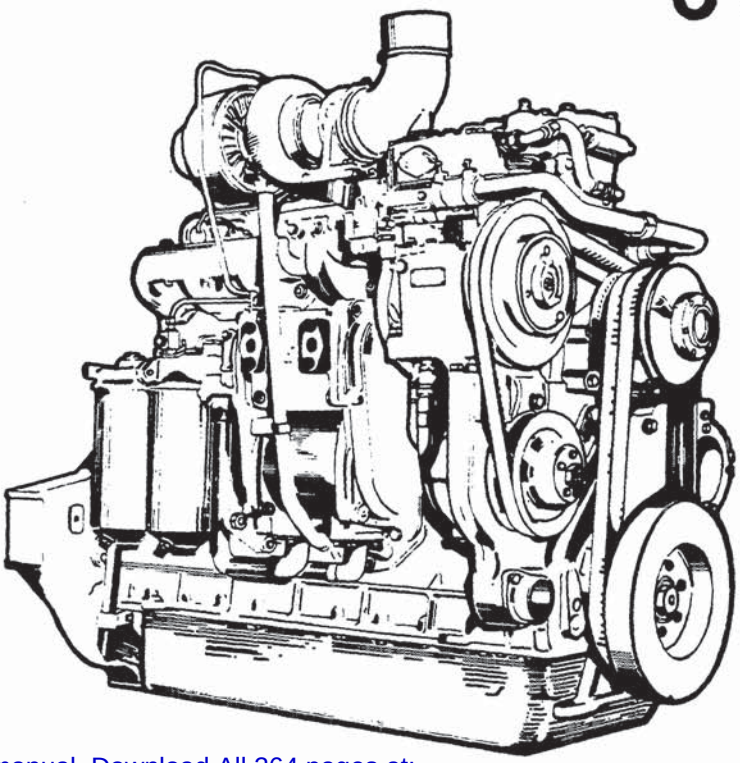
FIATALLIS®

16000 T
17000 MKII
19000 MKII
21000 MKII
25000 MKII
6138 L, LT, I



service manual
ENGINES

Form 70699853 English
(2-90)

16000 T
17000 MKII
19000 MKII
21000 MKII
25000 MKII
6138 L, LT, I

service manual
ENGINES

FORM 70699853 English
(Replaces 70663850)

WARNING

STUDY THE OPERATION AND MAINTENANCE INSTRUCTION MANUAL THROUGH BEFORE STARTING, OPERATING, MAINTAINING, FUELING OR SERVICING THIS MACHINE.

The Operation and Maintenance Instruction Manual provides the instructions and procedures for starting, operating, maintaining, fueling, shutdown and servicing that are necessary for properly conducting the procedures for overhaul of the related components outlined in this Service Manual.

This symbol is your safety alert sign. It MEANS ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED.

Read and heed all safety instructions carrying the signal words WARNING and DANGER.

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.

SUPPLEMENT NO. 3

SERVICE MANUAL FORM 70699853

6138LT, 6138T, 6138I ENGINES

(6-84)

ATTENTION: Insert this sheet in the front of publication as record of receipt. Replace or add pages in the publication according to instructions below.

Additional copies of this supplement are available. Please direct your request to:

FIATALLIS NORTH AMERICA - Publications Services Dept.,
3000 South 6th Street - Springfield, Il 62710 U. S. A.
or
FIATALLIS EUROPE S. p. A. - Magazzino Stampati
Viale Torino, 2 - 10040 Stupinigi (TO) Italy

Insert the following pages (SECTION 17A, complete) under the front cover.

This supplement (No. 3) covers the ...TS and TOLERANCES, etc., and the REMOVAL and INSTALLATION of the FUEL INJ... PUMP as applicable to the 6138 Series Engines.

REASON: To update the mar... ...lude the 6138 Series Engines.

NOTICE
THESE CHANGES ARE INCLUDED IN THIS COPY

FOREWORD

Always furnish serial number if making an inquiry to dealer or factory about this machine.

Many equipment owners employ the Dealer Service Department for all work other than routine lubrication and minor service. This practice is encouraged, as our Dealers are well informed and equipped to render efficient service by factory trained mechanics.

Illustrations show standard and optional items.

IMPORTANT

The information in this manual was current at the time of publication. It is our policy to constantly improve our product and to make available additional items. These changes may affect procedures outlined in this manual. If variances are observed, verify the information through your Dealer.

Fiatallis is not responsible for any liability arising from any damage resulting from defects caused by parts and/or components not approved by Fiatallis for use in maintaining and/or repairing products manufactured or merchandized by Fiatallis.

In any case, no warranty of any kind is made or shall be imposed with respect to products manufactured or merchandized by Fiatallis when failures are caused by the use of parts and/or components not approved by Fiatallis.

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FIAT-ALLIS

SUPPLEMENT NO. 2

SERVICE MANUAL

FORM 70699853

16000T, 17000 MARK II, 19000 MARK II,

21000 MARK II, 25000 MARK II

(10-80)

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REPLACE the following pages:

7-9	No change	12-5	No change	14-3	Revised	14-9	Added
7-10	Revised	12-6	Revised	14-4	Revised		Blank
7-11	Revised	13-3	No change	14-5	Revised	17-1	Revised
7-12	No change	13-4	Revised	14-6	Revised	17-2	Revised
12-3	Revised	14-1	Revised		Revised		
12-4	No change	14-2	Revise	d	Revised		

NOTICE
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REASON:

Head gasket and cylinder s .allation changes. Cylinder block specifications added for mach g purposes. Late model piston installation explained.

FIAT-ALLIS

SUPPLEMENT NO. 1
SERVICE MANUAL
FORM 70699853
16000T, 17000 MARK II, 19000 MARK II, 21000 MARK II, 25000 MARK II

(3-80)

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Replace the following pages:

4-17	(Revised)	12-9	(Added)	14-1	(Revised)
4-18	(No change)	12-10	(Added)	14-2	(Revised)
4-31	(No change)	12-11	(Added)	14-3	(Revised)
4-32	(Revised)	12-12	(Added)	14-4	(Revised)
4-33	(Revised)	12-13	(Added)	14-5	(Revised)
4-34	(Revised)	Blank		14-6	(Revised)
10-1	(Revised)	13-1	(Revised)	14-7	(Revised)
10-2	(No change)	13-2	(Revised)	14-8	(Revised)
10-7	(Revised)	13-3	(Revised)	17-3	(Revised)
10-7A	(Added)	13-4	(Revised)	17-4	(Revised)
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10-8	(Revised)	13-6	(Revised)	17-6	(Revised)
10-9	(Revised)	13-7	(Revised)	17-7	(Revised)
10-10	(No change)	13-8	(Revised)	17-8	(Revised)
12-1	(Revised)	13-9	(Revised)	18-9	(No change)
12-2	(No change)	13-10	(Added)	18-10	(Revised)
12-3	(Revised)	13-11	(Added)	18-11	(Revised)
12-4	(Revised)	13-12	(Added)	Blank	
12-5	(Revised)	13-13	(Added)	19-1	(Revised)
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12-7	(Revised)	13-15	(Added)	20-1	(Revised)
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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 border and lettering for ***WARNING*** and red with white border and lettering for ***DANGER*** points.

Never attempt to operate the machine or its tools from any position other than seated in the operator's seat. Keep head, body, limbs, hands and feet inside operator's compartment at all times to reduce exposure to hazards outside the operator's compartment.

Do not allow unauthorized personnel to operate service or maintain this machine.

Always check work area for dangerous features. The following are examples of dangerous work areas: slopes, over hangs, timber, demolitions, fire, high walls, drop off, back fills, rough terrain, ditches, ridges, excavations, heavy traffic, crowded parking, crowded maintenance and closed areas. Use extreme care when in areas such as these.

An operator must know the machine's capabilities. When working on slopes or near drop offs be alert to avoid loose or soft conditions that could cause sudden tipping or loss of control.

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

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

Keep operator's compartment, stepping points, grab-rails and handles clear of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling. Clean mud or grease from shoes before attempting to mount or operate the machine.

Be careful of slippery conditions on stepping points, hand rails, and on the ground. Wear safety boots or shoes that have a high slip resistant sole material.

For your personal protection. Do not attempt to climb on or off machine while machine is in motion.

Never leave the machine unattended with the engine running.

Always lock up machine when leaving it unattended. Return keys to authorized security. Heed all shut down procedures of the Operation and Maintenance Instruction Manual. Always set the parking brake when leaving the machine for any reason.

Do not wear rings, wrist watches, jewelry, 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, heavy gloves, ear protectors, safety glasses or goggles, reflector vests, or respirators. Consult your employer for specific safety equipment requirements.

Do not carry loose objects in pockets that might fall unnoticed into open compartments. Do not use machine to carry loose objects by means other than attachments for carrying such objects.

DO NOT CARRY RIDERS unless the machine is equipped for carrying people to reduce personal exposure to being thrown off.

Do not operate machinery in a condition of extreme fatigue or illness. Be especially careful towards the end of the shift.

Roll Over Protective Structures are required on wheel loaders, dozer tractors, track type loaders, graders and scrapers by local or national requirements. *DO NOT* operate this machine without a Roll Over Protective Structure.

Do not operate a machine without a falling object protective structure (FOPS).

Do not operate this machine without a rear canopy screen when machine is equipped with rear mounted towing winch.

Seat belts are required to be provided with roll over protective structures or roll protection cabs by local or national regulations. Keep the safety belt fastened around you during operation.

Where noise exposure exceeds 90 dBA for 8 hours, wear authorized ear protective equipment per local or national requirements that apply.

Keep clutches and brakes on machine and attachments such as power control units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturers at all times. *DO NOT* adjust machine with engine running except as specified.

Do not operate a machine with brakes out of adjustment. See the Operation and Maintenance Instruction Manual.

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

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.

SAFETY RULES

To prevent entrapment in cabs or mounted enclosures, observe and know the mechanics of alternate exit routes.

