B.U.M.F!

No. 3

NO. 3 NOVEMBER 1969

B. U. M. F.

BETTER
UNDERSTANDING OF
MAINTENANCE
FACTS

We've had a couple of letters as a result of BUMF No. 2, so we're printing them in this issue (and our answers) for you all to read. In fact, a regular "Letters to the Editor" feature would be an idea, so let's be hearing from you. Write to:-

The Editor
BUMF
CP. 29 Western Tower
Reading

In this issue of BUMF we're giving the Electricians a turn. BUMF Nos. 1 and 2 both covered the mechanical side of the house, so now the others are getting a look-in.

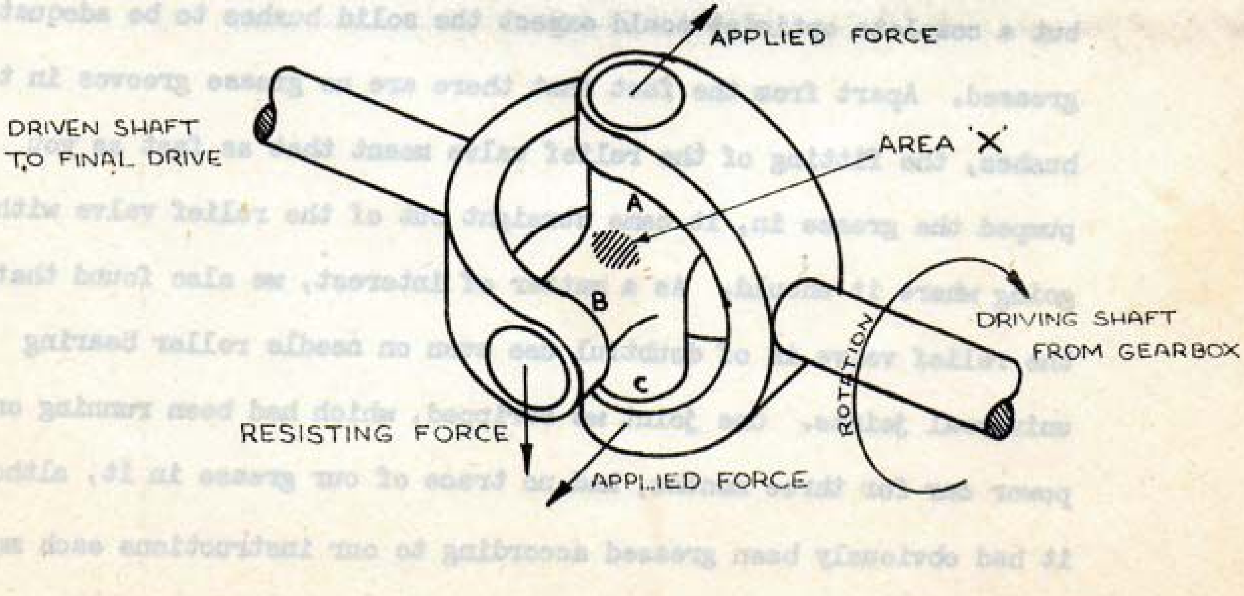
A correspondant has pointed out that BUMF No. 2 contains drawing errors on page 5 (Leyland Cooling Systems) and page 9 (Leyland Fuel Injection Pump). We are very sorry about these boobs, and are enclosing amended drawings with this issue of BUMF for you to put in the proper places.

Maintenance Section
Reading

5. D.M.U. CARDAN SHAFTS - Continued

You will know from the activity in the Depots, and the coming and going of various people, that we are well in the muck with our Cardan Shafts, and we are changing them as fast as we can get new shafts from Swindon. The story is rather complicated and we must go back to where we told you about the "blue star" shafts in BUMF No. 2.

When the "blue star" shafts started to arrive at the Depots, a lot of you noticed that grease relief valves were fitted, although we had told you they wouldn't be. We checked up with our technical powers-that-be and they told us that there are in fact a large number of star pieces which, although stronger than the old ones, still would be fitted with relief valves. These are considered to be "blue" so they have been fitted to new shafts and with plain steel bushes instead of needle rollers. In order to be sure that cracking wouldn't start around the relief valve hole, they are fitted so that the metal around the hole is in compression. The sketch below should make this clear:-



When the driving shaft is turned clockwise against a resisting load on the driven shaft, the forces exerted on the star pieces by the yokes try to distort the arms of the star pieces. In the sketch, A and B try to move apart, and the area X between them is under tension. Similarly arms C and D (behind the driving yoke) have a tension area between them. If the hole for the grease relief valve is drilled at X there is less metal to resist the load, so that the tensile stress is increased with a possibility of failure.

So far so good. We were fitting "blue star" cardan shafts to our sets and putting them out in traffic quite happily when the blow fell. 459 set going into Swindon Works (with "blue stars" fitted) was found to have three shafts with universal joints seized, and one with the star piece broken up! Investigation at Swindon showed that two thirds of the modified shafts in the store, which had never even run, were already tight.

We also did some investigations at Reading and found that nobody but a complete optimist could expect the solid bushes to be adequately greased. Apart from the fact that there are no grease grooves in the bushes, the fitting of the relief valve meant that as fast as you pumped the grease in, it came straight out of the relief valve without going where it should. As a matter of interest, we also found that the relief valve is of doubtful use even on needle roller bearing universal joints. One joint we stripped, which had been running on a power car for three months, had no trace of our grease in it, although it had obviously been greased according to our instructions each month!

On top of this, Swindon did a check on the steel bushes and found that on a high proportion of them, the outside and inside diameters were not concentric.

This was not a pretty picture, as it turned out there were about 60 suspect shafts in service, so we in the London Division decided that we must check daily to see if our universal joints were getting hot and therefore starting to seize, and we would blank off the relief valves and grease the star pieces until grease came out of all four arms. In the meantime, Swindon would selectively assemble new shafts and mark these with a yellow stripe across the blue painted star pieces. So now we have ordinary star pieces, yellow star pieces, blue star pieces, and blue/yellow stripe star pieces!

