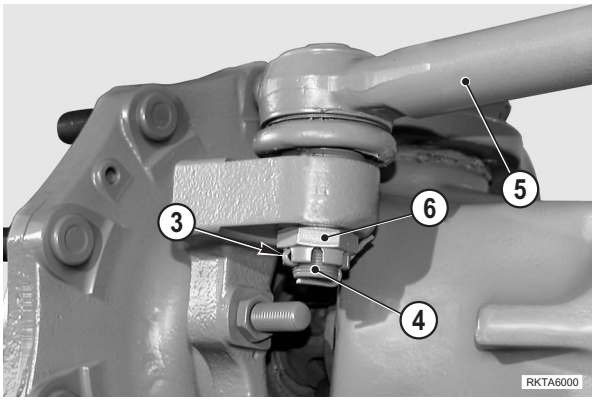
- **Removal of steering cylinder**

1 - Remove the centring sensor (1) of the steering piston (2), if supplied.

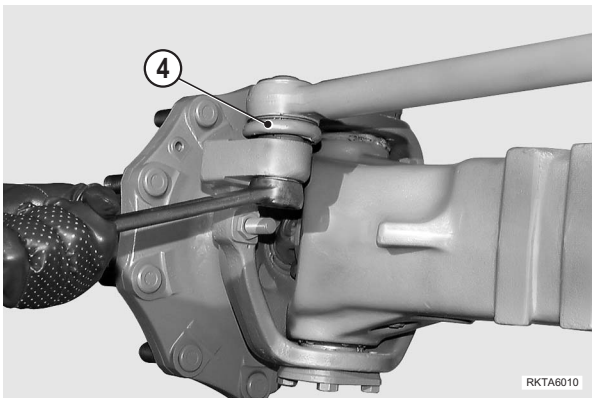


2 - Remove the safety cotter pins (3) from the articulation pins (4) of the steering bars (5).

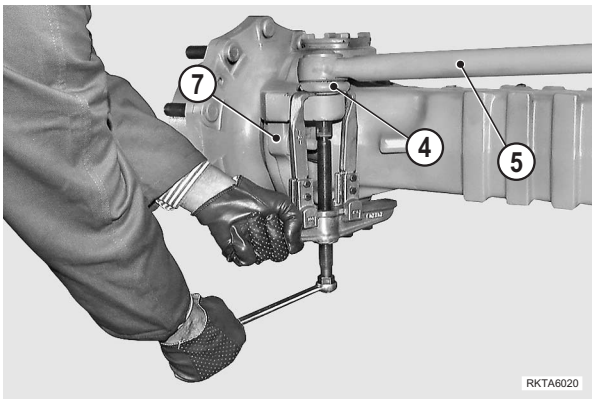
⚠ Dispose of used cotter pins.



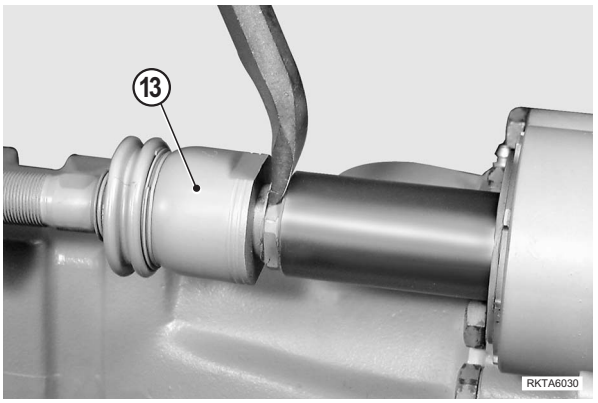
3 - Remove the castellated nuts (6) that lock the articulation pins (4).



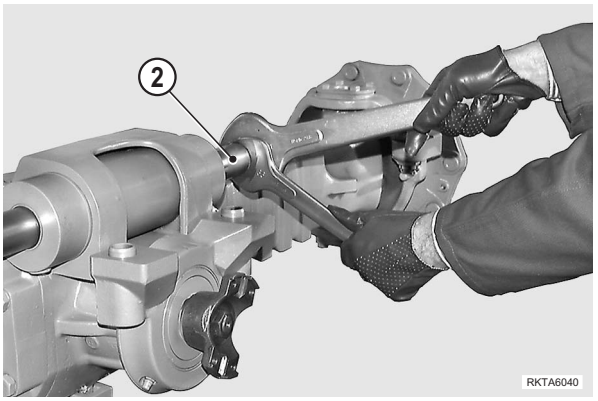
4 - Disconnect the tapered pins of the articulation (4) from the steering case (7) by means of a puller.



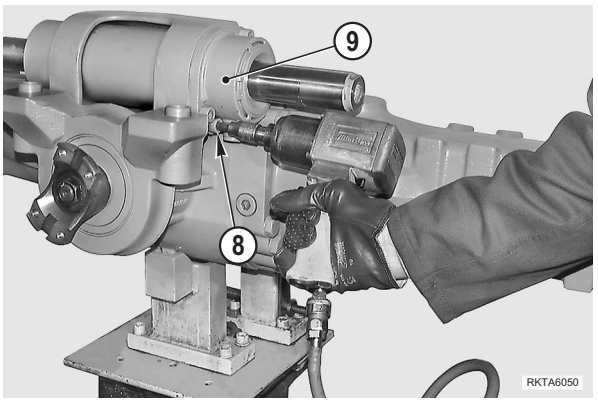
5 - If the connection of the steering bars includes a safety collar (13), raise the border.



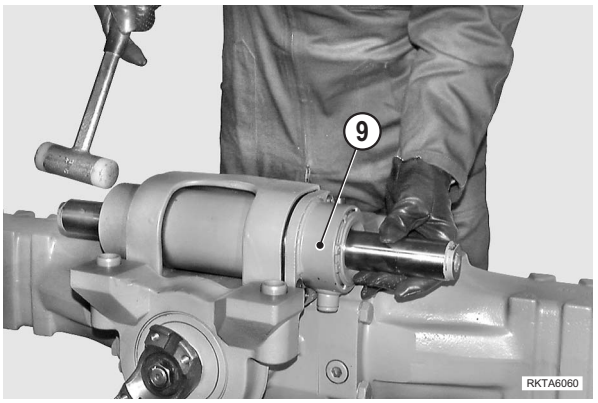
6 - Disconnect left and right steering bars (5) from the piston (2).



7 - Remove the securing screws (8) from the steering cylinder (9).

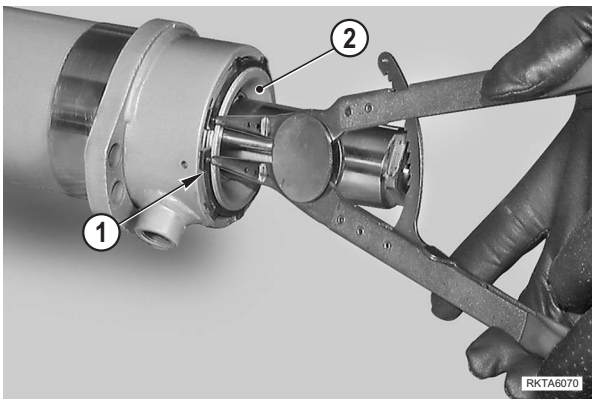


8 - Extract the cylinder (9) using a plastic hammer.



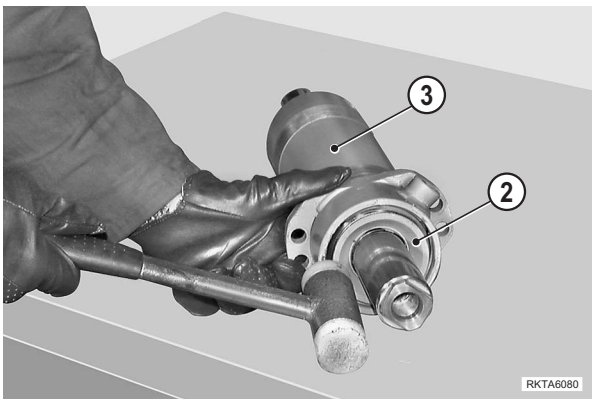
- **Disassembly of steering cylinder**

1 - Remove the snap ring (1) from the cylinder head (2).

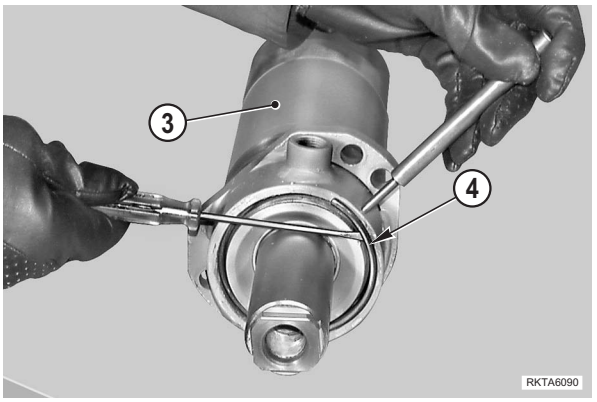


2 - With the help of a plastic hammer, push the head (2) inside the cylinder (3).

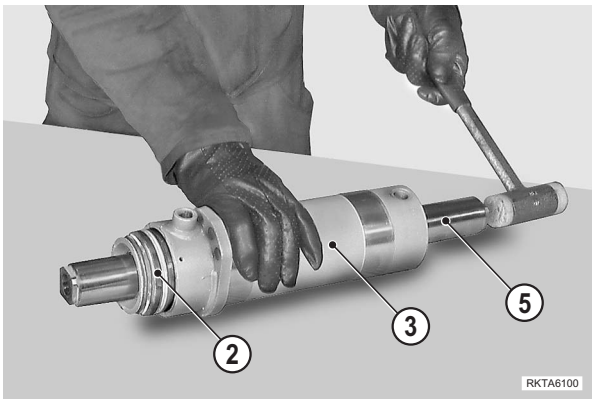
★ The head should line up with the edge of the cylinder.



3 - With the help of a drift, apply pressure to the stop ring (4) that is placed inside the cylinder (3) and extract the ring using a screwdriver.

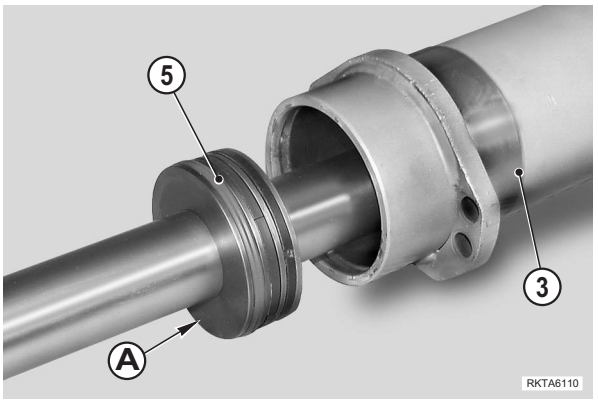


4 - Hammer the piston (5) on the rear of the head (2) using a plastic hammer. Continue hammering until the head (2) is ejected from the cylinder (3).



5 - Disassemble the cylinder unit (3) by extracting first the head (2), then the piston (5).

⚠ Note down the assembly side of the piston (5). The bevelled part "**A**" of the piston is oriented towards the head (2).



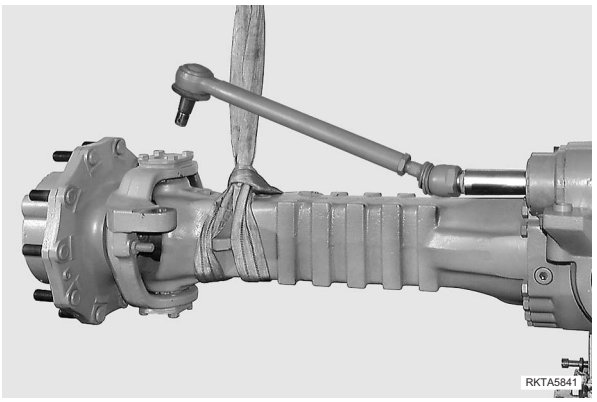
6 - Remove all seals, anti-extrusion rings and scraper rings from head (2), cylinder (3) and piston (5).

★ All seals must be replaced every time the unit is disassembled.

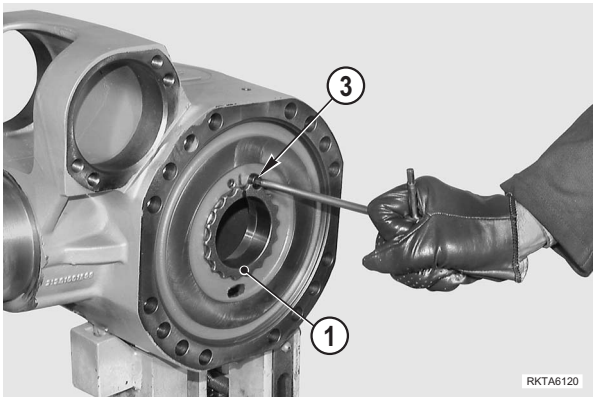
★ Particular attention must be paid not to damage the seats of both seals and piston slide.

• Differential

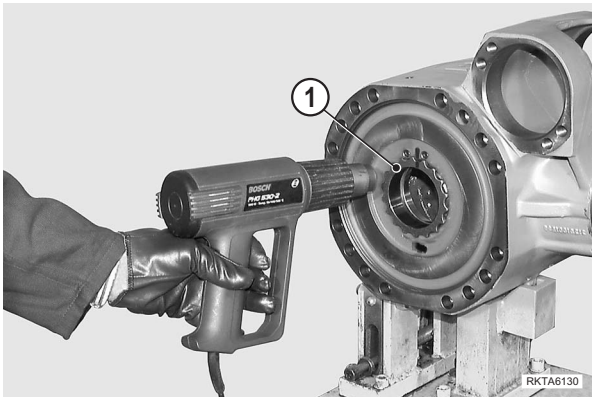
1 - Remove the complete arms.
(For details, see "Brakes").



2 - Mark the position of the ring nuts (1). Remove the fittin screws (3) from the ring nuts (1).

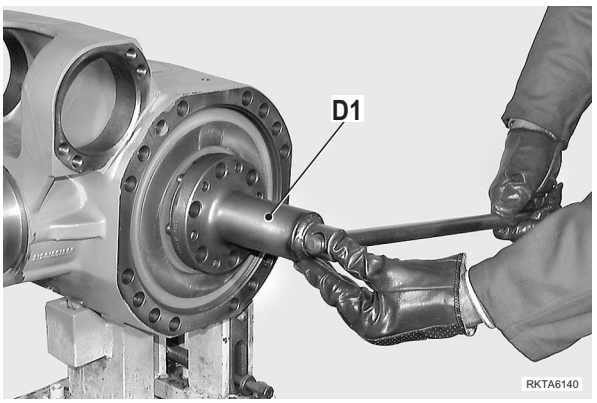


3 - Uniformly heat the ring nuts (1) up to a temperature of 80°C.

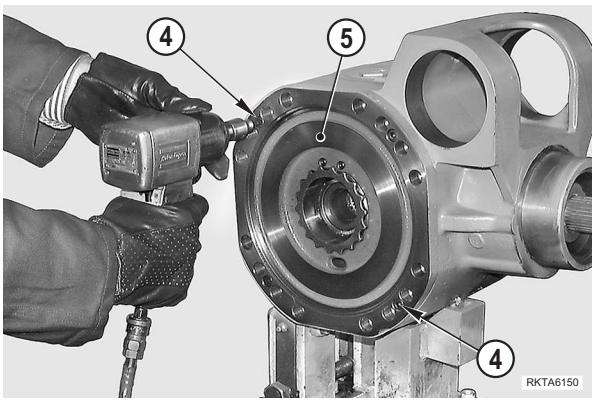


4 - Apply tool **D1** and remove the ring nuts.

★ Accurately clean the threaded portions on ring nuts of body and cover.

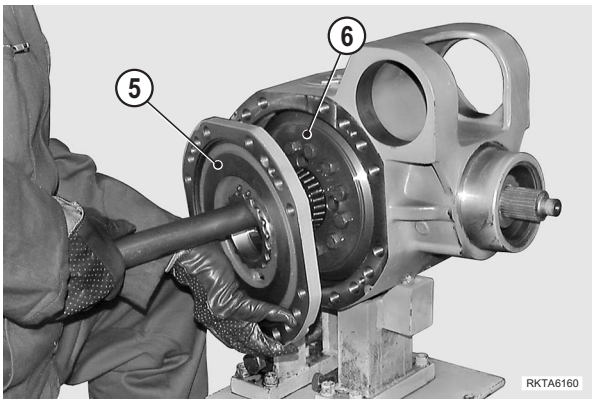


5 - Remove the fittin screws (4) from the middle cover (5).



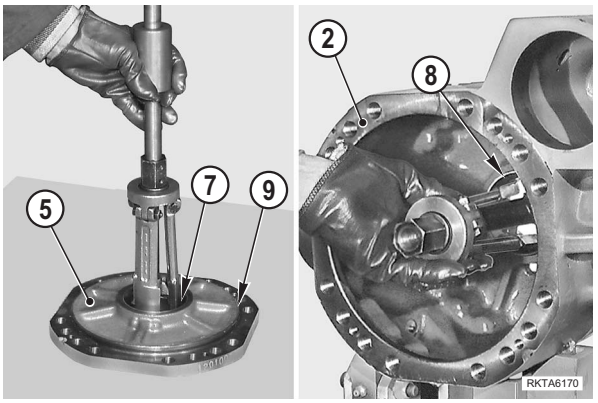
6 - Insert a screw-driver in the opposing slots then force and remove the middle cover (5) and the complete differential unit (6).

★ Support the pieces using a rod.



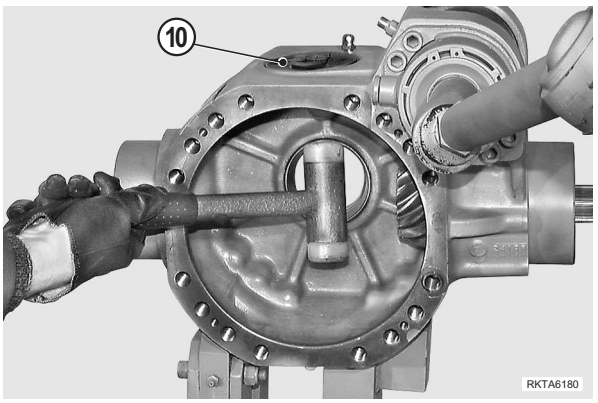
7 - If the bearings need replacing, extract the external thrust blocks of the bearings (7) and (8) from middle cover (5) and central body (2).

★ Accurately check the O-ring (9).

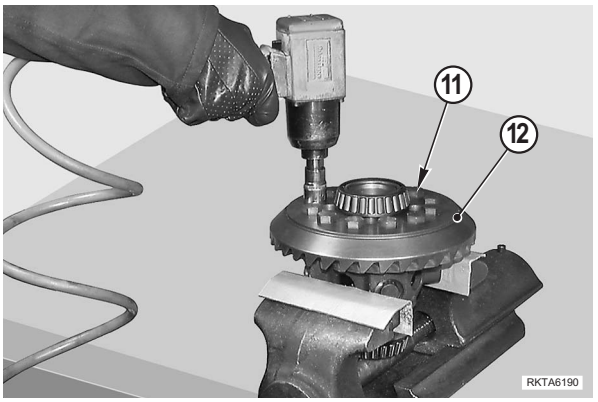


8 - Remove the top plug (10).

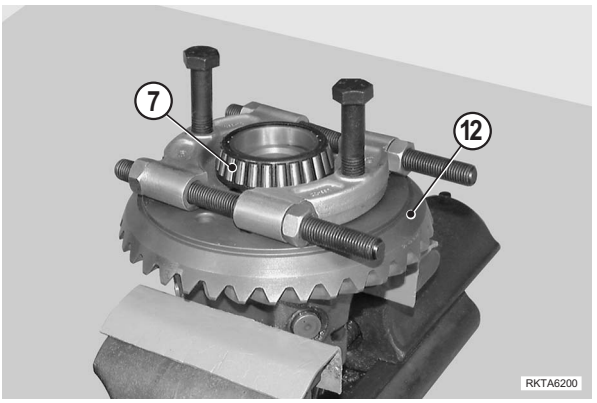
★ Top plug cannot be re-used.



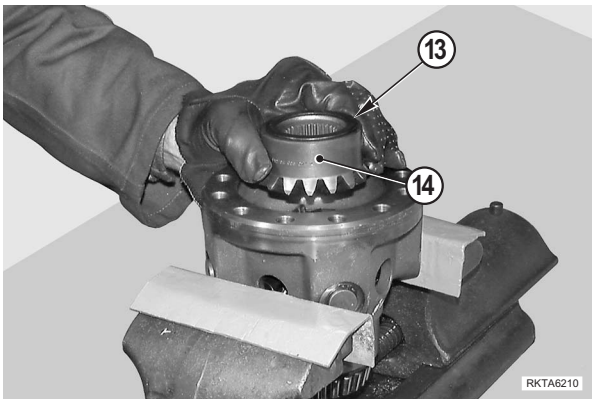
9 - Remove the fittin screws (11) from the crown (12).



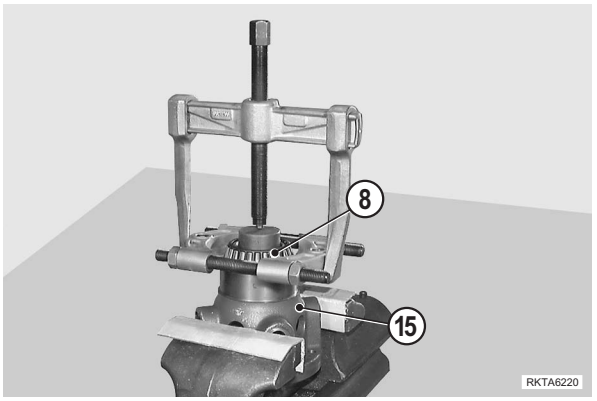
10 - If the bearing need replacing, extract the bearing (7) and remove the crown (12).



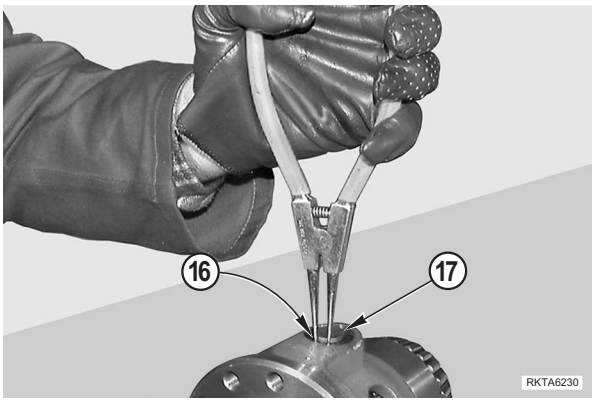
11 - Remove the shim washer (13) and the planetary gear (14).