On machines equipped with suction radiator fans, be sure to periodically check all engine exhaust parts for leaks as exhaust gases are dangerous to the operator. Keep a vent open to outside air at all times when operating within a closed cab.

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 recommendations of the manufacturer for storage and disposal.

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

OPERATION

Before starting machine, check, adjust and lock the operator's seat for maximum comfort and control of the machine.

DO NOT START OR OPERATE AN UNSAFE MACHINE. Before working the machine, be sure that any unsafe condition has been satisfactorily remedied. Check brakes, steering and attachment controls before moving. Advise the proper maintenance authority of any malfunctioning part or system. Be sure all protective guards or panels are in place, and all safety devices provided are in place and in good operating condition.

Check instruments at start-up and frequently during operation.

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

Be sure exposed personnel in the area of operation are clear of the machine before moving the machine or its attachments. *WALK COMPLETELY AROUND* the machine before mounting. Sound horn. Obey flag man, safety signals and signs.

Know the principles of cross steering of crawler tractors. Read section in Operation and Maintenance Instruction Manual on cross steering.

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.

If engine has a tendency to stall for any reason under load or idle, report this for adjustment to a proper maintenance authority immediately. Do not continue to operate machine until condition has been corrected.

Never use bucket as a man-lift.

Use recommended bucket for machine and material load ability and heaping characteristics of material, terrain, and other pertinent job conditions.

Avoid abrupt starts and stops when transporting a loaded bucket.

Inspect your seat belt webbing and hardware at least twice a year for signs of fraying, wear or other weakness that could lead to failure.

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 draw bars, cables or chains under load.

When pulling or towing through a cable or chain, do not start suddenly at full throttle. Take up slack carefully. Guard against kinking chains or cables. Inspect carefully for flaws before using. Do not pull through a kinked chain or cable due to the high stresses and possibility of failure of the kinked area. 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 COMPARTMENT OF MACHINES INVOLVED ARE PROPERLY GUARDED AGAINST POTENTIAL CABLE OR CHAIN BACKLASH.*

During operation always carry ripper in full raised position when not in use and lowered to ground when parked.

When counterweights have been provided, do not work machine if they have been removed unless their equivalent weight has been replaced. See the Operation and Maintenance Instruction Manual.

When operating a machine know what clearances will be encountered, overhead doors, wires, pipes, aisles, roadways; also the weight limitations of ground, floor, and ramps.

Know bridge and culvert load limits and do not exceed them. Know machine's height, width, and weight. Use a signal person when clearance is close.

Be sure that the exact location of gas lines, utility lines, sewers, overhead and buried power lines, and other obstructions or hazards are known. Such locations should be precisely marked by the proper authorities to reduce the risk of accidents. Obtain shut-down or relocation of any such facilities before starting work, if necessary.

Be certain to comply with all local, state, and federal regulations regarding working in the vicinity of power lines.

When roading find out what conditions are likely to be met - clearances, congestion, type of surface, etc. Be aware of fog, smoke or dust element that obscure visibility.

When backing, always look to where the machine is to be moved. Be alert to the position of exposed personnel. *DO NOT OPERATE* if exposed personnel enter the immediate work area.

SAFETY RULES

Never travel a machine on a job site, in a congested area, or around people without a signal person to guide the operator.

In darkness, check area of operation carefully before moving in with machine. Use all lights provided. Do not move into area of restricted visibility.

Maintain clear vision of all areas of travel or work. Keep cab windows clean and repaired. Carry blade low for maximum visibility while traveling. Obtain and use fan blast deflectors where tractors are used a pusher tractors in tandem.

Transport a loaded bucket with the bucket as far tipped back and in as low a position as possible for maximum visibility, stability, and safest transport of the machine. Carry it at a proper speed for the load and ground conditions.

Carry the bucket low when traveling with a load.

Maintain a safe distance from other machines. Provide sufficient clearance for ground and visibility conditions. Yield right-of-way to loaded machines.

Avoid going over obstacles such as rough terrain, rocks, logs, curbs, ditches ridges, and railroad tracks whenever possible. When obstructions must be crossed, do so with extreme care at an angle if possible. Reduce speed - down-shift. Ease up to the break over point - pass the balance point slowly on the obstruction and ease down on the other side.

Cross gullies or ditches at an angle with reduced speed after insuring ground conditions will permit a safe traverse.

Be alert to soft ground conditions close to newly constructed walls. The fill material and weight of machine may cause the wall to collapse under the machine.

Operate at speeds slow enough to insure complete control at all times. Travel slowly over rough ground, on slopes or near drop offs, in congested areas or on ice or slippery surfaces.

Be alert to avoid changes in traction conditions that could cause loss of control. *DO NOT* drive on ice or frozen ground conditions when working the machine on steep slopes or near drop offs.

Keep the machine well back from the edge of an excavation.

Be especially careful when traveling up or down slopes. Position the bucket in such a way as to provide a possible anchorage on the ground in case of a slide.

When proceeding across a hill side proceed slowly. Never turn sharply up hill or down hill.

Avoid side hill travel whenever possible. Drive up and down the slope. Should the machine start slipping sideways on a grade, turn it immediately downhill.

In steep down hill operation, do not allow engine to over speed. Select proper gear before starting down grade.

There is no substitute for good judgement when working on slopes.

The grade of slope you should attempt will be limited by such factors as condition of the ground, load being handled, the type of machine, speed of machine and visibility.

NEVER COAST the machine down grades and slopes with the transmission in neutral on power shift machines, or clutch disengaged on manually shifted machines.

To reduce the danger of uncontrolled machine, choose a gear speed before proceeding down grade that will hold machine to proper speeds for conditions.

Operating in virgin rough terrain that includes previously mentioned hazards is called pioneering. Be sure you know how this is done. Danger from falling branches and upturning roots is acute in these areas.

When pushing over trees, the machine must be equipped with proper over head guarding. Never allow a machine to climb up on the root structure particularly while the tree is being felled. Use extreme care when pushing over any tree with dead branches.

Avoid brush piles, logs or rocks. *DO NOT DRIVE THE MACHINE ONTO BRUSH PILES, LOGS, LARGE ROCKS* or other surface irregularities that break traction with the ground especially when on slopes or near drop offs.

Avoid operating equipment too close to an over hang or high wall either above or below the machine. Be on the look out for caving edges, falling objects and slides. Beware of concealment by brush and under growth of these dangers.

Park in a non-operating and non-traffic area or as instructed. Park on firm level ground if possible. Where not possible, position machine at a right angle to the slope, making sure there is no danger of uncontrolled sliding movement. Set the parking brake.

Never park on an incline without carefully blocking the machine to prevent movement.

If parking in traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and warning signals as required. Also provide advance warning signals in the traffic lane of approaching traffic.

Move the machine away from pits, trenches, overhangs and over head power lines before shutting down for the day.

When stopping operation of the machine for any reason, always return the transmission or hydrostatic drive control to neutral and engage the control lock to secure the machine for a safe start up. Set parking brake, if so equipped.

Never lower attachments or tools from any position other than seated in operator's seat. Sound the horn. Make sure the area near the attachment is clear. Lower the attachment slowly. *DO NOT USE* float position to lower hydraulic equipment.

SAFETY RULES

Always before leaving the operator's seat and after making certain all people are clear of the machine, slowly lower the attachments or tools flat to the ground in a positive ground support position. Move any multi purpose tool to positive closed position. Return the controls to hold. Place transmission control in neutral and move engine controls to off position. Engage all control locks, set parking brake, and open and lock the master (key, if so equipped) switch. Consult Operation and Maintenance Instruction Manual.

Always follow the shut down instructions as outlined in the Operation and Maintenance Instruction Manual.

MAINTENANCE

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

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.

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

Always turn the master switch (key switch if so equipped) to the *OFF* position before cleaning, repairing, or servicing and when parking machine to forestall unintended or unauthorized starting.

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

Never lubricate, service or adjust a machine with the engine running, except as called for in the Operation and Maintenance Instruction Manual. Do not wear loose clothing or jewelry near moving parts.

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.

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

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.

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

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

When making equipment checks that require running of the engine, have an operator in the operator's seat at all times with the mechanic in sight: Place the transmission in neutral and set the brakes and lock. *KEEP HANDS AND CLOTHING AWAY FROM MOVING PARTS.*

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.

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

Keep head, body, limbs, feet, fingers, or hands away from bucket, blade or ripper when in raised position.

If movement of an attachment by means of machine's hydraulic system or winches 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, set brakes, sound horn and call for an all clear. Raise attachments slowly.

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

Never align holes with fingers or hands - Use the proper aligning tool.

Disconnect batteries before working on electrical system or repair work of any kind.

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

BATTERY GAS IS HIGHLY FLAMMABLE. Leave battery box open to improve ventilation when charging batteries. Never check 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.

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.

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.

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

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

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

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

SAFETY RULES

Never use gasoline or solvent or other flammable fluid to clean parts. Use authorized commercial, non-flammable, non-toxic solvents.

Never place gasoline or diesel fuel in an open pan.

Shut off engine and be sure all pressure in system has been relieved before removing panels, housings, covers, and caps. See Operation and Maintenance Instruction Manual.

Do not remove hoses or check valves in the hydraulic system without first removing load and relieving pressure on the supporting cylinders. 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.

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 card board 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.

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

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

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.

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

Block all wheels before bleeding or disconnecting any brake system lines and cylinders.

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

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 of the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to appropriate blocking as a safety measure before proceeding with service or maintenance work according to local or national requirements.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine per local or national 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.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets local or national requirements to reach the service point. If such ladders or platforms are not available, use the machine hand holds 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 local or national requirements.

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 people in the vicinity.

In lifting and handling heavy parts, slings must be of adequate strength for the purpose intended and must be in good condition.

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.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 207 kPa (30 psi) according to local or national requirements.

