FIATALLIS

20 convert
crawler tractor

Service manual

PRINT No. 604.06.024 - English

FIAT-ALLIS

20 convert

crawler tractor

SERVICE MANUAL

ATTENTION:

The manual was updated by supplement No. 604.06.024.01 included at the end of the book.

FIAT-ALLIS M.M.T. S.p.A. - DIREZIONE ASSISTENZA TECNICA

NOTICE

Measures in Imperial and U.S. units are given for operator's convenience and, though the closest approximation is sought, they are normally rounded off for practical reasons. In case of discrepancies only the metric units should be considered.
Wear limits are given for guidance only.

NEW DESIGNATION OF SERVICE TOOLS

Due to organization requirements, starting from October 1976, all part numbers of service tools have been modified by the addition of prefix 75. For instance, part number of pressure gauge kit 291314 is now 75291314. Service tools part numbers shown in this manual are not yet updated, but orders should be placed preferably making reference to the new numbers.

FIAT-ALLIS - Macchine Movimento Terra S.p.A. - DIREZIONE ASSISTENZA TECNICA

Servizio Pubblicazioni Tecniche - Print No. 604.06.024 - X-1975 - 700 - S.A.N.
2nd Printing - XI-1978 - 800

SAFETY RULES

GENERAL

Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling, or servicing machine.

Read and heed all machine-mounted safety signs before starting, operating, maintaining, fueling or servicing machine.

Machine-mounted safety signs have been color coded yellow with black borders and lettering for warning and red with white borders and lettering for danger points.

No unauthorized personnel should be allowed to service or maintain this machine. Do not perform any work on equipment that is not authorized. Follow the Maintenance and Service procedures.

Do not wear rings, wrist watches, jewelry, or loose or hanging apparel, such as ties, torn clothing, scarves, unbuttoned, or unzipped jackets that can catch on moving parts. Wear proper safety equipment as authorized for the job. Examples: hard hats, safety shoes, safety glasses or goggles, heavy gloves, reflector vests, ear protectors, or respirators. Consult your employer for specific safety equipment requirements.

Do not use controls or hoses as handholds when climbing on or off machine. Hoses and controls are movable and do not provide a solid support. Controls may also be inadvertently moved causing accidental machine or equipment movement.

Do not jump on or off machine. Keep two hands and one foot, or two feet and one hand, in contact with steps and grab-rails and handles at all times.

Machine should not be serviced with anyone in the operator's seat unless they are qualified to operate the machine and are assisting in the servicing.

Keep operator's compartment, stepping points, grab-rails and handles clean of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling.

Never attempt to operate the machine or its tools from any position other than seated in the operator's seat.

Keep operator's compartment clear of loose objects.

If movement of an attachment by means of the machine's hydraulic system is required for service or maintenance, do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachment or tool, make sure to set brakes, sound horn and call for an all clear. Raise attachment slowly.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine per OSHA requirements. Never allow anyone to walk under or be near unblocked raised equipment. Avoid working or walking under raised blocked equipment unless you are assured of your safety.

Never place head, body, limbs, fingers, feet or hands into the exposed portion between uncontrolled or unguarded scissor points of machine without first providing secure blocking.

Never service or adjust a machine with the engine running, except as called for in the Operation and maintenance Instruction Manuals.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets OSHA requirements to reach the service point. If such ladders or paltforms are not available, use the machine handholds and steps as provided. Perform all service or maintenance carefully.

Shop or field service platforms and ladders used to maintain or service machinery should be constructed and maintained according to OSHA requirements.

Disconnect batteries and TAG all controls according to OSHA requirements to warn that work is in progress. Block the machine and all attachments that must be raised per OSHA requirements.

Never check or fill fuel tanks, storage batteries or use starter fluid near lighted smoking materials or open flame due to the presence of flammable fluid.

Brakes are inoperative when manually released for servicing. Provision must be made to maintain control of the machine by blocking or other means.

Always place the fuel nozzle against the side of the filler opening before starting and during fuel flow. To reduce the chance of a static electricity spark, keep contact until after fuel flow is shut off.

Use only designated towing or pulling attachment points. Use care in making attachment. Be sure pins and locks as provided are secure before pulling. Stay clear of drawbars, cables or chains under load.

To move a disabled machine, use a trailer or low boy truck if available. If towing is necessary, provide warning signals as required by local rules and regulations and follow operation and maintenance instruction manual recommendations. Load and unload on a level area that gives full support to the trailer wheels. Use ramps of adequate strength, low angle and proper height. Keep trailer bed clean of clay, oil and all materials that become slippery. Tie machine down securely to truck or trailer bed and block tracks (or wheels) as required by the carrier.

Never align holes with finger or hands — USE the proper aligning tool.

Remove sharp edges and burrs from reworked parts.

Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazards of electrical shock.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are supported by proper slings and hooks. Use lifting eyes if provided. Watch out for

General (Continued)

people in the vicinity

Never place gasoline or diesel fuel in an open pan.

Never use gasoline or diesel fuel or other flammable fluid for cleaning parts. Use authorized commercial, non-flammable, non-toxic solvents.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 30 psi according to OSHA requirements.

Do not operate machine in closed area without proper ventilation to remove deadly gases

Do not smoke or permit any open flame or spark near when refueling, or handling highly flammable materials.

Do not use an open flame as a light source to look for leaks or for inspection anywhere on the machine.

Be sure all mechanics tools are in good condition. DO NOT use tools with mushroomed heads. Always wear safety glasses with side shields.

Move carefully when under, in or near machine or implements. Wear required protective equipment, such as hard hat, safety glasses, safety shoes, ear protectors.

When making equipment checks that require running of the engine, have an operator in the operator seat at all times with the mechanic in sight. Place the transmission in neutral and set the brakes and lock. Keep head, body, limbs, feet, hands and fingers away from blade or ripper when in raised position.

Shut off engine and disengage the Power Take-Off lever before attempting adjustments or service.

Do not perform any work on equipment that is not authorized. Follow the Maintenance or Service Manual Procedures.

For field service, move machine to level ground if possible and block machine. If work is absolutely necessary on an incline, block machine and its attachments securely. Move the machine to level ground as soon as possible.

Guard against kinking chains or cables. Do not lift or pull thru a kinked chain or cable. Always wear heavy gloves when handling chain or cable.

Be sure cables are anchored and the anchor point is strong enough to handle the expected load. Keep exposed personnel clear of anchor point and cable or chain. DO NOT PULL OR TOW UNLESS OPERATOR'S COMPARTMENTS OF MACHINES INVOLVED ARE PROPERLY GUARDED against accidental cable or chain backlash.

Keep maintenance area CLEAN and DRY. Remove water or oil slicks immediately.

DO NOT pile oily, greasy rags — they are a fire hazard. Store in a closed metal container.

Before starting machine or moving attachment check and adjust and lock operator's seat. Be sure all personnel in the area are clear before starting or moving machine and any of its attachments. Sound horn.

Rust inhibitors are volatile and flammable. Prepare parts in well ventilated place. Keep open flame away — DO NOT SMOKE. Store container in a cool well-ventilated place secured against unauthorized personnel.

Do not carry loose objects in pockets that might fall unnoticed into open compartments.

Keep clutches and brakes of machine and attachments such as Power Control Units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturer at all times. DO NOT adjust with engine running.

Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.

Wear welders protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding. Wear dark safety glasses near welding. — DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.

Know your jacking equipment and its capacity. Be sure the jacking point used on the machine is appropriate for the load to be applied. Be sure the support for the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to authorized blocking as a safety measure before proceeding with service or maintenance per OSHA requirements.

Wire rope develops steel slivers. Use authorized protective equipment such as heavy gloves, safety glasses when handling.

Never use makeshift jacks when adjusting track tension. Follow the Undercarriage Service Manual.

Handle all parts with extreme care. Keep hands and fingers from between parts. Wear authorized protective equipment such as safety glasses, heavy gloves, safety shoes.

START UP

Do not run the engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.

Do not place head, body, limbs, feet, fingers, or hands near rotating fan or belts. Be especially alert around a pusher fan.

STARTING FLUID IS FLAMMABLE. Follow the recommendations as outlined in the Operation and Maintenance Instruction Manual and as marked on the containers. Store containers in cool, well-ventilated place secure from unauthorized personnel. DO NOT PUNCTURE OR BURN CONTAINERS. Follow the recommendation of the manufacturer for storage and disposal.

Safety Rules

ENGINE

Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling if hot. See Operation and Maintenance Instruction Manual.

Keep engine exhaust system and exhaust manifolds clear of combustible material. Equip machine with screens and guards when working under conditions of flying combustible material.

Do not run engine when refueling and use care if engine is hot due to the increased possibility of a fire if fuel is spilled.

Never attempt to check or adjust fan belts when engine is running.

Do not adjust engine fuel pump when the machine is in motion.

Never lubricate a machine with the engine running.

Avoid running engine with open unprotected air inlets. If such running is unavoidable for service reasons, place protective screens over all inlet openings before servicing engine.

ELECTRICAL

Be sure to connect the booster cables to the proper terminals (+ to +) and (- to -) at both ends. Avoid shorting clamps. Follow the Operation and Maintenance Instruction Manual procedure.

Always turn the master switch to the off position when maintaining or servicing machine.

BATTERY GAS IS HIGHLY FLAMMABLE. Leave battery box open to improve ventilation when charging batteries. Never check battery charge by placing metal objects across the posts. Keep sparks or open flame away from batteries. Do not smoke near battery to guard against the possibility of an accidental explosion.

Check for fuel or battery electrolyte leaks before starting service or maintenance work. Eliminate leaks before proceeding.

Do not charge batteries in a closed area. Provide proper ventilation to guard against an accidental explosion from an accumulation of explosive gases given off in the charging process.

Disconnect batteries before working on electrical system.

HYDRAULIC

Fluid escaping under pressure from a very small hole can almost be invisible and can have sufficient force to penetrate the skin. Use a piece of cardboard or wood to search for suspected pressure leaks. DO NOT USE HANDS. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Shut off engine and be sure internal pressure is relieved before removing panels, housing covers, and caps. See Operation and Maintenance Instruction Manual.

When making pressure checks use the correct gage for expected pressure. See Operation and Maintenance Instruction Manual or Service Manual for guidance.

ATTACHMENTS

Keep head, body, limbs, feet, hands and fingers away from blade, bucket or ripper when in raised position. Use authorized blocking as a safety measure before proceeding with service or maintenance per OSHA requirements.

If movement of an attachment by means of the machine's hydraulic system is required for service or maintenance do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachments or tools, make sure to set brakes, sound horn and call for an all clear. Raise attachment slowly.