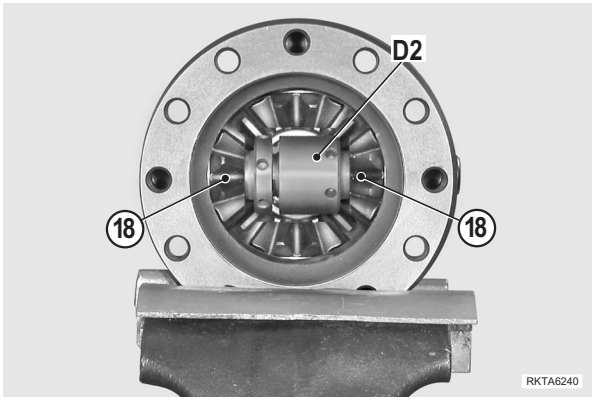
12 - If the bearing need replacing, extract the bearing (8) from the differential carrier (15).



13 - Remove the snap rings (16) from the two pins (17) of the planet wheel gears (18).

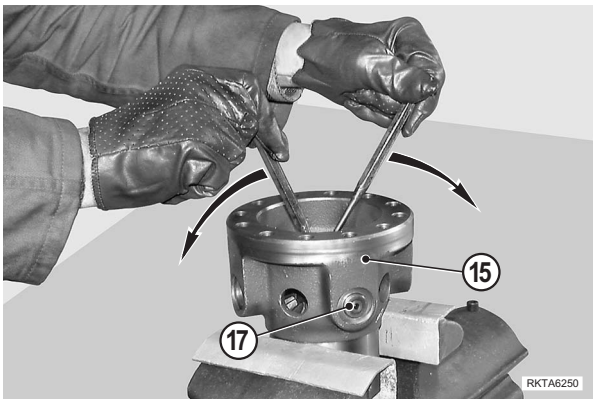


14 - Insert tool **D2** between the planet wheel gears (18).

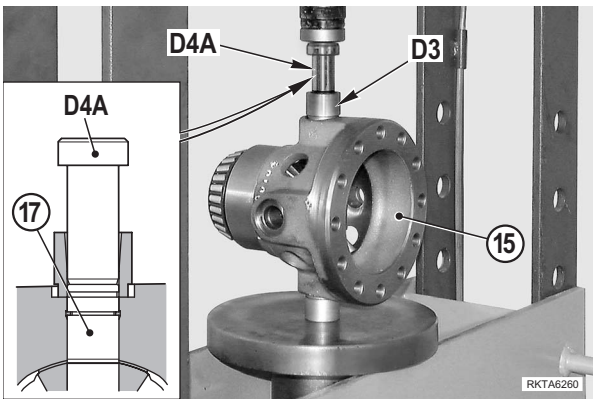


15 -Force tool **D2** in-between the planet wheel gears (18) using two pin-drivers.

⚠ Make sure that tool **D2** is perfectly lined up with the pins (17) when locked.

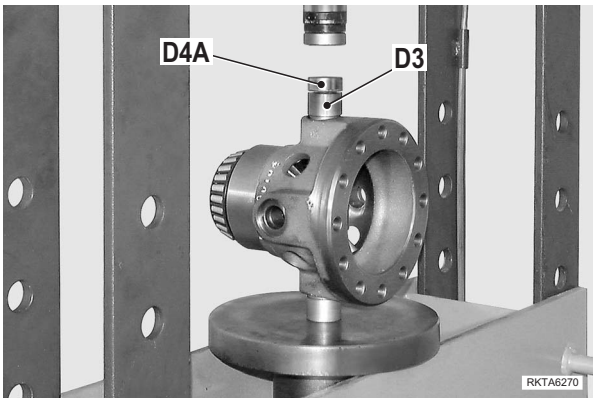


16 -Place the differential carrier (15) under a press, position bush **D3** and insert gudgeon **D4A**. Press **D4A** pin to limit position.

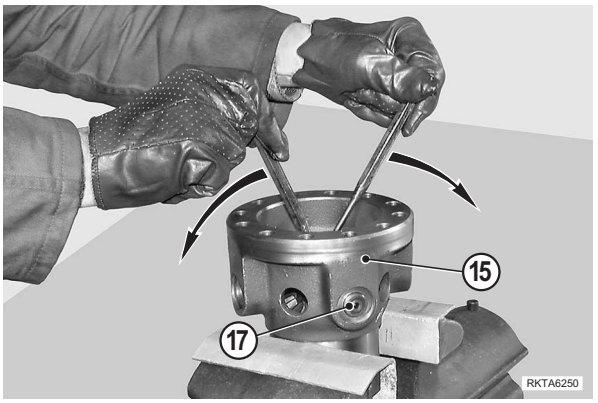


17 -Remove gudgeon **D4A** and bush **D3**.

★ In this condition the tool **D2** contains pin (17).



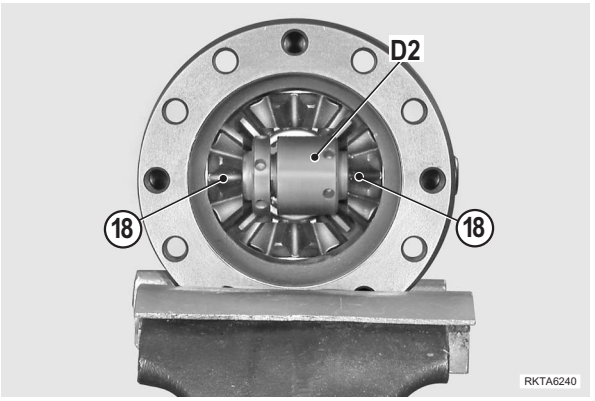
18 -Remove tool **D2** together with the pin (17) of the planet wheel.



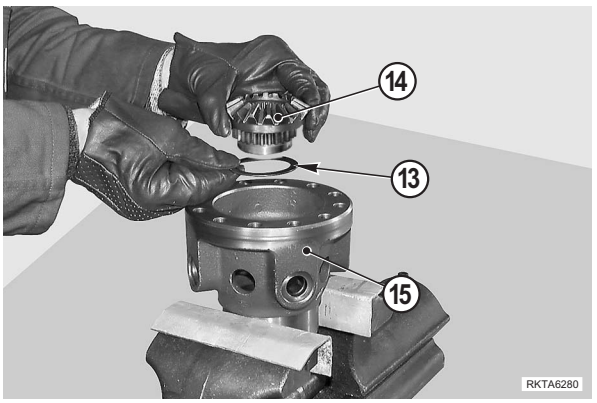
19 - Leave the released planetary gear in position and again lock tool **D2**.

20 - Repeat the operations for the extraction of the pin of the 2nd planet wheel (17).

21 - Repeat the operations for all other pins.

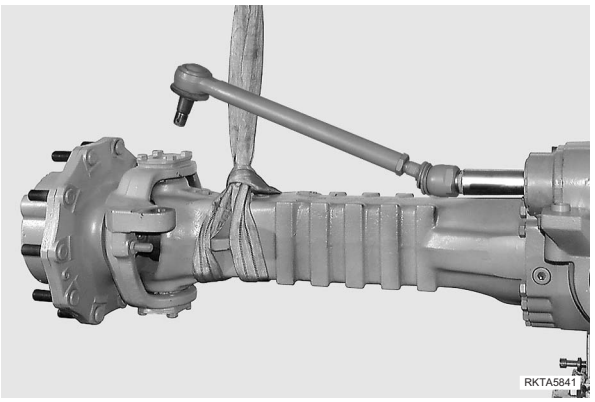


2 - Remove tool **D2** and remove the last two planet wheel gears (18), the 2nd differential unit gear (14) and the relative shim washer (13) from the differential carrier.



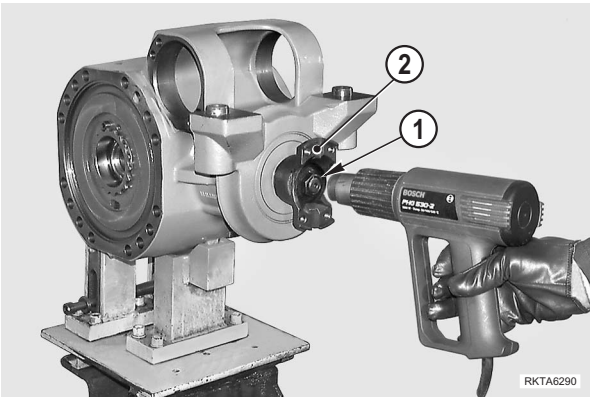
- **Bevel pinion**

1 - Remove the complete arms and the differential unit. (For details, see "Brakes" e "Differential").

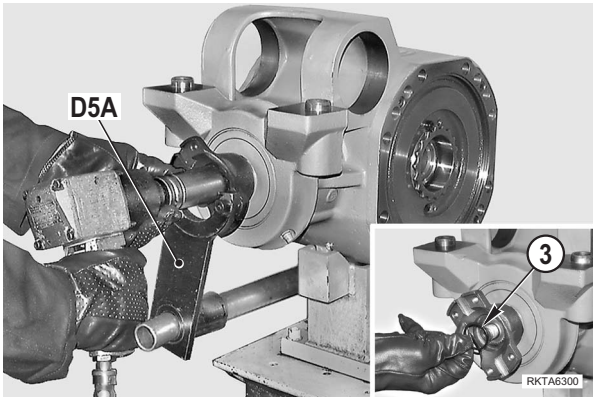


2 - If disassembly is awkward, heat the check nut (1) of the flange (2) at 80 °C.

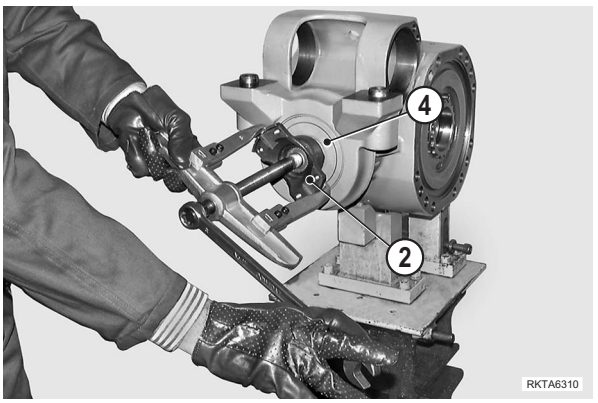
★ Heating is meant to unloose the setting of Loctite on the nut (1).



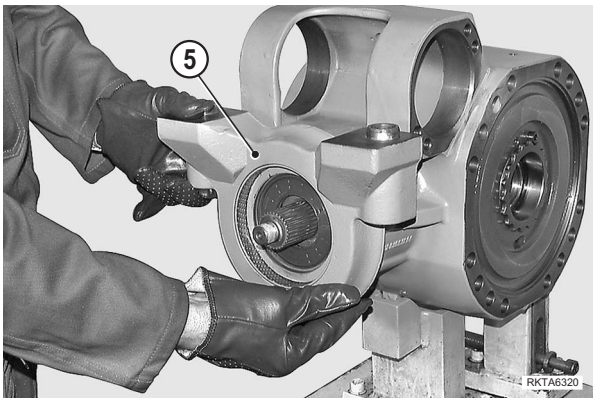
3 - Position tool **D5A** (or **D5B**), so as to avoid pinion rotation. Unloose and remove the nut (1); also remove the O-ring (3).



4 - Remove the flange (2) complete with guard (4) by means of a puller.



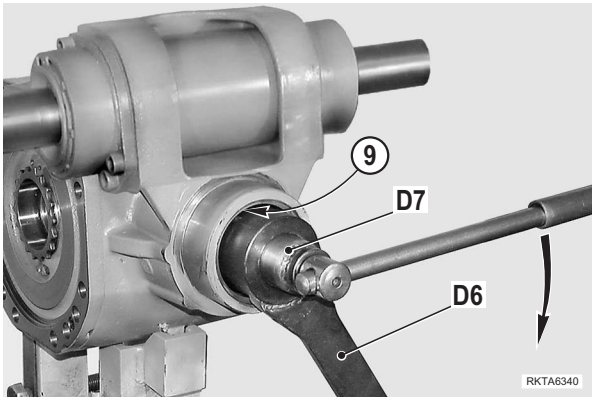
5 - Remove the swinging support (5)



6 - Remove the sealing ring (6).

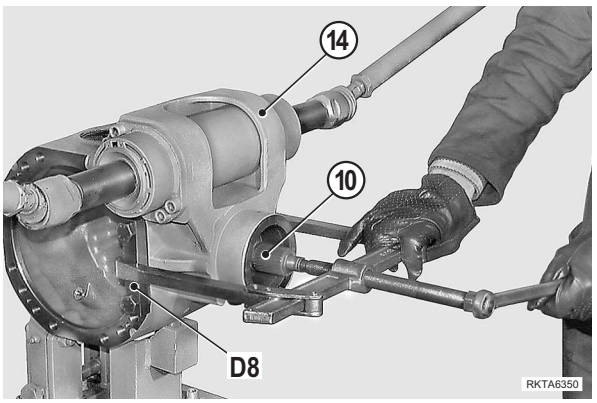
7 - Position wrench **D6** onto the ring nut (9) and apply bar hold **D6** to the pinion (10).
Stop wrench **D6** and rotate the pinion so as to release and remove the ring nut (9).

★ If disassembly proves awkward, weld the ring nut at approx. 80 °C.

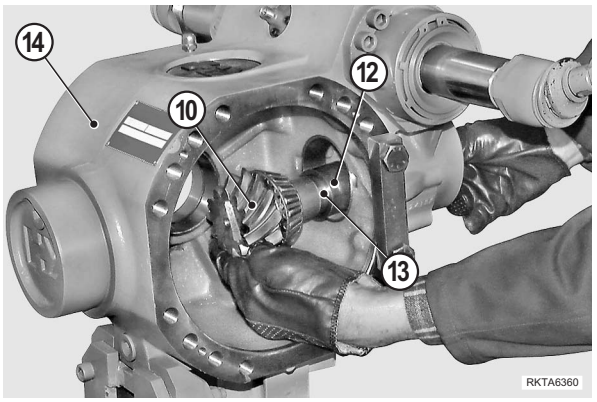


8 - Apply blocks **D8** and, with the help of a puller, extract the pinion (10) complete with the internal bearing (11), the distance piece (12) and shims (13).

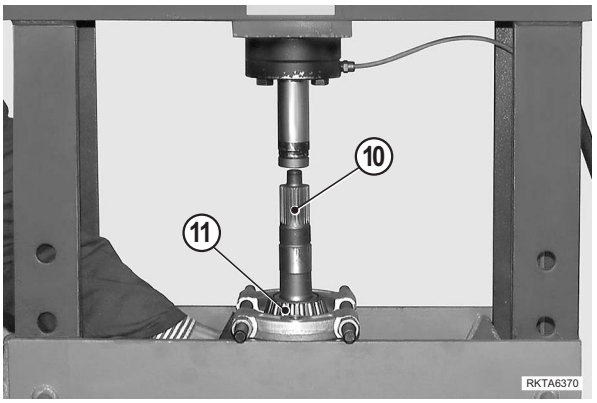
★ The thrust blocks of the bearings remain in the central body (14).



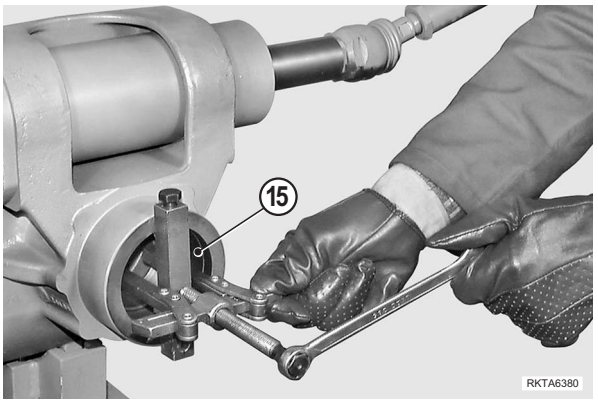
9 - Remove the pinion (10), shims (13) and distance piece (12).



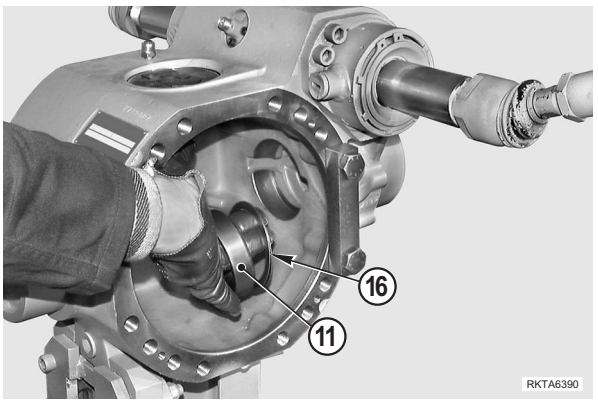
10 - Using a puller and a press, remove the inner bearing (11) from the pinion (10).



11 - Remove the thrust block of the external bearing (15).



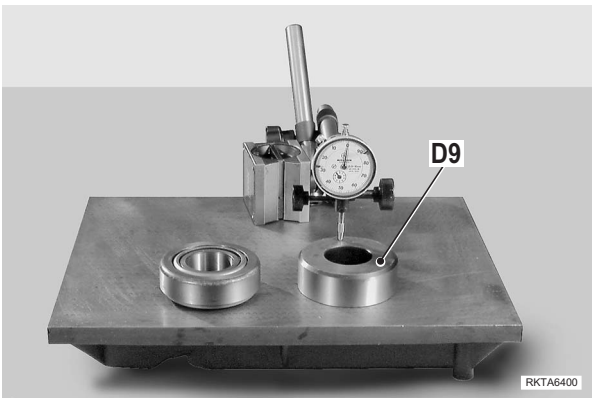
12 - Insert a drift in the appropriate holes and remove the thrust block of the internal bearing (11) as well as the shim washers (16).



ASSEMBLY

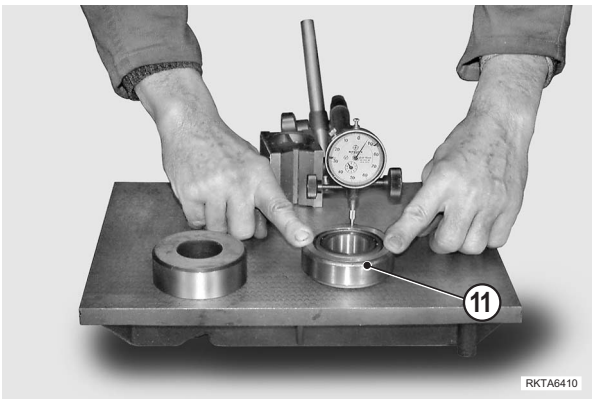
- **Bevel pinion**

1 - Using a surface plate, reset a centesimal comparator and place it on the measurement ring **D9** (with a thickness of 30.2 mm).
Preset the comparator to approx. 2 mm.

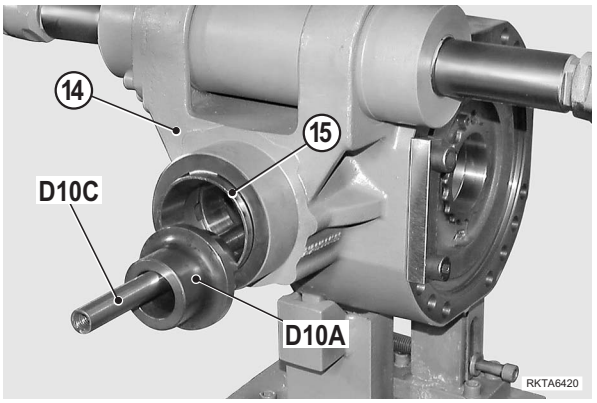


2 - Bring the internal bearing (11), complete with its thrust block, under the comparator.
Determine overall thickness "**D**" of the bearing checking the discrepancy between this size and the size of the measurement ring.

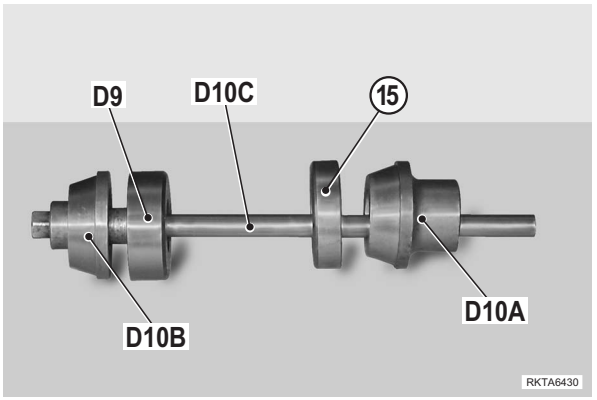
⚠ Press the thrust block in the centre and take several measurements while rotating the thrust block.



3 - Partially insert the thrust block of the external bearing (15).

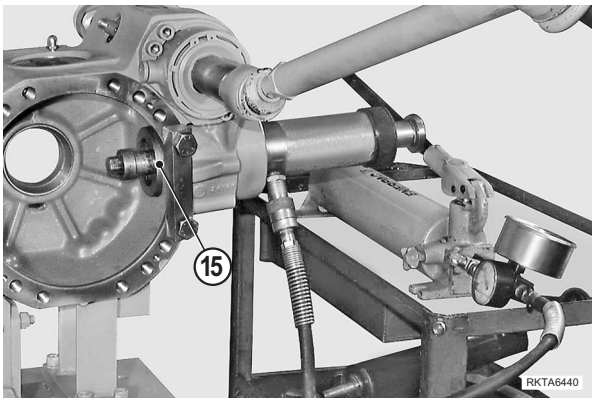


4 - Install tension rod **D10C**, measurement ring **D9** and front guide tool **D10A** on the thrust block of the external bearing (15).

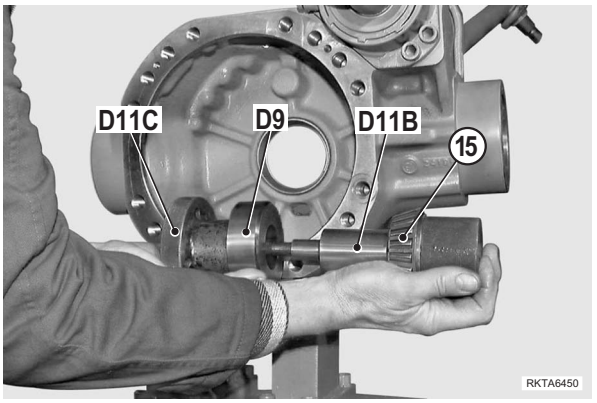


5 - Connect the tension rod to the press and move the thrust block of the external bearing (15) into its seat. Disconnect the press and remove the tension rod.

⚠ Before starting the next stage, make sure that the thrust block has been completely inserted into its seat.