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

Replace seat belts every two years on open canopy units and every three years on machines with cabs or at change of ownership.

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.

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

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

Remove sharp edges and burrs from reworked parts.

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

Do not strike hardened steel parts with anything other than a soft iron or non-ferrous hammer.

Do not rush. Walk, do not run.

Know and use the hand signals used on particular jobs and know who has the responsibility for signaling.

SAFETY RULES

Face the access system when climbing up and down.

Apply the parking device and place the transmission in neutral before starting the machine.

Do not bypass the starter safety switch. Repair the starter safety controls if they malfunction.

Fasten seat belt before operating.

Steering should be checked to both right and left. Brakes should be tested against engine power. Clutch and transmission controls should be moved through or to neutral positions to assure disengagement. Operate all controls to insure proper operation. If any malfunctions are found, park machine, shut off engine, report and repair before using machine.

If the power steering or the engine ceases operating, stop the machine motion as quickly as possible. Lower equipment, set parking device and keep machine securely parked until the malfunction is corrected or the machine can be safety towed. Never lift loads in excess of capacity.

Should the machine become stuck or frozen to the ground, back out to avoid roll over.

Know and understand the job site traffic flow patterns.

Keep the machine in the same gear going down hill as used for going up hill.

When roading a machine, know and use the signaling devices required on the machine. Provide an escort for roading where required.

Always use the recommended transport devices when roading the machine.

Do not attempt repairs unless proper training has been provided.

Use extreme caution when removing radiator caps, drain plugs, grease fittings or pressure taps. Park the machine and let it cool down before opening a pressurized compartment.

Release all pressure before working on systems which have an accumulator.

When necessary to tow the machine, do not exceed the recommended towing speed, be sure the towing machine has sufficient braking capacity to stop the towed load. If the towed machine cannot be braked, a tow bar must be used or two towing machines must be used - one in front pulling and one in the rear to retard. Avoid towing over long distances.

Observe proper maintenance and repair of all pivot pins, hydraulic cylinders, hoses, snap rings and main attaching bolts.

Always keep the brakes and steering systems in good operating condition.

Replace all missing, illegible or damaged safety signs. Keep all safety signs clean.

Do not fill the fuel tank to capacity. Allow room for expansion.

Wipe up spilled fuel immediately.

Always tighten the fuel tank cap securely. Should the fuel cap be lost, replace it only with the original manufacturers approved cap. Use of a non-approved cap may result in overpressurization of the tank.

Never drive the machine near open fires.

Use the correct fuel grade for the operating season.

SECTION 1 - DESCRIPTION AND SPECIFICATIONS

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1 - DESCRIPTION

1.1 GENERAL

1.1.1
The 16000T, 17000 MKII, 19000 MKII, 21000 MKII, and 25000 MKII engines covered in this manual are all six cylinder, vertical in-line four cycle, water cooled, open combustion chamber, turbocharged, full diesel engines. The main differences between the various models are as follows:

16000T, 17000 MKII - 844 in.^{3} (13.8 lt) displacement
19000 MKII - 799 in.^{3} (12.8 lt) displacement, piston cooled
21000 MKII - 844 in.^{3} (13.8 lt) displacement, piston cooled
25000 MKII - 844 in.^{3} (13.8 lt) displacement, piston cooled, equipped with intercooler.

1.1.2
All the engines have two intake valves and two exhaust valves per cylinder. All valves are equipped with valve rotators and all valve springs are equipped with dampers.

1.1.3
On the 19000 MKII, 21000 MKII, and 25000 MKII, piston cooling is accomplished by a constant oil spray to the underside of each piston. The oil is sprayed from an internal jet located below each cylinder bore and connected into the main oil gallery of the cylinder block.

1.1.4
The intercooler, used on 25000 Mark II engines, cools the air after it leaves the turbocharger and before it enters the air intake manifold. Cooling the air causes it to contract, making it denser so that the air entering the combustion chambers contains a greater concentration of oxygen to aid complete combustion of the fuel.

1.1.5
Fuel is supplied to the cylinders by a constant stroke, cam-actuated, multi-plunger fuel injection pump. The pump delivers accurately metered quantities of fuel, under high pressure, through fuel injection nozzles, into the cylinders at a definite timing in relation to the engine firing cycle. The fuel is ignited by heat generated by compression of the air in the cylinders.

1.1.6
A combustion chamber is located in the head of each piston and the fuel injection nozzles are mounted in the cylinder head directly above each combustion chamber. The shape of the combustion chamber, angle of fuel injection, and the contour of cored air passages in the cylinder heads, causes extreme turbulence of the air within the cylinders and results in the fuel and air being thoroughly mixed for complete combustion.

1.1.7
The engines are fully pressure lubricated by a gear type oil pump driven by the crankshaft gear. Engine cooling is accomplished by coolant forced through the engine cooling and radiator system by a centrifugal type water pump. The water pump is belt driven from the crankshaft pulley.

1.2 PRINCIPLES OF OPERATION

1.2.1
In a four cycle diesel engine, a power stroke is made by each piston for every two complete revolutions of the crankshaft. The sequence of the strokes is as follows: Intake, compression, power, and exhaust.

1.2.2
As the piston moves downward on the first (intake) stroke, air enters the cylinder

through the air intake manifold and the intake valves, which start to open a few degrees before the piston reaches top dead center. The intake charge consists of air only, with no fuel mixture.

1.2.3
Shortly after the piston starts to move upward on the second (compression) stroke, the intake valves close. The air is compressed in the cylinder and compression of the air raises the temperature in the cylinder to approximately 1000°F (538°C.) At the proper moment during the compression stroke, a metered quantity of fuel is injected into the combustion chamber under extremely high pressure. The finely atomized fuel is ignited by the heat of the compressed air and starts to burn immediately.

1.2.4
Expansion of the burning gases forces the piston downward on its third (power) stroke. Near the bottom of the power stroke, the exhaust valves start to open.

1.2.5
As the piston moves upward on the fourth(exhaust) stroke, the exhaust valves are open and burned gases are forced out of the cylinder by the upward travel of the piston. A few degrees before the piston reaches top dead center, the intake valves start to open to admit a fresh charge of air to the cylinder. A few degrees after top dead center, the exhaust valves completely close and the cycle is repeated.

2 - SPECIFICATIONS (Refer to 2A for 6138 Engine Specifications)

2.1 ENGINE DATA AND CHARACTERISTICS

Number of Cylinders 6
Bore . . . . . 5.25 in. (133.35 mm)
Stroke:
16000T, 17000 MKII, 21000 MKII and 25000 MKII . . . . 6.50 in. (165.10 mm)
19000 MKII . . . . 6.0 in. (152.4 mm)
Total Displacement:
17000 MKII, 21000 MKII and 25000 MKII . . . . . 844 in.^{3}(13.8 lt)
19000 MKII . . . . . 779 in.^{3}(12.8 lt)
Crankshaft Rotation (Viewed from Fan End) . . . . . Clockwise
Number of Main Bearings 7
Compression Ratio (Nominal) 15.1:1
Compression Pressure (Minimum at sea level 600 rpm hot. 500±15 psi(35.15±1.05 kg/cm^2)
Firing Order 1-5-3-6-2-4
Minimum Stabilized Water Temperature . . . . . 180°F. (82°C.)
Maximum Permissible Exhaust Restriction . . . . . 2"(50.8 mm)Hg

2.2 FUEL INJECTION

Nozzle Opening Pressure . . 4100-4150 psi (288.26-291.77 kg/cm^2)
Fuel Injection Timing . . . Refer to FUEL INJECTION Service Manual
Fuel Injection Pump Speed Ratio to Crankshaft 0.5:1

2.3 VALVE TIMING

IMPORTANT: For checking valve timing set tappets at 0.023" (0.58mm)

Intake Valves Open BTDC . . . . . 28°
Intake Valves Close ABDC . . . . . 48°
Duration . . . . . 256°
Exhaust Valves Open BBDC . . . . . 53°
Exhaust Valves Close ATDC . . . . . 23°
Duration . . . . . 256°
Over Lap . . . . . 51°
Clearance for Valve Tappets:
Intake Valves . . . 0.015" Hot (0.38mm)
Exhaust Valves . . 0.020" Hot (0.51mm)

2.4 LUBRICATION

Type . . . . . Full Pressure
Lubricating Oil Filter (Mounted on Engine) . . . . . Full Flow
Lubricating Oil Specifications . . . A. P. I. classification CD, MIL-L-45199B, or MIL-L-2104C

2.5 ENGINE SPEEDS

For specified high and low idle engine speeds which vary depending upon the unit in which the engine is used, refer to the Operator Manual of the particular unit in question.