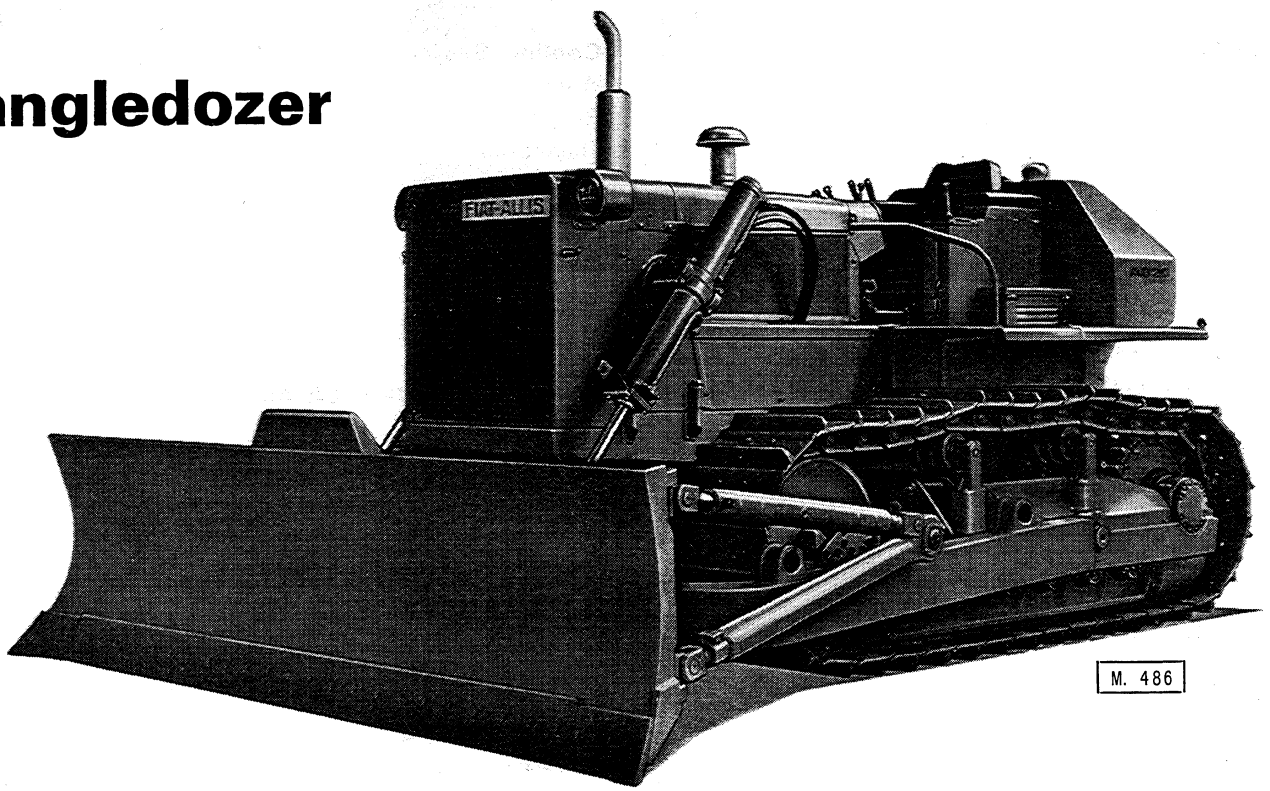
Do not use machine to carry loose objects by means other than attachments for carrying such objects.

Never use any gas other than dry nitrogen to charge accumulators. See Operation and Maintenance Instruction Manual.

Keep clutches and brakes of machine and attachments such as power control units, winches adjusted according to Operating and Maintenance Manuals of the manufacturers at all times.

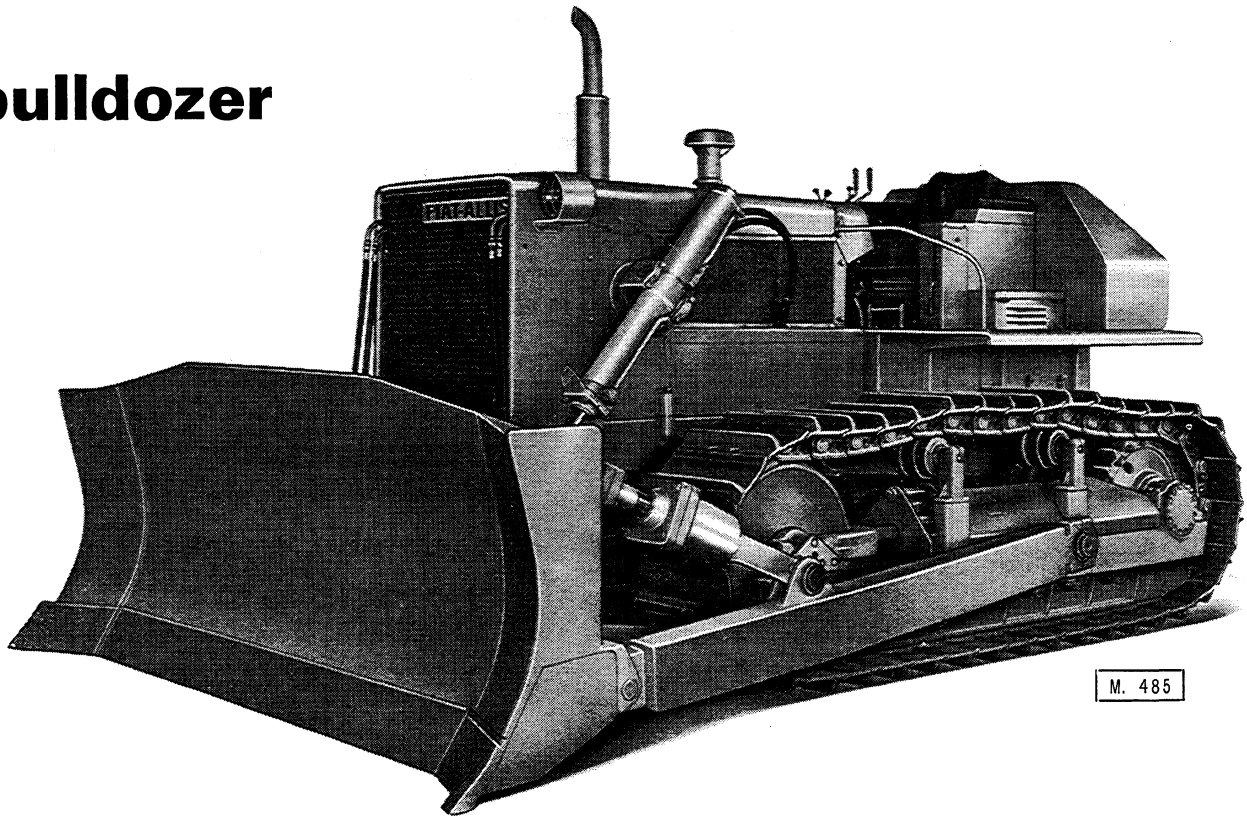
CRAWLER TRACTOR 20 convert

angledozer



M. 486

bulldozer



M. 485

INDEX

GENERAL

FOREWORD

The information given in this manual applies to Model 20 Angledozer and Bulldozer with torque converter. The direct drive version of the same model is described in a supplementary publication.

SPECIFICATION

IDENTIFICATION DATA

Chassis type	
— Engineering code	623600
— Marketing code	200 CIT
Engine type	8215.02.515
Equipment type	Angledozer 20 Bulldozer 20

ENGINE

Cycle	Diesel, naturally-aspirated
Strokes	Four
Injection	Direct
Number of cylinders	Six
Bore	137 mm (5.3937 in)
Stroke	156 mm (6.1417 in)
Capacity	13798 cc
Compression ratio	16 to 1
Main bearings	Seven
Crankshaft rotation (as seen from fan side)	Clockwise
Maximum speed, full load	1850 rpm
Maximum speed, no load	2050 rpm
Minimum speed, no load (idling)	700 rpm

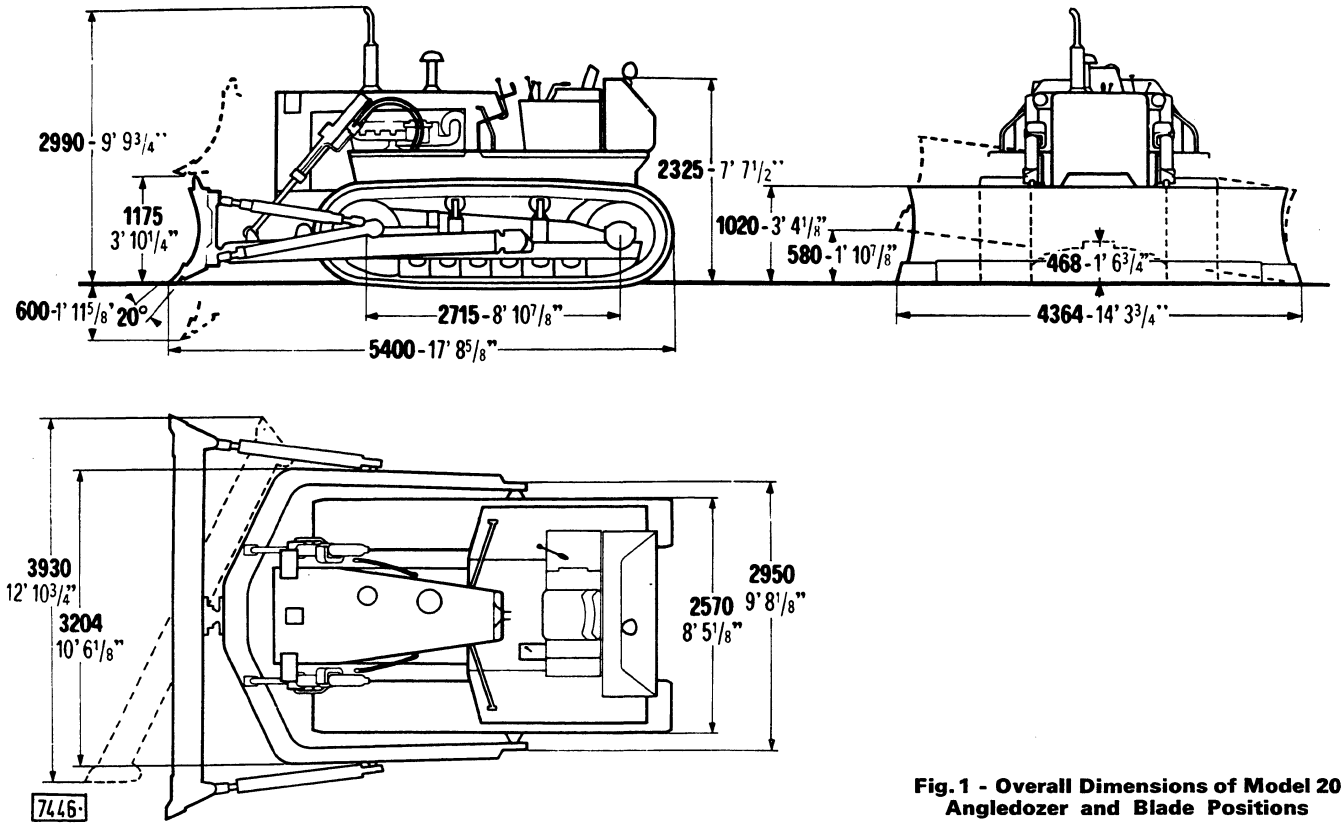


Fig. 1 - Overall Dimensions of Model 20 Angledozer and Blade Positions

Valve Gear

Valves	Pushrod-operated, OH
Tacho-hourmeter rating	1600 rpm

Fuel System

Precleaner	Centrifugal
Air cleaner	Twin, paper element, in-line
Air cleaner indicator	Dash-mounted
Oil bath cleaner	Optional
Fuel filter	Twin, in-line, paper and cloth element, feed pump suction line mounted
Injection pump	FIAT-BOSCH, in-line, L.H. helix
Timing	22° B.T.D.C.
Firing order	1-5-3-6-2-4
Fuel injectors	Three-orifice, 140° spray angle

Lubrication System

Type	Forced feed
Oil pump	Double, gear, feed and scavenge
Pump drive ratio	
— A.M. pump	1 to 1
— P.M. pump	1.130 to 1
Injection pump lubrication	From engine
Fuel filters	
— Suction	Steel gauze on both pumps
— Outlet	Twin, paper cartridge, side by side
Oil cooler	Tube and fin, off engine cooling system

Cooling System

Type	Water
Pump	Centrifugal, blade
Thermostat	Two, wax, side by side
Water pump drive ratio	1.377 to 1
Radiator	6-deep vertical tube core
Fan	Blower type, 6-bladed

DRIVE COUPLING AND SHAFT

Drive coupling	Flexible, rubber pad, flanged to flywheel
Drive shaft	Double universal jointed, drive coupling-to-torque converter