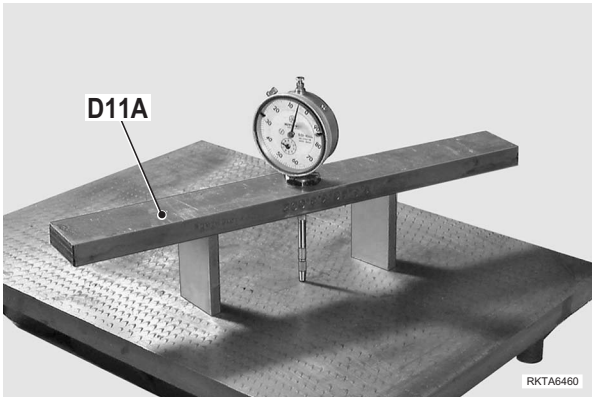


6 - Insert tool **D11B** complete with external bearing (15), measurement ring **D9** and gauged ring nut **D11C**. Manually tighten.

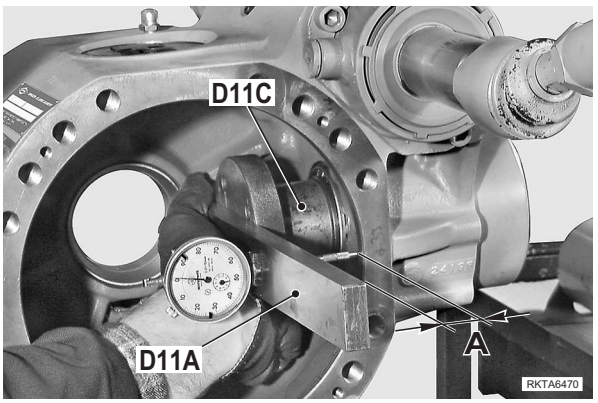


7 - Fit a centesimal comparator with long stem into bar **D11A**; when the bar rests on two size- blocks of 57 mm, reset the comparator.

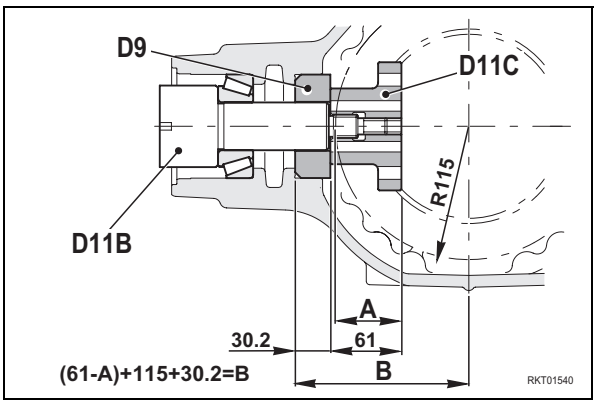
8 - Preset the comparator to approx. 2 mm and reset.



9 - Lay bar **D11A** on gauged nut **D11C** and take the size "**A**" at about 57 mm corresponding to the maximum diameter of arms centring.

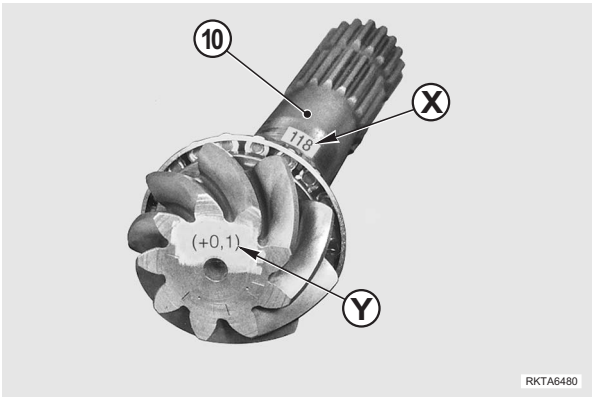


10 - Calculate size "**B**" which will be the first useful value for calculating the size of the shims (16) that are to be inserted under the thrust block of the internal bearing (11).

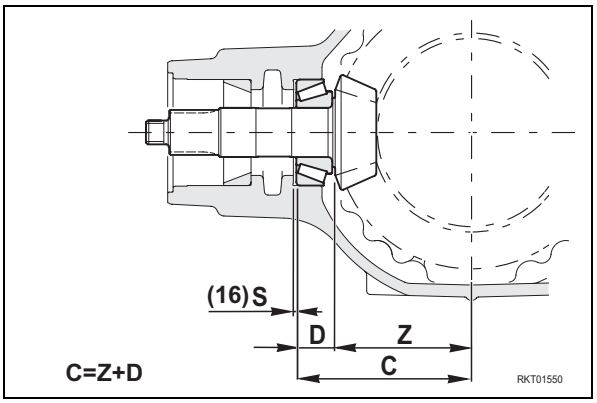


11 - Check the nominal size (X) marked on the pinion and add or subtract the indicated variation (Y) so as to obtain size "**Z**".e.g.:

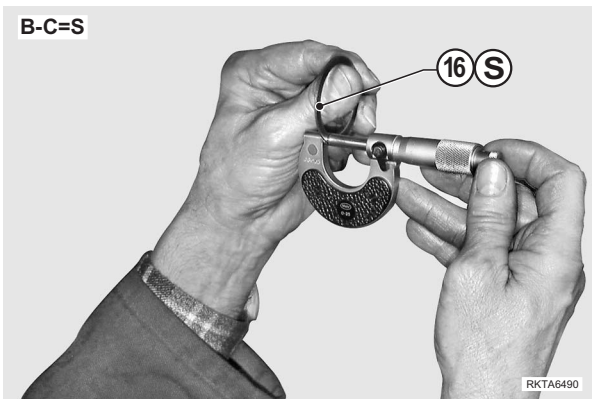
Es: Z=118 + 0.1= 118.1
Z=118 – 0.2= 117.8



12 - Calculate size "**C**" which represents the second value for calculating the size of the shims "**S**" that are to be placed under the thrust block of the internal bearing (11).

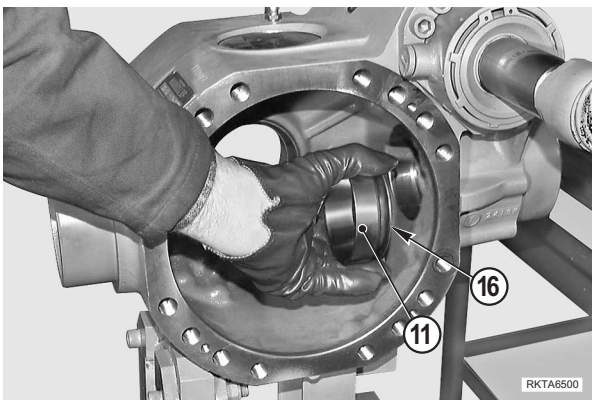


13 - Calculate the difference between sizes "**B**" and "**C**" so as to obtain the size "**S**" of the shim (16) that will go under the thrust block of the internal bearing (11).



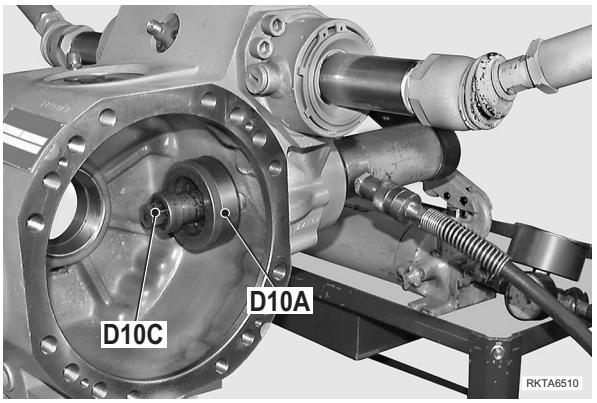
14 - Insert shim "**S**" (16) and the thrust block of the internal bearing (11) in the central body.

★ To hold shim "**S**" (16) in position, apply grease.

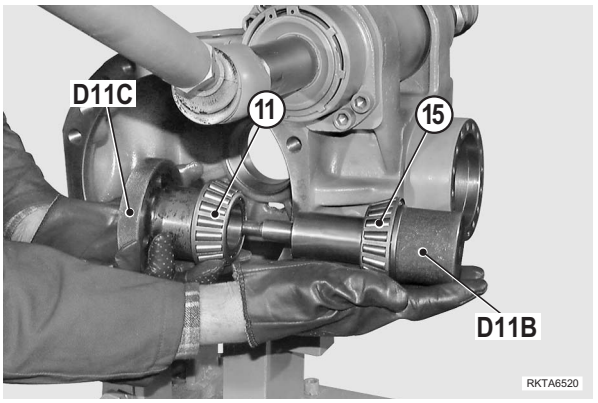


15 - Position tool **D10A** and tension rod **D10C**.
Connect the tension rod to the press, fasten the thrust block and then remove the tools.

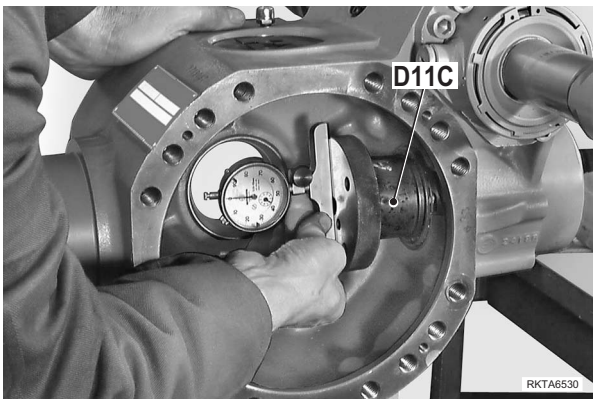
★ Before going on to the next stage, make sure that the thrust block has been completely inserted.



16 - Position tools **D11C** and **D11B** complete with tapered bearings (11) and (15); manually tighten until a rolling torque has been obtained.

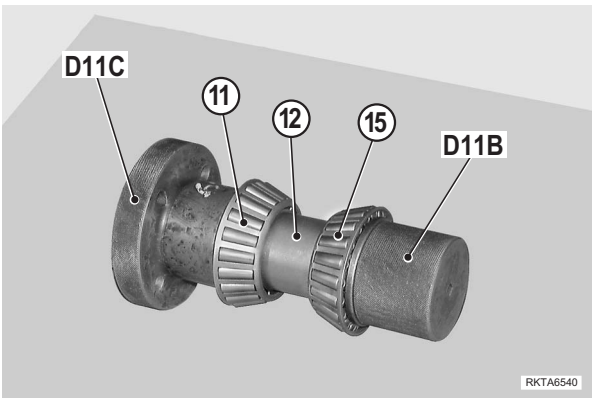


17 - Insert the stem of a depth comparator in either side hole of tool **D11C**; reset the comparator with a presetting of approx. 3 mm.

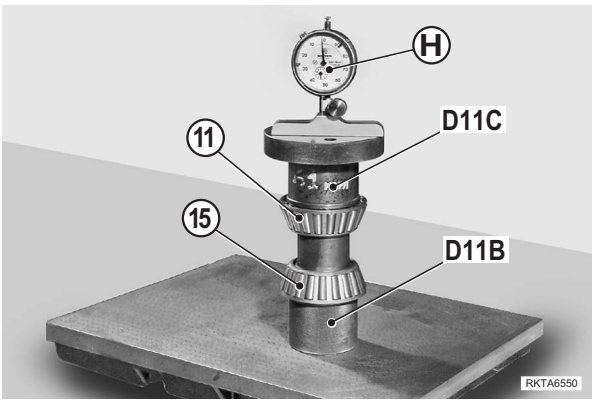


18 - Remove the comparator and release tools and bearings from the central body.

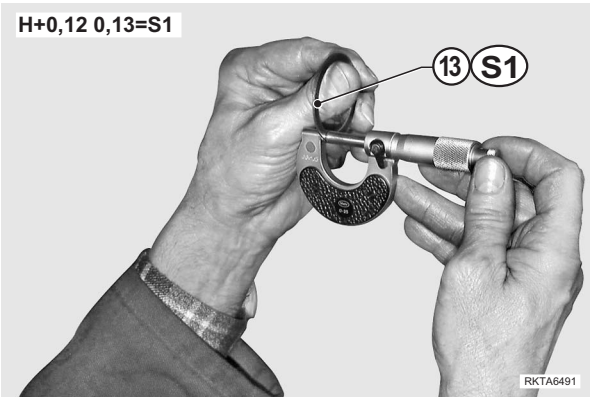
19 - Re-install all and insert the distance piece (12) between bearings (11) and (15); manually tighten the whole pack.



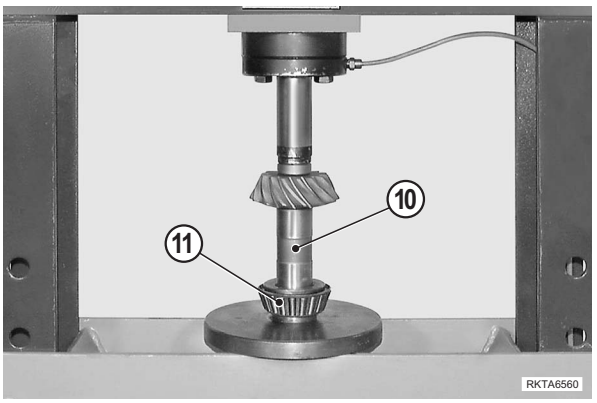
20 - Insert depth comparator into tool **D11B-D11C** and measure variation "**H**" in relation to the zero setting performed back at point 18.



21 - The variation is to be added to a set value of 0.12–0.13 mm, so as to obtain the size of shim "**S1**" (13) which will be inserted between the external bearing (15) and the distance piece (12) and subsequently, to determine the preload for the bearings.

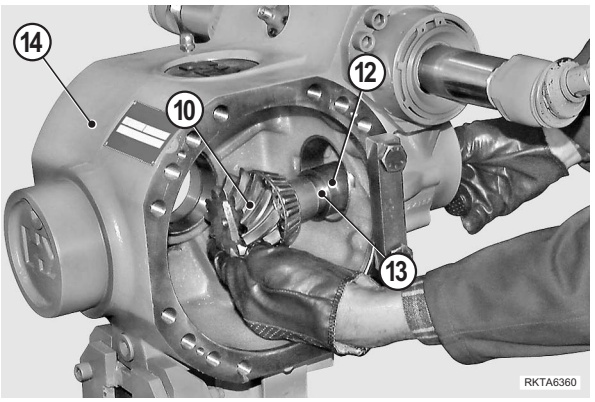


22 - Position the internal bearing (11) and the pinion (10) under a press; force the bearing onto the pinion.

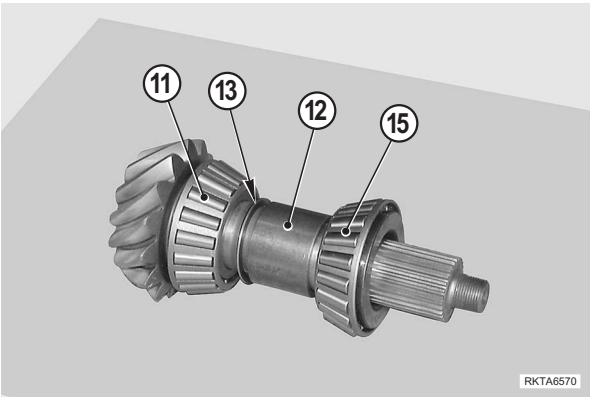


23 - Fit the pinion (10), shim "**S1**" (13) and distance piece (12) in the main body (14).

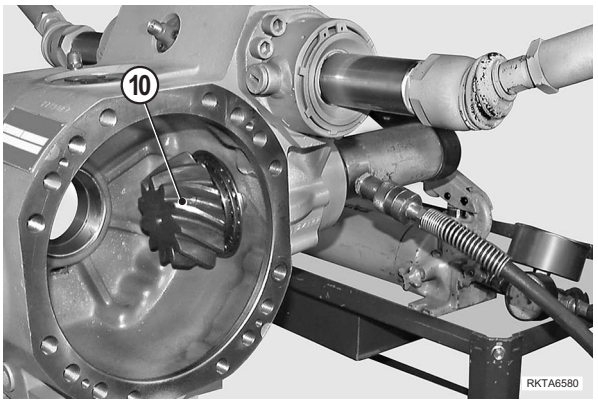
★ The finer shims must be placed in- between the thicker ones.



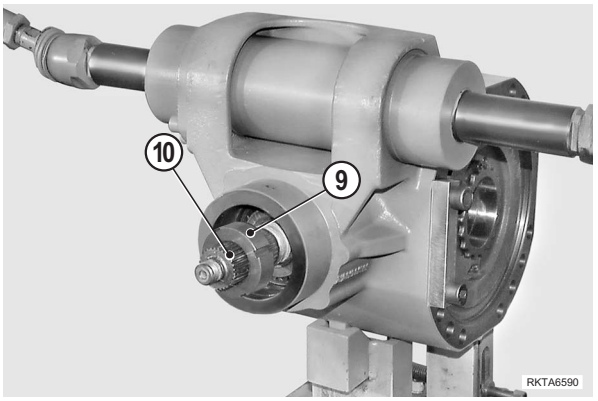
24 - Insert the external bearing (15) in the central body in order to complete the pack arranged as in the figure.



25 - Connect the pinion (10) to the tie rod **D12A** and **D12B**; connect the tie rod **D12C** to the press and block.



26 - Apply Loctite 242 (for the front axle) or Loctite 270 (for rear axle) to the thread of the ring nut (9) and screw the nut onto the pinion (10).



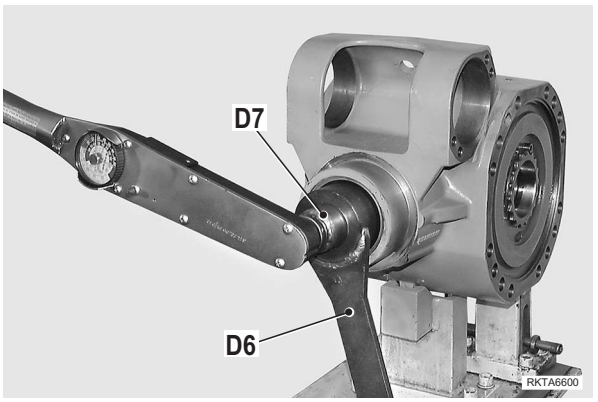
27 - Apply special wrench **D6** to the ring nut (9) and bar-hold **D6** to the pinion (10).

28 - Lock the wrench **D6** and rotate the pinion using a dynamometric wrench, up to a minimum required torque setting of:

- front axle: 500 Nm.
- rear axle: 900 Nm

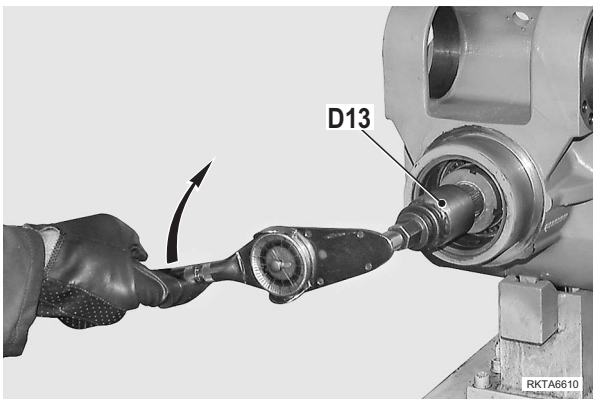
29 - Apply onto the pinion (10) the bar-hold "**D13**" and with the help of a torque metre, check the torque of the pinion (8).

- Torque: 120–170 Ncm



⚠ If torque exceeds the maximum value, then the size of shim "**S1**" (13) between the bearing (15) and the distance piece (12) needs to be increased.If torque does not reach the set value, increase the torque setting of the ring nut (9) in different stages to obtain a maximum value of:

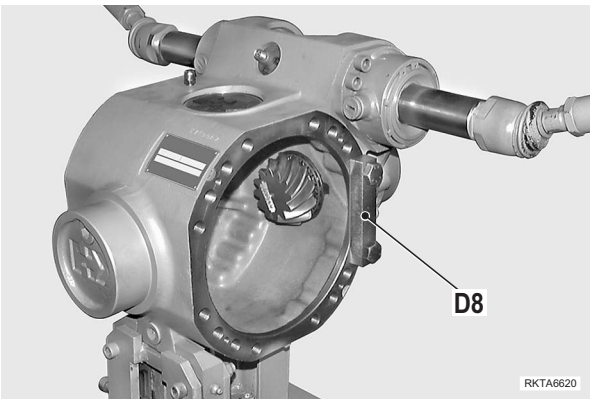
- front axle: 570 Nm
- rear axle: 1000 Nm



⚠ If torque does not reach the minimum value, then the size of shim "**S1**" (13) needs to be reduced.

⚠ When calculating the increase or decrease in size of shim "**S1**", bear in mind that a variation of shim (13) of 0.01 mm corresponds to a variation of 60 Ncm in the torque of the pinion (10).

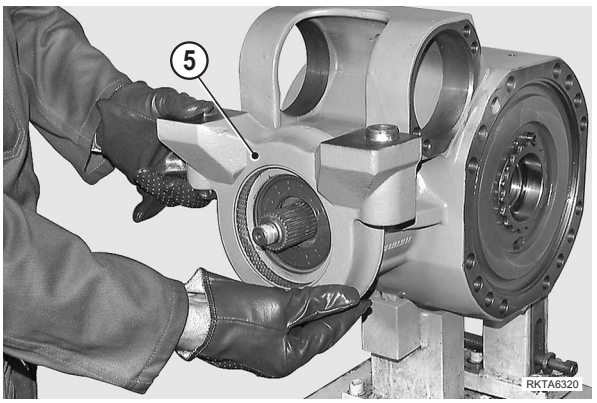
30 - Remove blocks **D8** (used for extracting the pinion) and re-install the arms.
(For details, see "Bevel pinion").



31 - Lubricate the outer surface of the new sealing ring (6) and fit it onto the central body (14) using tool **D14**.

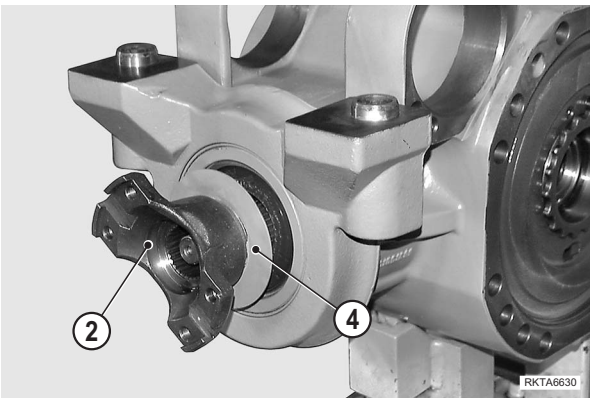
32 - Install the swinging support (5).

★ Check that it is properly oriented.



33 - Fit the flange (2) complete with the guard (4) and fasten it. For keying the flange (2), use a plastic hammer if necessary.

★ Make sure that the guard (4) is securely fastened onto the flange and that it is not deformed.