So away we went again, changing shafts, blanking off and greasing, when the next blow fell. 455 set dropped a shaft in traffic when only two days out of Swindon Works. And this one had "blue/yellow stripe" cardan shafts! And it had given no warning of trouble.

Our immediate reaction to this one was "no more solid bushes until the design boys have solved the problem," and we are now getting the old "yellow star" shafts to fit as a temporary measure. These, of course, are fitted with needle roller bearings, (and most of us think "quite right too").

So that is where we are at the moment, not quite back to square one.

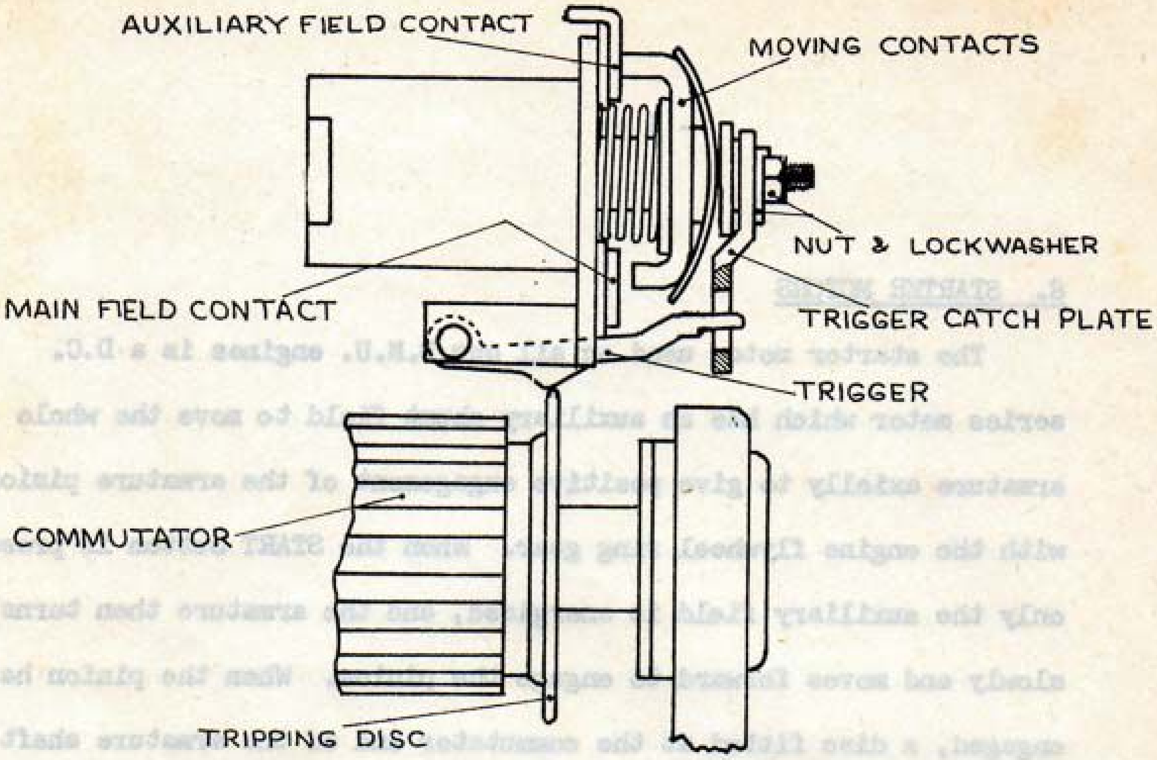
We have had a meeting with our technical chiefs from Paddington, the Swindon Works people, and representatives of Derby Design, and the result of this is that we are going to stay with "yellow star" shafts until the design boys have sorted things out. There is one difference though. We will continue to blank off relief valves on the new shafts so that we can be sure that the grease will go where we want it. Then, when we grease the universal joints, we will continue to pump until grease comes out of all four arms.

So you can see that we have all done a lot of work without getting very far. You have been changing shafts and Swindon has been stripping and assembling by the dozen. (Even I've got writers' cramp trying to tell you all about it). Possibly by the time these words appear in print the picture will have changed again, but let's all hope that BUMF No. 4 will be the last where we have to say more about cardan shafts.

8. STARTER MOTORS

The starter motor used on all our D.M.U. engines is a D.C. series motor which has an auxiliary shunt field to move the whole armature axially to give positive engagement of the armature pinion with the engine flywheel ring gear. When the START button is pressed, only the auxiliary field is energised, and the armature then turns slowly and moves forward to engage the pinion. When the pinion has engaged, a disc fitted at the commutator end of the armature shaft lifts a switch trigger and allows the main field contacts to close. This brings the motor on to full power, and the engine turns over. If the engine will not turn (for instance, if it is seized) an overload clutch on the starter (between the armature and pinion) slips and prevents the teeth being broken or the armature being stalled and burned.. The clutch is set to slip at 80 - 100 lb.ft. torque.

All this sounds very simple and reliable, but unfortunately this is not so. Starter motors are averaging 4 months life, and very few reach a life of 8 months laid down in MP.11A