2A SERIES 6138 SPECIFICATIONS

1. ENGINE (BASIC)	ENGLISH	METRIC
Model Number-Turbocharged Engine	6138LT-6138T	6138LT-6138T
Model Number-Turbocharged and Intercooled Engine	6138I	6138I
Type	4 Cycle	4 Cycle
Number of Cylinders	6	6
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4
Bore	5.25 in.	133.0 mm
Stroke	6.50 in.	165.0 mm
Displacement	844 cu. in.	13.8 lt.
Crankshaft Rotation (viewed from fan end of engine)	Clockwise	Clockwise
Number of Main Bearings	7	7
Compression Ratio (nominal)	15.1:1	15.1:1
Compression Pressure at Sea Level, 600 rpm, Hot	500 psi ± 15 psi	3447 kPa±103 kPa
Maximum Premissable Exhaust Restriction	2 in. Hg.	6.75 kPa
2. COOLING SYSTEM		
Water Pump, Centrifugal Type	Belt Driven	Belt Driven
Stabilized Coolant Temperature (minimum)	180°F	82°C
Radiator and Expansion Tank Cap (pressurized)	7 psi	48 kPa
Nominal Capacities:		
Basic Engine with Dry Exhaust Manifold	*8 gal.	*30.3 lt.
Basic Engine with Dry Exhaust Manifold and Intercooler	*9 gal.	*34.1 lt.
*NOTE: To obtain total capacity of cooling system for particular application, add basic engine capacity to capacity of applicable optional cooling system equipment listed below:		
Optional Cooling System Equipment:		
Radiator and Hoses-used with basic engine having dry exhaust manifold	8.5 gal.	32.2 lt.
Radiator and Hoses-used with basic engine having dry exhaust manifold and intercooler	10 gal.	37.9 lt.
Water Cooled Exhaust Manifold	2 gal.	7.6 lt.
Heat Exchanger and Expansion Tank	6 gal.	22.1 lt.
Torque Converter Fluid Cooler	2 gal.	7.6 lt.
3. LUBRICATION SYSTEM		
Circulating Pressure Type System	Full Flow	Full Flow
Oil Pump	Gear Type	Gear Type
Pressure Control	Regulating Valve	Regulating Valve
Standard Oil Filters	Full Flow Type	Full Flow Type
Supplemental Oil Filter (optional)	Bypass Type	Bypass Type
Oil Pressure-Hot:		
Full Load Speed Oil Pressure Range	30 to 50 psi	207 to 345 kPa
Idle Speed, 600-700 rpm	10 psi minimum	69 kPa minimum
Angle of Operation:		
Standard Oil Pan	30°	30°
Optional Oil Pan	45°	45°
Nominal Oil Capacities:		
Filter and Oil Change Quantity:		
Standard Oil Pan and Full-Flow Filters	**45 qt.	**42.6 lt.
Optional Oil Pan and Full-Flow Filters	**47 qt.	**44.5 lt.
Optional Bypass Filter	14 qt.	13.3 lt.
**If engine is equipped with optional bypass type oil filter, add capacity of filter to oil pan and full flow oil change capacities listed above.		
4. FUEL INJECTION SYSTEM		
Nozzle Holder Assembly:		
Nozzle, Spring Loaded Type	Four Hole Orifice	Four Hole Orifice

2A SERIES 6138 SPECIFICATIONS—CONTINUED

	ENGLISH	METRIC
Fuel Injection Pump:		
Power Unit:		
Manufacture	Robert Bosch	Robert Bosch
Pump Type-Flange Mounted	Plunger Type	Plunger Type
Generator Drive Engine:		
Manufacture	Robert Bosch	Robert Bosch
Pump Type-Flange Mounted	Plunger Type	Plunger Type
Pump Speed Ratio to Crankshaft	0.5:1.0	0.5:1.0
Fuel Pump Timing to Engine-Static:		
1400 to 1750 rpm	34° BTDC	34° BTDC
1751 to 2100 rpm	37° BTDC	37° BTDC
5. GOVERNOR		
Governor Regulation:		
Standard Mechanical Type:		
Power Units	10%	10%
Generator Drive	3-5%	3-5%
Optional-Hydraulic Woodward Type SG	3-5%	3-5%
Optional-Hydraulic Woodward Type PSG	1-5%	1-5%
Speed Settings:		
Idle-Power Units	500-600 rpm	500-600 rpm
Full Load-Power Units	Rated rpm	Rated rpm
Idle-Generator Drive Engines	1400 rpm	1400 rpm
Full Load-Generator Drive Engines	1500 and 1800 rpm	1500 and 1800 rpm
6. VALVE DATA:		
Valve Lash Adjustment:		
Intake Valve Clearance-Hot	0.015 in.	0.38 mm
Exhaust Valve Clearance-Hot	0.020 in.	0.51 mm
7. ELECTRICAL SYSTEM		
Standard:		
Starter	24V.	24V.
Alternator	24V., 45 Amp	24V., 45 Amp
Ground Polarity	Negative (-)	Negative (-)

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1 - GENERAL

1.1
The engine cooling system includes the radiator, water pump, heat exchanger, water and oil manifold, water inlet and water outlet manifolds, thermostats, coolant temperature gauge, coolant filter, water passages in cylinder block and cylinder heads, and intercooler (25000 MKII).

1.2
All units, using engines covered in this manual, have a pressurized cooling system. A double acting pressure relief valve is provided in the radiator filler cap. The valve is set to open at 6 to 8 psi(0.42 to 0.49 kg/cm^2).

1.3
The water pump draws water from the bottom of the radiator and forces it through the heat exchangers, water and oil manifold, water inlet manifold, and the cored water passages in the engine. The coolant is discharged from the cylinder heads into the water outlet manifold through the thermostat housing and radiator inlet tube, to the top tank of the radiator. As coolant passes from top to bottom of the radiator, the radiator dissipates heat to the air drawn or pushed through radiator core by the cooling fan.

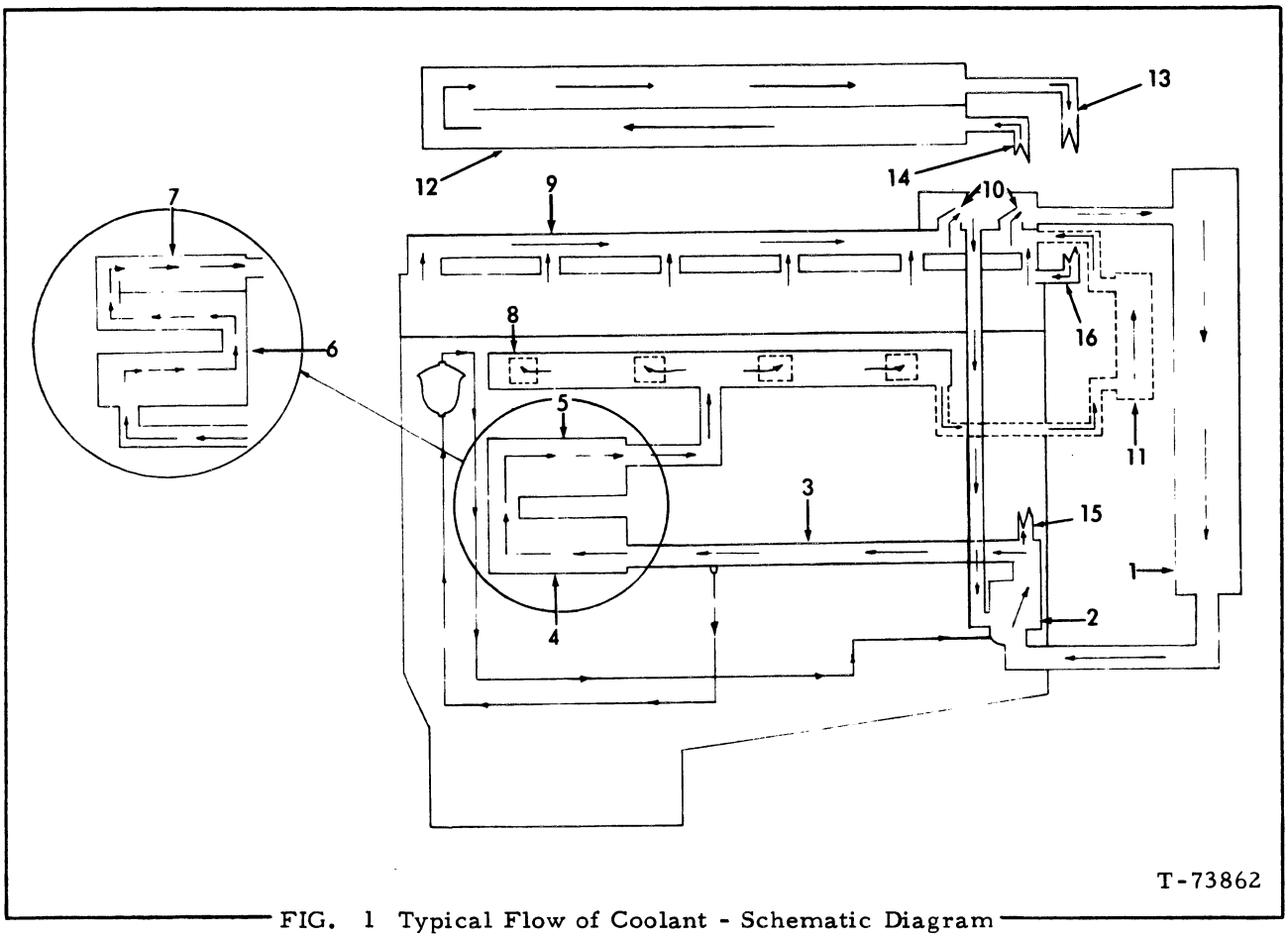

FIG. 1 Typical Flow of Coolant - Schematic Diagram

1. Radiator
2. Water Pump
3. Water Pump-to-Heat Exchanger Tube
4. Heat Exchanger - Engine Oil Cooler (21000 MKII)
5. Heat Exchanger - Torque Converter and Transmission (21000 MKII)
6. Heat Exchanger - Engine Oil Cooler (25000 MKII)
7. Heat Exchanger - Torque Converter and Transmission (25000 MKII)
8. Water Inlet Manifold
9. Water Outlet Manifold
10. Thermostats
11. Air Compressor (if so equipped)
12. Intercooler
13. Intercooler Outlet
14. Intercooler Inlet
15. To Intercooler Inlet
16. From Intercooler Outlet

2 - RADIATOR

2.1 GENERAL

The radiator, Fig. 2, consists basically of a core, top tank, bottom tank, and side members bolted together to form an assembly.