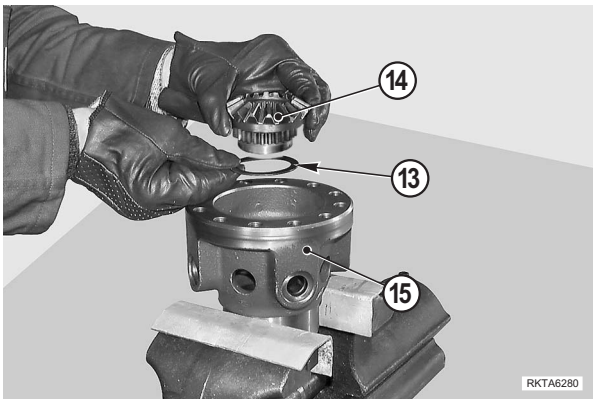


34 - Apply Loctite 242 to the threaded part of the pinion (10).Position tool **D5A** (or **D5B**) and fasten it in order to avoid rotation.Insert O-ring (3) the nut (1) and tighten it using a dynamometric wrench.

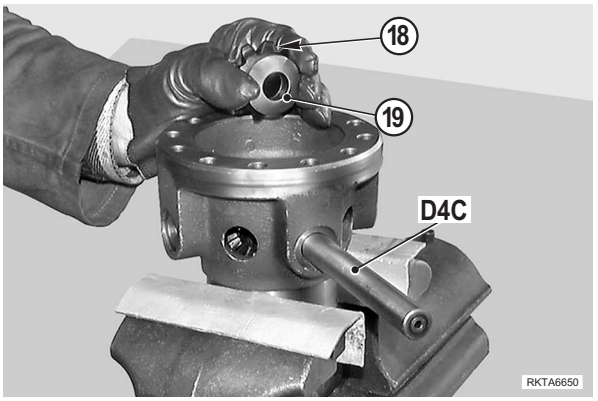
Torque wrench setting: 280–310 Nm

- **Differential**

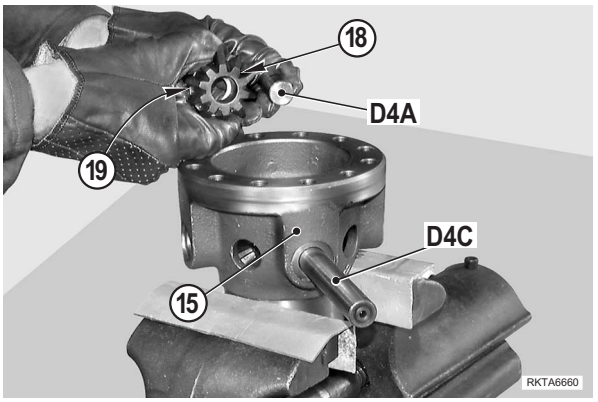
1 - Insert the shim washer (13) and the planetary gear (14) in the differential carrier (15).



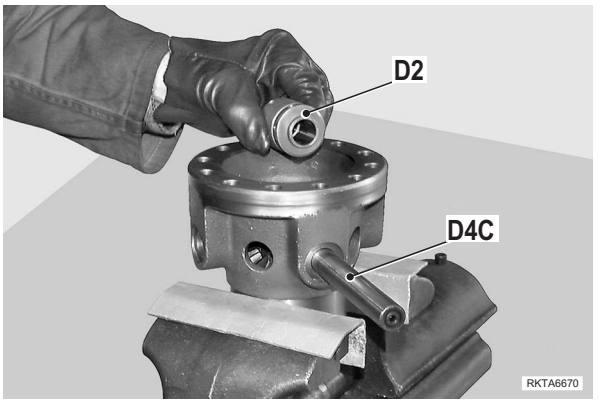
2 - Position the shim washer (19) and the first planet wheel gear (18).
Hold them in position using bar **D4C**.



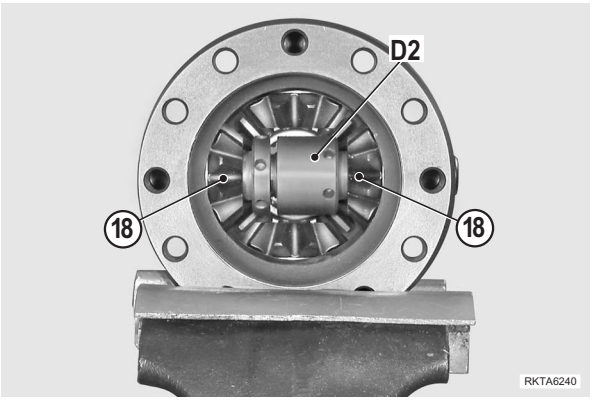
3 - With the help of gudgeon **D4A**, position the second planet wheel gear (18) and the relative shim washer (19).



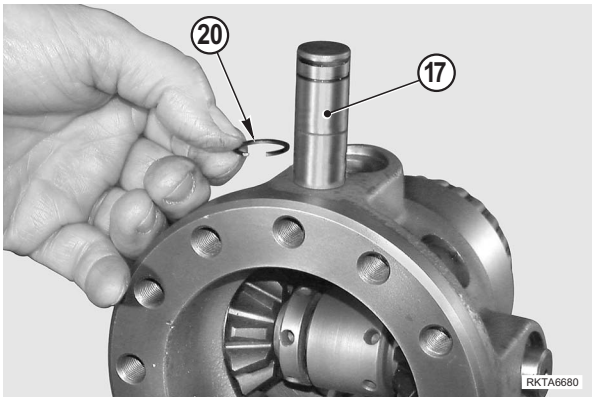
4 - Insert tool **D2** between the two planetary gears (18). Line up the entire unit by pushing bar **D4C** all the way down until gudgeon **D4A** is ejected.



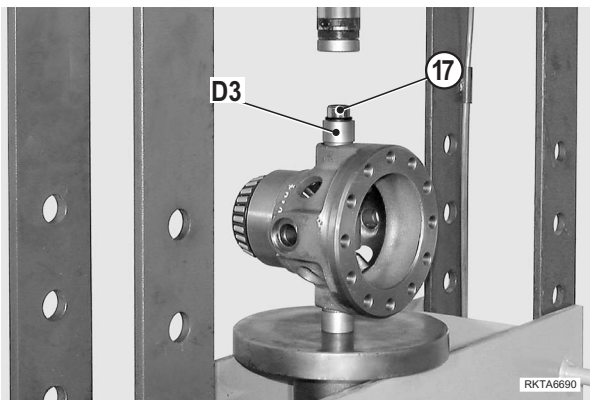
5 - Lock tool **D2** behind the planet wheel gears (18). After locking, remove bar **D4C**.



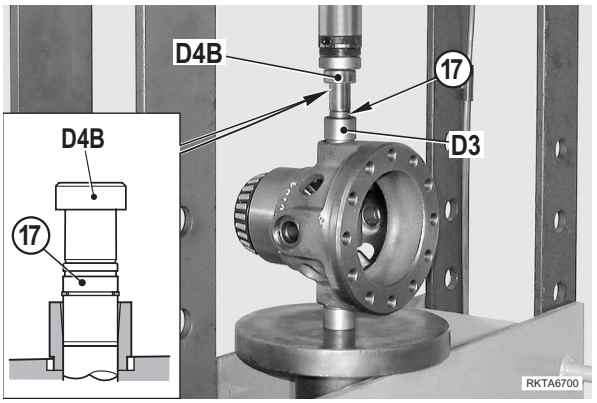
6 - Fit the snap rings (20) onto the pins (17).



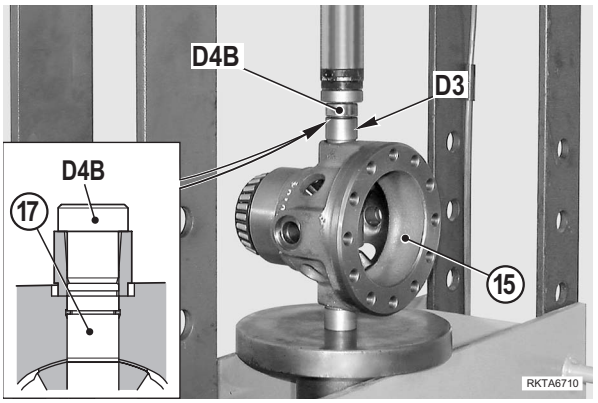
7 - Place the differential carrier (15) under the press, position bush **D3** and insert the planet wheel pin (17).



8 - Put gudgeon **D4B** on top of the planet wheel pin (17).

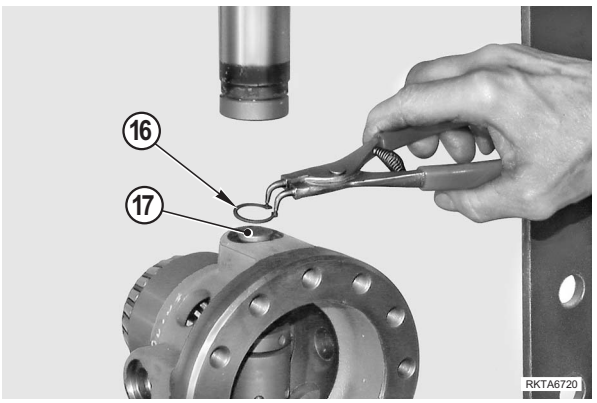


9 -Press **D4B** pin all the way down.

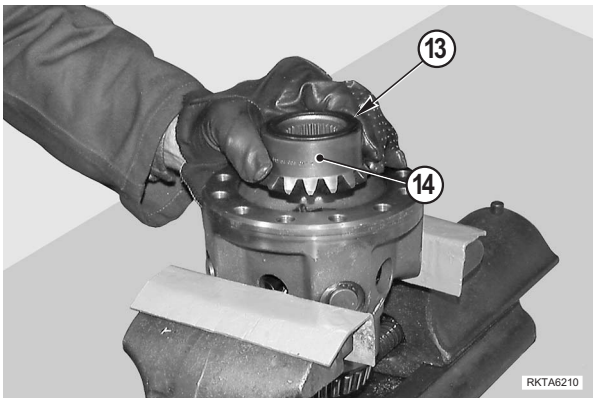


10 -Remove gudgeon **D4B**, bush **D3** and fit the snap ring (16) on the pin (17).

⚠ Make sure that the snap ring centres the seat and that it rests on the surface of the differential carrier.Repeat the operations on the other planet wheel pin or planet wheel axle.

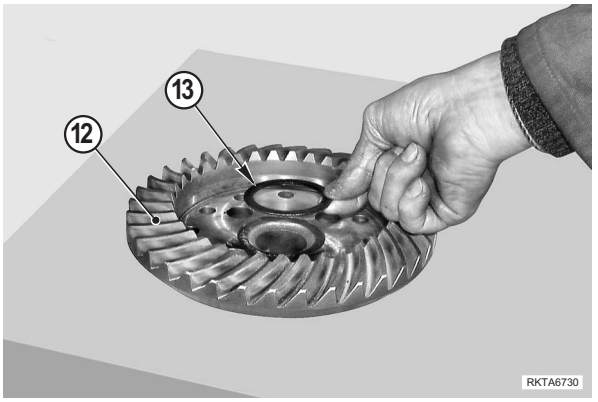


11 -Position the second planetary gear (14) in the differential carrier (15).



12 -Position the shim washer (13) on the crown (12).

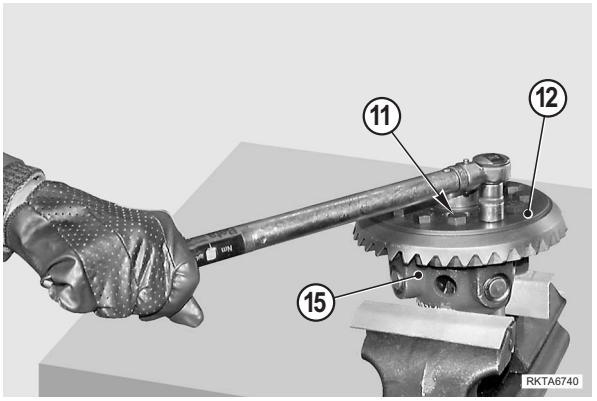
★ In order to hold the shim washer (13) in position, apply grease to it.



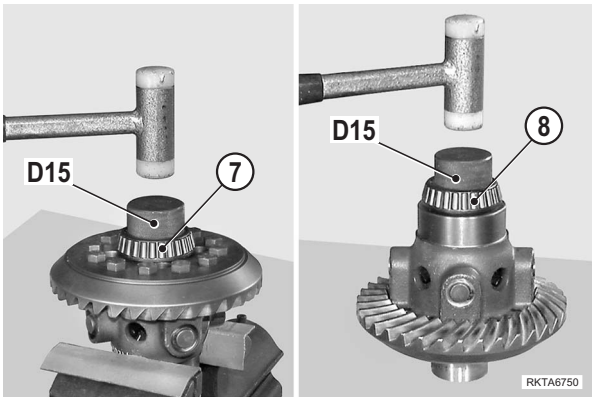
13 - Position the crown (12) on the differential carrier (15) and lock it with screws (11) applied with Loctite 242.

Torque wrench setting for screws:128–142 Nm

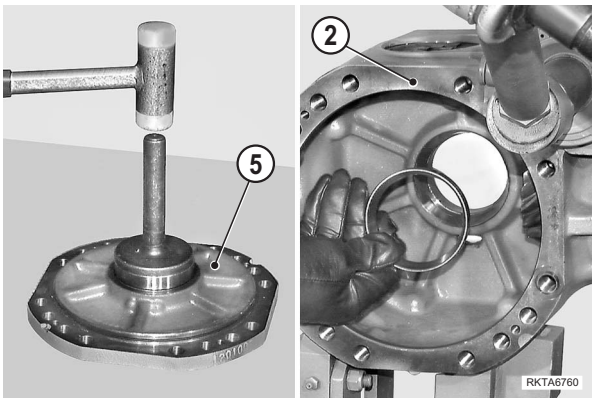
★ Secure the screws using the cross-tightening method.



14 - Install the bearings (7) and (8) using tool **D15**.

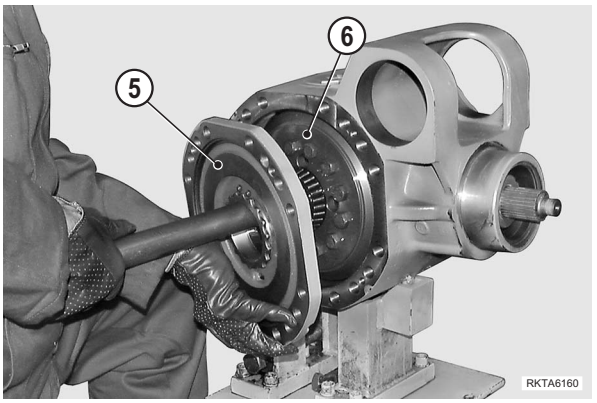


15 - If the bearings are replaced, insert the external thrust blocks in the middle cover (5) and in the central body (2).



16 - Position the differential unit (6) in the central body (2) with the help of a bar and fit the middle cover (5).

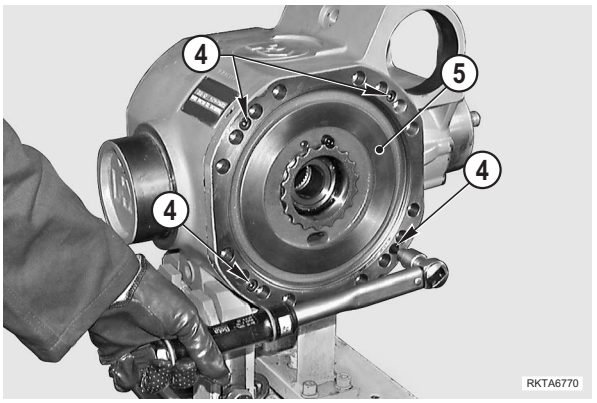
★ Thoroughly check the state of the O-ring (9) and make sure that the cover is fitted with the oil discharge in the lower position.



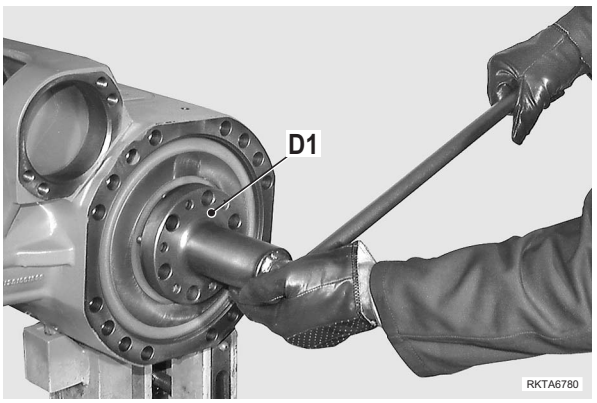
17 - Lock the middle cover (5) with screws (4).

Torque wrench setting for screw: 23.8–26.2 Nm

★ If the ring nuts (1) are removed, spread them with Loctite 242.

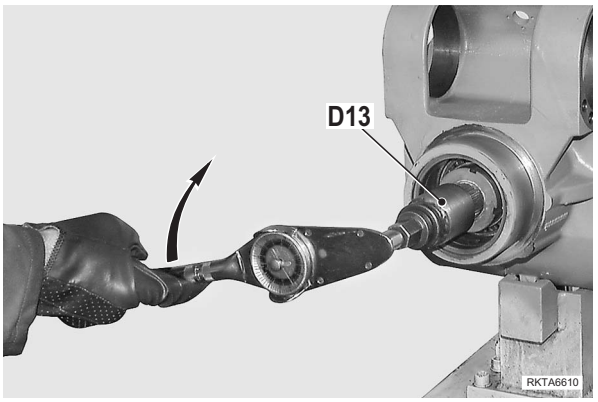


18 - Tighten ring nuts on the crown side until clearance between pinion and crown is zero, then lock the crown; go back 1/4–1/2 turn

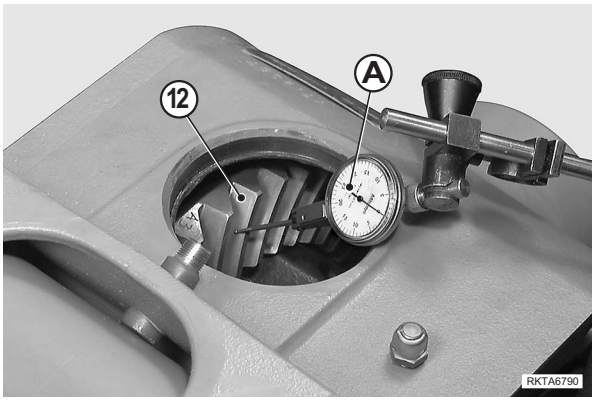


19 - Pre-set the bearings by means of the ring nut situated on the opposite side of the crown, so as to increase pinion torque up to 140–210 Ncm.

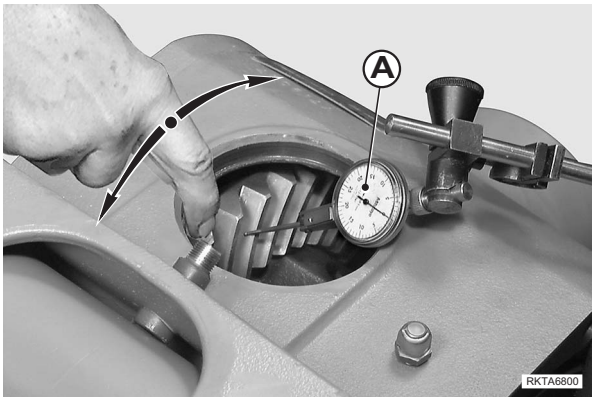
If bearings are not new, check the static torque; if bearings are new, check the continuous torque.



20 - Introduce a comparator with rotary key "**A**" through the top plug hole (10).
Position the comparator on the centre of one of the teeth of the crown (12), pre-set it to 1mm and reset it.



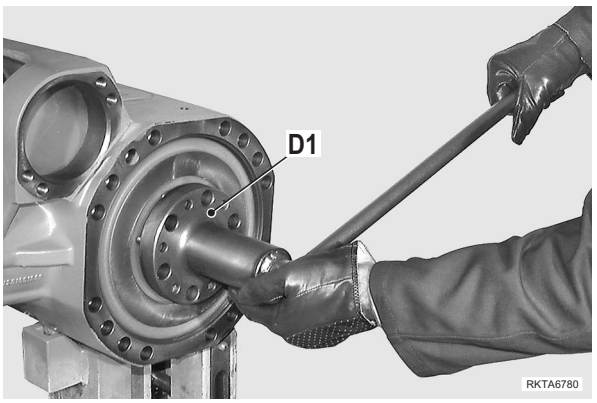
21 - Manually move the crown (12) in both directions in order to check the existing backlash between the pinion and the crown.



22 - Adjust the backlash between the pinion and the crown by unloosing one of the ring nuts (1) and tightening the opposite to compensate.

★ Normal backlash: 0.18–0.23

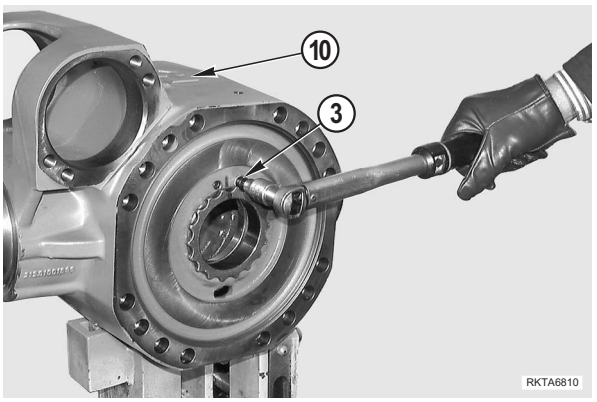
★ Difference between MIN. and Max. clearance for whole circumference should not exceed 0.09 mm.



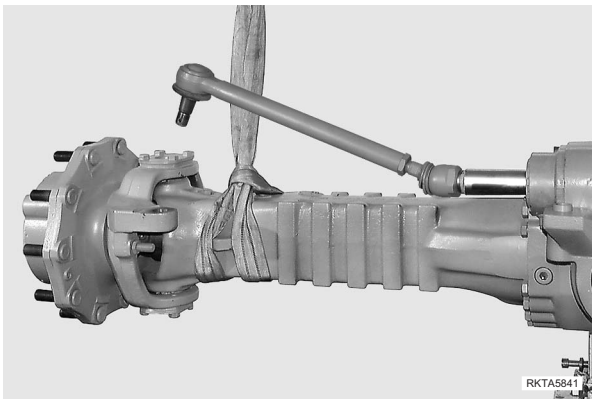
23 - Apply Loctite 242 to the screws (3), fit them into one of the two holes and tighten.

Torque wrench setting: 23.8–26.2 Nm

24 - Fit the top plug (10) after applying repositionable jointing compound for seals to the rims.