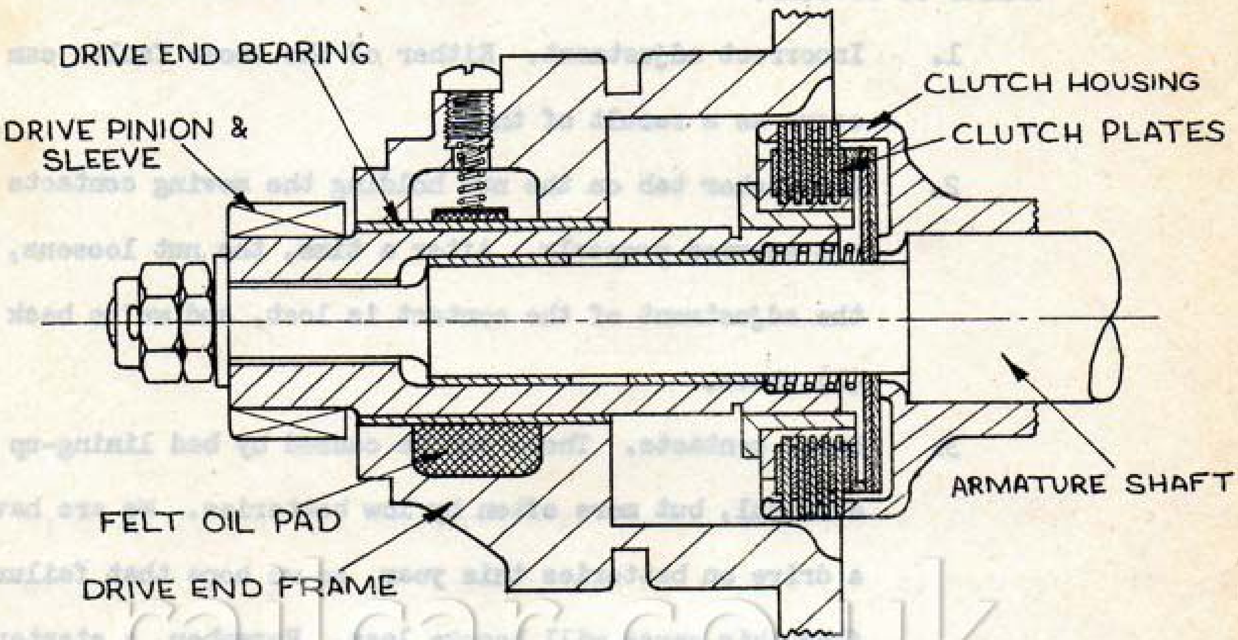
SOLENOID SWITCH
(SHOWING AUX. FIELD CONTACT MADE)

The two main causes of failure are associated with the solenoid switch inside the starter. If the main field switch contacts fail to make, the starter pinion will enter the flywheel gear, but the engine does not turn. The other source of trouble is that the main field contacts make before the armature has moved fully forward, so that the motor runs at full speed before the pinion goes into engagement. This causes damage to both the pinion and the ring gear teeth as they hammer on each other. Our repair when this sort of thing happens is just to change the starter motor, but it is essential that before this is done, the ring gear teeth must be examined and dressed up. If this is not done, sooner or later the new starter will jam in gear causing at least flat batteries, or at worst a burn-up, because the starter stays energised.

Now why does the solenoid switch cause trouble? There are a number of reasons:-

1. Incorrect adjustment. Either of the above faults can occur as a result of this.
2. Lockwasher tab on the nut holding the moving contacts not secured properly. After a time, the nut loosens, the adjustment of the contact is lost, and we're back to (1) above.
3. Burnt contacts. These can be caused by bad lining-up on overhaul, but more often by low batteries. We are having a drive on batteries this year, so we hope that failures from this cause will become less. Remember, a starter motor takes a very heavy current - from 550 to 880 amps, depending on whether it's on a Suburban set or an Inter-City, and this current can go up to 1800 amps if the engine is seized.
4. Armature wear. After much use, a ridge tends to wear in the solenoid armature which may cause the armature to jam and prevents operation of the switch.
5. Broken wire. Not a very common fault, but on occasion the solenoid goes open-circuit due to a break in its winding.

Solenoid switches are not the only cause of trouble. According to a C.A.V. agent excessive wear on the front end bearing has been found on a number of starters sent for overhaul. This wear allows the armature to drop and foul the field coils or pole pieces, with consequent malfunction. This is apparently a design fault, and is being looked into.

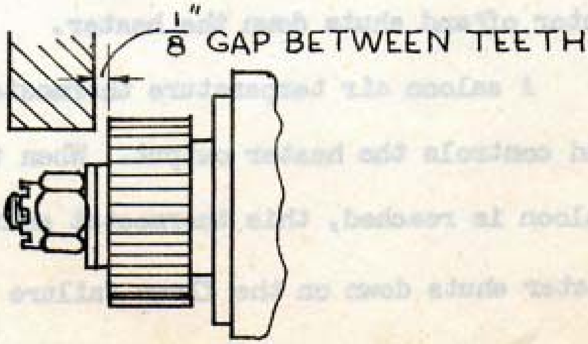


Another cause of starter failures is the old one of earth faults. Usually, earth faults are the result of dirt or water getting inside the casing, but these failures can also be the result of mishandling. Incidentally, mishandling is also likely to be at the back of a lot of the solenoid switch troubles, showing itself as one of the faults listed before.

Starter motors come in for a lot of bad treatment in the Works, in transit between the Works and Depots, and at the Depot. They are heavy items, and it is difficult to move heavy things about without bumping them a bit. The worst thing you can do with these starters is to stand them up on end, so that as they get jolted, the solenoid switch comes in for a lot of punishment. We are trying to get carrying boxes for transit, and have made a sample, but it is rather heavy, and we are trying to make a lighter one. Also we are making up a carrying handle for use in the Depot.

At the moment, we don't really know whether our starter motor failures are due to bad maintenance or bad overhaul, or whether the starter is, in fact, man enough for the job we ask it to do. We are of course looking into this, and earlier this year we had four starter motors specially overhauled, and special care was taken in handling and fitting them. One failed after three weeks, and we found there was a sticky substance on the pinion which was stopping the armature from moving forwards. We never found out where this stuff came from, but it was cleaned off, and the starter has been O.K. since. So far, the other three motors have run for five months and are still going strong.

One last thing which can cause early starter failure is bad fitting to the engine. This can cause as many failures as all the other troubles, and so we must take care when we fit a starter motor. We've already mentioned that the flywheel ring gear teeth must be examined and all the burrs cleaned up, but the gap between the pinion and the ring gear is critical. This must be set at 1/8"as shown in the sketch below. <u>DON'T</u> guess the distance - use a bit of 1/8" plate as a gauge, and get it right!