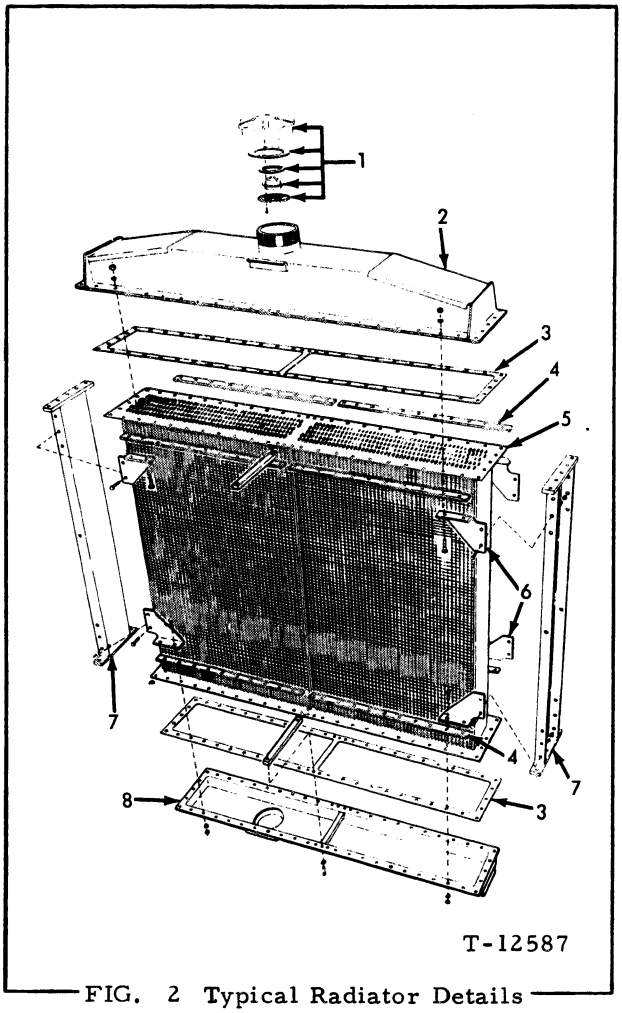

FIG. 2 Typical Radiator Details

1. Filler Cap (With Pressure Valve)
2. Top Tank
3. Gasket
4. Core Flange Clamp
5. Core
6. Corner Gussets
7. Side Member
8. Bottom Tank

2.2 RADIATOR INSPECTION

2.2.1
Thoroughly clean exterior of radiator, removing all foreign material from between cooling cores and fins. Be careful not to bend fins, straightening any that may be bent.

2.2.2
The radiator can be completely disassembled if necessary, Fig. 2. If disassembled, use new gaskets when reassembling.

2.2.3
Do not paint radiator core as this decreases cooling efficiency.

2.2.4
After reassembling radiator, test for leaks. Cover inlet and outlet openings and immerse in water. Test using no more than 10 psi (0.7 kg/cm^2) internal air pressure.

3 - FAN, FAN BELTS AND FAN HUB

3.1 DESCRIPTION

The engine may be equipped with either a pusher type or suction type fan depending upon the application. The fan pushes or pulls (according to type used) air through the radiator and helps cool the engine coolant circulating through the radiator core. The fan hub assembly is mounted on a bracket bolted to the front of the engine. The fan is bolted to the fan hub, which rotates on ball bearings, and is driven from the crankshaft pulley by V-belts.

3.2 FAN BELT ADJUSTMENT

3.2.1
The fan belts are properly adjusted when the belts can be pressed inward (by hand) 0.75" to 1.00" (19.1 to 25.4 mm) at a point halfway between the fan hub and the crankshaft pulley. Adjust fan belts following instructions for the particular belt arrangement involved. Always check and retighten new belts after one hour of running time.

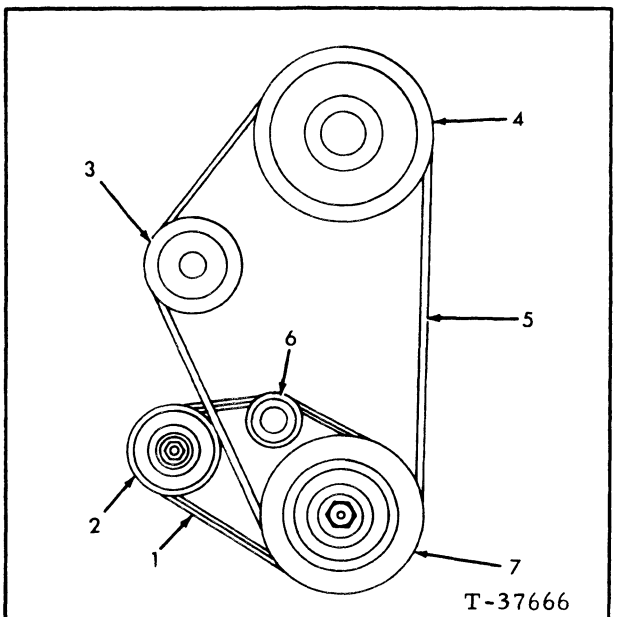

FIG. 3 Belt Arrangement - Crawler Tractors

1. Water pump drive belt
2. Water pump pulley
3. Alternator pulley
4. Fan hub
5. Fan belts
6. Water pump idler pulley
7. Crankshaft pulley

3.2.2 BELT ARRANGEMENT - CRAWLER TRACTORS (Fig. 3), 19000 MKII ENGINES (Fig. 4)

Loosen generator adjusting arm capscrew and move generator in or out until correct belt tension is obtained (see paragraph 3.2.1), then tighten capscrew.

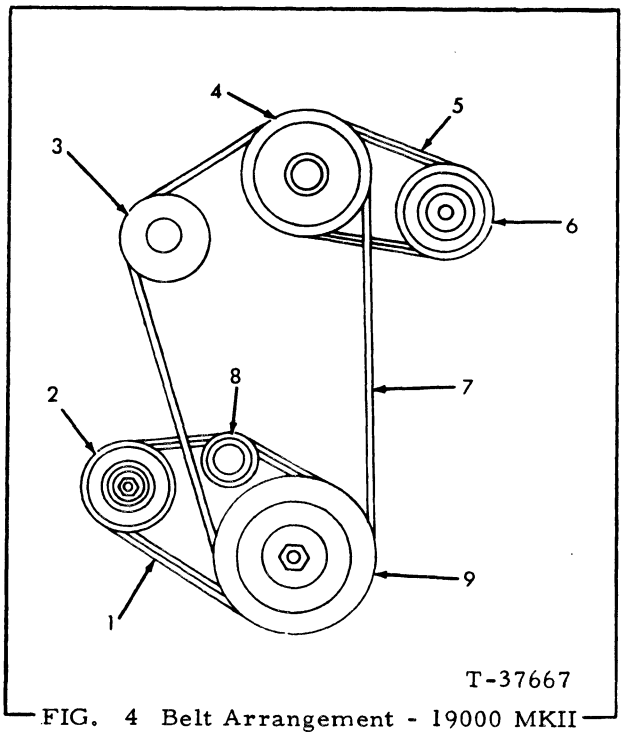

FIG. 4 Belt Arrangement - 19000 MKII

1. Water pump drive belt
2. Water pump pulley
3. Generator pulley
4. Fan hub
5. Air compressor drive belt
6. Air compressor pulley
7. Fan belts
8. Water pump idler pulley
9. Crankshaft pulley

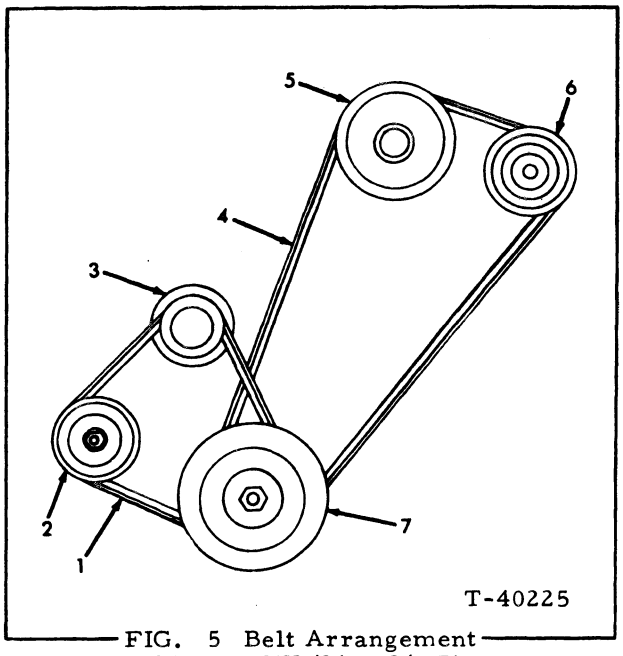

FIG. 5 Belt Arrangement
21000 MKII (260, 260E)

1. Water pump and generator drive belt
2. Water pump pulley
3. Generator pulley
4. Fan belts
5. Fan hub
6. Air compressor pulley
7. Crankshaft pulley

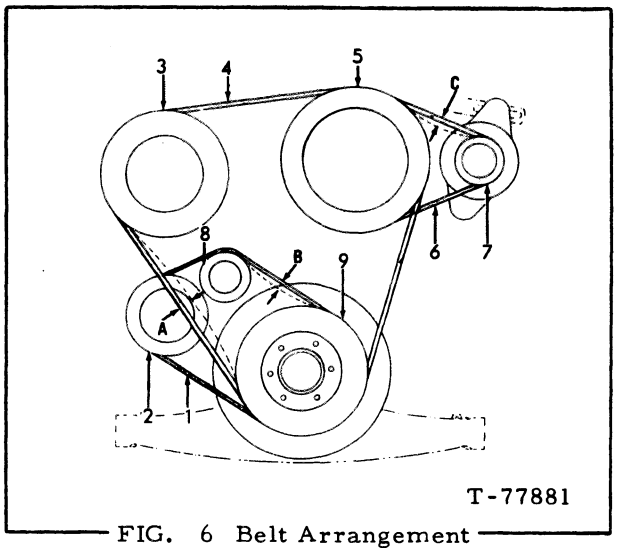

FIG. 6 Belt Arrangement
21000 MKII (260-A, 260E-A), 25000 MKII

1. Water pump drive belt
2. Water pump pulley
3. Air compressor pulley
4. Air compressor/Fan drive
5. Fan hub
6. Alternator drive belt
7. Alternator pulley
8 Water pump idler pulley
9. Crankshaft pulley
A. 0.5" (12.7 mm)
B. Automatically adjusted by spring loaded damper
C. 0.2" (5.1 mm)

3.2.3 BELT ARRANGEMENT - 260, 260E (Fig. 5)

Loosen fan hub spindle retaining nut. Loosen locknut and turn adjusting screw in fan hub to obtain correct belt tension (See paragraph 3.2.1)

3.2.4 BELT ARRANGEMENT - 21000 MKII (260-A, 260E-A), 25000 MKII (Fig. 6)

The water pump belt adjustment is taken up automatically by the idler pulley (9). The fan and air compressor belt is adjusted correctly when the belt can be pressed inward by hand 0.5" (12.7 mm) or when 118 to 124 lb (53.33 to 56.24 kg) is indicated on a belt tension gauge. The alternator drive belt is properly adjusted when it indicates 90-95 lb (40.8-43.1 kg) on a belt tension gauge or can be pressed inward 0.2" (5.1 mm) by a force of 8 lb (3.6 kg).