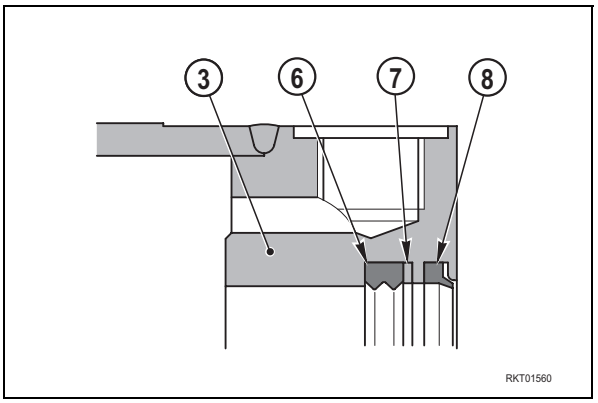
25 - Re-install the complete arms.
(For details, see "Brakes").



- **Steering cylinder**

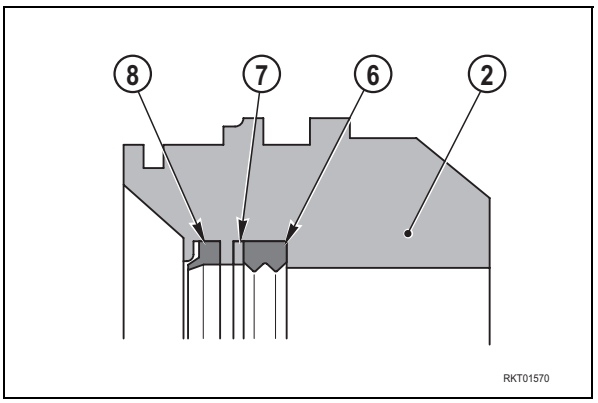
1 -After applying grease, install the sealing ring (6) of the shaft, the anti-extrusion ring (7) and the scraper ring (8) inside the cylinder (3).

⚠ Thoroughly check that positioning of the anti-extrusion ring (7) is correct.



2 -After applying grease, install the sealing ring (6) of the shaft, the anti-extrusion ring (7) and the scraper ring (8) in the head (2).

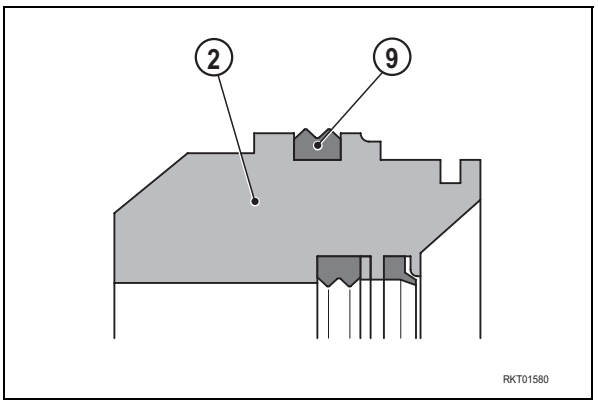
⚠ Thoroughly check that positioning of the anti-extrusion (7) ring is correct.



3 -Fit the seal (9) onto the outside of the head (2).

⚠ 1 - In order to facilitate assembly, apply grease to the outer surface of the piston.

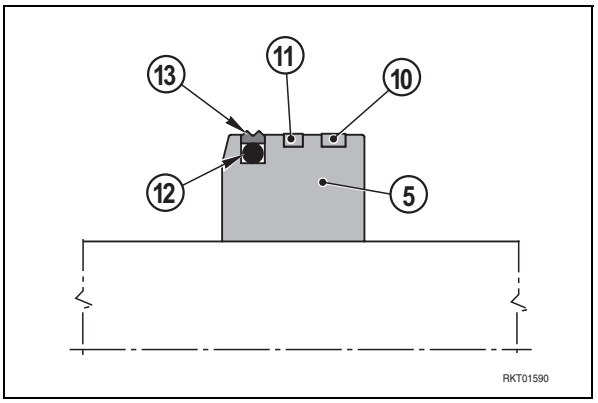
2 - Do not roll the seal (9) up.



4 -Prepare the piston (5) by fitting it with the guide ring (10), the magnetic ring (11), the O-ring (12) and the seal (13).

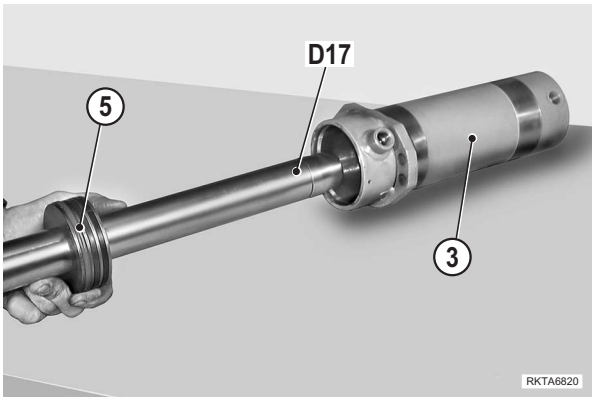
⚠ 1 - In order to facitilate assembly, apply grease.

2 - If a centring sensor is not fitted, then the magnetic ring (11) should be replaced by another guide ring (10).

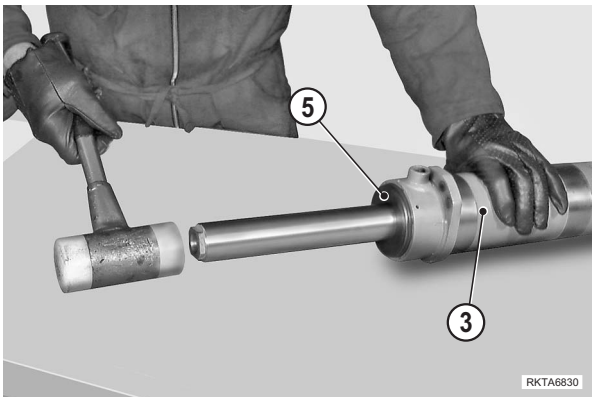


5 - Apply tool **D17** to the shaft on the opposite side of the head (2) and centre it on the cylinder (3) so that it fits into the piston (5).

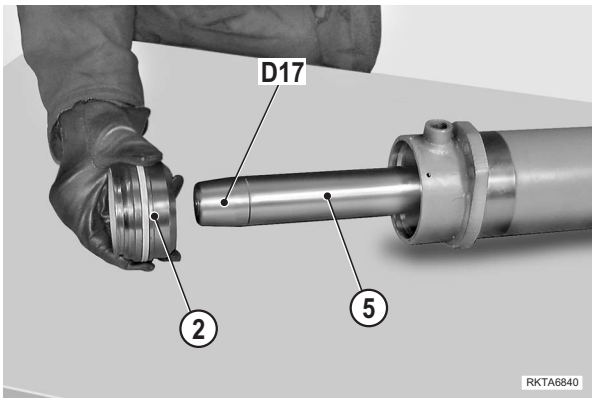
★ Apply a little grease to seals and cylinder.



6 - Push the piston (5) into the cylinder for 100 mm using a plastic hammer.

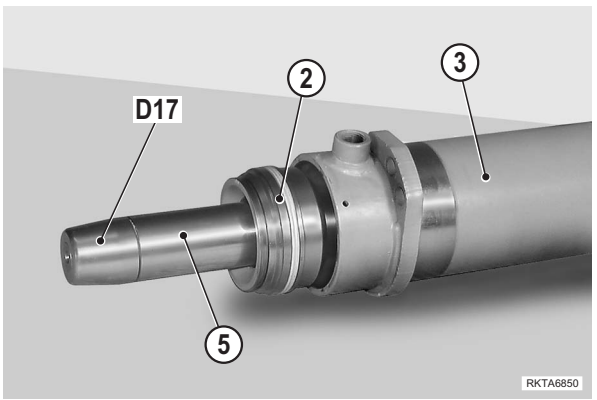


7 - Remove tool **D17** and apply it to the opposite side of the piston (5).

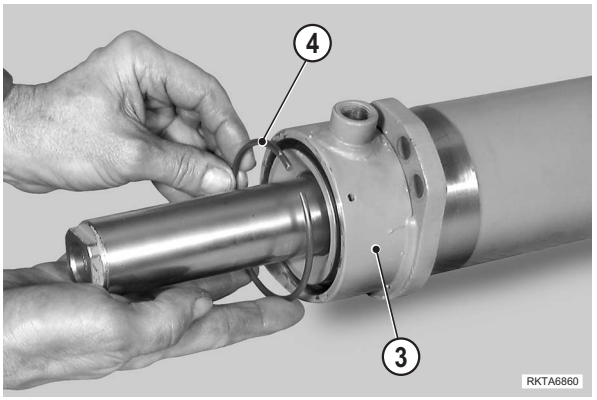


8 - Apply grease to head (2) seals, fit the head onto the piston (5) and push it into the cylinder (3) using a plastic hammer.

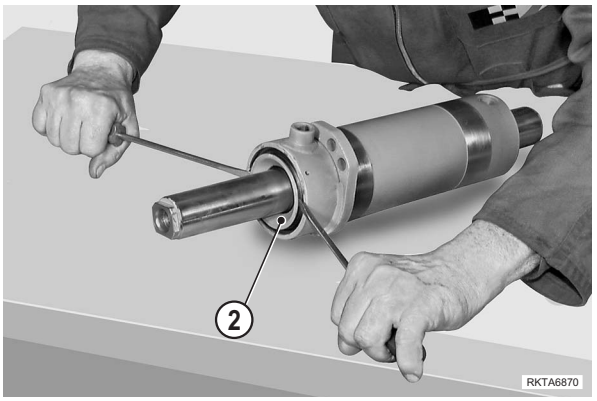
★ Insert the head as to line it up with the edge of the cylinder.



9 - Insert the stop ring (4) ensuring that it fits into the seat of the cylinder (3).

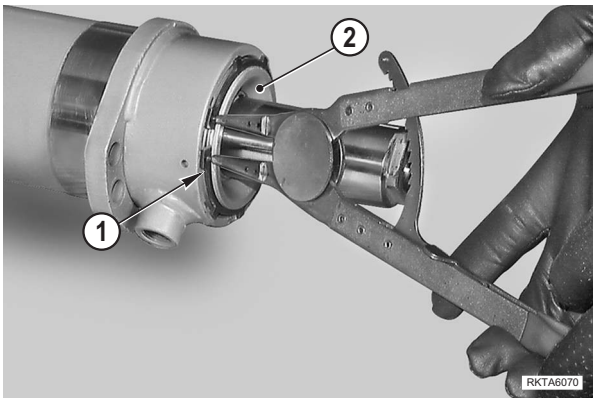


10 - Apply pressure to the head using two screwdrivers or levers until the head is fastened onto the stop ring (4).



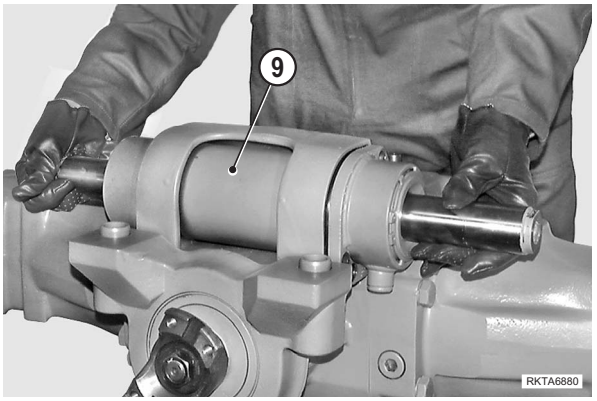
11 - Fit the snap ring (1) on the head (2).

⚠ Make sure that the snap ring (1) is securely fastened in its seat.
If necessary, force it into its seat using a drift and a hammer.



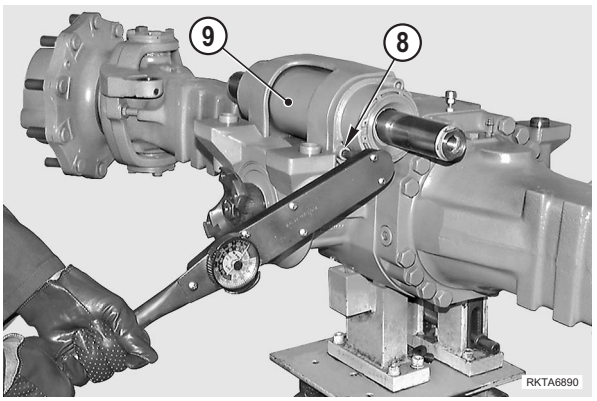
- **Steering cylinder**

1 - Check that the O-rings (15) of the axle unit are in good condition; lubricate the seats of the seals (15) and fit the steering cylinder (9) into its seat.



2 - Lock the cylinder by cross- tightening the screws (8).

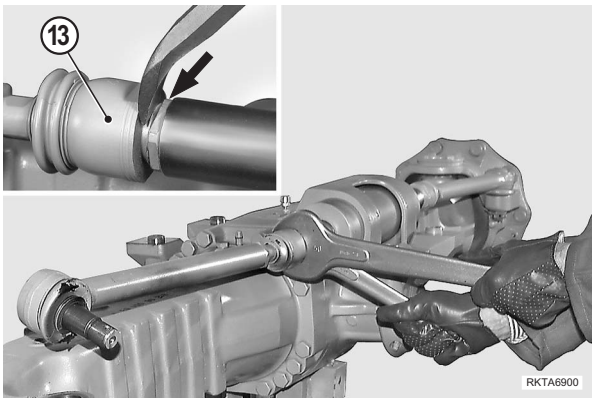
Torque wrench setting: 116–128 Nm



3 - Apply Loctite 242 to the thread and connect the steering bars by screwing the terminals onto the piston stem.

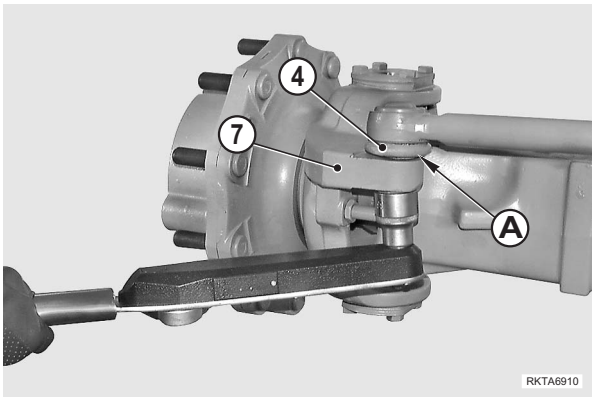
Torque wrench setting: 240–270 Nm

★ Versions with coupling require that the rim of the articulation (13) is riveted onto the surfaces of the piston stem.



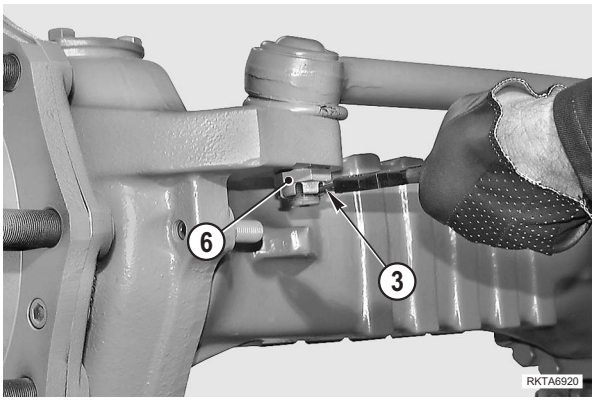
4 - Insert the pins (4) in the steering case (7) and lock into position using a torque wrench setting of 260–290 Nm. Find the position of the notching in relation to the hole of the cotter pins and tighten the nut (6) further.

Check that rubber guards (**A**) are intact.



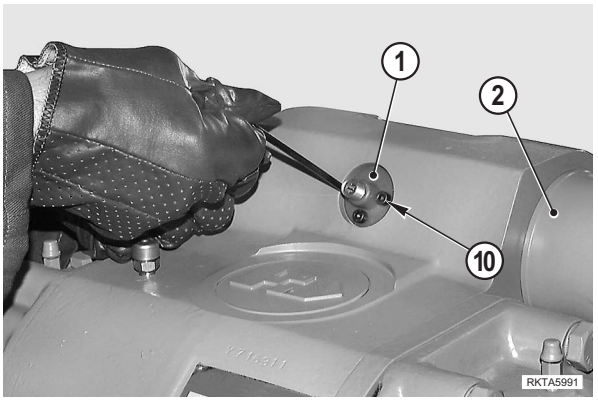
5 - Insert the cotter pins (3) and bend the safety stems.

⚠ Use new cotter pins.

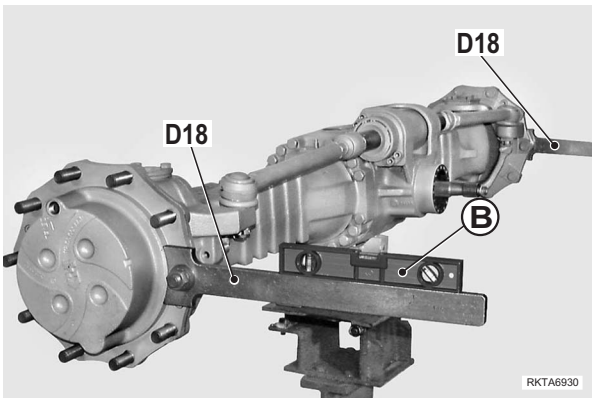


6 Install the proximity (1) for checking piston (2) centring - if applicable - and tighten the screws (10).

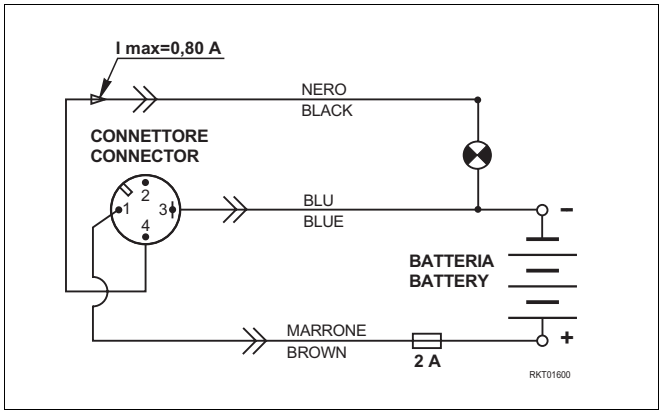
Torque wrench setting: 5–6 Nm

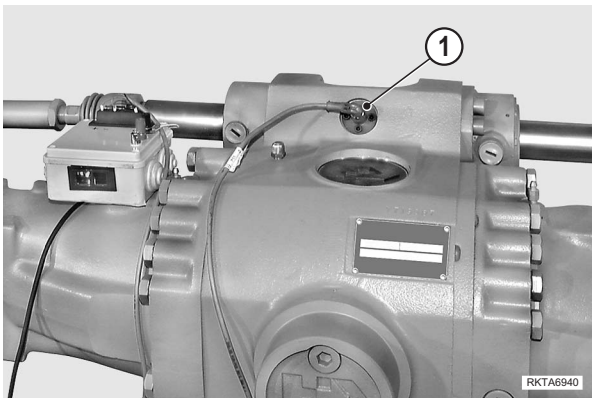


⚠ Eliminate the action of the negative brake, if fitted.Apply tools **D18** to the hubs and lock them.
Using a level "B", check that tools are perfectly flat and parallel to each other.

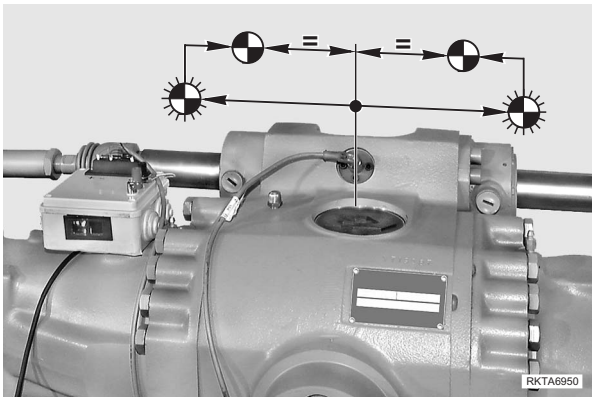


7 - Connect the sensor (1) to the inspection device according to diagram.



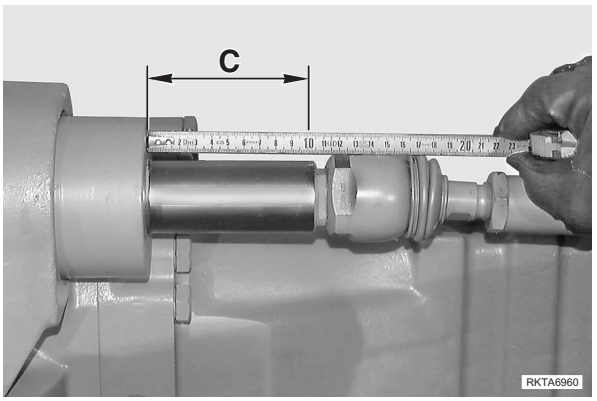


8 - Centre the piston by slowly moving it first in one direction then in the other and position it half way on the stroke, which is determined by the switching on and off of the signal lamp of the inspection device in the reversal stage.



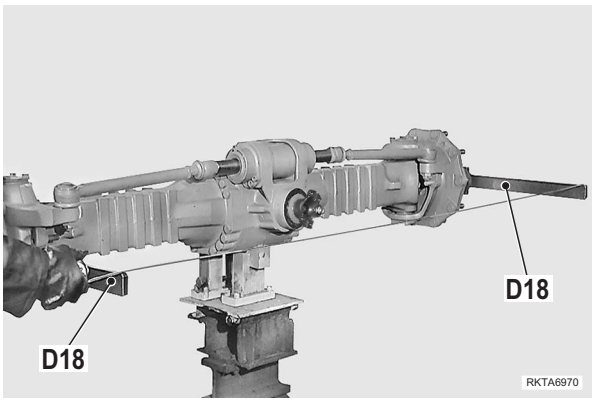
9 - Inspect jut "**C**" on one side of the piston and note down the size for checking later adjustments.

★ If cylinders come without a sensor, the centring of the piston must be carried out on the basis of the maximum stroke.



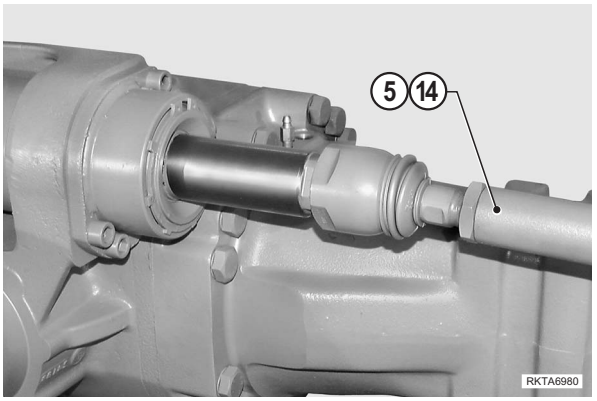
10 - Without moving the piston, check front and rear size at the edge of tools **D18**.
Max. difference: 0.6–0.7 mm

★ In order to check the rear size, rotate the bevel pinion and check that tools **D18** are flat.