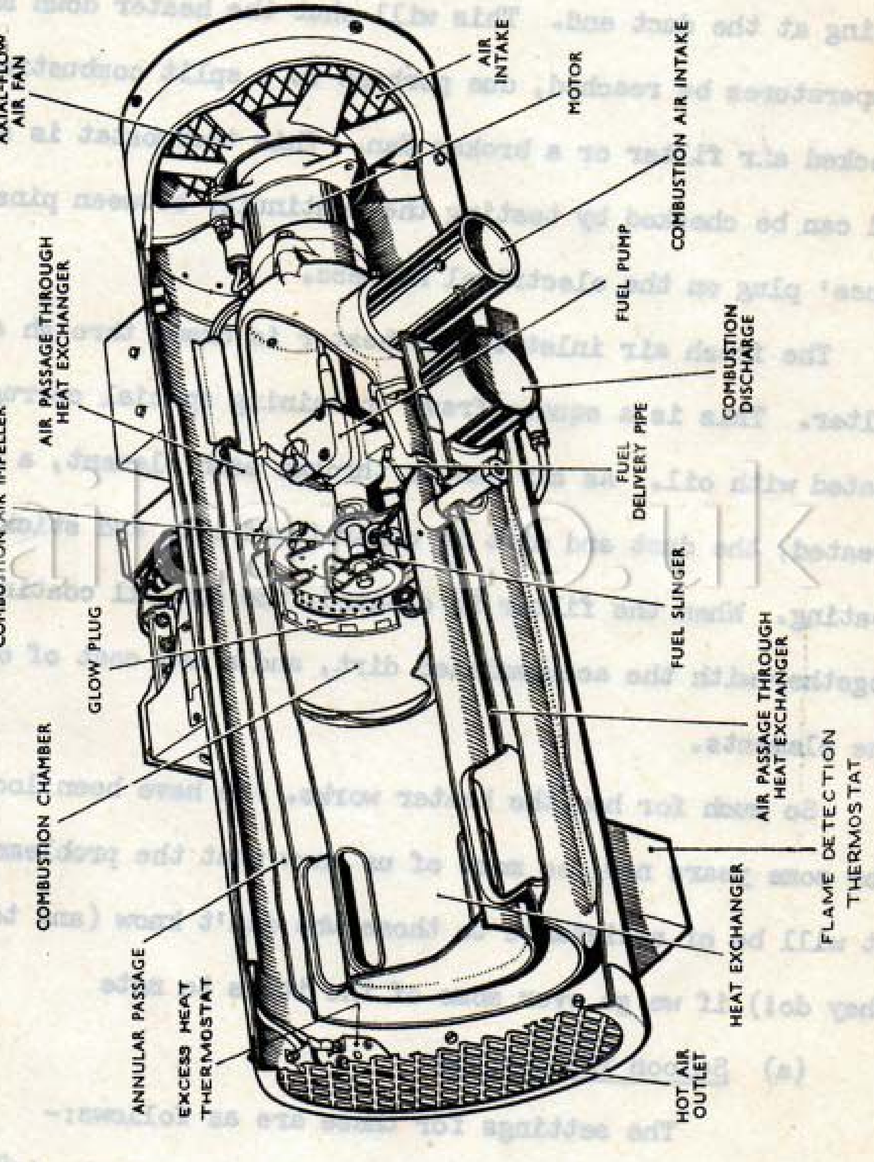


9. SMITH'S FULLY AUTOMATIC HEATERS

The Smith's Heater is simply a burner unit inside a combustion chamber, the whole thing being contained in an outer casing. The burner consists of a "slinger" type nozzle which rotates and sprays atomised fuel on to an annular flame ring. On the slinger shaft is a small impeller which provides air in the correct proportion to fuel for clean combustion. Also on the shaft is a fuel pump, and the shaft extends to the outside of the combustion chamber to the electric motor which drives it. The speed of the motor is about 3,500 r.p.m. (dependent upon the battery voltage), and the motor also drives an axial-flow fan which forces fresh air through the combustion unit heat exchanger and into the air ducting of the railcar.

Ignition is by means of a glow plug which, having lit the fuel spray is switched off automatically, and the flame maintains itself as long as fuel is fed to the slinger. The probe of a flame detection thermostat is mounted at the duct end of the heater. This fits into a threaded sleeve which extends through into the combustion chamber. The thermostat keeps the fuel valve energised and the motor unit running as long as the flame is burning. It also switches off the glow plug when the flame is first established. If the flame goes out, this thermostat switches the motor off and shuts down the heater.

A saloon air temperature thermostat is fitted inside the railcar and controls the heater output. When the desired temperature in the saloon is reached, this thermostat shuts off the fuel valve, and the heater shuts down on the flame failure condition, and similarly the



SMITH'S COMBUSTION HEATER

heater starts up again when the saloon thermostat senses a drop in air temperature.

An excess heat thermostat is fitted inside the top of the heater casing at the duct end. This will shut the heater down should excessive temperatures be reached, due perhaps to a split combustion chamber, a blocked air filter or a broken fan. This thermostat is self-resetting, and can be checked by testing the continuity between pins 2 and 5 on the Jones' plug on the electrical harness.

The fresh air inlet to the heater is drawn through a Ventex intake filter. This is a square frame containing special corrugated elements coated with oil. As air passes through each element, a vortex is created, the dust and dirt is centrifuged out, and sticks to the oil coating. When the filter is cleaned, the old oil coating is washed off together with the accummulated dirt, and a new coat of oil formed on the elements.

So much for how the heater works. We have been looking after them for some years now, so most of us know what the problems are. However, it will be of assistance to those who don't know (and to some who think they do!) if we go over some of the items to note

(a) <u>Saloon Thermostats</u>

The settings for these are as follows:-

Power Cars -	Drivers side (No. 1 Heater)	68°F
	Co-Drivers side (No. 2 Heater)	65°F
Trailers	1st class saloon	65°F
	2nd class saloon	68°F

The reason for the different settings is to ensure that the two heaters on a car dont cycle on and off together. If they did, we would have full heat or none alternately.

When testing heater operation on exams. the ambient temperature may be above the thermostat settings, and the heater will not run. To overcome this, DON'T alter the thermostat, just join pins 11 and 12 on the Jones plug on the left-hand side of the relay panel. This will short out the saloon thermostat and allow the heater to operate. There is, as you see, no need to vary the thermostat settings, and this must not be done. We are looking into means of sealing the adjustments to prevent unauthorised tampering, and will let you know in a future issue of BUMF how to do it.