CONVERTER AND TRANSMISSION

Converter type	Hydraulic, single stage, single phase
Torque multiplication ratio	2.44 to 1
Transmission/reverser	4 epicyclic trains, 1 clutch and 4 hydraulically operated oil bath brakes
Number of speeds	3 forward and 3 reverse
Hydraulic power shift control	Lever to left of operator
Neutral lock	Push-down lever permitting engine starting and operator movements in complete safety
Speeds	Forward and resverse
— First	Up to 3.9 kph (2.4 mph)
— Second	Up to 6.9 kph (4.3 mph)
— Third	Up to 11 kph (6.8 mph)
Step-up unit	Constant mesh, between output shaft and bevel drive

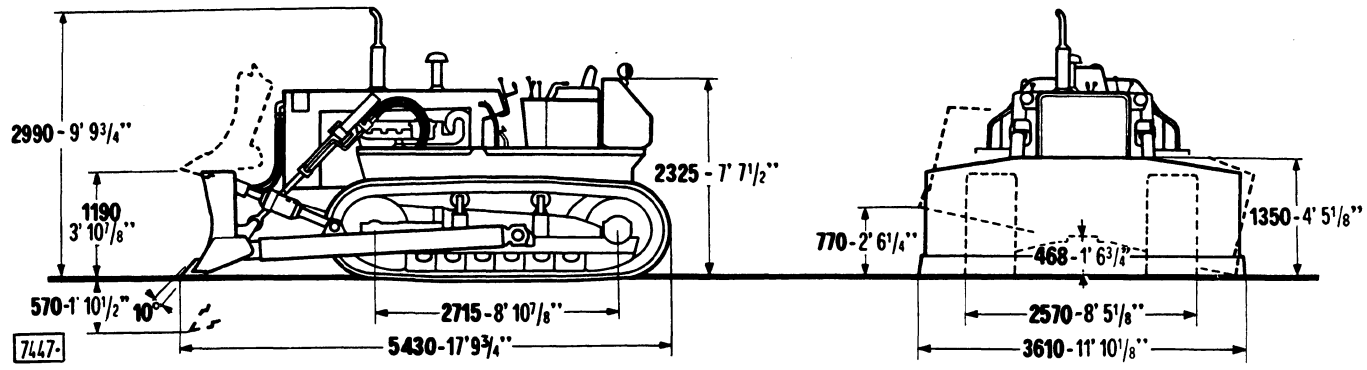


Fig. 2 - Overall Dimensions of Model 20 Bulldozer and Blade Positions

Power Take-off

Splined shaft	Converter impeller driven
Shaft speed	1850 rpm
Direction of rotation (as seen from rear of machine)	Anticlockwise

CONVERTER/TRANSMISSION HYDRAULIC SYSTEM

Hydraulic pump	Double, gear, converter impeller driven through gear train
— Pump drive ratio	1.108 to 1
— Feed pump rated output	117 litre/min (25-3/4 imp. Gall or 31 U.S. Gall)
— Feed pump rated pressure	23 kg/cm² (327 psi)
Oil filter	
— Suction	Steel gauze
— Outlet	Paper cartridge
Filter warning	Indicator
Speed selector valve	Spool
Retarder valve	Hydraulic accumulator giving progressive forward and reverse brake engagement
Transmission relief valve	
— Pressure setting	19 to 23 kg/cm² (270 to 327 psi)
Torque converter safety valve	
— Pressure setting	4.5 to 5 kg/cm² (64 to 71 psi)
Lubricating oil pressure relief valve	
— Pressure setting	2 to 2.3 kg/cm² (28.5 to 32.7 psi)
Oil cooler	Shell and tube, branched off the engine cooling system

BEVEL DRIVE

Type	Spiral, centrally mounted, bolted-on ring gear
— Reduction ratio	2.923 to 1 (13/38)

STEERING CLUTCHES

Type	14 in, oil bath, multi-plate, hydraulically operated, side mounted
— Number of plates to each clutch	15
Control	Separate levers, dash-mounted

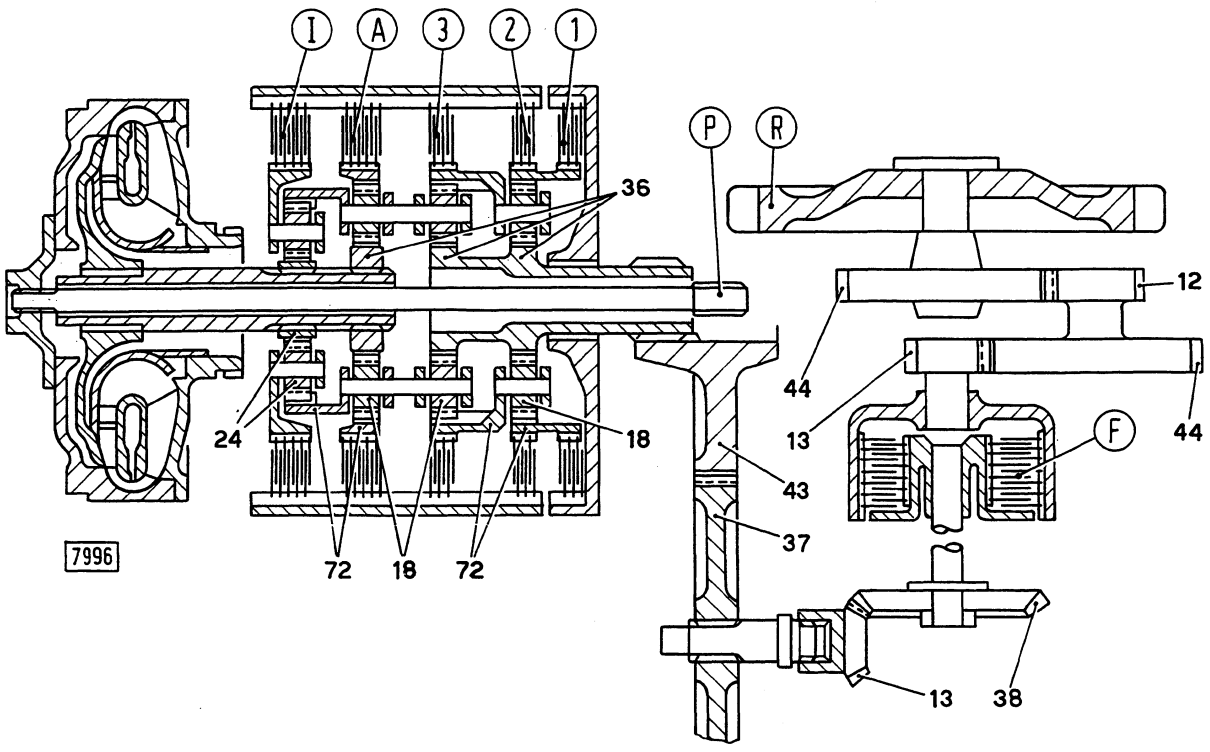


Fig. 3 - Schematics of Bulldozer 20 Convert Transmission

A/I. Forward/reverse brakes - F. Steering clutch - P. Power take-off - R. Sprocket - 1. First speed clutch - 2/3. Second/third speed brakes

BRAKES

Service

Type	Oil-bath, band, acting on outer steering clutch drums
Operation	Hydraulic
Control	Latched pedals
Drum diameter	406 mm (16 in)
Brake band width	120 mm (4.72 in)

Parking

Type	Service bands
Operation	Mechanical
Control	Latched pedals and locking lever

Emergency

Type	Rapid speed reversal through selector lever

STEERING CLUTCH/BRAKE HYDRAULIC SYSTEM

Hydraulic pump	Gear
Pump drive	Converter impeller driven gear train
Pump drive ratio	1 to 1
Rated pump output	54 litre/min (11.9 Imp Gall or 14.3 U.S. Gall)
Rated pressure	
— A.M. pump	29 kg/cm² (412 psi)
— P.M. pump	31 kg/cm² (441 psi)
Oil filter	
— Suction	Steel wool cartridge
— Return	Paper cartridge
Control valve block	Servovalve, shuttle and interlock valves for steering clutch and brake cylinder control
Steering clutch valve setting	23 to 24 kg/cm² (327 to 341 psi)
Relief valve setting	
— A.M.	25 to 29 kg/cm² (355 to 412 psi)
— P.M.	27 to 31 kg/cm² (384 to 441 psi)
Brake power cylinders	Separate

HUB REDUCTION UNITS

Type	Spur gear, double reduction
Reduction ratio	12.410 to 1

SPROCKETS

Ring gear	Split, bolted-on
Floating ring seals	Long life
Number of teeth	25
Pitch circle diameter	868 mm (34.2 in)
Face width	93 to 95 mm (3.66 to 3.74 in)

UNDERCARRIAGE

Track frames	Boxed, pivotting, anchored at rear and guided at front
Number of shoes to each chain	38
Shoe width	600 mm (24 1/2 in)
Link pitch	216 mm (8 1/2 in)
Ground contact area (standard shoes)	32580 cm² (5050 in²)
Specific ground pressure (standard shoes)	.66 kg/cm² (9.4 psi) approx.
Optional shoe width	700 mm (27 1/2 in)
Track tensioner	Double recoil spring, hydraulically adjustable
Overload valve setting	1000 to 1050 kg/cm² (14,223 to 14,934 psi)
Front idlers	Long life floating ring seal mounted
Track rollers	6 off (each chain) sealed for life, floating ring seals
Top idlers	2 off (each chain) sealed for life, floating ring seals

FRONT SUSPENSION

Cross beam	Pivotted at centre and resting on track frame pads

REAR SUSPENSION

Pivots	Sprocket axle and rear axle case

EQUIPMENT

Hydraulic system	Double gear pump, sequence valve for automatic by-pass of main pump upon increasing operating pressure
Pump drive	Convertor impeller driven gear train
Pump drive ratio	1 to 1
Rated pump output	
— Up to 90 kg/cm² or 1,280 psi	278 litre/min (61 Imp Gall or 74 U.S. Gall)
— 90 to 160 kg/cm² or 1,281 to 2,276 psi	101 litre/min (22 1/4 Imp Gall or 26 3/4 U.S. Gall)
Oil filters	
— Suction	Steel wool cartridge
— Return	Paper cartridge, partial flow (A.M.) or full flow (P.M.)
Hydraulic valve block	3-spool, relief valve, safety, reverse flow and non-return valves in each circuit, fitted next to operator's seat
Relief valve setting	158 to 162 kg/cm² (2,247 to 2,304 psi)
Blade cylinders	Two, double acting, stroke control and rapid lower valves
— Bore and stroke	120 x 1,030 mm (4 3/4 x 40 1/2 in)
Tilt/pitch diverter valve	Bulldozer only
Tilt/pitch cylinders	Two, double acting, flow control valve (bulldozer only)
— Bore and stroke	180 x 126 mm (7 x 5 in)
Ripper cylinders (RP 20 optional)	Two, double acting
— Bore and stroke	140 x 570 mm (5 1/2 x 22 1/2 in)

ELECTRICAL SYSTEM (24 V)

Batteries	Two, series
— Capacity (20-hour rate)	
— MARELLI	143 Ah
— TITANO	136 Ah
Alternator	3-phase, self-rectifying
— Type	FIAT A 12 M 124/24/26 B
— Rated output	32 A approx.
Voltage regulator	
— Type	FIAT RC 2/24
Alternator warning relay	
— SIPEA	T 5240
— WEPOO	90003
Starter	Sliding armature, clutch
— Type	MARELLI MT 16 PC
— Rated output	6 HP

WEIGHTS

Dry engine (without lubricant, coolant and air cleaner)	1,180 kg (2,602 lb)
Standard machine (fully operational)	
— Angledozer	21,160 kg (46,658 lb)
— Bulldozer	21,240 kg (46,834 lb)

SPARE PARTS

When ordering spare parts please state:—

— Tractor model (marketing code) and frame number.

— Engine type and number.

— Spare part number (see the Spare Parts Catalogue).