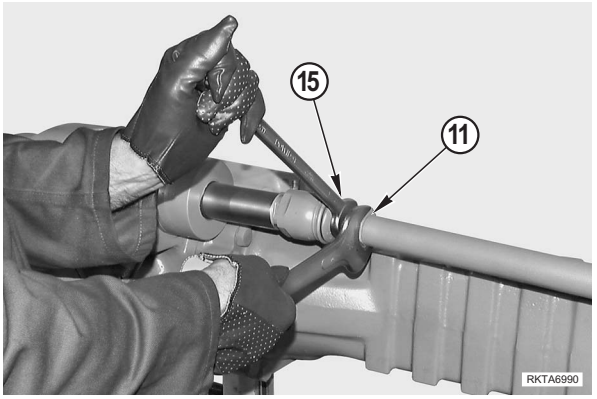
11 - If necessary, adjust convergency without moving the centring of the piston and adjust the length of the steering bars (5) or (14).

★ With a half turn of screw, the front size is reduced by about 3 mm, whereas the rear one is increased by about 3 mm.



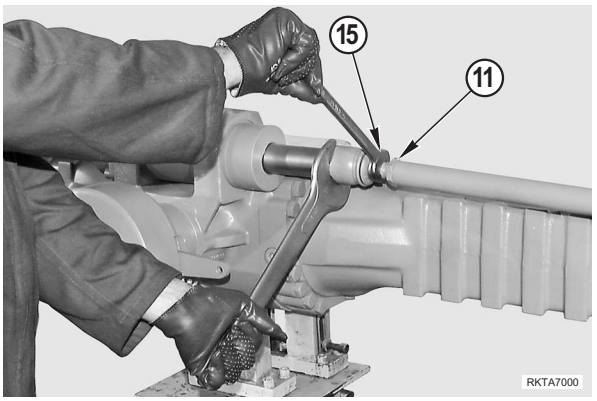
- **Convergency adjustment**

1 - Unloose the nuts (11) and screw them onto the ball-and-socket joints (15).



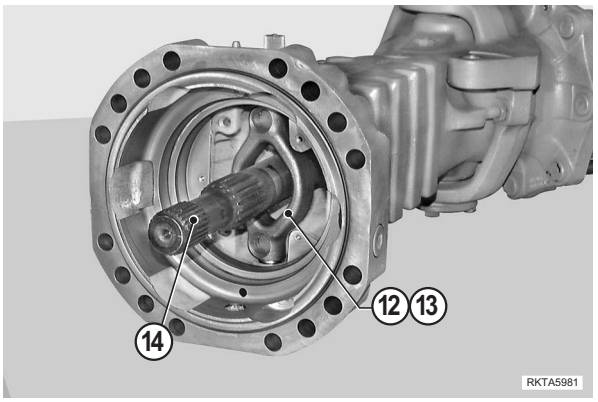
2 - Hold the articulations still and rotate the ball-and-socket joints (15). Once the convergency has been adjusted, lock the nuts (11).

Torque wrench setting for nuts: 298–328 Nm



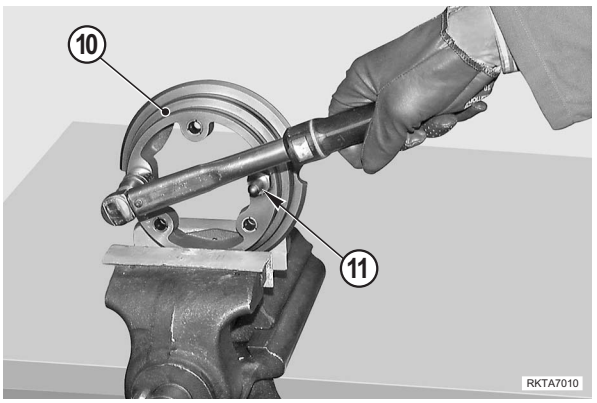
- **Parking brake assembly (front axle)**

1 - Install the thrust levers (12 and 13) first, and then the double offset joint (14).

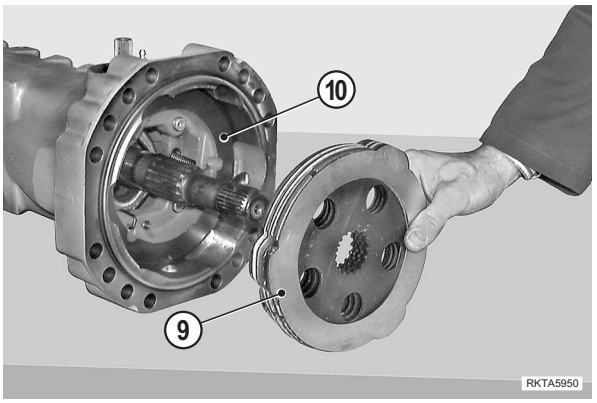


2 - Apply a coat of Loctite 270 to the point threads (11) and then install the points to the piston (10).

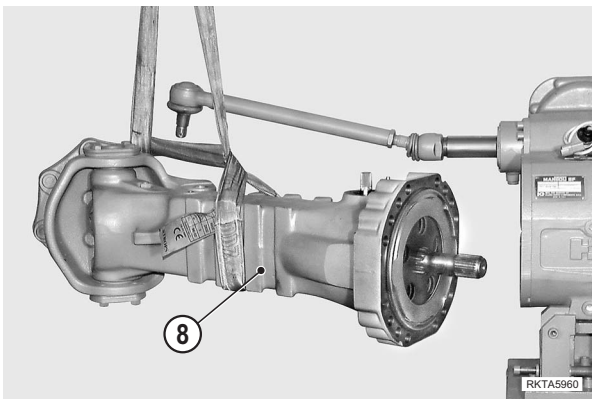
Point tightening torque: 30–35 Nm



3 - Re-install piston (10) and brake rotors (9). (For details, see "Brakes").

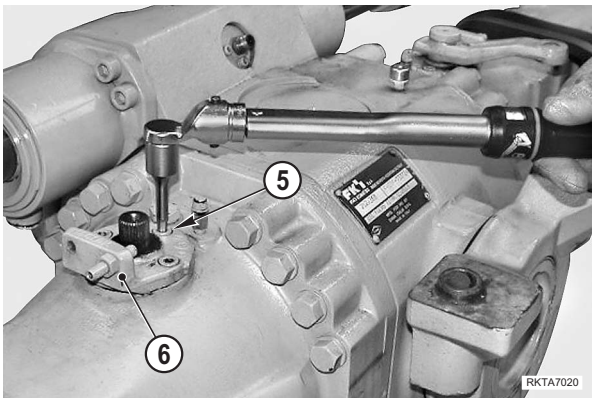


4 - Install the axle shafts (8) to the main body; check for proper axle shaft levelling and then lock the axle shafts. (For details, see "Brakes").



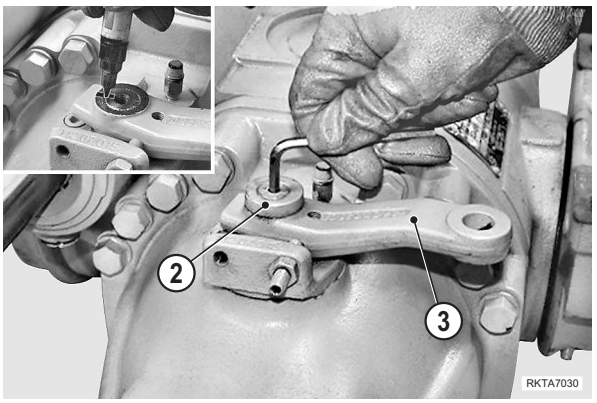
5 - Install the bushing (6) together with the O-ring seal (7) and lock it into position with screws (5).

Screw tightening torque: 23.8–26.2 Nm

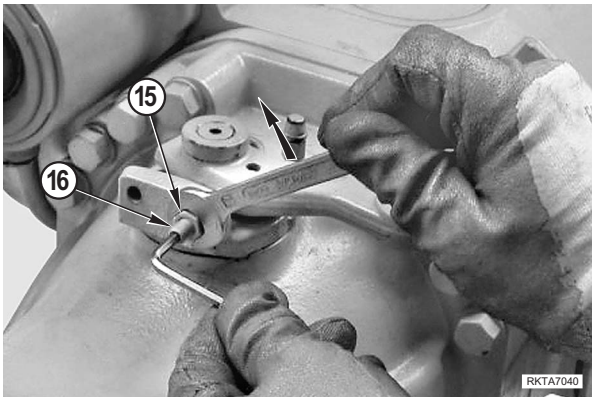


6 - Install the following parts in the sequence given: lower O-ring seal (4), lever (3) washer (2) and associated O-ring seal (4), and then lock into position with a screw (1).

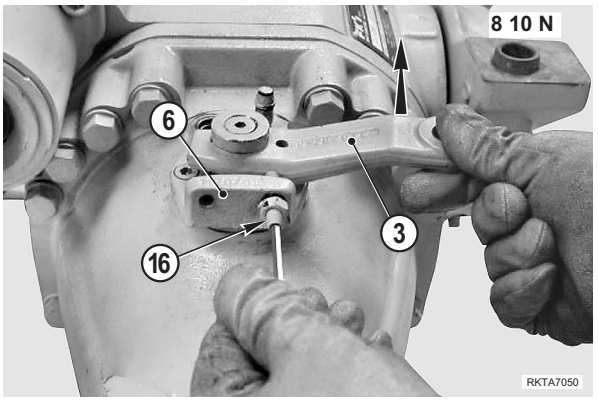
★ Do not change the positions previously marked during disassembly.



7 - Connect the braking circuit and apply maximum operating pressure to allow the rotors to set.
Release the pressure, loosen the nut (15) and unscrew the dowel (16) by a few turns.



8 - Apply an 8-10 N (0.8-1 Kg) force to the lever (3). The force should be directed in the braking direction to eliminate pre-travel.
Hold the force and simultaneously tighten the nut (16) until contact with the bushing (6) is achieved.

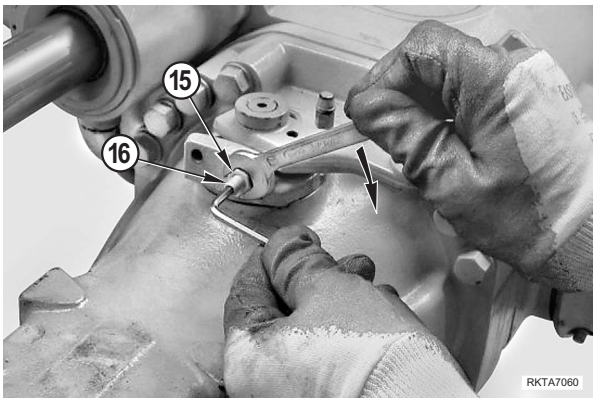


9 - Lock the dowel (16) in this position with the nut (15).

Nut tightening torque: 20–25 Nm

★ Pre-travel should be eliminated without loading the thrust levers (12 and 13).

★ After connecting the control cable, you should check that both dowels (16) will contact the bushing when the brakes are released.

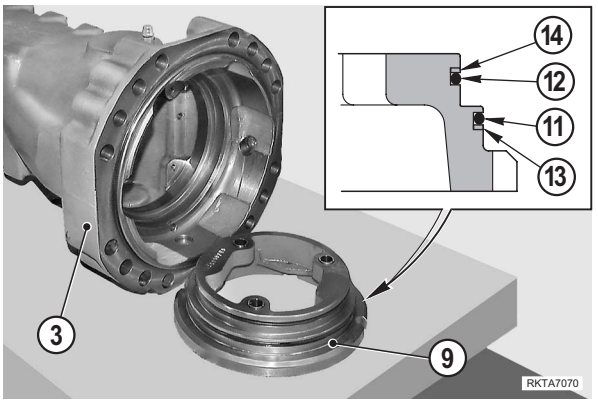


• Brakes

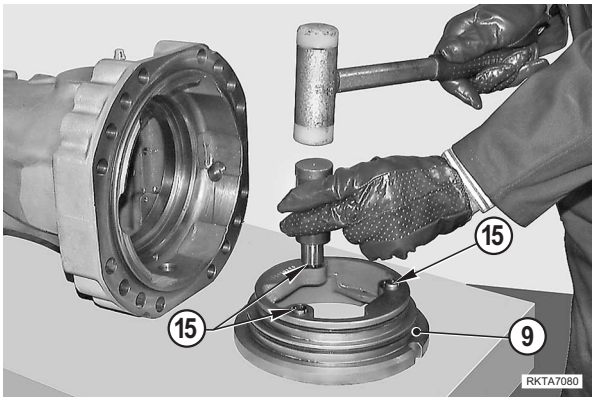
1 - Thoroughly clean the piston (9) and the seal channels.

2 - Replace the O-rings (11 and 12) and anti-extrusion rings (13 and 14) and make sure not to alter the direction of installation.

Thoroughly check for proper positioning of the anti-extrusion rings (13 and 14).

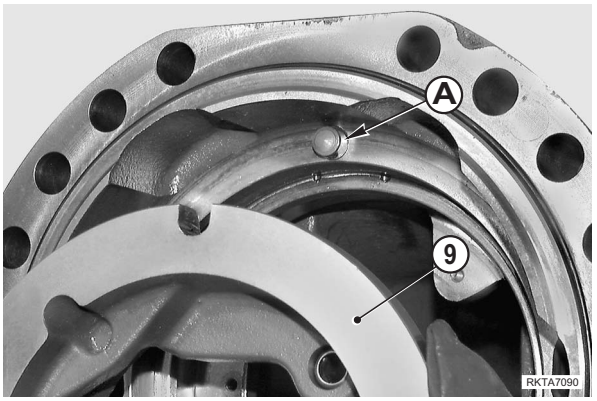


3 - Introduce the springs (15) for stroke self-regulation and make them flush with the piston (9).

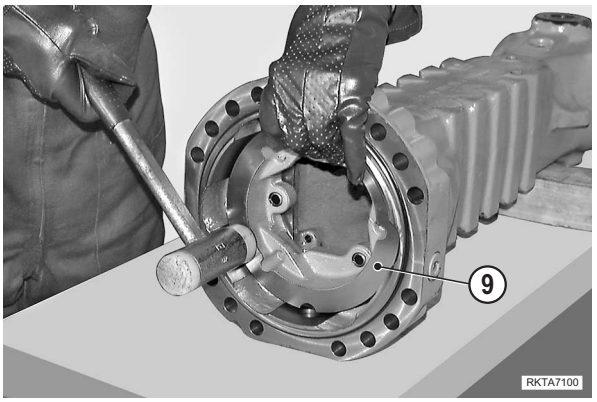


4 - Lubricate the seals (11 and 12) and install the piston (9) to the axle-shaft (3).

⚠ Ensure that the piston seat connects to the stop pin (A) inside the axle-shaft.



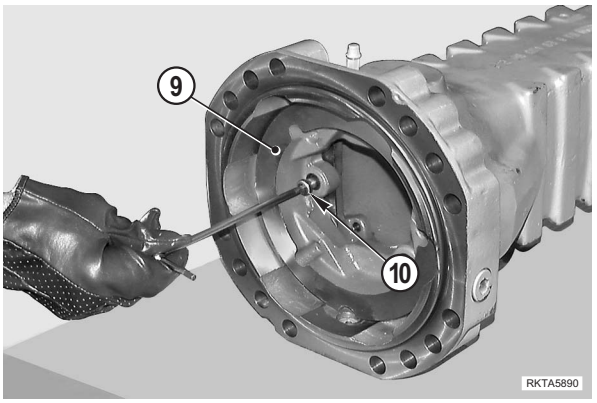
5 - Assist the installation of the piston (9) by lightly tapping with a plastic hammer along the contour.



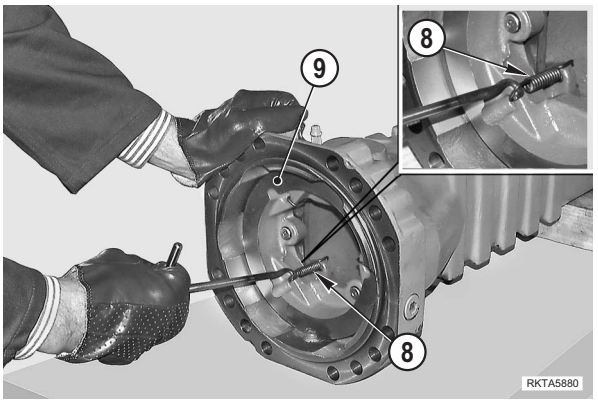
6 - Install the pin screws (10). Be sure that they are all the same colour.
White: clearance 1 mm
Yellow: clearance 0.75 mm
Blue: clearance 0.5 mm

7 - Apply Loctite 270 to the threads.

Tightening torque: 5–7 Nm

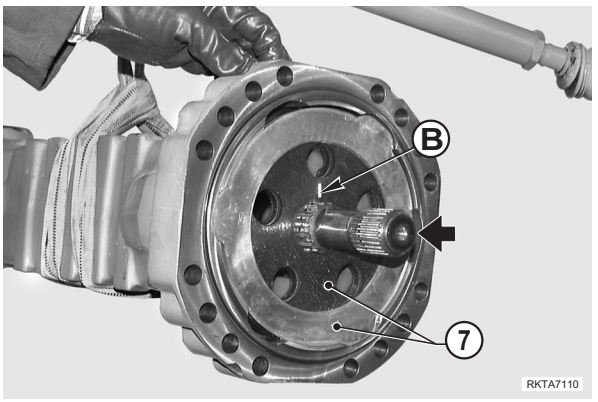


8 - Install the return springs (8) of piston (9).
Use utmost care not to deform the spring connections.

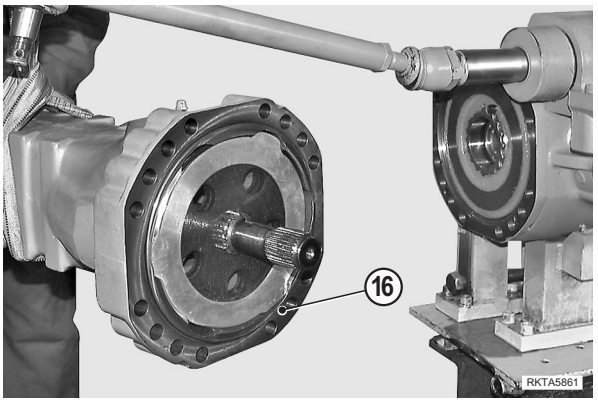


9 - Lightly lubricate the braking rotors (7) and install them to the axle shaft in the proper sequence, orientated in such a way that the oil holes and the "**B**" marks are perfectly aligned.

★ Steel rotors should be installed in such a way as to expose the slot corresponding to the oil level plug.

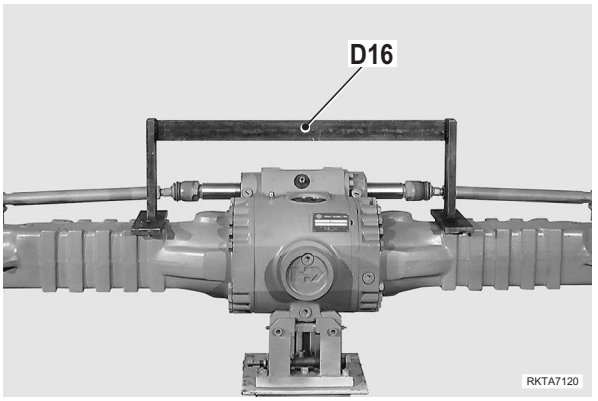


10 - Check the axle shaft retainer ring (16) for being undamaged and properly positioned. Install the complete axle shaft. Lock it into position with two opposing screws (4) and washers (5).



11 - Use tool **D16** to check for axle shaft planarity and finally lock the axle shafts with the screws (4) and washers (5) using the criss-cross tightening method.

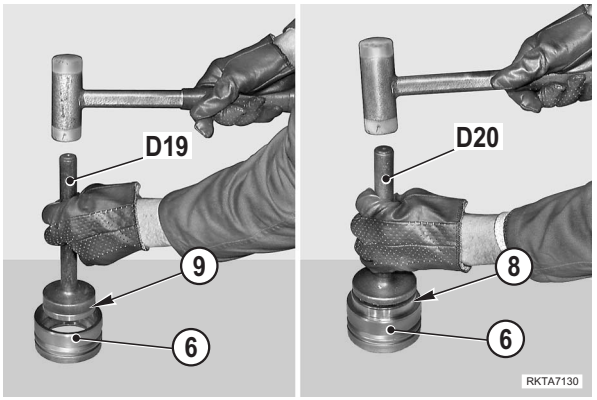
Tightening torque: 298 Nm



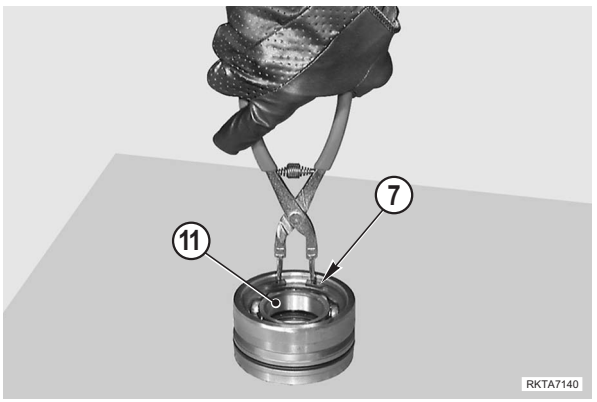
- **Cardan shaft**

1 - Using tools **D19** and **D20**, insert the sealing ring (9) and the bearing (8) in the bush (6).

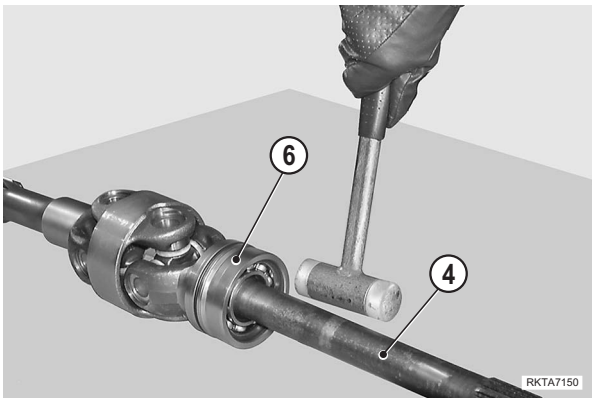
★ Carefully check the assembly side of the seal (12).