3.3 FAN REMOVAL, INSPECTION AND INSTALLATION

3.3.1
Remove fan guard or fan shroud.

3.3.2
Remove capscrews securing fan to fan hub and remove fan and fan spacer is so equipped.

3.3.3
Inspect fan for cracks, loose rivets, or bent blades. Repair or replace if necessary.

3.3.4
Install fan by a direct reversal of removal procedure.

3.4 FAN BELT REMOVAL, INSPECTION AND INSTALLATION

3.4.1
Remove fan.

3.4.2
Relieve tension on fan belts until belts can be slipped off of pulleys. Remove fan belts.

3.4.3
Inspect fan belts for excessive slickness, oil-soak, wear, tears, cracks, and overstretching. The fan belts are a matched pair. If only one belt replacement is required, both belts must be replaced to assure satisfactory belt proper tension.

3.4.4
Install fan belts by slipping belts into proper grooves in pulleys, and adjusting belt to proper tension.

3.4.5
Install fan.

3.5 FAN HUB REMOVAL

3.5.1
Remove fan and fan belts.

3.5.2
Remove all belts from fan pulley.

3.5.3
Remove nut and washer fromend of spindle. On some engines it may be first necessary to remove a roll pin from the spindle nut.

3.5.4
If there is an adjusting screw in the spindle, back the screw out of the spindle.

3.5.5
Pull fan hub assembly from bracket.

3.6 FAN HUB DISASSEMBLY AND INSPECTION - 16000T, 17000 MKII, 21000 MKII (CRAWLER APPLICATION) (FIG. 7)

3.6.1
Remove snap ring (1) and hub cap (2).

3.6.2
Remove retainer snap ring (12).

3.6.3
Remove retainer (11) from hub.

3.6.4
Remove sealing washer (10).

3.6.5
Remove retaining washer (9).

3.6.6
Place hub assembly in a press, with fan end of hub up, and press spindle (13), bearings (8) and (4), spacing washer (5), and spacing sleeve (6) from the hub (7).

3.6.7
Remove nut (3) from spindle.

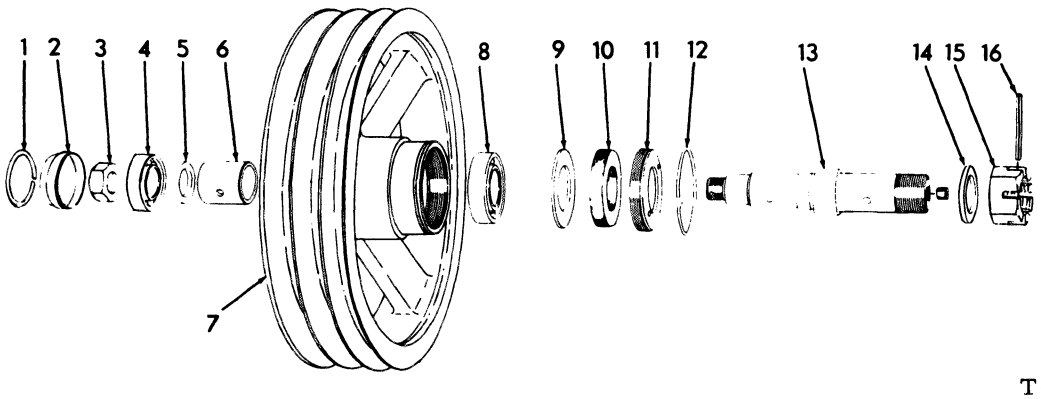

FIG. 7 Hub - 16000 T, 17000 MKII, 21000 MKII (Crawlers)

1. Snap ring
2. Hub cap
3. Nut
4. Front ball bearing
5. Spacing washer
6. Spacing sleeve
7. Hub
8. Rear ball bearing
9. Retaining washer
10. Spindle sealing washer
11. Washer retainer
12. Snap ring
13. Spindle
14. Plain washer
15. Slotted nut
16. Pin

3.6.8
Press spindle from bearings.

3.6.9
Wash all parts thoroughly in clean solvent or fuel and examine the parts for wear or damage. Rotate bearings by hand and check for looseness, roughness, or binding; replace them if necessary. Inspect the spindle and be certain it is not bent or worn. Inspect the fan hub for wear; make certain that grooves are smooth and that the hub is not chipped or cracked. Discard sealing washer (10) and install new one when assembling.

3.7 FAN HUB ASSEMBLY AND INSTALLATION 16000T, 17000 MKII, 21000 MKII (CRAWLER APPLICATION)(FIG. 7)

3.7.1
Install pipe plug into spindle (13) if plug has been removed.

3.7.2
Press rear ball bearing (8) onto spindle. If bearing is shielded, side with shield goes against shoulder of spindle.

3.7.3
Place spacing sleeve (6) and spacing washer (5) in position on spindle. Press front bearing (4) onto spindle.

3.7.4
Install bearing retaining nut (3) and tighten to 150-170 lb -ft (20.7-23.5 kg-m). Be certain that nut is tight against bearing.

3.7.5
Place hub (7) in a press, fan end downwards, and press spindle and bearings assembly onto hub. While pressing spindle onto hub, pack space between bearings with clean pressure gun lubricant.

3.7.6
Place bearing retaining washer (9) and a new sealing washer (10) in position on the spindle. Soak sealing washer (10) in clean engine oil before installing. Turn the sealing washer retainer (11) into the hub until the retainer contacts the rear bearing washer and tighten to a torque of 200 lb -ft (27.7 kg-m).

3.7.7
If the hole in the retainer does not align with the hole in the hub, use a 0.125" (3.175 mm) bit and drill a hole in the retainer using the hole in the hub as a pilot. Install the retainer snap ring (12).

3.7.8
Install hub cap (2) and snap ring (1).

3.7.9
Install key into spindle. Install spindle into bore of fan mounting bracket, then install plain washer and spindle retaining nut. Tighten nut and install roll pin.

3.7.10
Install and adjust fan belts and any other belts which may be driven by fan hub. Install fan.

3.8 FAN HUB DISASSEMBLY AND INSPECTION 19000 MKII (FIG. 8)

3.8.1
Remove spacer (16) and gasket (2).

3.8.2
Remove washer (9) and lockwire (14).

3.8.3
Remove cotter pin and slotted nut (4) and washer (3).

3.8.4
Press spindle (10) from hub (1).

3.8.5
Remove front bearing cone (5) from hub.

3.8.6
Remove grease retainer (15) from spindle. Discard grease retainer and use a new one when assembling hub.

3.8.7
Remove rear bearing cone (8) and bearing cups (7) and (6) may be removed from the hub.

3.8.8
Wash all parts thoroughly in clean solvent or fuel and examine parts for wear or damage. Inspect bearings to see that they roll freely and are free from cracked, pitted, or worn rollers and bearing cups; replace bearings if necessary. Inspect fan hub for wear; see that grooves are smooth and that hub is not chipped or cracked.

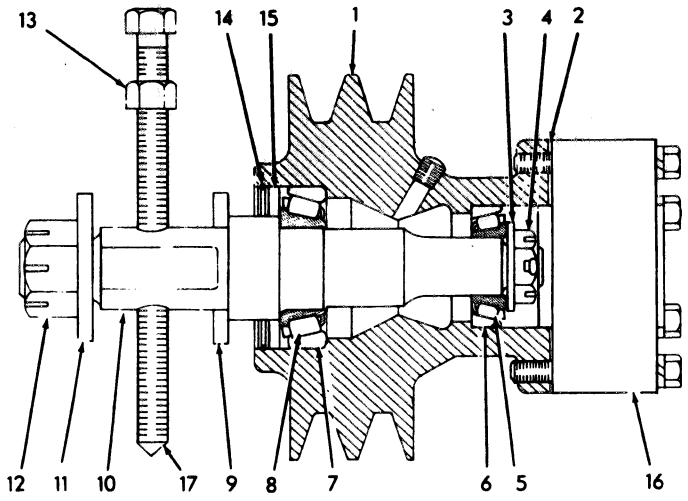

FIG. 8 Fan Hub - 19000 MKII

1. Hub
2. Gasket
3. Washer
4. Slotted nut
5. Front Bearing cone
6. Front Bearing cup
7. Rear Bearing cup
8. Rear Bearing cone
9. Front washer
10. Spindle
11. Rear washer
12. Lock nut
13. Adjusting screw
14. Lock wire
15. Grease retainer
16. Spacer
17. Adjusting screw

3.9 FAN HUB ASSEMBLY AND INSTALLATION - 19000 MKII (FIG. 8)

3.9.1
Press bearing cups (6) and (7) into hub (1) until they bottom in their respective counterbores.

3.9.2
Press bearing cone (8) onto spindle (10) until it is tight against shoulder on spindle.

3.9.3
Place spindle in position in hub and hand pack the cavity between bearings with a good grade of ball and roller bearing lubricant.