(b) Flame Detection Thermostats

These have been a source of trouble for some time, the main fault being the failure of the "hot" contacts to open, so that the heater blows cold air. The thermostats are in process of modification, the Invar operating rod inside the sleeve is being made in four pieces instead of two in an attempt to stop the rod jamming if the sleeve becomes distorted. This distortion occurs partly through the alternate heating and cooling, partly through mishandling, and partly through thumping the cap because the thermostat has stuck. The heater is very conveniently sited so that the flame detection thermostat can be kicked from platform level, but don't do it, because you will only make matters worse. If the thermostat doesn't work - CHANGE IT.

(c) <u>Relay Panels</u>

These panels have been modified and this has proved successful in reducing the failure rate. Remember that there are diodes in the panels which may be damaged if a Megger is used, so be sure to disconnect the three plugs when testing.

(d) <u>Resistance Boxes</u>

Remember that when you fit a new heater, you must set the glow plug resistance to No. 5.

(e) <u>Glow Plugs</u>

The glow plug we are using now has been stuffed up with a fire cement to lessen the chance of getting the element carboned up and so being short circuited. This plug still needs regular cleaning on our machine, but it doesn't get as messy as the old type. The main thing with glow plugs is quite simple - change them regularly. Item 7 on the weekly exam. says change them, so do it. Never mind if the glow plug looks O.K. or even works O.K. - CHANGE IT!

The Derby Research Department has developed an experimental glow plug which hardly needs cleaning. The element is a very small diameter Pyrotenax cable with a stainless steel sheath, so it can't short circuit, and a small quantity has been made and put out for trial on another Region. The big problem with this experimental plug is the cost of manufacture, which is very high, so we're all hoping that the production boys will be successful in bringing the price down.

10. THROTTLE MOTORS

In BUMF No. 2 we went through the setting up of the fuel injection pump on the Leyland engine. Now we're going to explain how to set up the throttle motor so that the engine will be O.K. in service.

Assuming that the fuel pump is properly set, we now connect the throttle motor to it, and then synchronise the engines. Remember that it is the fuel pump idling screw which determines the idling revs, and not the throttle motor - or the governor damper.

Now, this is where two trends of thought emerge. The Leyland Mannual states:-

"Attach the throttle motor control rod to the fuel pump lever and the lever on the throttle motor.

With the throttle motor in the idling position (right back) adjust the control rod to obtain idling position on the fuel pump, and check that the engine does not stall when engaging gear.

With the throttle motor in the full-throttle position (No.4 E.P. Valve energised) set No. 4 adjuster screw in the throttle motor so that the fuel pump lever is at full throttle. In order to avoid possible damage to the fuel pump, the control rod should be set so that a .005" feeler will just pass between the stop on the fuel pump control lever, and the stop on the pump.

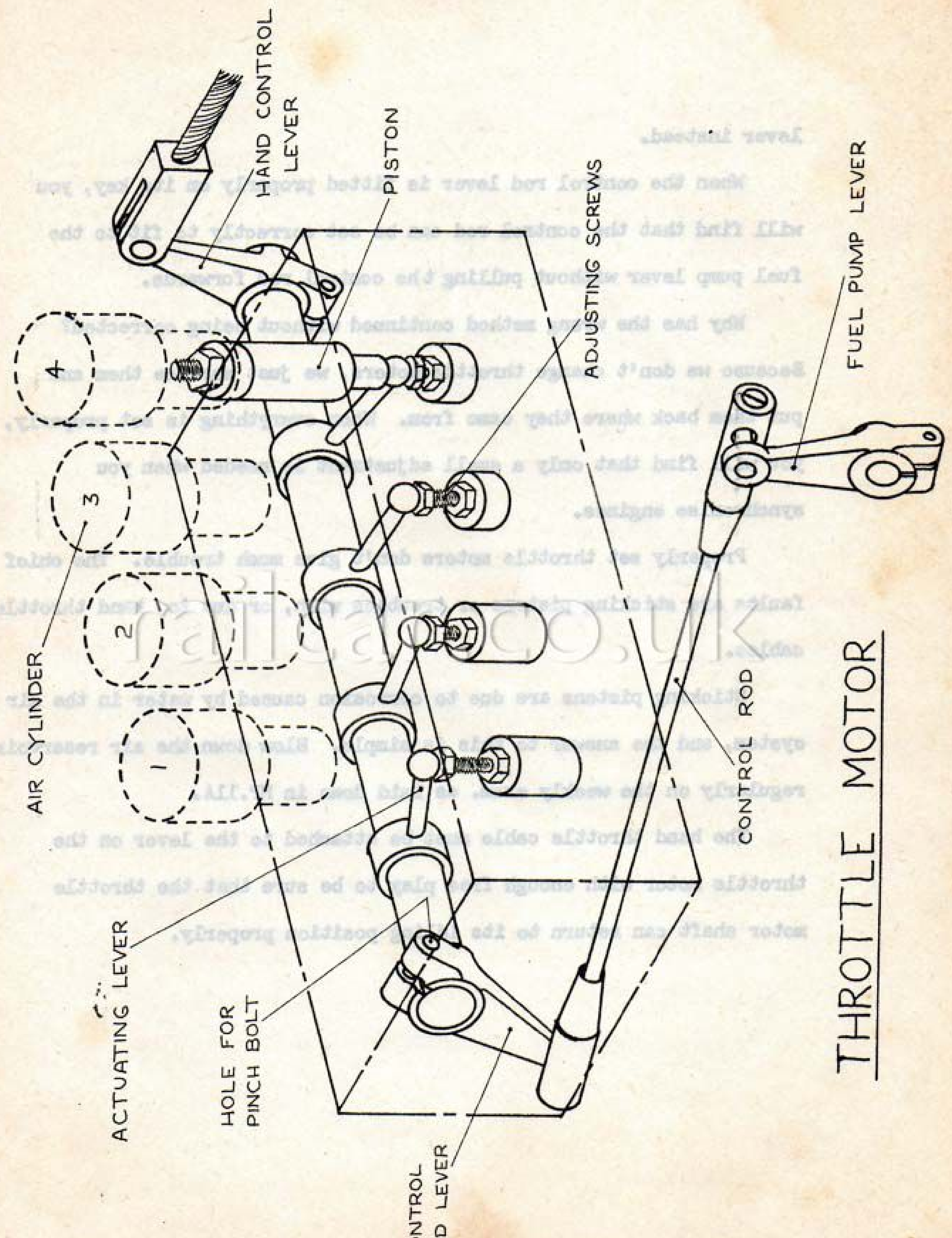
Set the three remaining adjusting screws in the throttle motor to divide equally the angle of travel of the fuel pump lever between idling and full throttle positions. Having set all adjusting screws, they should be securely locked by means of the Locknuts."