RECOMMENDED LUBRICANT SPECIFICATION

FIAT Designation	International Designation	FIAT Designation	International Designation
AGERTER oil GI/M oil	MIL-L-2104 C, API CD service ATF oil, type A - Suffix A	AW 90/M oil grassofiat G 9 grease	SAE 90 EP, MIL-L-2105 B Lithium-calcium mineral grease, water, load and heat resistent, to N.L.G.I. 2
AP 31/51 oil	Hydraulic oil containing lubricity, wear control and rust inhibiting additives		

CAPACITIES

DESCRIPTION	Litres	kg	Imp Units	US Units	TYPE OF FLUID	
					FIAT Designation	Viscosity Grade
Engine oil						
— Sump only	26.4	24	46 1/2 Pints	55 3/4 Pints	Oliofiat AGERTER	(1)
— Sump, filters and lines	34.2	31	60 Pints	72 Pints	Oliofiat AGERTER	(1)
Advance device oil	.39	.35	3/4 Pint	1 Pint	Oliofiat AGERTER	(1)
Air cleaner oil (optional)	4.7	4.3	8 1/4 Pints	10 Pints	Oliofiat AGERTER	(1)
Converter/transmission oil						
— Transmission	35	32	61 1/2 Pints	74 Pints	Oliofiat GI/M (2)	SAE 20
— Total	40	37	70 1/2 Pints	84 1/2 Pints	Oliofiat GI/M (2)	SAE 20
Steering clutch/brake oil						
— Rear axle	55	50	97 Pints	116 Pints	Oliofiat AGERTER 10 W (below freezing)	SAE 10 W
— Total	66	61	116 1/4 Pints	139 Pints	Oliofiat AGERTER 30 (above freezing)	SAE 30
Hub reduction oil (each)	44	40	77 1/2 Pints	93 Pints	Oliofiat AW 90/M	SAE 90
Idler and roller oil	11	10	19 1/2 Pints	23 1/4 Pints	Oliofiat AGERTER 30	SAE 30
Equipment oil						
— No ripper						
— Angledozer	66	61	116 1/4 Pints	139 Pints	Oliofiat AP 31 (below freezing)	SAE 10 W
— Bulldozer	74	67	130 1/4 Pints	156 1/4 Pints		
— Ripper						
— Angledozer	91	83	160 1/4 Pints	192 Pints	Oliofiat AP 51 (above freezing)	SAE 20 W
— Bulldozer	98	89	172 1/2 Pints	207 Pints		
Drive shaft and general-purpose lubricating grease	—	—			Grassofiat G 9	
Track tension grease	—	—			Grassofiat G 9	
Fuel	435	—	95 3/4 Gall	115 Gall	Diesel oil	
Coolant (incl. radiator and exchangers)	59	—	13 Gall	16 Gall	Water (3)	

(1) FIAT AGERTER oil viscosity grade (SAE) in relation to atmospheric temperature, below —15° C, **10 W**, —15° C to 0° C, **20 W**, up to 35° C, **30** and above 35° C, **40**.

(2) Check transmission oil level at 1000 engine rpm, after warm-up.

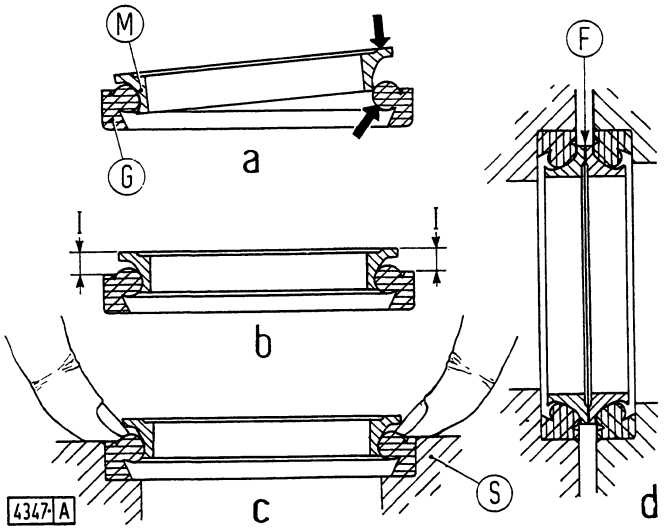
(3) At the beginning of the cold season use FIAT or other approved antifreeze.

GENERAL FITTING NOTES

FLOATING RING SEALS

Carefully examine metal rings (M) ensuring that their sealing surfaces are free from score marks, dents or wear due to misalignment or flatness errors.

Both metal rings, and rubber seals (G), should be renewed together, even if only one is found to be defective.



Do not pair new and worn metal rings together, nor used rings of different pairs.

If necessary, rubber seals (G) may be renewed without changing the metal rings.

To fit a seal proceed as follows:

— Remove all sharp corners and burrs, and carefully clean the rubber seal housings.

— Thoroughly clean the rubber seals.

— Couple each metal ring to the associated rubber seal as shown in (a), pushing and pressing as indicated by the arrows.

— Ensure that each metal ring is correctly seated; dimension I (see detail b) should be equal all round.

— Place each seal assembly in position by depressing the rubber ring as shown in detail (c).

— Before pairing the seal assemblies (see detail d) clean sealing faces (F) using a lint-free cloth and smear a light coat of thin oil over the contact surfaces.

ROTARY SHAFT SEALS

To fit rotary shaft seals proceed as follows:

— Prior to fitting soak the seals for at least half an hour in the fluid to be retained.

— Carefully clean the shaft and ensure that the contact surface is free from damage.

— Turn the end of the sealing lip towards the fluid to be retained; if of the thrower lip type, turn the grooves so that during shaft rotation the fluid tends to be thrown back.

— Smear the sealing lip with a very thin coat of lubricant (oil is better than grease) and pack the space between sealing lip and dust shield with grease (applicable to double lip seals).

— Fit the seals into their housing using a flat ended tool or ram. Under no circumstances fit with a drift and hammer.

— Avoid entry of the seal into the recess in a tilted position. Exert a firm and uniform pressure squarely on it and ensure that the seal is pressed fully home.

— To prevent sealing lip damage during fitting, use some sort of protection before sliding over the shaft.

O-RINGS

Lubricate each ring prior to fitting and, on reassembly, slide over the part but do not twist, otherwise leakage will result.

FACE SEALING RINGS

To remove proceed as follows:

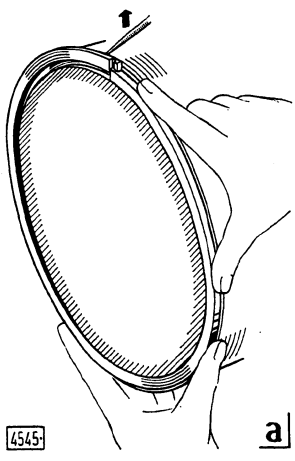
— Depress one end of the ring (see a).

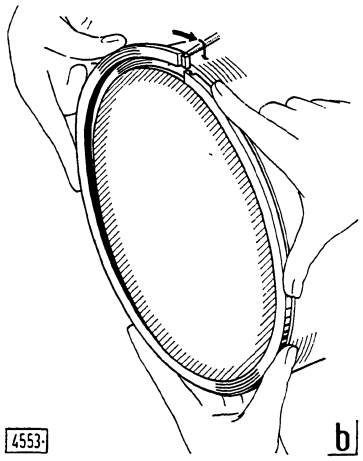
— Hold in position and insert a scriber point beneath the other end to separate the interlocking ends as shown.

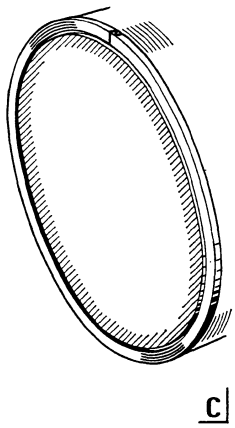
To refit adopt the following procedure:

— Re-position the seal and depress one end of the ring (see b).

— Hold in position and lift the free end (see b) until the two ends lock together correctly (see c).







HYDRAULIC SYSTEM PRESSURE CHECKPOINTS

To diagnose the sources of possible machine hydraulic system trouble use the pressure checkpoints provided on each hydraulic circuit prior to dismantling any component.

The table given on page 14 indicates:—

— Identification code of pressure tapping derived from Fig. 4.

— Pressure point thread size.

— Identification code of the optional threaded fitting.

— Normal pressure rating at 1850 engine rpm after warm-up.

— Page reference of relevant information.

Reference (Fig. 4)	Thread Size	Fitting Part No.	Normal pressure		See page
			kg/cm²	psi	
A	M 14 x 1.5	291325 (*)	3 to 4	43 to 57	41
H	M 10 x 1	292357 (*)	19 to 23	270 to 327	74
R-V	M 14 x 1.5	293061	19 to 23	270 to 327	74
1-2-3	M 10 x 1	292357 (*)	19 to 23	270 to 327	74
W	M 10 x 1	292357 (*)	3 to 3.5	43 to 50	74
S	M 10 x 1	292357 (*)	2 to 2.3	28 to 33	74
P	M 8 x 1.25	291318 (*)	27 to 31 (1)	384 to 441 (1)	102
P_d-P_s	M 8 x 1.25	291318 (*)	23 to 24 (2)	327 to 341 (2)	102
B	M 8 x 1.25	291318 (*)	158 to 162 (3)	2247 to 2304 (3)	148

(*) Fittings included in pressure gauge kit **291314/1**.
(1) Brake pedal fully depressed.
(2) After steering clutch withdrawal.
(3) Relief valve pressure setting.

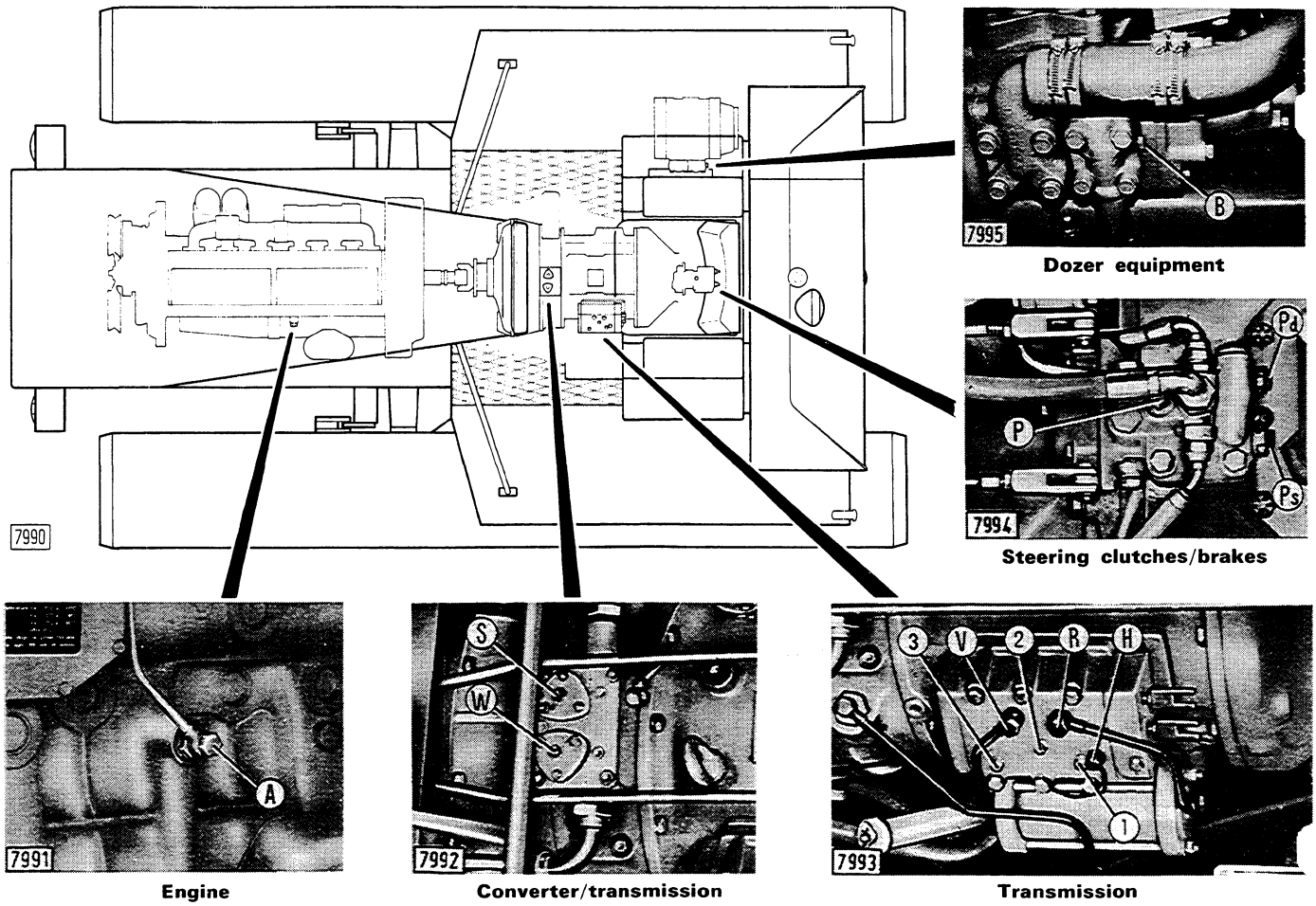


Fig. 4 - Position of Pressure Checkpoints

A. Engine lubrication - B. Equipment control - H. Valve block inlet - P. Brakes - Pa/Ps. R.H. and L.H. steering clutches - R. Reversing - S. Transmission lubrication - V. Forward speed - W. Torque converter - 1. First speed - 2. Second speed - 3. Third speed.