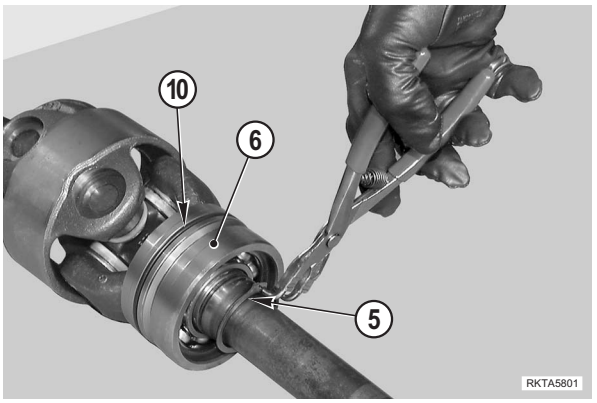
2 - Fit the snap ring (7) on the bearing (8).



3 - Heat the bearing in oil at an approx. temperature of 100°C and fit the entire bush (6) on the u-joint (4).



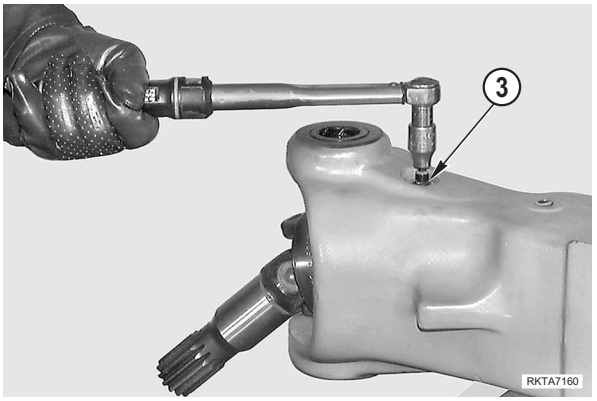
4 - Fit the check ring (5) on the bushing unit (6); also put the O-ring (10) into position.



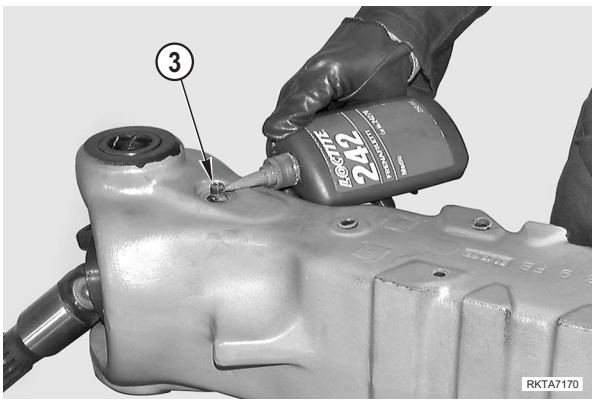
5 - Insert the u-joint and tighten the top and bottom dowels (3).

Torque wrench setting: Max. 15 Nm

★ For u-joint coming with a bush, centre the point of the check dowels in the slot.

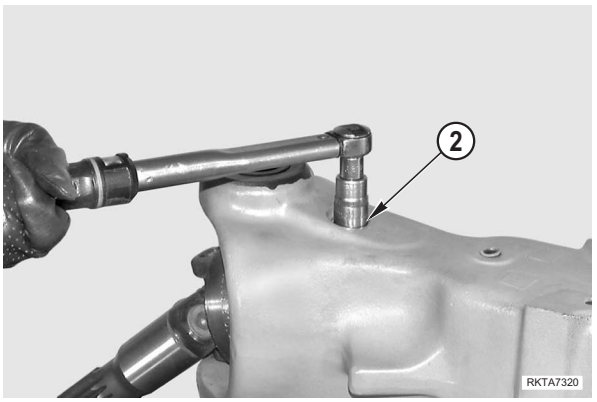


6 - Apply Loctite 242 to the jutting parts of the dowels (3).



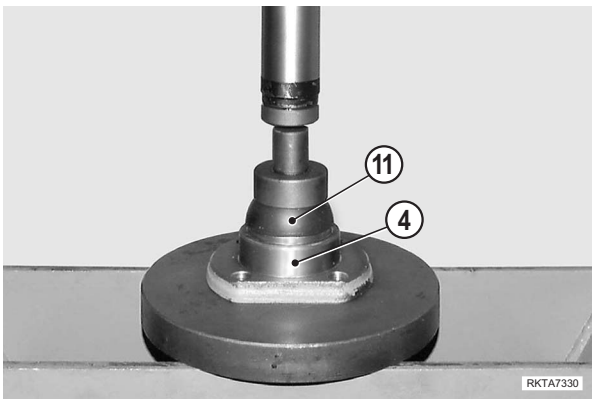
7 - Screw the check nuts (2) of the dowels (3) and lock them using a dynamometric wrench.

Torque wrench setting: 122 Nm



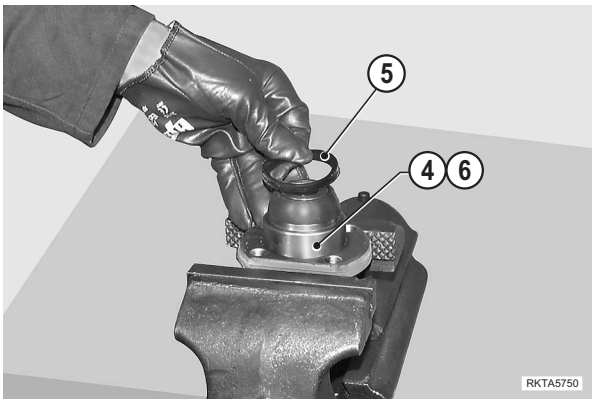
- **Steering case**

1 - If the bottom articulation pin (4) has been extracted, position the pin under a press and fit the ball cover (11).

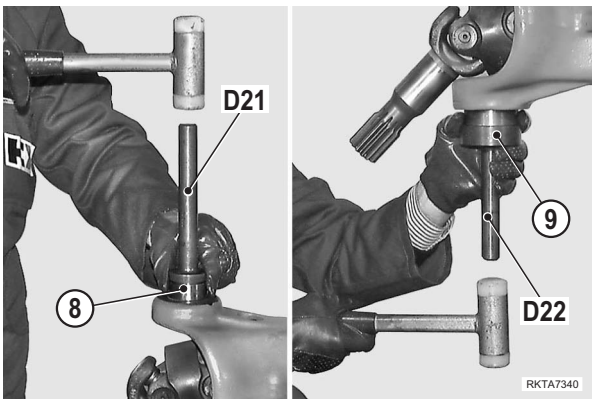


2 - Fit the front sealing rings (5) onto the articulation pins (4) and (6).

★ Carefully check that the rings are properly oriented (5).



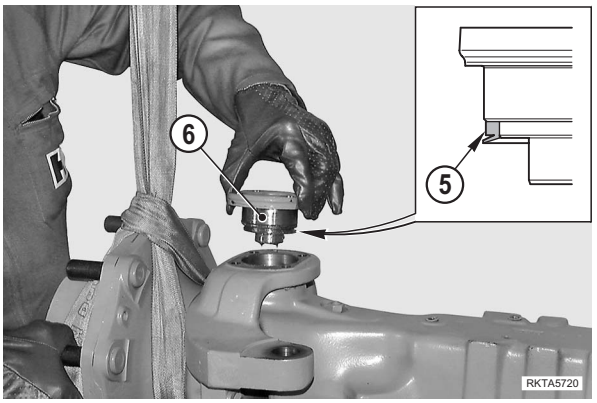
3 - Lubricate the top bush (8) or the bottom ball bush (9) and fit them into the fulcrum holes of the arm.
Use tools **D21** and **D22**.



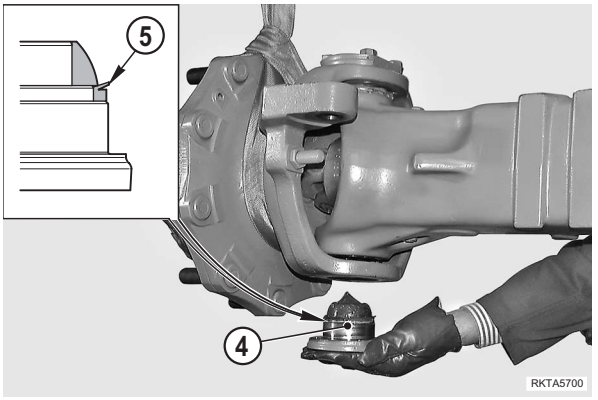
4 - Lubricate the terminal of the u-joint (10) and install the steering case (7).
Pay due attention not to damage the dust cover rings and the sealing rings.

5 - Fit a new seal (5) onto the top articulation pin (6). Lubricate and install the unit in the steering case. Position the screws (3) and lightly tighten.

6 - Check the correct assembly side of the seal (5).



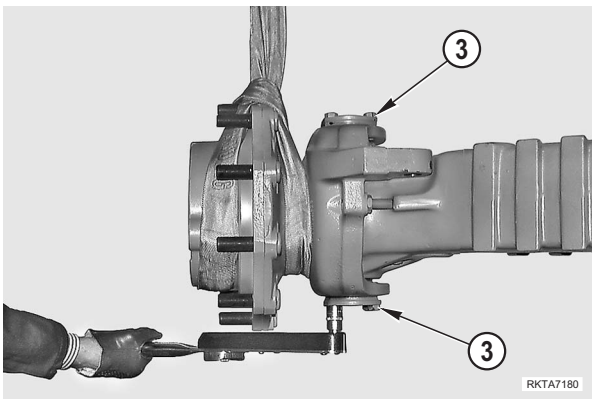
7 - Fit a new seal (5) onto the bottom articulation pin (4). Lubricate and fit the unit in the steering case. Position the screws (3) and lightly tighten.



8 - Check for the correct assembly side of the seal (5).

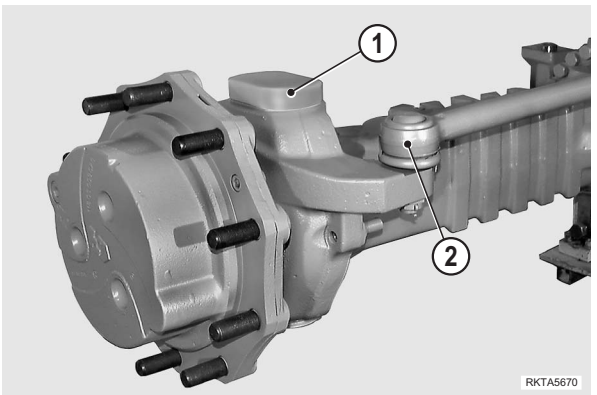
9 - Tighten the new fittin screws (3) of top and bottom articulation pins in sequence using the cross tightening method.

Torque wrench setting: 128–142 Nm



10 - Connect the articulation pin (2).
(For details, see "Steering cylinder").

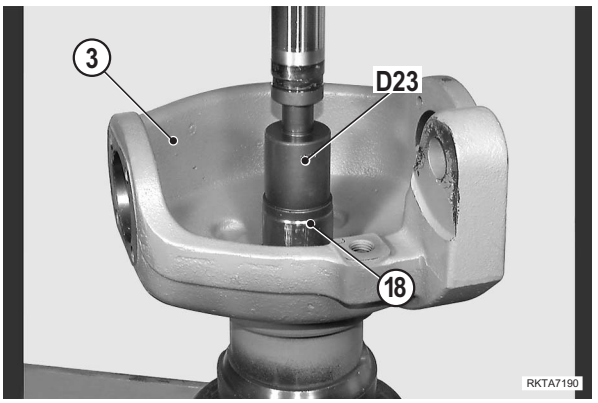
11 - Lubricate articulations with Molikote and fit the dust cover (1).



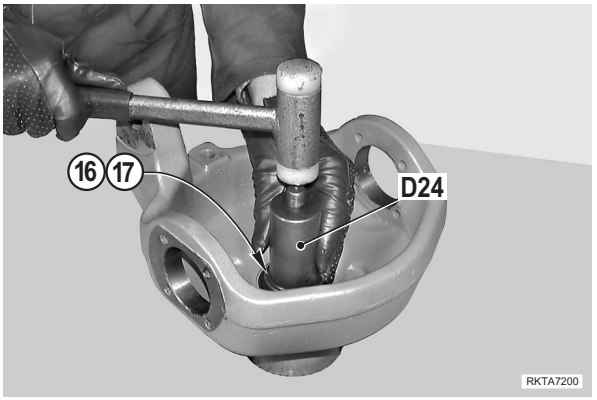
- **Planetary reduction**

1 - Lubricate the bushing (18) and the seat of the steering case (3).

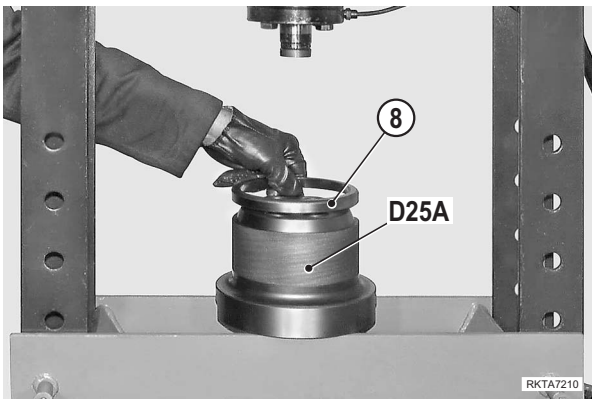
2 - Install the bushing (18), using tool **D23**.



3 - Lubricate the outer surface of the sealing ring (17) and centring ring (16); fit them into their seat using tool **D24**.

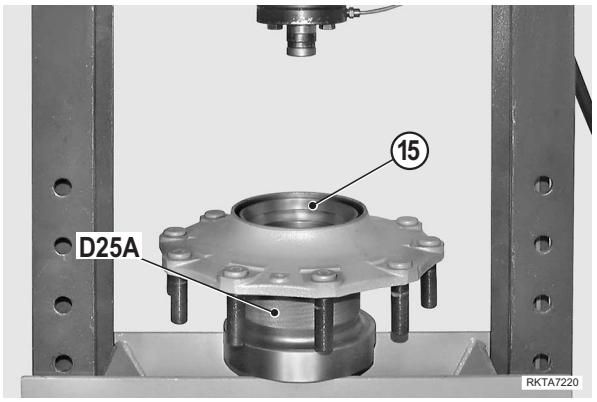


4 - Position the lower part of tool **D25A** and the thrust block of the external bearing (8) under the press.

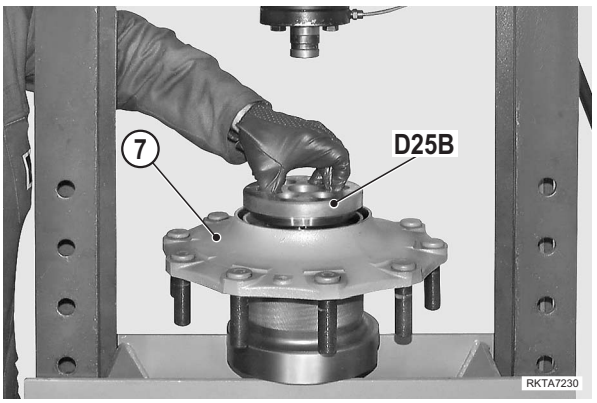


5 - Lubricate the seats of the bearings and position the hub (7) on tool **D25A**; position the thrust block of the internal bearing (15).

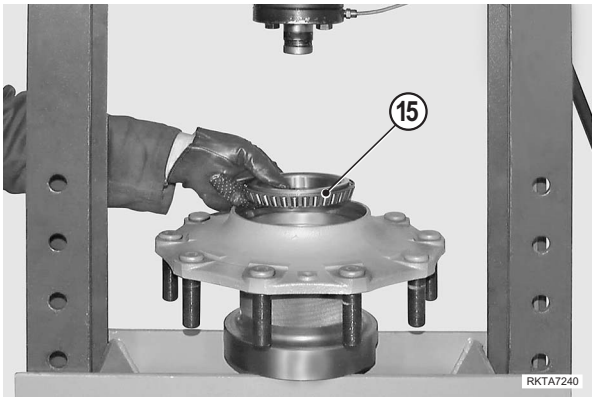
★ Check that the thrust block is correctly oriented.



6 - Position the upper part of tool **D25B** and press the thrust blocks into the hub (7) all the way down.



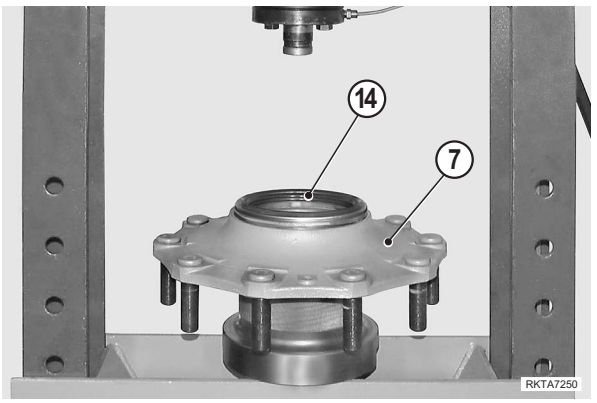
7 - Apply a repositionable jointing compound for seals to the outer surface of the sealing ring (14).



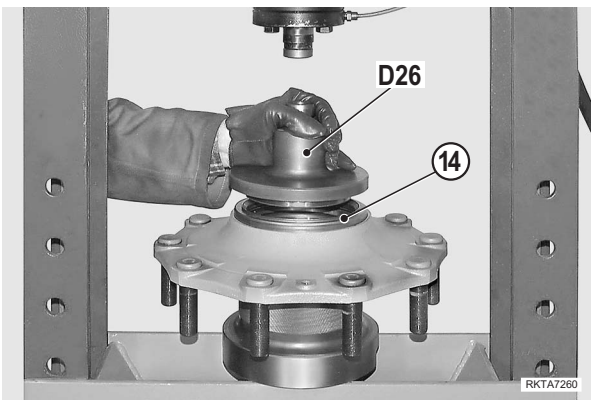
8 - Apply a repositionable jointing compound for seals to the outer surface of the sealing ring (14).

9 - Position the sealing ring (14) in the hub (7).

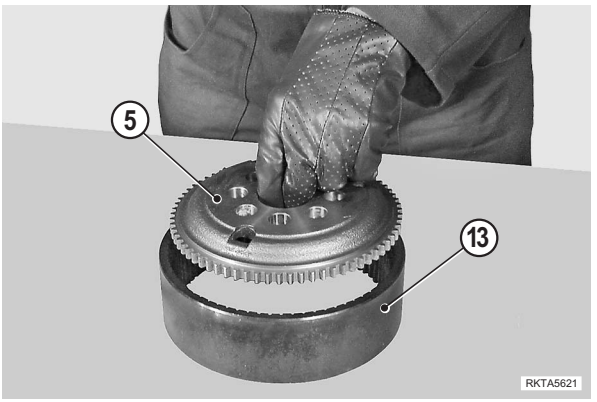
★ Check that the ring (14) is correctly oriented.



10 - Position tool **D16** and press the sealing ring (14) into its seat.

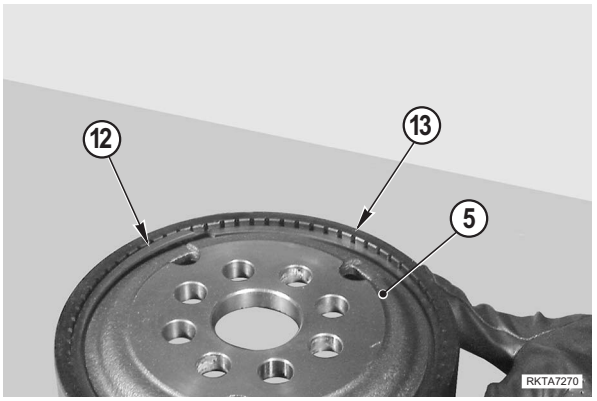


11 - Insert the flange (5) in the crown (13).

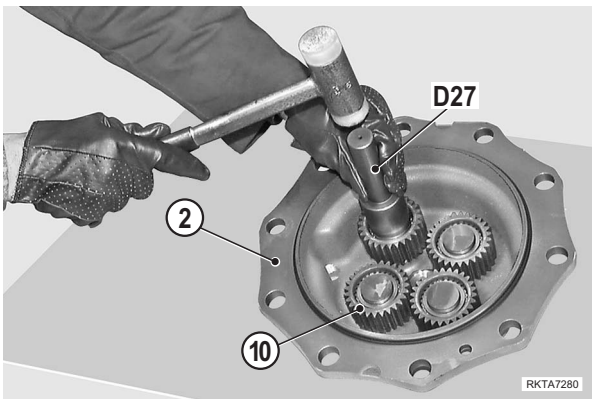


12 - Insert the snap ring (12) in order to fix the flange (5) in the crown (13).

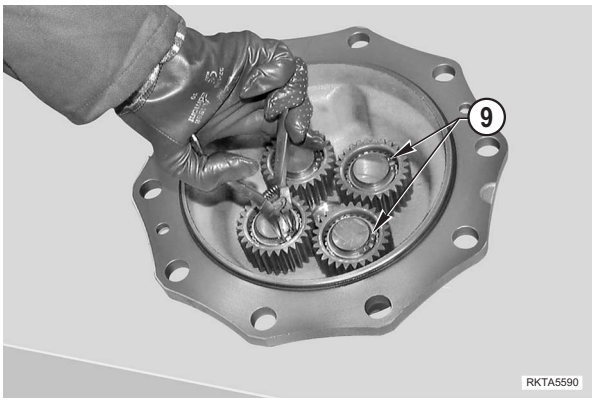
★ Carefully check that ring (12) is properly inserted in the slot of the crown (13).



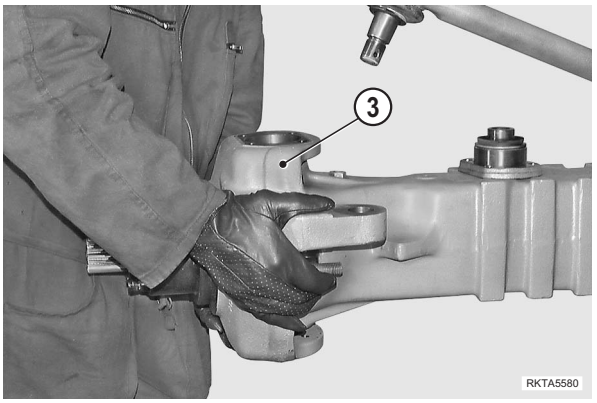
13 - With the help of tool **D27**, insert the planet wheel gears (10) into the cover (2).
Accurately check the orientation.



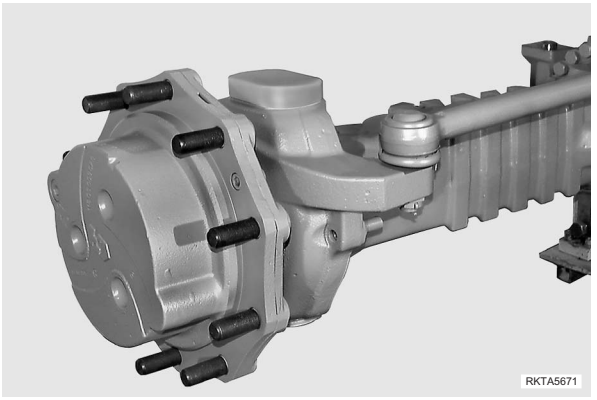
14 - Lock the gears (10) into position by fitting the snap rings (9).