3.9.4
Support lower end of spindle and drive or press bearing cone (5) into position on spindle.

3.9.5
Install washer (3) and slotted nut (4). Clamp spindle in a vise and tighten nut until a slight drag is felt when hub is rotated. Tap hub with a soft hammer to make sure bearings are properly seated. Back nut off just far enough so that cotter pin can be installed. Install cotter pin.

3.9.6
Install grease retainer (15) and lock wire (14).

3.9.7
Place washer (9) in position on spindle.

3.9.8
Insert spindle into slotted hole of fan mounting bracket.

3.9.9
Start adjusting screw (17) into spindle. Install washer (11) and nut (12) but do not tighten at this time.

3.9.10
Install fan belts. Turn adjusting screw until fan belts are properly adjusted, then lock adjusting screw with lock nut (13). Tighten nut (12) securely.

3.9.11
Hand pack cavity at front end of fan hub with a good grade of ball and roller bearing lubricant, then install gasket (2), spacer (16) and fan.

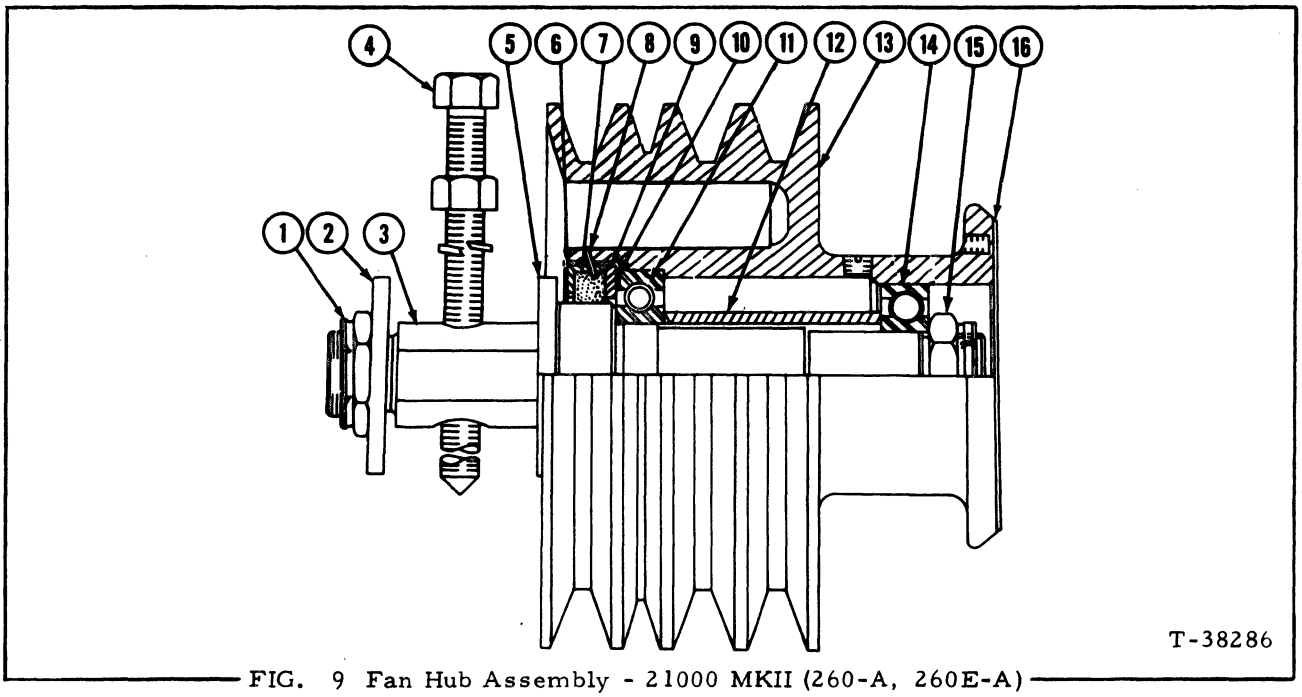

FIG. 9 Fan Hub Assembly - 21000 MKII (260-A, 260E-A)

1. Nut
2. Washer
3. Spindle
4. Adjusting screw
5. Washer
6. Retainer
7. Washer
8. Lock wire
9. Sealing washer
10. Gasket
11. Rear ball bearing
12. Spacer
13. Hub
14. Front ball bearing
15. Locknut
16. Gasket

3.10 FAN HUB DISASSEMBLY AND INSPECTION - 21000 MKII (260-A, 260E-A)(FIG. 9)

3.10.1
Remove washer (5), retainer (6), washer (7), lock wire (8), sealing washer (9), and gasket (10).

3.10.2
Remove nut (15).

3.10.3
Place hub in a press, fan end up, and press out spindle (20).

3.10.4
Press out bearings (14) and (11) and spacer (12).

3.10.5
Wash all parts thoroughly in clean solvent or fuel and examine the parts for wear or damage. Rotate bearings by hand and check for looseness, roughness, or binding; replace them if necessary. Inspect the spindle and be certain it is not bent or worn, Inspect fan hub for wear; make certain that grooves are smooth and that the hub is not chipped or cracked. Discard sealing washer (11) and gasket (12) and install new ones when assembling.

3.11 FAN HUB ASSEMBLY AND INSTALLATION - 21000 MKII (260-A, 260E-A)(FIG. 9)

3.11.1
Lubricate spindle (3) with clean pressure gun lubricant.

3.11.2
Press bearing (11), bearing spacer (12), and bearing (14) onto spindle.

3.11.3
Press spindle and bearings into hub (13), packing space between bearing spacer and hub with pressure gun lubricant as spindle is pressed into hub.

3.11.4
Place gasket (10) and washer (9) onto spindle.

3.11.5
Install washer (7), washer retainer (6), lock wire (8), and washer (5).

3.11.6
Install nut (15) finger tight. Clamp spindle in a vise and tighten nut until a slight drag is felt when hub is rotated. Tap hub with a soft hammer to make sure bearings are properly seated.

3.11.7
Insert spindle through hole of fan mounting bracket.

3.11.8
Start adjusting screw (4) into spindle. Install washer (2) and nut (1) but do not tighten at this time.

3.11.9
Install fan belts. Turn adjusting screw (4) until fan belts are properly adjusted, then lock adjusting screw with nut and lockwasher. Tighten nut (1) securely.

3.11.10
Hand pack cavity at front end of fan hub with a good grade of ball and roller bearing lubricant. Install gasket (16), spacer and fan.

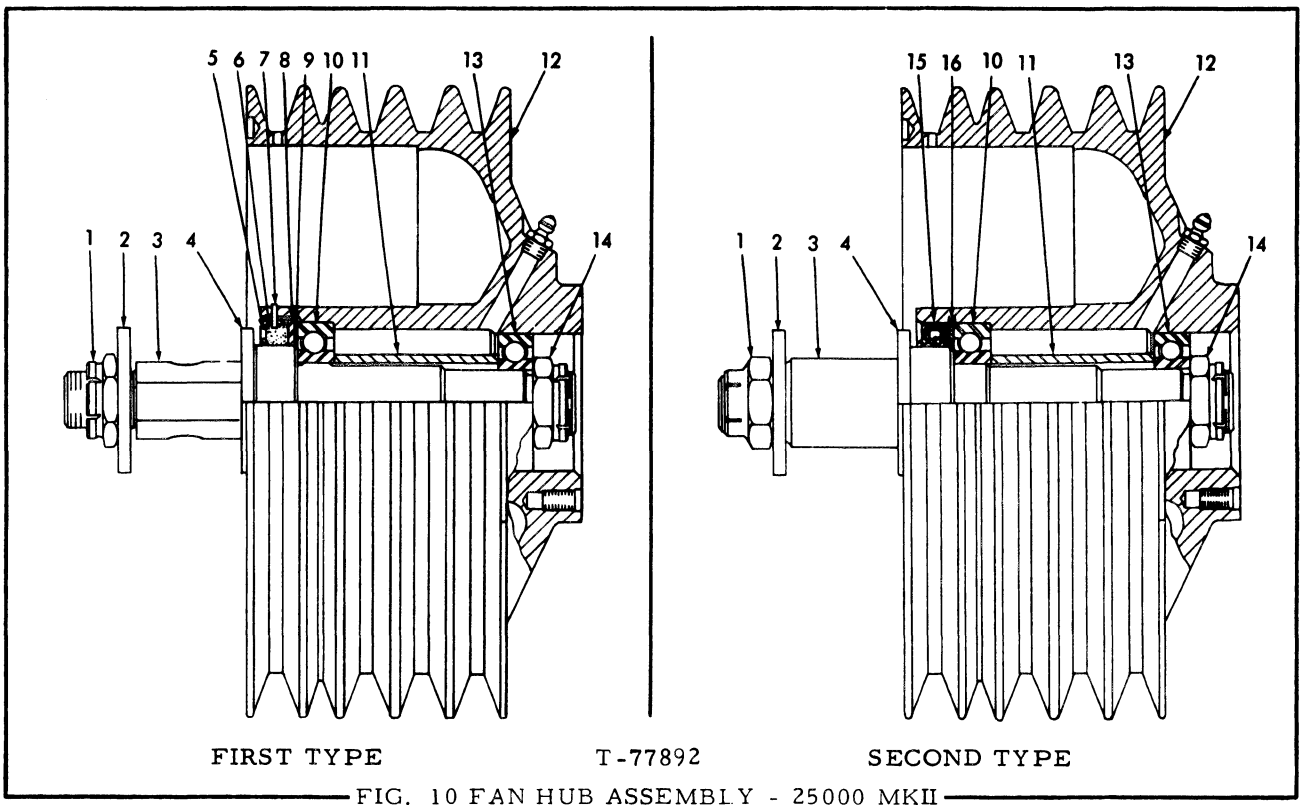

FIG. 10 FAN HUB ASSEMBLY - 25000 MKII

1. Fan hub spindle nut
2. Spindle nut washer
3. Fan hub spindle
4. Spindle washer
5. Sealing washer retainer
6. Bearing sealing washer
7. Sealing washer locking wire
8. Sealing washer
9. Retainer gasket
10. Rear ball bearing
11. Bearing spacer
12. Fan hub
13. Front ball bearing
14. Front spindle nut
15. Spindle seal
16. Snap ring

3.12 FAN HUB DISASSEMBLY AND INSPECTION 25000 MKII (FIG. 10)

3.12.1
Remove nut (14) from spindle.

3.12.2
Remove washer (4). On First-Type hubs, remove retainer (5), washer (6), locking wire (7), sealing washer (8) and gasket (9). On Second Type hubs, remove seal (15) and snap ring (16).