ENGINE

PERFORMANCE TEST DATA

BENCH TEST CONDITIONS

Engine on bench with fan, air cleaner and exhaust silencer removed.

Atmospheric pressure 740 ± 5 mm Hg.

Ambient temperature 20° ± 3°C.

Relative humidity 70 % ± 5.

Fuel density 830 ± 10 gram/litre.

Injection timing 22 ± 1° B.T.D.C., cylinder No. 1 on compression stroke.

Throttle	rpm	Engine H.P.		Time required to burn 500 cc (30.5 cu in) of fuel (seconds)
		2 hour run-in	50 hour run-in	
Maximum (full load)	1850	195 (min.)	200 (min.)	43 (min.)
Maximum (full torque)	1400	156 (min.)	160 (min.)	55 (min.)
Maximum (no-load)	Up to 2050	—	—	—
Minimum (idle)	675 to 725	—	—	—

COMPRESSION TEST

If engine performance is found to be unsatisfactory, check the injection system (changing nozzles and injection pump) and the compression in each cylinder.

To check engine compression use tester **291310** and proceed as follows:

— Remove the injectors.

— Fit dummy injector **292632 (682 N2)** in place of the injector of the cylinder under test, and ensure positive sealing by applying a copper washer on the bottom of the fuel injector sleeve.

— Hold the injection pump at shut-off and take the necessary readings driving the engine through the starter.

In normal operating conditions, compression should be higher than 25 kg/cm² or 356 psi as recorded at 40° to 60° C sump oil temperature, 760 mm Hg (sea level) atmospheric pressure.

The minimum compression which is acceptable for a worn engine is 22 kg/cm² or 313 psi, maximum allowance between cylinders being 3 kg/cm² or 43 psi.

In this connection it should be noted that every 100 metres or 328 ft altitude increase above sea level results in a 1 % (approx.) decrease in compression.

Insufficient compression may be due to faulty valves and seats, pistons and associated rings, cylinder liners or cylinder head gaskets.

Note: The purpose of the compression test is to assess the consistency of compression in the cylinders and the test results should not be taken as an absolute indication of engine efficiency.

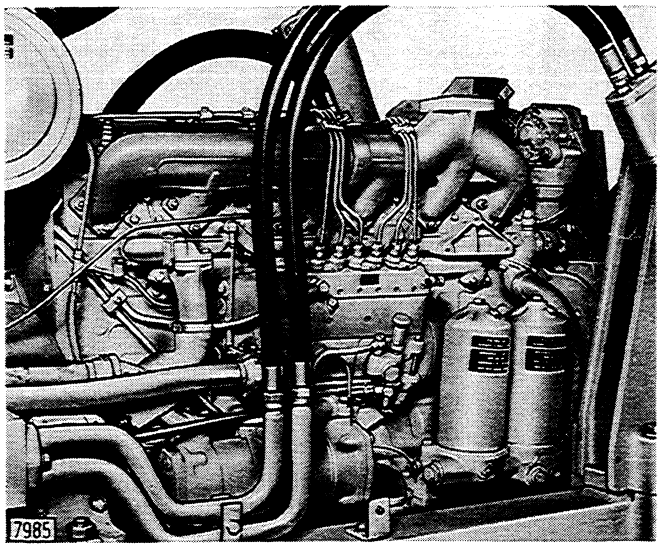


Fig. 5 - Rear R.H. Side View of Engine in Position on the Machine

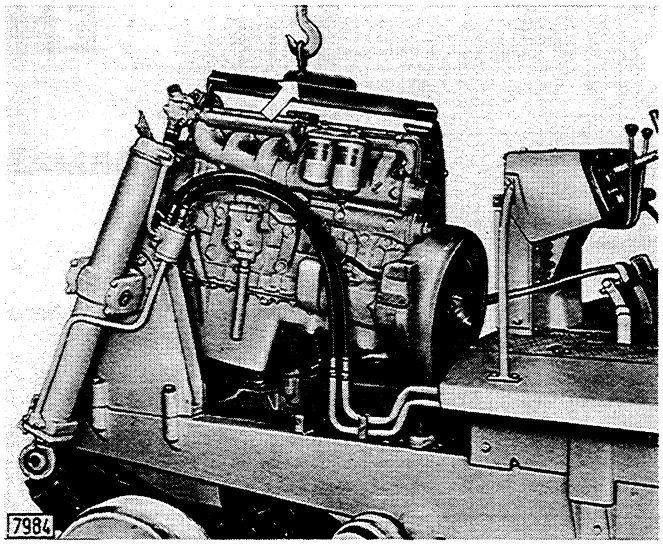


Fig. 6 - Removing the Engine Assembly Using Lift Hook 291493

Note: Lift eye arrowed

ENGINE REMOVAL

1. Take off the following:

— Engine side covers, the radiator grille and the bonnet after disconnecting the hadlamp leads, the exhaust pipe and the centrifugal pre-cleaner.

— The front lower engine cover. Also drain the cooling system.

— The radiator with attached cowl after removing the fan protective grille, the connecting sleeves and the water drain pipe.

— Hydraulic cylinder carrier crossmember.

— The throttle control linkage.

2. Disconnect all pipes and leads connecting the engine to the machine.

3. Remove the following:

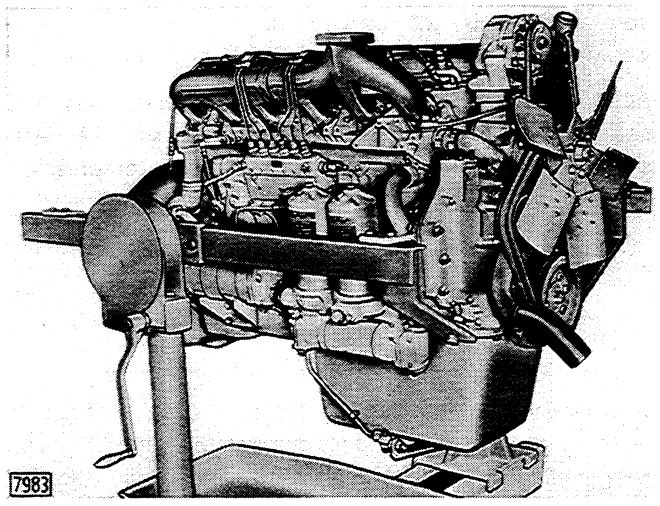
— Air cleaner with attached support and sleeves.

— Front and rear engine mounting retaining nuts.

— Front L.H. mounting pad retaining nuts.

4. Unscrew the drive shaft lock ring (6, Fig. 42).

5. Use lift hook **291493** as shown in Fig. 6; at the rear use only the R.H. eyelet hooked to the air cleaner



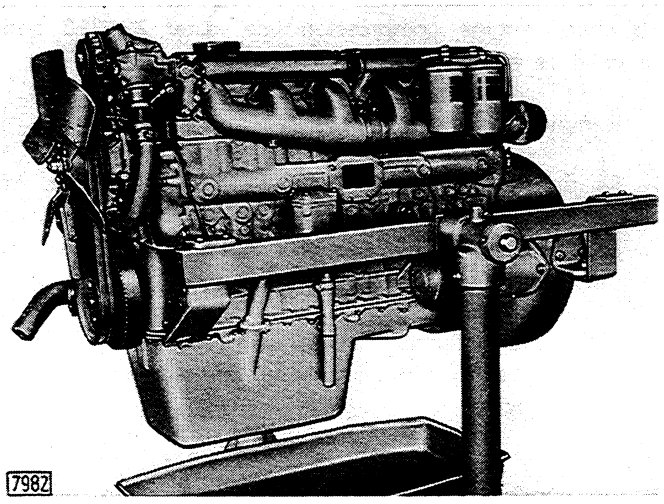


Fig. 7 - R.H. and L.H. Side View of Engine Assembly in Position on Rotary Overhaul Stand 290090

stud provided with nut, and tension the hoist so as to take the load off the engine mounting screws.

6. Remove the rear and front L.H. brackets freeing the latter from its pad.

7. Raise the engine until the front R.H. mounting bracket is clear of the pad, move forwards to withdraw the drive shaft and lift clear.

8. Refit the brackets previously removed.

ENGINE OVERHAUL

Place the engine on rotary overhaul stand **290090** using two front brackets **291607** and two rear brackets **291608** and adhere to the instructions given under the appropriate headings.

ENGINE INSTALLATION

Remove the rear and front L.H. brackets and reverse the removal procedure noting the following points:

— Ensure that the spline of the drive shaft is fitted with its cork seal (15, Fig. 42) and smear with NEVER-SEEZ lubricant (supplied by ANGST-PFISTER).

— Hook up using lift hook **291493** as shown in Fig. 6 and offer up the engine lining up the reference marks (Fig. 42) applied to the drive shaft universal joints.

ENGINE BLOCK AND CYLINDER HEADS

CYLINDER BLOCK AND LINERS

The finish machined cylinder liners are heat-treated before press-fitting into the block. Their selection according to grades A and B (see Fig. 9) takes place after press-fitting, without any need for further processing.

The grade identification letters are stamped in the top of the block adjacent to the liners.

LINER RENEWAL

Inspect the liners for wear as follows:

— Check the liner bore over the working length (X, Fig. 9) swept by the piston rings.

— The diameter reading should be taken in both the upper and lower part of the working length in plane (c) parallel to the crankshaft and in plane (d) at right angles to it.

— Compare the readings to establish the amount of liner out-of-roundness and taper.

To assess the piston working clearance check the liner bore diameter in lower part (Z) in plane (d) only.

If out-of-roundness or taper in excess of .15 mm or .006 in is detected, renew the cylinder liners as oversize pistons are not available.