That's what the Leyland Mannual says, but the most common way of doing the job is as follows:-

Connect the control rod to the fuel pump lever. If it's too short, pull the rod until the swivel bolt enters the fuel pump lever. Then set No. 4 throttle adjusting screw until a .005" feeler will pass through the stop on the pump. Now adjust No. 1 throttle screw so that the engine speed will increase to about 550 - 600 r.p.m. (just below the runaway position). Then set No. 2 and No. 3 adjusting screws so that they are running in line between No. 1 and No. 4.

If you think about it, there's not much difference between the two methods except for the fitting of the control rod. In one case the rod is adjusted to fit the fuel pump lever accurately, and in the other, it's pulled forward to fit.

The reason for the second way of doing the job is because there hasn't been enough thread on the control rod to allow it to be adjusted to the required length, and so everyone has pulled it forward to couple to the fuel pump lever. The answer to this one is that the lever on the throttle motor is not set properly. This lever should be located on the throttle motor shaft with a Woodruff key, while on the other end of the shaft, the hand throttle cable lever should be fitted without a key. In quite a lot of instances there is no key fitted to the control rod lever, and sometimes it has been fitted to the hand throttle



THROTTLE MOTOR

lever instead.

When the control rod lever is fitted properly on its key, you will find that the control rod can be set correctly to fit to the fuel pump lever without pulling the control rod forwards.

Why has the wrong method continued without being corrected? Because we don't change throttle motors, we just service them and put them back where they came from. When everything is set properly, you will find that only a small adjustment is needed when you synchronise engines.

Properly set throttle motors don't give much trouble. The chief faults are sticking pistons or troubles with, or due to, hand throttle cables.

Sticking pistons are due to corrosion caused by water in the air system, and the answer to this is simple. Blow down the air reservoirs regularly on the weekly exam. as laid down in MP.11A.

The hand throttle cable must be attached to the lever on the throttle motor with enough free play to be sure that the throttle motor shaft can return to its idling position properly.

THE EDITOR REPLIES

Dear Editor,

May I comment on the No. 2 issue of BUMF. You ask on the leading page, do we want a board cover to keep the copies in? I should have thought the answer to this was obvious. I consider the cover of BUMF to be a cheap and tatty piece of brown paper, held together by one staple, so unless a board cover is provided quickly, No. 2 issue will just disintegrate.

On page 5 of the same issue, schematic of D.M.U. Cooling System, there is no vent pipe from the radiator to header tank, no overflow pipe from header tank, no filler pipe, and no water level switch.

On page 9 the idling screw is illustrated on the wrong side of the pump. As great emphasis is made about the idling screws, surely the pump should be illustrated correctly.

However, No. 2 issue contained some interesting articles, let's hope it continues.

"Hopeful" (name supplied)

Dear 'Hopeful',

Well, we asked for comments on BUMF - it looks like we've got 'em!

The cover of BUMF is a cheap (but not tatty) piece of brown paper, which is the reason we asked if board covers were wanted. A number of other people have asked the same question as yourself, so we have ordered some, and they will be available on request to your foreman.

Your comments on the drawings are well founded. Unfortunately we only employ a second-rate draughtsman, and an even worse checker, so these boobs slipped through. In this issue of BUMF you will find that we have printed the cooling system schematic again, with the omissions put in properly.

The idling screw on the fuel pump is <u>shown</u> on the proper side, but the arrow pointing to it is wrong. The reason for this is rather long, and you probably wouldn't believe it, but the arrow should obviously point to the upper of the two screws behind the throttle lever. We have had another drawing made (our poor draughtsman) and we have pointed out both errors at the beginning of this issue.

Ed.

To Editor,

<u>Inter City Power Cars - Water Level Switch</u>

Could you please tell me which way the modification to the Low Water level circuitry is to be done. At the present time there are two modifications in being:-

1. Engine will motor but not fire with low water
2. Engine will not motor with low water.

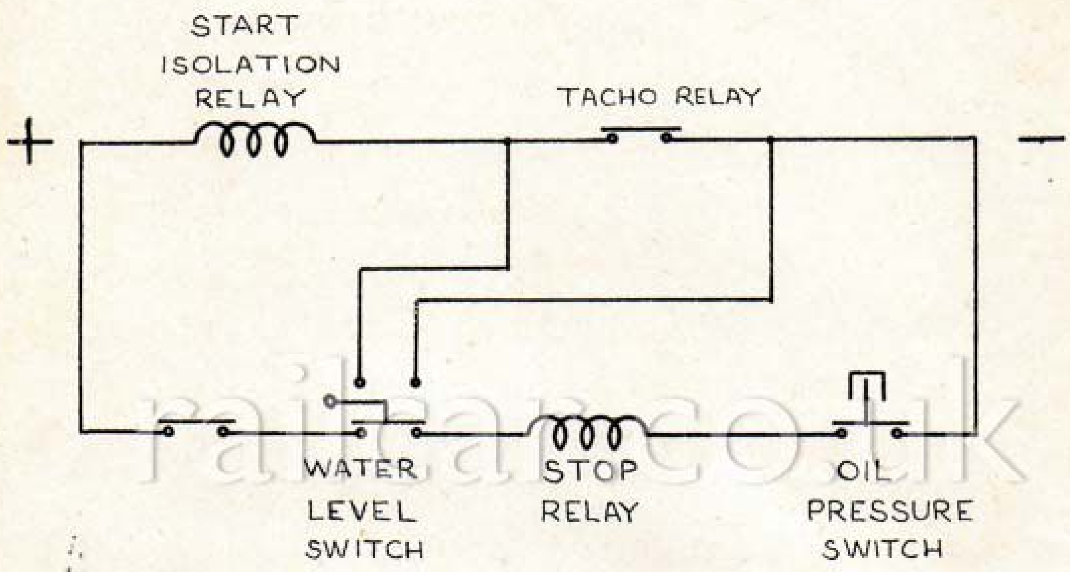
If item 1 is the correct modification, confusion will exist, because this condition could be caused by a Stop Solenoid.