3.12.3
Place hub in a press, fan end up, and press out spindle (3).

3.12.4
Press out bearings (10) and (13) and spacer (11).

3.12.5
Wash all parts thoroughly in clean solvent or fuel and examine the parts for wear or damage. Rotate bearings by hand and check for looseness, roughness, or binding; replace them if necessary. Inspect the spindle and be certain it is not bent or worn. Inspect fan hub for wear; make certain that grooves are smooth and that the hub is not chipped or cracked. On First Type hubs, discard sealing washer (8) and gasket (1) and install new ones when assembling. On Second Type hubs, discard seal (15) and install new seal when assembling.

3.13 FAN HUB ASSEMBLY AND INSTALLATION - 25000 MKII (FIG. 10)

3.13.1
Lubricate spindle with clean pressure gun lubricant.

3.13.2
Press bearing (10) onto spindle until it seats.

3.13.3
Press spacer (11) onto spindle.

3.13.4
Press bearing (13) onto spindle.

3.13.5
Press spindle and bearings, as an assembly, into hub (12), packing space between spacer and pulley with clean pressure gun lubricant as spindle is pressed inward.

3.13.6
On First Type hubs, install new gasket (9), washer (8), washer (6), lockwire (7), retainer (5) and washer (4). On Second Type hubs, install snap ring (16) and new seal (15).

3.13.7
Install nut (14) finger tight. Tap hub with a soft hammer to make sure bearings are seated properly.

3.13.8
Insert spindle through hole of fan mounting bracket.

3.13.9
Install washer (2) and nut (1) finger tight.

3.13.10
Install fan belts. Adjust fan belt tension by mean of adjusting screw in air compressor base.

3.13.11
Tighten nut (1) to a torque of 210 lb -ft (29.0 kg-m) on First Type hub assemblies and to 500 lb -ft (69.1 kg-m) on Second Type hub assemblies.

3.13.12
Tighten nut (14) to a torque of 185 lb. -ft. (25.6 kg-m)

3.13.13
Pack cavity at front end of fan hub with pressure gun lubricant. Install spacer, capscrews, and fan.

4 - COOLANT FILTER

4.1
On 16000 T, 17000 MKII, 19000 MKII, and 21000 MKII engines, the coolant filter is mounted on a bracket at the right front of the engine (Fig. 11). On 25000 MKII engines a spin-on type filter is mounted on a bracket at the right front of the engine behind the fan pulley (Fig. 12).

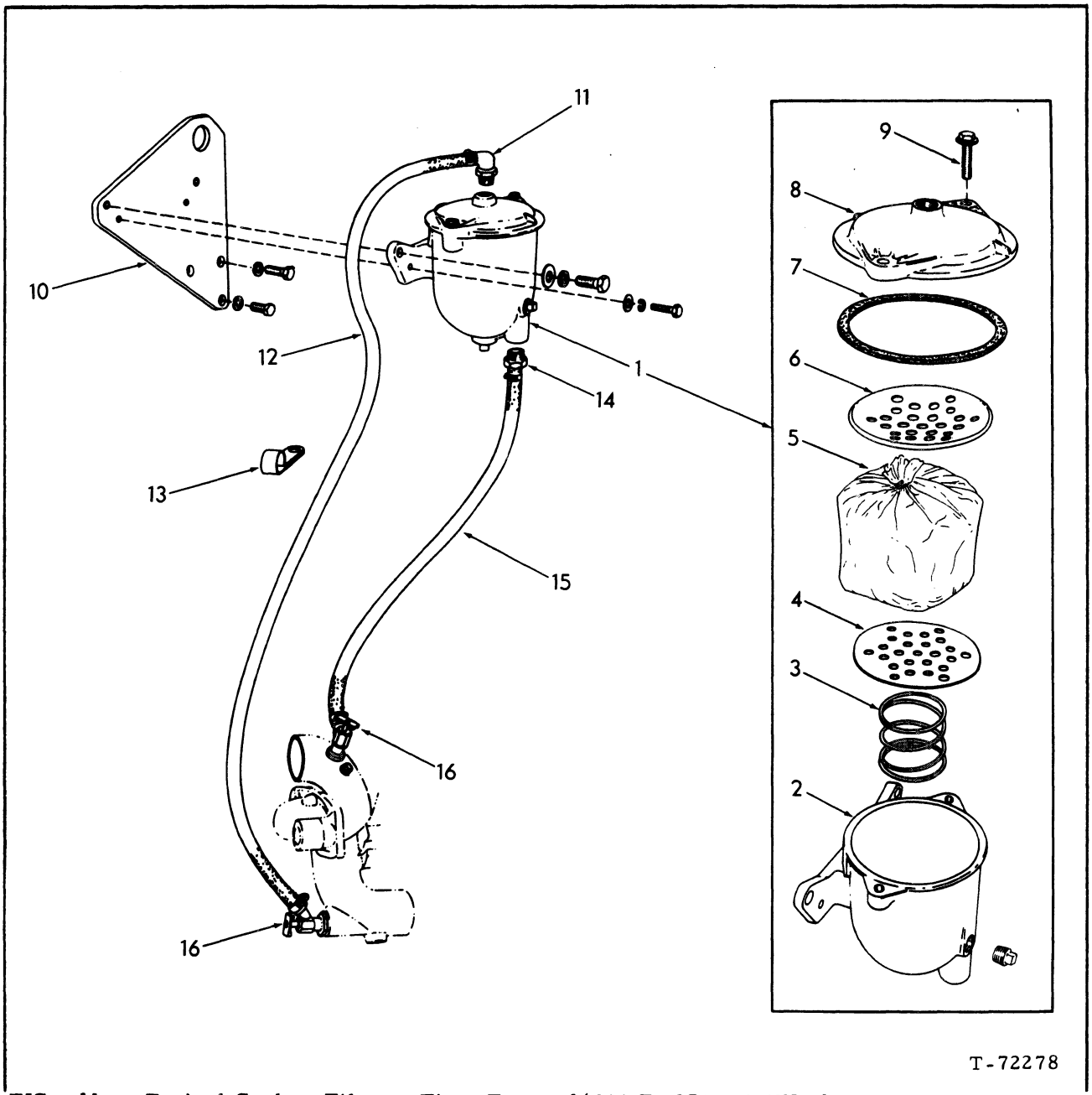

FIG. 11 Typical Coolant Filter - First Type - 16000 T, 17000 MKII, 19000 MKII, 21000 MKII

1. Filter Assy.
2. Filter body
3. Spring
4. Lower plate
5. Element kit
6. Upper plate
7. Gasket
8. Cover
9. Bolt Assy.
10. Mounting bracket
11. Elbow
12. Outlet hose from filter
13. Hose clamp
14. Nipple
15. Inlet hose to filter
16. Shut-off valve

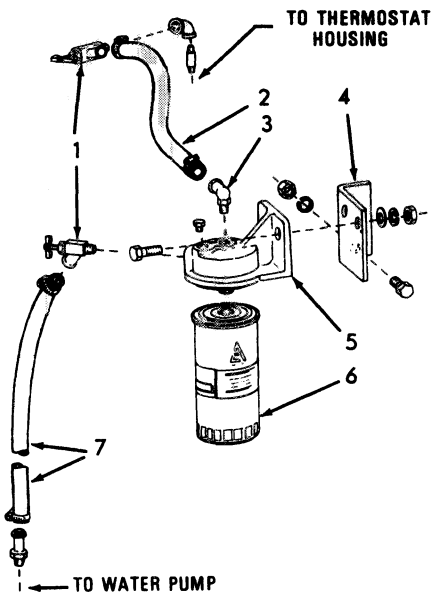

FIG. 12 TYPICAL COOLANT FILTER-Second Type

1. Shut-off valve
2. Inlet hose
3. Elbow
4. Bracket
5. Filter Head Assy.
6. Filter
7. Outlet hose

4.2
The inlet and outlet valves must both be open before coolant can circulate through the filter. Coolant enters the filter from the thermostat housing, flows through the filtering element, and then exits toward the inlet side of the water pump.

4.3
For detailed instructions on filter element replacement, refer to the respective unit Operator Manual.

5 - THERMOSTATS

5.1 GENERAL

5.1.1
The two thermostats, located at the front of the water outlet manifold, are so positioned that when they are closed, the flow of coolant from the engine water outlet manifold to the radiator is completely shut off. The flow of coolant is then directed from the water outlet manifold through the water by-pass tube and back to the inlet side of the water pump.

5.1.2
Before the thermostats open, the coolant circulates through the engine circulating system only. When the thermostats open, the coolant circulates through the radiator and the engine circulating system.

5.1.3
The thermostats are of the by-pass type. Both thermostats have an opening temperature of 180° F. (82° C.). It does not make any difference in their operation which thermostat is placed in the front or rear openings in the water outlet manifold. The thermostats are designed to start opening at 180°F. (82°C.) and to be fully opened at 195°F. (90°C.)

5.1.4
Replacement of the thermostats is necessary when the thermostats become corroded, or stick in the open or closed position. If the engine overheats or does not reach and maintain a minimum temperature of 180°F. (82°C.) the thermostats should be removed and tested as a possible cause of trouble.