Withdraw the cylinder liners from the bottom of the crankcase using plate **292884.**

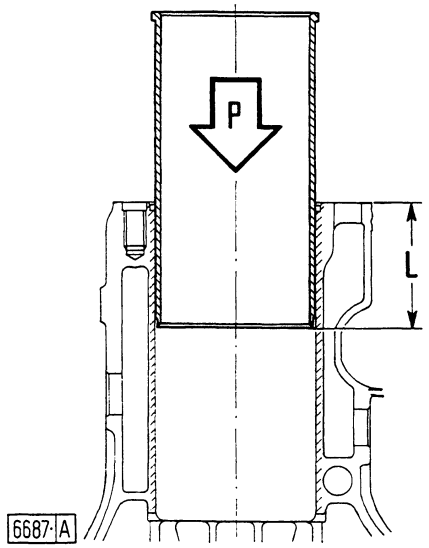


Fig. 8 - Pressing the Liners in the Engine Block

L = 100 mm or 3.93 in lead-in depth prior to load application - P = 400 to 4,500 kg or 882 to 9,922 lb liner fitting load (see text)

When fitting replacement liners proceed as follows:

— Thoroughly clean both the liners and the block bores.

— Apply a thin coat of oil to the block bore.

— Drive each liner into the crankcase from cold using a suitable press and plate **291611**.

— When the liner is 100 mm or 4 in in (see L, Fig. 8), the load (P) required to drive the liners fully home is 400 to 4500 kg or 882 to 9922 lb.

— A load lower than 400 kg or 882 lb indicates insufficient interference, whilst one higher than 4500 kg or 9922 lb means excessive interference. Replacement liners should be fitted so that load (P) is within the stated range.

Note: If it is impossible to obtain the correct fit owing to a block bore diameter in excess of nominal value, maximum allowance being .05 mm or .002 in, adopt .05 mm or .002 in oversize liners.

— With the liner fully home, check the liner bore by placing a suitable dial gauge set to zero on plane (a and b, Fig. 9), subsequently repeating the readings in three points (1, 2 and 3) at different heights.

— Also check that top depth or liner protrusion (H) is —.020 to .055 mm or —.0008 to .0022 in.

— Where necessary, re-apply the grade identification letters (see e).

If in the course of overhaul block bore out-of-roundness is found to be in excess of .1 mm or .004 in the bores should be opened out by .25 mm or .010 in (see Engine Data).

After opening out the block recut the lead-in chamfer according to the dimensions given in Fig. 9.

If the block top needs skimming (which should be done with the liners removed) also restore the original depth of counterbore and lead-in chamfer according to the dimensions shown in Fig. 9, to obtain fitted liner dimension (H) as prescribed.

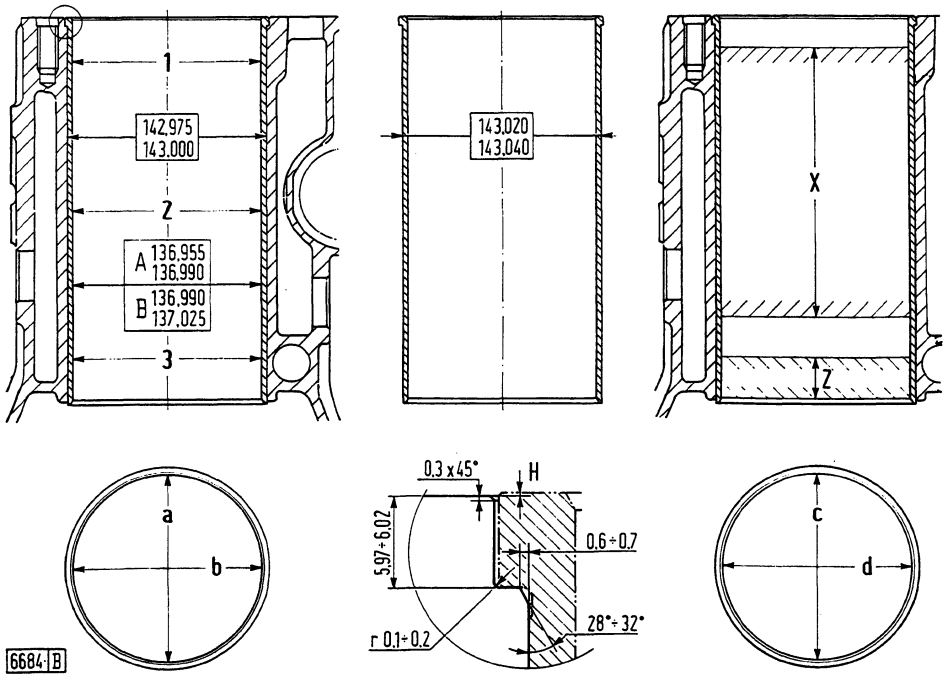


Fig. 9 - Liner and Block Dimensions and Inspection Data

A and B. New liner grades after fitting - H = —.020 to .055 mm (—.0008 to .0022 in) liner top depth or protrusion - Z. Liner bore inspection area on plane (d) t determine piston working clearance - X. Working length for assessment of liner bore wear on planes (c and d) (corresponding to the swept area) - 1., 2. and 3. New liner bore measurement points on right angle planes (a and b).

Note: The liner bore is surface-hardened and must not be ground, honed or dressed at all after fitting. Owing to their low interference, these liners can be removed and refitted several times without any adverse effect.

OIL SUMP

Removal and refitting of the oil sump with the engine on the overhaul stand will be facilitated by using hook **291494**.

With the engine fitted to the machine oil sump removal necessitates front lower cover removal and engine oil draining. Remove the sump screws and withdraw the sump supporting it with a two-rope sling inserted between engine and frame side members.

Hoist the frame until the oil sump comes off the cross member and place the wood blocks as shown in Fig. 12. Subsequently, remove the retaining screws and lift off the sump.

To refit the oil sump proceed as follows:

— Always renew the complete gasket.

— Using jointing compound, apply the gasket assembly to the sump ensuring that the holes are correctly aligned and the rear end of the gasket protrudes by 1 to 1.5 mm or .04 to .06 in. If necessary, cut off the excess material.

— Coat gasket seams (A, Fig. 10) and ends (B) with jointing compound.

— Place the sump in position and screw in screws (2) through a few turns.

— Fully tighten screw (1) and refit screws (3) to 3/4 of their full depth.

— Slightly slacken screws (1) and fully tighten screws (3).

— Fully tighten screws (2) in a staggered sequence.

— Check that screws (3) are adequaterly tight and tighten screws (1).

CYLINDER HEADS

Check head flatness by placing each cylinder head on a surface plate smeared with carbon black and, if necessary, re-dress by scraping, or grinding if the amount of distortion is in excess of .15 mm or .006 in.

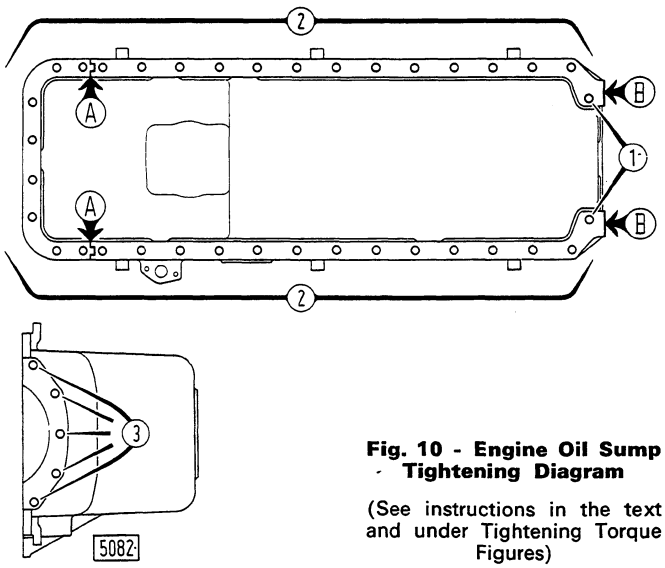


Fig. 10 - Engine Oil Sump - Tightening Diagram

(See instructions in the text and under Tightening Torque Figures)

When grinding, the maximum amount of material which can be removed should not exceed 5 mm or .02 in.

If valve seat recutting is also necessary the maximum allowance will be 1 mm or .04 in.

Remember that new cylinder head thickness should be 139.750 to 140.000 mm or 5.5108 to 5.5118 in.

After refitting the fuel injectors and the valves, ensure that:

— Fuel injector protrusion is 3.5 to 4 mm or .138 to .157 in (A.M. engines up to engine No. 000599) and 1.5 to 2 mm or .059 to .078 in (P.M. engines).

— Valve depth is 1.3 to 1.7 or mm .051 to .066 in.

If injector protrusion is less than prescribed skim the taper seat in the sleeve using cutter **291339**. If excessive protrusion is detected, renew the sleeve.

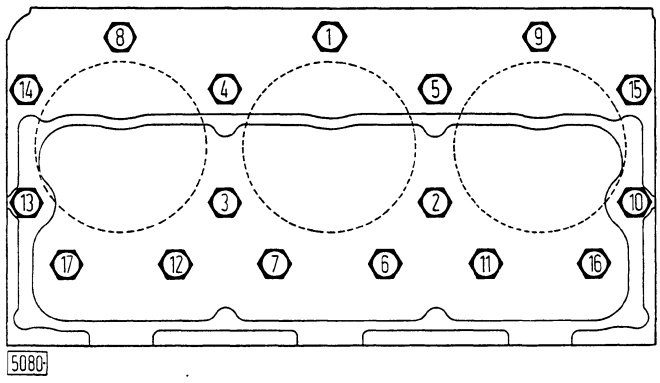


Fig. 11 - Cylinder Head Tightening Diagram

Note: The prescribed tightening torque should be reached in at least 3 successive stages adopting the sequence indicated above.

To renew the fuel injector sleeves, use the set of taps **A. 90424/1** (**290687**) for tapping, and extractor **A. 42110** (**290633**) to remove from the heads.

Install the new injector sleeves using the hand press and expand their top end using punch **291350**.

Check for leaking core plugs and fuel injector sleeves.

In case of doubt, renew all suspect parts. Injector sleeve leakage can often be obviated by means of punch **291350**.

To obtain a good seal between injector and sleeve bottom, dress the taper seat using cutter **291339**.

When refitting the head gaskets ensure that the side marked ALTO lies uppermost; before refitting, smear the gasket surfaces with carbon dust.

VALVE SEAT RECUTTING

Use tool **29113** to rest the cylinder heads on, and support **291112** to position the valves.

For valve seat recutting, use universal cutter **A. 60419** (**292913**) proceeding as follows:

— Remove all deposits and carefully clean the valve guide bore prior to inserting the cutter pilot.

— Attach the tool to the associated support and place in position.

— Zero the cutter on the valve seat centreline.

— Take .1 mm or .004 in cuts until a complete new seat is obtained.

— Take a .05 mm or .002 in finish cut.

The tool provided enables the seat width to be reduced to the value prescribed in Fig. 12.

Should the universal cutter not be available for any reason, satisfactory results can be obtained by means of hand cutter kit **291610** bearing in mind the following points:

— Universal cutter machined seats do not necessitate grinding-in of new valves.

— Hand cutter machined seats must be ground-in together with the valves.

After the seats have been recut several times, when valve depth below the cylinder head face exceeds the prescribed allowance (see page 19), the cylinder head can be reconditioned by adopting valve seat inserts (see Data Table).