M. Terzic
(Electrician Reading)

Dear Mr. Terzic,

The correct system is that the engine will not motor with low water. This modification is one of those which we understood were carried out at Canton, but it is obvious from your letter that not all the Inter-Cities were done.

The modified system uses the second set of contacts on the water level switch to short out the tacho relay contacts which are in service with the Start Isolation Relay. The sketch below will show you the circuit.

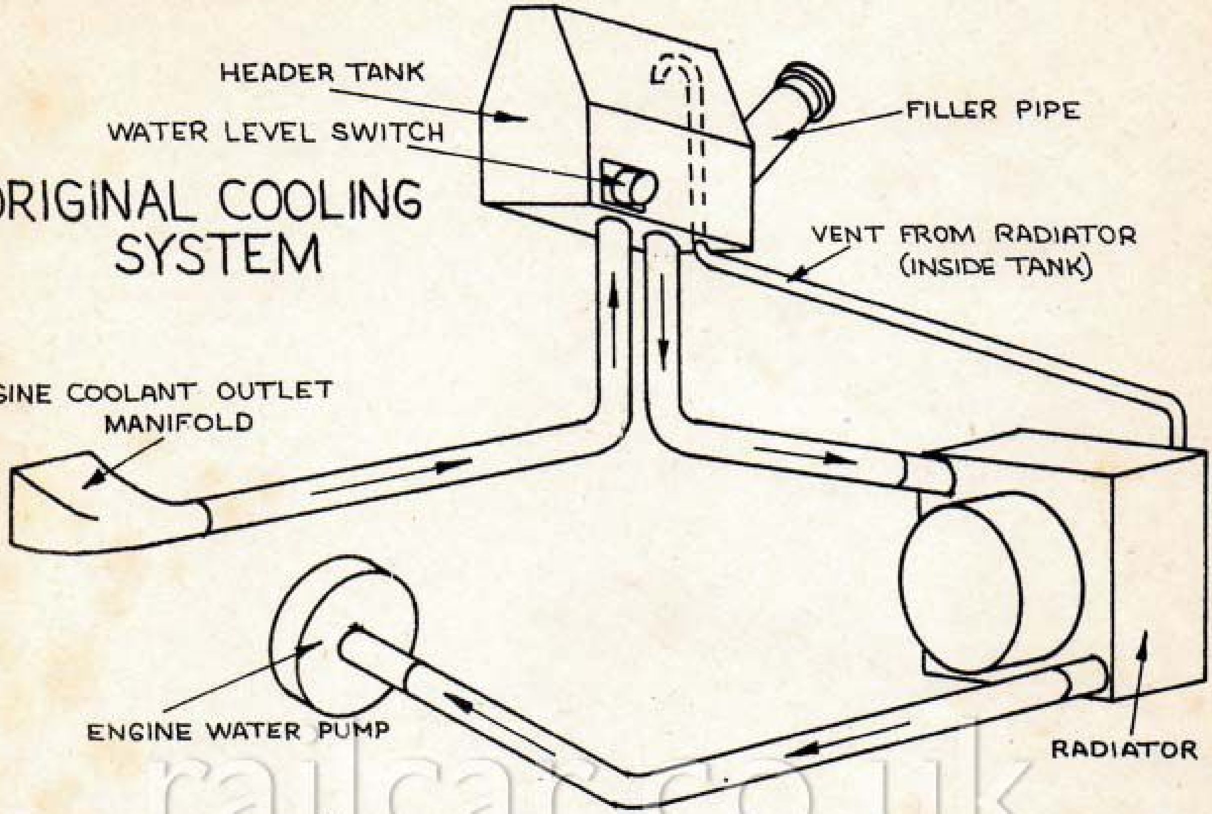


The tacho relay contacts open when the engine shuts down as a result of low water because the tacho stops generating. As the second set of contacts on the water level switch is connected as shown, the start isolation relay stays energised, and the starter motor can't be used.

Thank you for pointing out that the modification has not been done on all cars. We will now have to check each car on the next Depot exam, so that we know which ones want modifying, and can do the job.