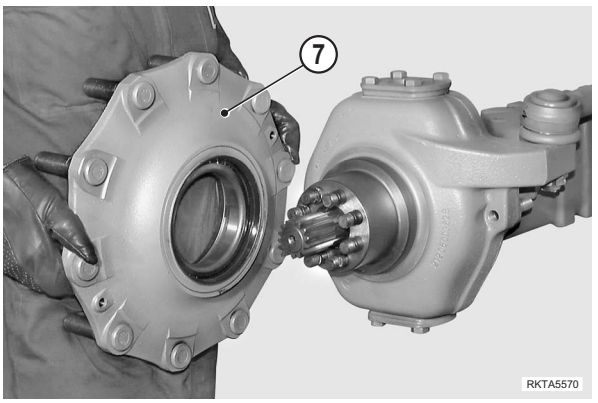
15 - Fit the steering case (3) onto the U-joint (19) and install the articulation pins.
(For details, see "Steering case").



16 - Connect the steering bars.
(For details, see "Steering cylinder").

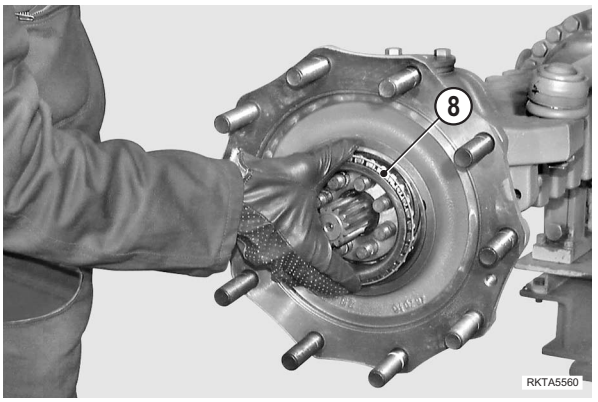


17 - Install the hub (7).



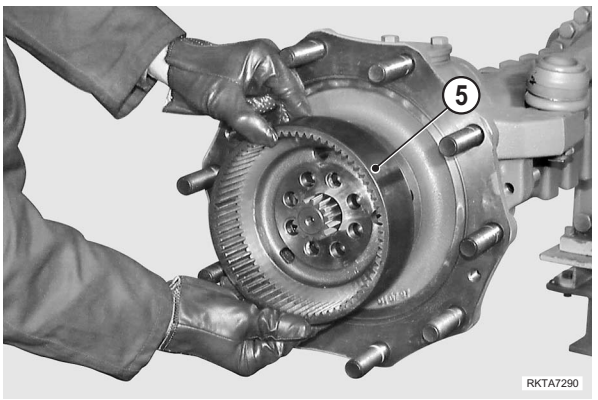
18 - Install the external bearing (8).

★ Using a plastic hammer, drive the bearing to the limit stop by lightly hammering around the edge.



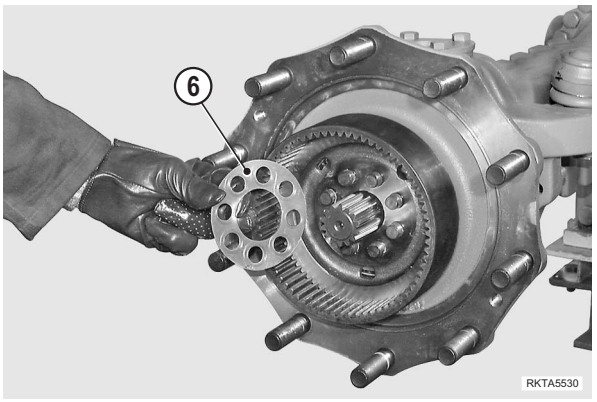
19 - Fit the complete crown flange (5).

★ In order to fasten the flange (5), use a plastic hammer and alternately hammer on several equidistant points.



20 - Apply Tecnolube Seal 101 grease to the surface of the safety flange (6) which touches the crown flange (5).

21 - Fit the safety flange (6).

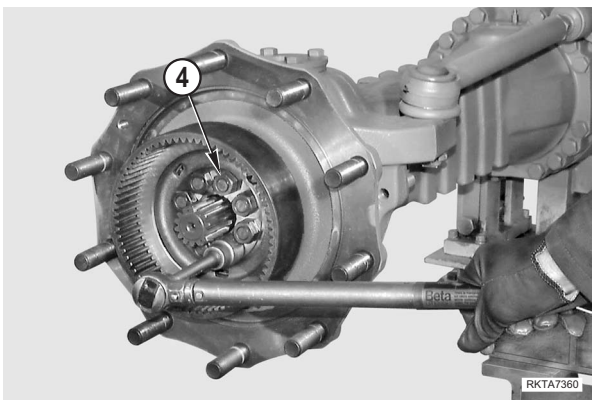


22 - Apply Loctite 242 to the studs and fit in the nuts (4).

23 - Cross tighten the nuts (4) in two stages.

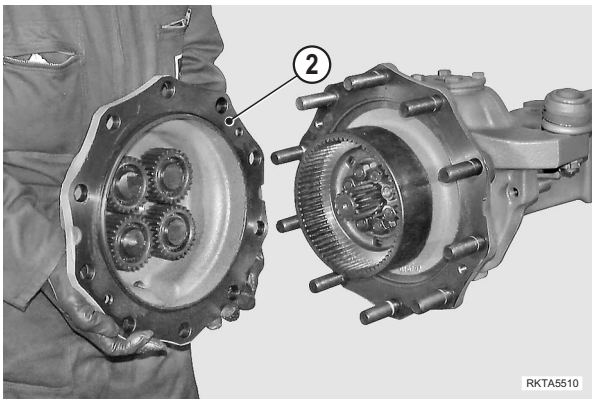
Initial torque wrench setting: 120 Nm

Final torque wrench setting: 255–285 Nm



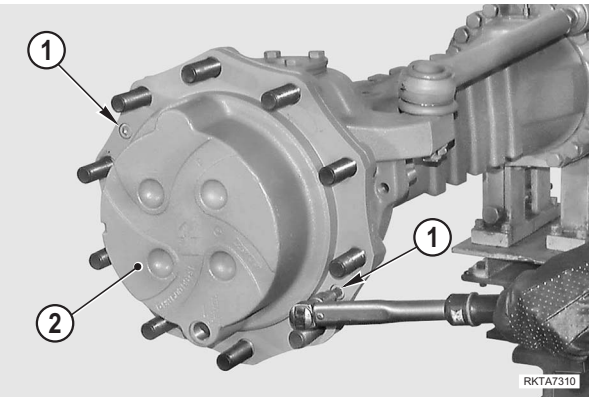
24 - Fit the planetary carrier cover (2) onto the hub (3).

★ Check that the O-ring (20) is in good condition and in position.



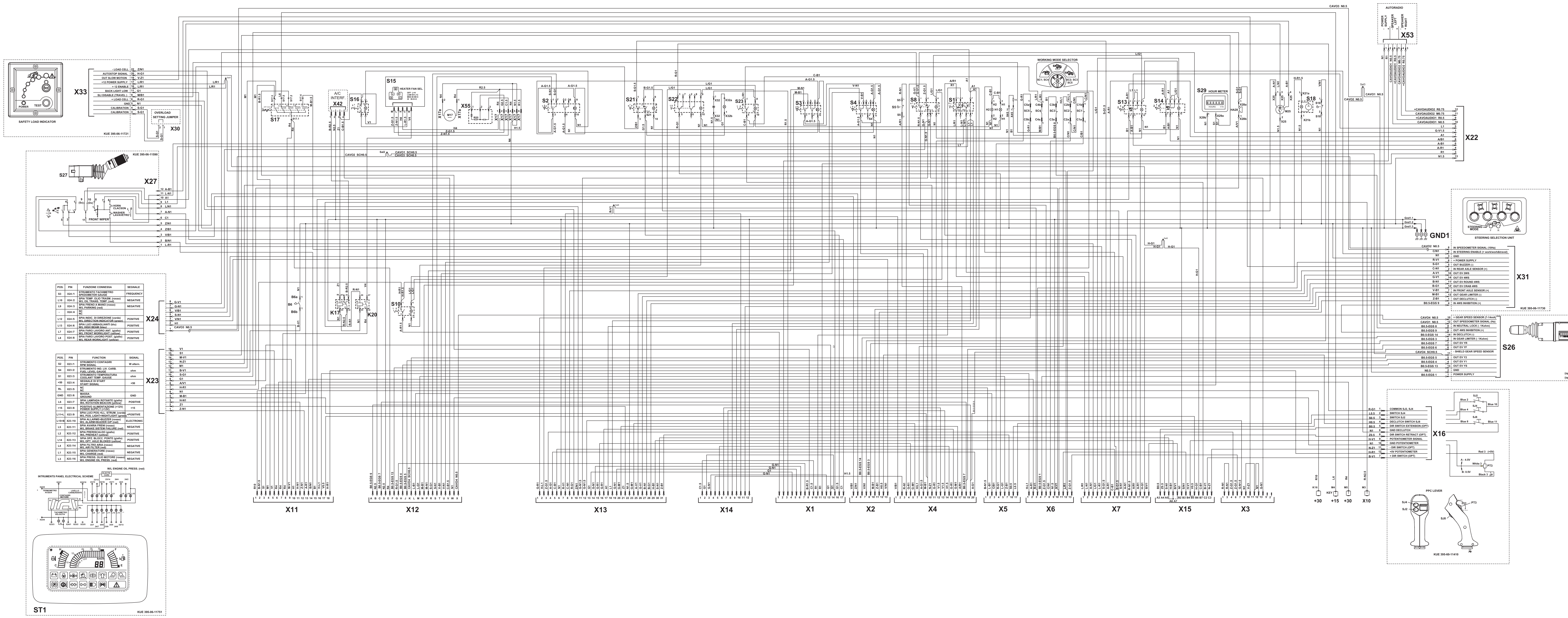
25 - Lock the planetary carrier cover (2) by tightening the screws (1).

Torque wrench setting for screws: 40–50 Nm



90 OTHERS

CAB WIRING

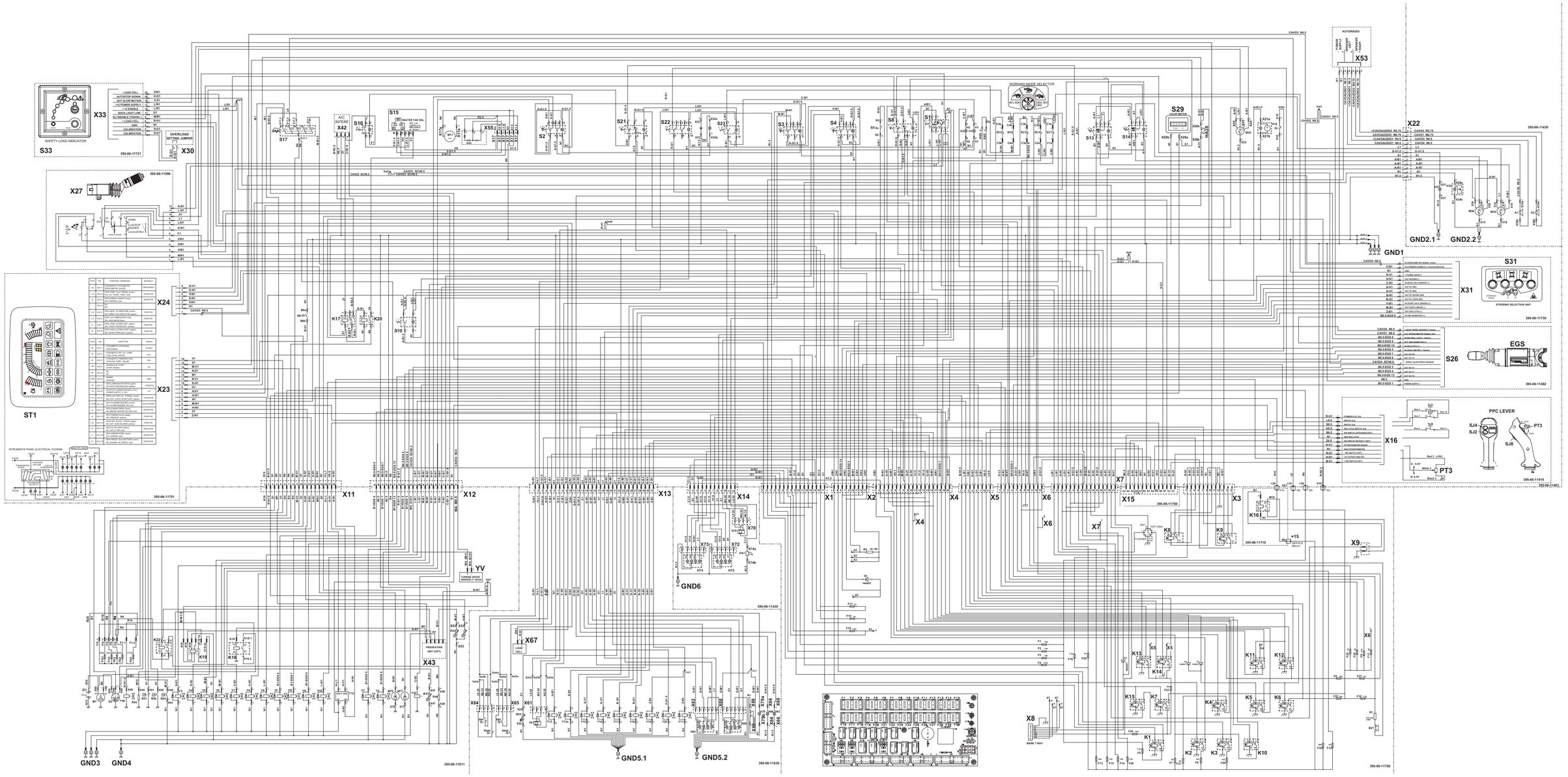


POS.	PIN	FUNZIONE CONNESSA	SEGNALE
S3	X24 /1	STRUMENTO TACHIMETRO SPEDOMETER GAUGE	FREQUENCY
L10	X24 /2	SPIA TEMP. OLIO TRASM. (rosso) W/L OIL TRANS. TEMP. (red)	NEGATIVE
L9	X24 /3	SPIA FRENO A MANO (rosso) W/L PARKING (red)	NEGATIVE
-	X24 /4	NC NC	
L12	X24 /5	SPIA INDIC. DI DIREZIONE (verde) W/L DIRECTION INDICATOR (green)	POSITIVE
L13	X24 /6	SPIA LUCI ABBAGLIANTI (blu) W/L HIGH BEAM (bleu)	POSITIVE
L7	X24 /7	SPIA FARO LAVORO ANT. (giallo) W/L FRONT WORKLIGHT (yellow)	POSITIVE
L8	X24 /8	SPIA FARO LAVORO POST. (giallo) W/L REAR WORKLIGHT (yellow)	POSITIVE

POS.	PIN	FUNCTION	SIGNAL
S2	X23 /1	STRUMENTO CONTAGIRI RPM SIGNAL	W altern.
S4	X23 /2	STRUMENTO IND. LIV. CARB. FUEL LEVEL GAUGE	ohm
S1	X23 /3	STRUMENTO TEMPERATURA COOLANT TEMP. GAUGE	ohm
+50	X23 /4	SEGNALE DI START START SIGNAL	+50
RL	X23 /5	NC NC	
GND	X23 /6	MASSA GROUND	GND
L6	X23 /7	SPIA LAMPADA ROTANTE (giallo) W/L ROTATION BEACON (yellow)	POSITIVE
+15	X23 /8	POSITIVO ALIMENTAZIONE (+12V) POWER SUPPLY (+12V)	+15
L11+L	X23 /9	SPIA LUCI POS.+ILL. STRUM. (verde) W/L POS. LIGHT+NIGHTLIGHT (green)	+POSITIVE
L15+B	X23 /10	SPIA ALLARME+BUZZER (rosso) W/L ALARM+BUZZER O/P (red)	ELECTRONIC
L5	X23 /11	SPIA AVARIA FRENI (rosso) W/L BRAKE SISTEM FAILURE (red)	NEGATIVE
L2	X23 /12	SPIA PRERISCALDO (giallo) W/L PREHEAT (yellow)	POSITIVE
L14	X23 /13	SPIA OPZ. BLOCC. PONTE (giallo) W/L OPT. AXLE BLOKED (yellow)	POSITIVE
L4	X23 /14	SPIA FILTRO ARIA (rosso) W/L AIR FILTER (red)	NEGATIVE
L1	X23 /15	SPIA GENERATORE (rosso) W/L CHARGE (red)	NEGATIVE
L3	X23 /16	SPIA PRESS. OLIO MOTORE (rosso) W/L ENGINE OIL PRESS. (red)	NEGATIVE

RKT00760

ELECTRICAL DIAGRAM



COMPONENTS

- A1 Speaker right
- A2 Speaker left
- B6 Low brake oil level
- B22 Fuel level sender
- B44 Air filter blocked switch
- B47 Temperature switch fuel filter
- B51 Engine oil pressure switch
- B56 Max oil temperature transmission switch
- B64 Boom 30° switch
- B65 Boom retracted switch
- BZ1 Buzzer
- G1 Battery
- G2 Generator
- H1 No Autostop warning light
- H2 No Autostop warning light
- H32 Cigarette lighter light
- H33 Rear work light
- H34 Cabin lamp
- H62 Rear left light
- H66 Boom work light
- H67 Boom work light
- H68 Rear right light
- H72 Front right light
- H73 Front left light
- H79 Number plate light
- HA1 Horn
- HA28 Buzzer
- HA69 Back up alarm
- M1 Starter motor
- M15 Roof windshield wiper motor
- M17 Heater fan motor
- M18 Rear windshield wiper motor
- M25 Front windscreen wiper motor
- M76 Front washer pump
- M77 Rear, roof washer pump
- R48 Fuel filter resistor
- R53 Engine water temperature sender
- R54 Engine air preheating resistor
- R55 Heater fan resistor
- S1 Hazard switch
- S2 Right stabilizer switch
- S3 Left stabilizer switch
- S4 Frame leveling switch
- S5 Brake pedal switch
- S8 Boom work light switch
- S10 Beacon light switch
- S13 Rear windshield wiper motor switch
- S14 Roof windshield wiper motor switch
- S15 Heater fan speed selector switch
- S16 Air conditioner swtch
- S17 Key switch
- S18 N.C. switch parking brake
- S21 General light switch
- S22 Auxiliary boom solenoid valve switch
- S23 Switch disable autostop (opt)
- S27 Steering column lights-windshield
- S29 Hour meter
- S31 Steering mode selection unit
- S61 Rear axle alignement sensor
- S70 Front axle alignement sensor
- ST1 Instrument panel
- SC1 N.C. steering, EV boom ext/retr. disable (travel side)
- SC2 N.C. frame leveling, stabilizer disable (work side)
- SC3 N.C. EGS neutral lock (work side)
- SC4 N.O. oveload warning display disable (travel side)
- SC5 N.C. frame leveling, stabilizer disable (work side)

FUSES

- F1 Hazard fuse 10A
- F2 Cigarette lighter socket fuse 10A
- F3 Beacon light fuse 10A
- F4 Cabin lamp + radio fuse 7.5A
- F5 Horn relay fuse 7.5A
- F6 High beam relay fuse 15A
- F7 Stop light fuse 5A
- F8 EV. rear axle lock, boom 30° switch fuse 10A
- F9 Steering unit fuse 10A
- F10 EGS fuse, small buzzer 7.5A
- F11 Opt. fusE 5A
- F12 Boom work light fusE 15A
- F13 Front windshield wiper motor, horn relay fuse 10A
- F14 Column light switches and flasher fuse 10A
- F15 Roof and rear windshield wiper motor fusE 10A
- F16 Elettrostop fuse 7.5A
- F17 Back light left, front light right and number plate lamp fuse 3A
- F18 Back light right, front light left and instrument light fuse 3A
- F19 Optional fusE 7.5A
- F20 Low beam relay fusE 15A
- F21 Back up alarm, backward light fuse 10A
- F22 Relay off services, working mode selector fuse 10A
- F23 Boom auxiliary line fuse 10A
- F24 Autostop unit (optional) fuse 10A
- F25 Cold area preheating unit (opt) fuse 5A
- F26 Front instrument fuse 3A
- F27 Overloading warnig panel fuse 3A
- F28 Side light fusE 7.5A
- F29 Rear work light fusE 5A
- F30 A/C condenser fan fuse 20A
- FG1 General, services relay fuse 50A
- FG2 Cabin fan heater fuse 30A
- FG3 Key switch fuse 50A
- FG4 Fuse unit and fuel preheating relay fuse 50A
- FG5 Engine air preheating megafuse 175A

RELAYS

- K1 Horn relay
- K2 Low beam relay
- K3 High beam relay
- K4 Back up alarm relay
- K5 Gear engaged relay
- K6 Services relay
- K7 Boom auxiliary valve relay
- K8 Optional valve relay
- K9 Boom work light relay
- K10 Stop light relay
- K11 Frame leveling and stabilizer relay
- K12 Rear axle lock relay
- K13 Boom auxiliary line relay 1
- K14 Boom auxiliary line relay 2
- K15 Boom ext/ retr proportional valve power supply relay
- K16 Service relay
- K17 A/C Fan condenser relay
- K18 Engine air preheating relay
- K20 Cabin fan heater relay
- K22 Fuel preheating relay

SOLENOID VALVES

- Y1 Transmission solenoid valve "1"
- Y2 Transmission solenoid valve "2"
- Y3 Up right stablizer solenoid valve
- Y4 Down right stablizer solenoid valve
- Y5 Up left stablizer solenoid valve
- Y6 Down left stablizer solenoid valve
- Y7 Left frame leveling solenoid valve
- Y8 Right frame leveling solenoid valve
- Y9 Boom auxiliary solenoid valve 1
- Y10 Boom auxiliary solenoid valve 2
- Y11 Rear axle lock solenoid valve 1
- Y12 Proportional ext/retraction solenoid valve
- Y13 Ext/retract boom charge solenoid valve
- Y13a PPC boom charge solenoid valve
- Y15 2WS steeering solenoid valve
- Y16 4WS steering solenoid valve
- Y17 Round steering solenoid valve
- Y18 Crab steering solenoid valve
- Y19 Rear axle lock solenoid valve 2
- Y20 Optional solenoid valve
- Y46 Fuel shut off solenoid valve
- Y52 A/C clutch
- YF Forward speed solenoid valve
- YR Reverse speed solenoid valve
- YS Transmission "splitter" solenoid valve