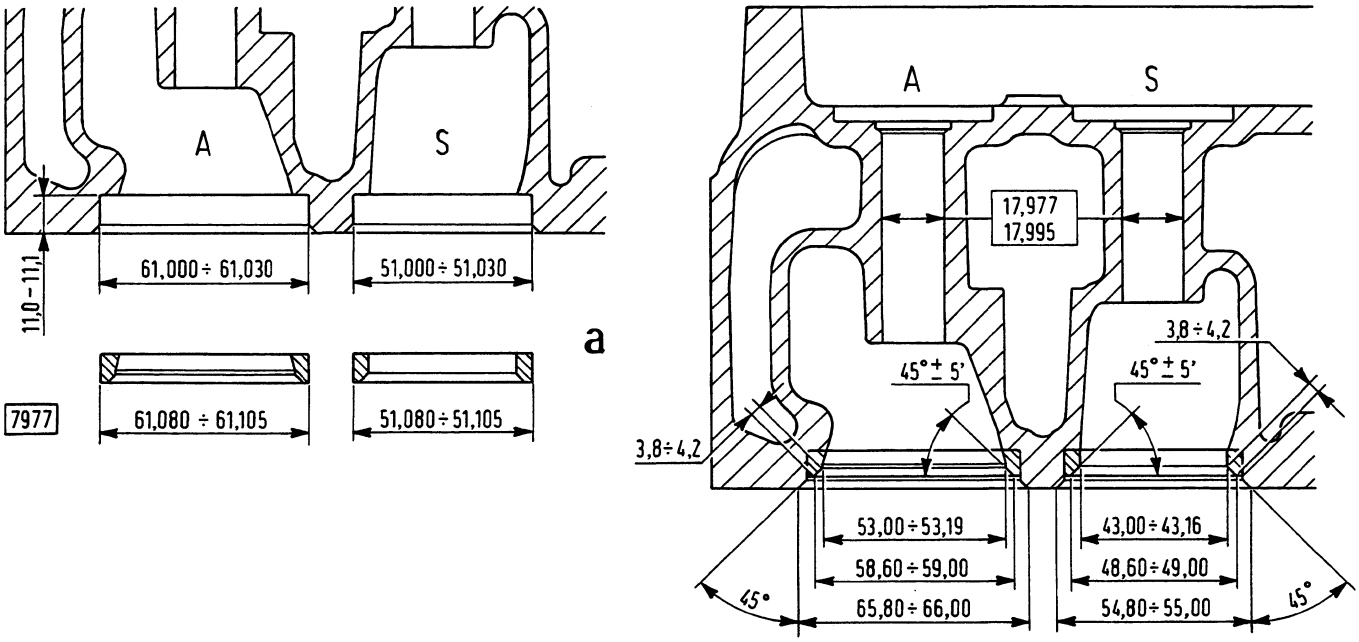


Fig. 12 - Valve Seat and Guide Housing Details

a. Valve seat insert details - A. Inlet - S. Exhaust

Note: Valve seat insert oversize, .20 mm or .008 in on outside diameter (see Data Table).

VALVEGEAR

CAMSHAFT

To renew the camshaft bushes, remove the retaining screws and proceed as follows:

— For front and rear bushes, remove the rear engine mounting and use universal extractor **292909**.

— For intermediate bushes, use drift **292797**.

To take out the camshaft preferably remove the engine assembly (page 16). Engine removal is, however, always necessary for camshaft bush dismantling.

To reinstall the camshaft bushes proceed as follows:

— Reposition the bushes so that the retaining screws register with the associated holes and ensure that holes (B and G, Fig. 13) coincide with the block lubricating ports (b and g) respectively.

— Reposition the two intermediate bushes first, acting from the front of the engine block using drift **292797**.

— For front and rear bushes, use drift **292796**.

— After assembly, the bushes do not need reaming.

When refitting the camshaft, ensure that the rear end cover with attached angle drive is dismantled.

Note: Prior to starting an overhauled engine, lubricate the camshaft by introducing 1 kg or 1-3/4 pints of oil through each cylinder head.

TO INSPECT CAMSHAFT AND BUSHES

Check both camshaft journals and bushes (Fig. 13) for wear and excessive running clearance (see Data Table).

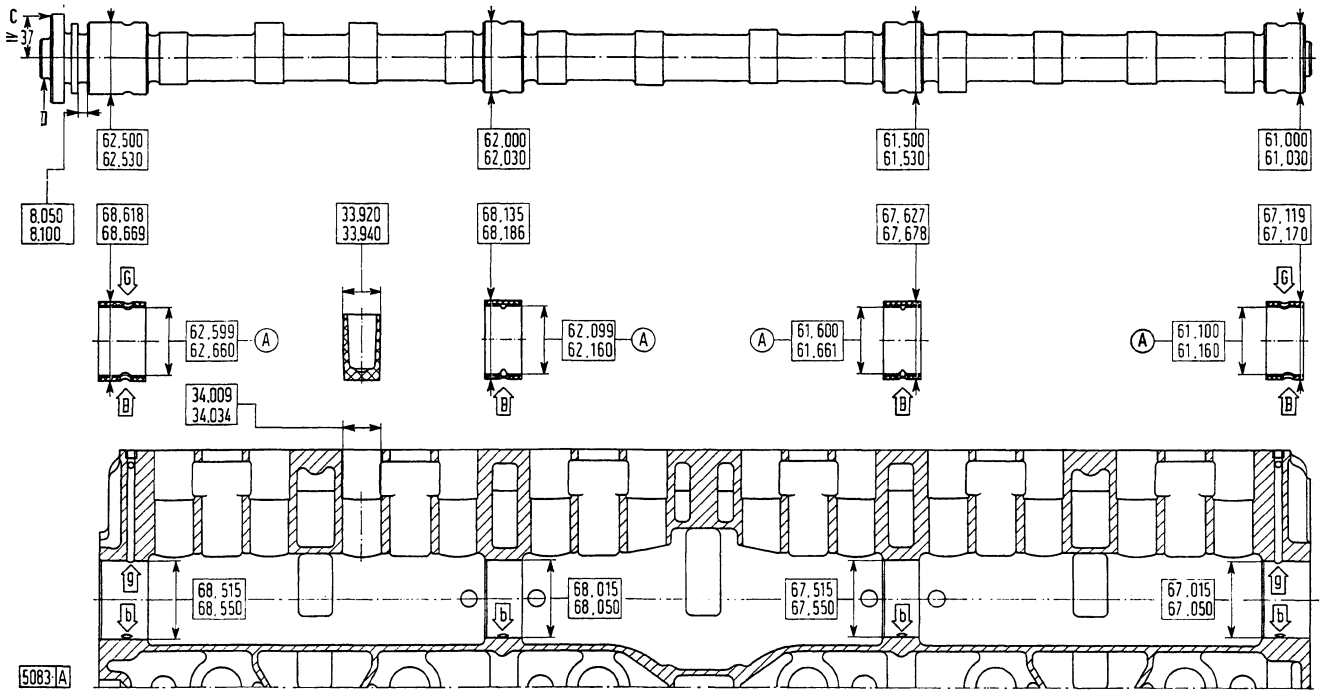


Fig. 13 - Camshaft, Bush, Tappet and Housing Details

A. Fitted bush I.D. - C/D. Flange runout sylus position - b/g and B/G. Lubricating ports and ways for camshaft journals and bushes

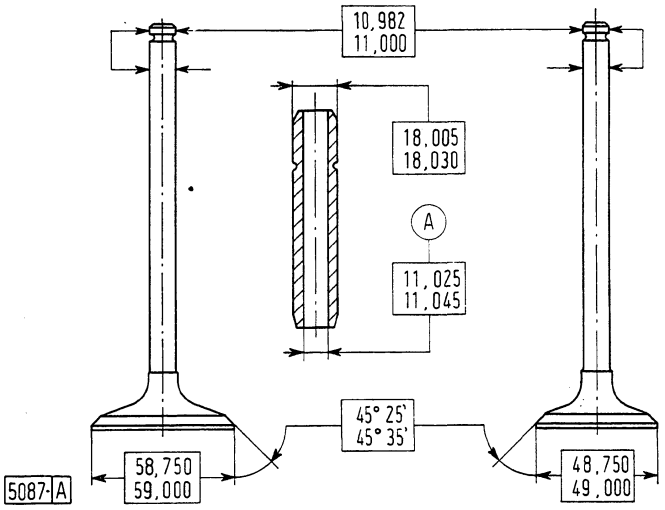


Fig. 14 - Valve and Guide Details

A. Fitted diameter after reaming.

Bushes are not supplied with undersize inside diameter. If the running clearance is found to exceed .25 mm or .010 in, the bushes should be renewed, if necessary together with the camshaft itself.

Check the driven gear flange for runout as follows:

— Place the camshaft with two end journals over V-blocks and rest the stylus of a dial gauge on the flange face at approximately 37 mm or 1.5 in from the centreline (C, Fig. 13).

— Rotate the shaft and check that over one revolution the recorded runout does not exceed .01 mm or .0004 in.

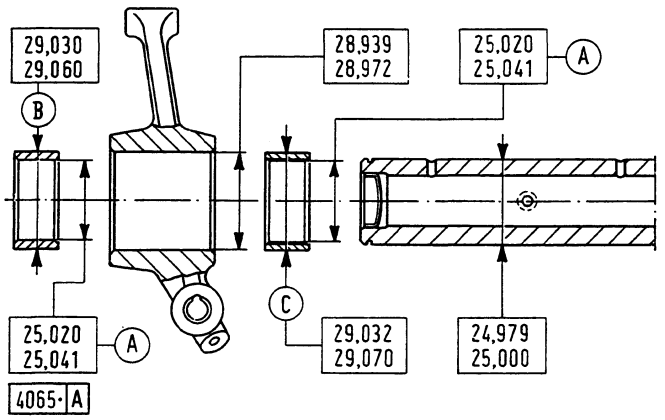


Fig. 15 - Rocker, Bush and Shaft Details

A. Fitted diameter after reaming - B. Bronze bush - C. White metal lined steel shell.

— Place the stylus over spigot surface (D) and check that over one full revolution the amount of out-of-round does not exceed .01 mm or .0004 in.

Also check for shaft distortion by placing the stylus of the dial gauge over the two centre journals; maximum eccentricity should not exceed .10 mm or .004 in over one revolution. If necessary, straighten the camshaft using a suitable press.

VALVES AND GUIDES

To remove the valves use tool **291050**.

Maximum valve stem working clearance is .20 mm or .008 in.

Check valve stems and guides for size using a micrometer gauge and kit **A. 95723 (292867)**. If the clearance recorded is excessive, renew the valves in question. If following valve replacement the clearance still exceeds the specified value, also renew the valve guides.

To renew the guides use drift **291496**, together with a suitable press, acting from the underside of the heads to remove, and from the top to refit.

When checking the guides, note the following points:

— Each guide should have a locating circlip.

— The guides should be tight in their seats in the heads, otherwise fit oversize guides (see Data Table).

— After refitting, each guide should be reamed using reamer **291665**.

Exhaust guides are 10 mm or .394 in shorter than inlet valve guides.

After reassembly, check that valve depth below cylinder head is 1.3 to 1.7 mm or .051 to .066 in.

TO ADJUST VALVE CLEARANCE

For valve clearance adjustment, use spanner **290886** and a feeler gauge. The correct clearance is .30 mm or .012 in for inlet valves and .40 mm or .016 in for exhaust valves.

Cylinder matching for valve clearance adjustment is 1-6, 2-5 and 3-4. Bring the valves of the first cylinder of each pair in a condition of balance to adjust the valves of the second cylinder of the same pair and vice versa.

TAPPETS AND ROCKERS

Tappet withdrawal necessitates cylinder head removal.

Check tappet working clearance; if in excess of .20 mm or .008 in, fit oversize tappets and open out the associated bores in the engine block (see Data Table).

Check the rocker shaft and rocker bushes for wear and play.

If necessary, renew the bushes noting the following points:

— Only bronze replacement bushes (B, Fig. 15) are available, whereas the bushes originally fitted in production may consist of white-metal-lined steel shells (C).

— When fitted in position, the bushes should lie flush with the rocker sides.

— After fitting, the bushes should be reamed by means of expanding blade reamer **290001**.

Inspect the rocker toes. When regrinding becomes necessary, remember that the depth of case (hardened layer) is 1.2 to 2 mm or .047 to .079 in, in the centre of the toe.

Reinstall the rocker shaft as indicated in Fig. 16, noting the following points:

— Lubricating ports (7, 8 and 9) should be clear.

— Position the shafts so that the machined dimples line up with the stud holes drilled in brackets (4) to obtain correct alignment of lubricating ports (8).

— The thickness of spring plates (5) should be 1.5 mm or .059 in.