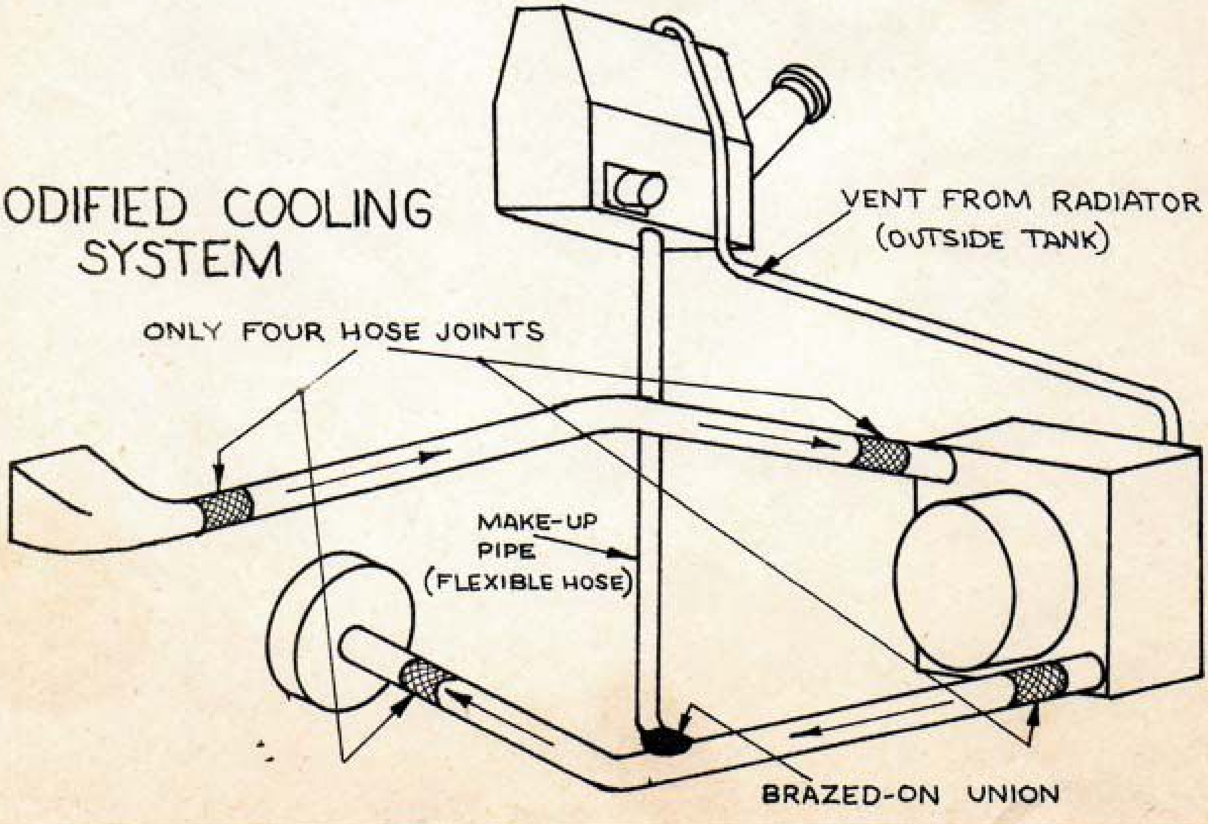
Ed.

ORIGINAL COOLING SYSTEM



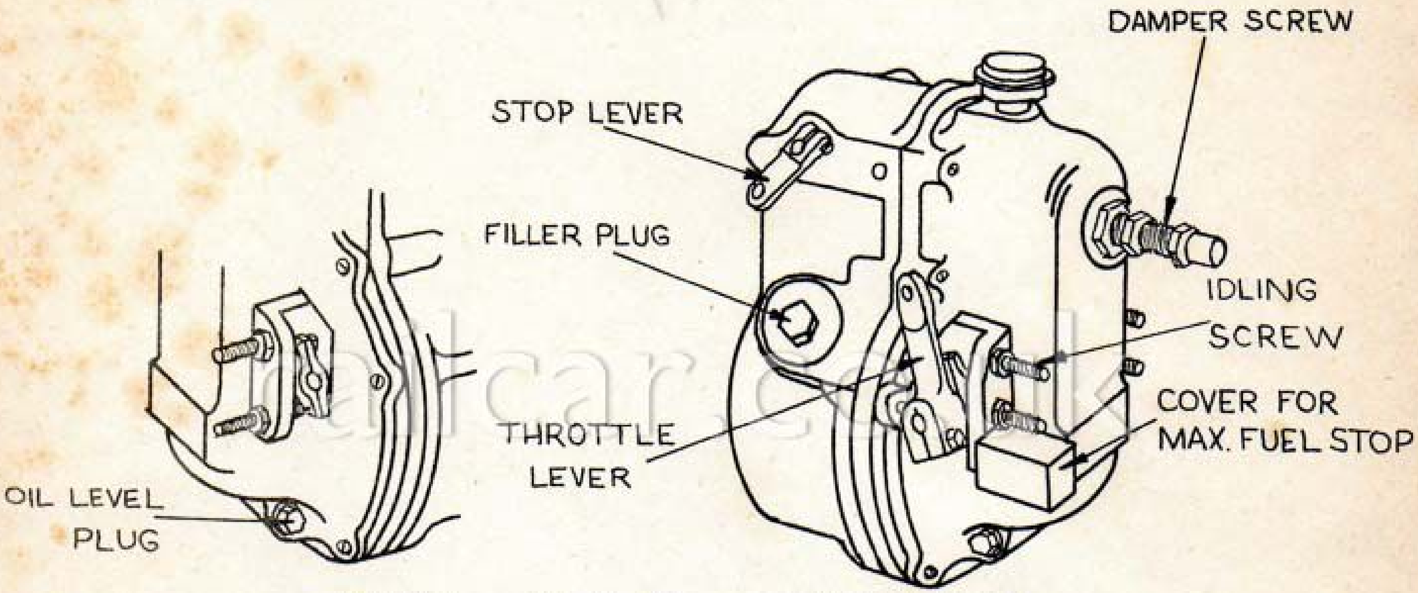
NOTE! PIPE RUNS ARE DIAGRAMMATIC ONLY

MODIFIED COOLING SYSTEM



the damper - well out!

The engine revs are adjusted using the idling screw on the governor, so check the speed with a hand tachometer on the crankshaft fan pulley - NOT the cab gauge - and adjust if necessary to 410 rpm and retighten the lock nut. The speed is not all that critical, 415 or 420 makes no difference but 410 is a minimum.



FUEL PUMP GOVERNOR

The next job is the governor damper. Remember, this is NOT the means of adjusting engine idling speed, and must not be used as such. On the end of the damper screw is a spring loaded plunger which bears on the end of the injection pump rack to stabilise it at idling speed and stop the engine hunting.

Screw the damper in until the engine runs slightly faster, then screw out again until the revs are back to normal, and then screw out a further half-turn. Tighten the lock nut on the damper screw.

Now the fuel injection pump is set up, and we have one more check to do. Race the engine up to full speed and see that it drops smoothly and