— End washers (6) are available in three different thicknesses, namely 1.5 mm, 2 mm and 2.5 mm or .060 in, .080 in and .100 in. Use the correct thickness in order to reduce the end float of the end rockers to a minimum.

VALVE TIMING

To refit the valvegear proceed as follows:

— Provisionally adjust the valve clearance (on both inlet and exhaust valves) to .5 mm or .020 in on cylinders 1 and 6.

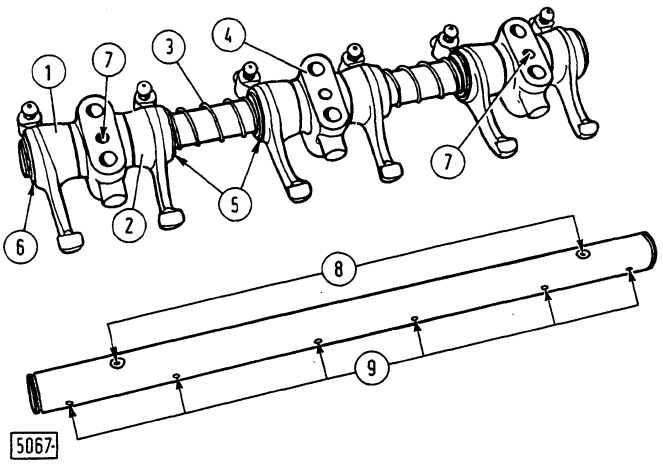


Fig. 16 - Refitting Rocker Assemblies

1. Inlet valve rockers - 2. Exhaust valve rockers - 3. Spacer springs - 4. Rocker brackets - 5. Spring plates - 6. End washers - 7./8./9. Lubrication ports

— Slacken the fuel injectors and rotate the crankshaft until reference mark P.M.S. 1-6 (stamped on flywheel periphery) lines up with the associated fixed timing pointer.

— Reposition the gears over their shaft taking care to align reference marks 1-1, 2-2 and 3-3 shown in Fig. 18, fitting the idler gear last. This is necessary because the other two timing gears have their assembly position restricted by dowels (1 and 2).

— Retighten the retaining screws.

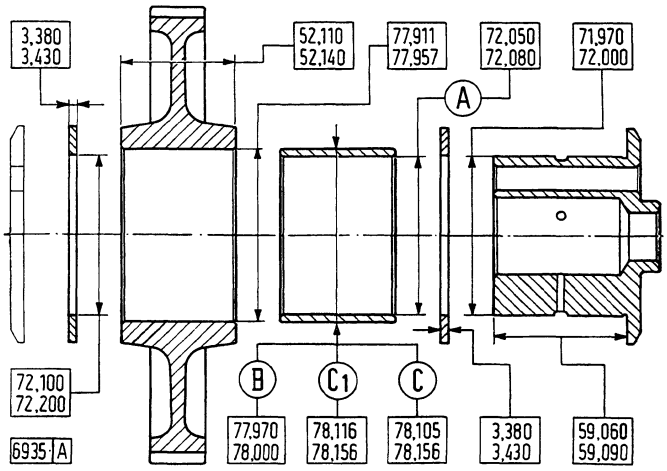
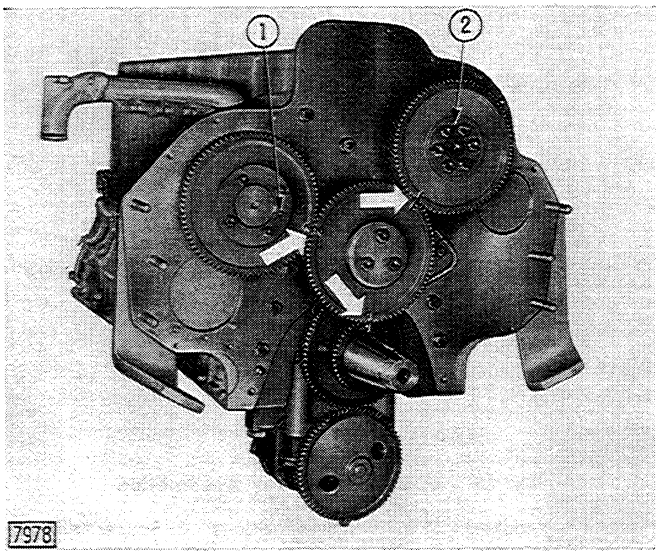


Fig. 17 - Idler Gear and Jackshaft Details

A. Bush fitted diameter - B. Bronze bush - C. White-metal-lined steel shell (Vandervell type) - C_1. White-metal-lined steel shell (Clevite type)



— Turn the crankshaft through a few degrees in either direction to ensure that piston No. 1 is on the firing stroke; consequently, the associated valves should be closed whilst the valves of cylinder No. 6 should be open and in a condition of balance within the prescribed angular setting.

Fig. 18 - Valve Timing

Note: Valve timing marks 1-1, 2-2 and 3-3 arrowed.

1. Injection pump gear dowel - 2. Camshaft gear dowel.

CRANKGEAR

CRANKSHAFT

To remove the crankshaft withdraw the engine and place on rotary overhaul stand **290090** as directed on page 16, noting the following points:

— Remove the crankshaft vibration damper hub using extractor **291504**.

— Prior to removing the flywheel housing, take off the oil sump and fit bracket **291609** to attach the engine block to the rotary overhaul stand.

Note: The bracket retaining screw on both the engine and the stand should be tightened after slackening the retaining screws on bracket **291608**.

Check both main journals and crankpins. Scratches and evidence of pick up may be eliminated using a zero grade emery clotch.

— Score marks, ovality or taper errors in excess of .05 mm or .002 in necessitate journal re-skimming to the nearest undersize dimension (see Data Table).

After re-grinding, blend the journal fillets and chamfer the lubricating holes as shown in Fig. 19.

Subsequently, check the crankshaft noting the following points:

— Ovality of the journals should not exceed .008 mm or .0003 in.

— Taper of each journal should be lower than .012 mm or .0004 in.

— Maximum misalignment with the shaft over V-blocks and cranks 1 and 6 at the top, should be .05 mm or .002 in (D, Fig. 20).

— Maximum misalignment of each pair of crankpins with respect to the main journals should not exceed ± .25 mm or .010 in when measured as shown in Fig. 20.

— The allowance on the distance from top of crankpin to crankshaft rotational axis should not exceed ± .10 mm or .004 in.

— Run-out as measured with the dowel gauge stylus in (A) at the periphery of the crankshaft flange should not exceed .02 mm or .0008 in. Moreover, eccentricity in (B) should not exceed .04 mm or .0001 in.

Check the core plugs for leakage using oil at 10 kg/cm² or 142 psi. In case of replacement, press the new plugs fully home and stake in position. Subsequently, re-check the circuit with oil under pressure.

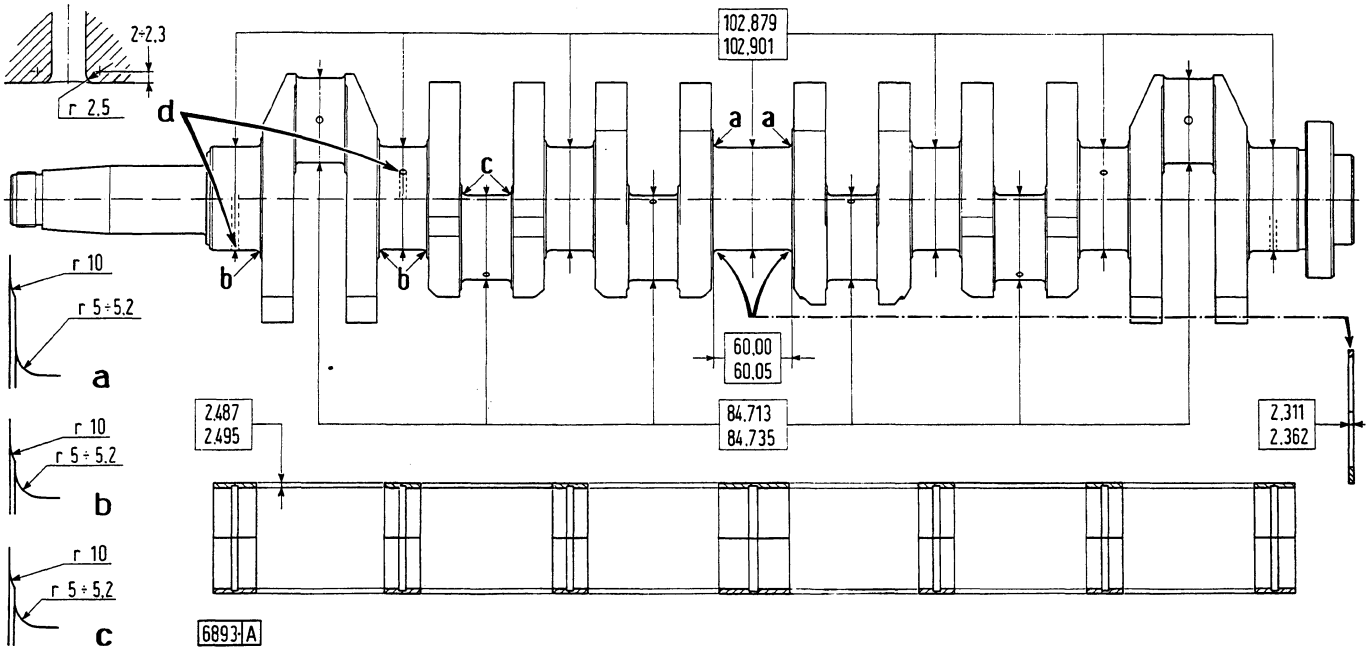


Fig. 19 - Crankshaft Journal, Bearing and Thrust Washer Details

a/b/c. Journal fillet radius details - d. Lubrication port chamfer details

MAIN AND BIG-END BEARINGS

The white-metal-lined thin-shell bearings do not need any fitting operation and should be renewed whenever their working surfaces are found to be scored or worn.

Check the bearing running clearance as follows:

— Carefully clean the journals, the bearings and the bearing housings.

— Place a length of Perfect Circle Plastigage, type PR-1 or PB-1 calibrated wire over the bearing at approximately 6 mm or 1/4 in from the centreline.

— Fit the bearing cap with attached calibrated wire and tighten to the prescribed torque.

— Remove the cap and compare the width of the compressed calibrated wire with the reference scale printed on the wire container.

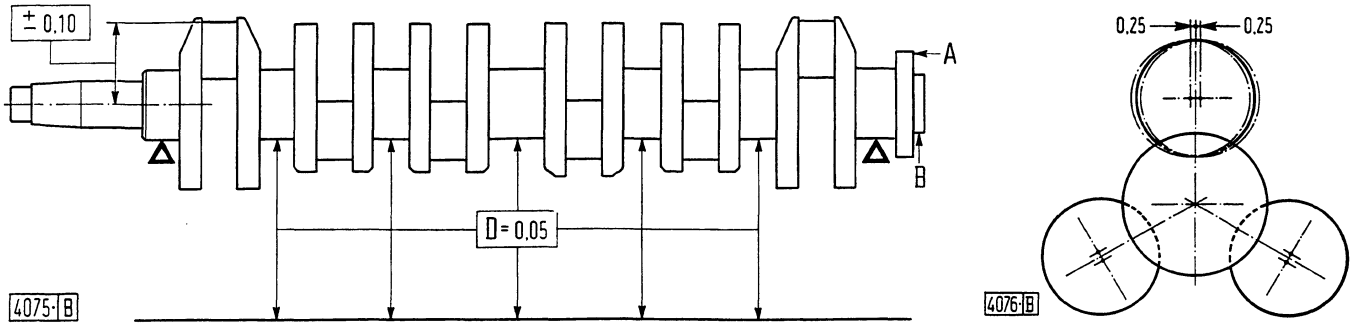


Fig. 20 - Checking Main Journal and Crankpin Alignment

A/b. Flange run-out stylus positions - D. Maximum main journal misalignment