ELECTRICAL SYSTEM

The electrical system is of the 12 volt earth return type, the positive terminal of the battery being earthed.

THE BATTERY

The battery is supported in a suitable carrier behind the engine on the clutch housing. It is insulated from the engine by an asbestos bulkhead.

The battery has 9 plates per cell with a capacity of 80 ampere hours at the 10-hour rate, and depending on the territory concerned it is supplied in either a wet or dry (uncharged) state.

Provided the battery is properly maintained, it will function satisfactorily between the extreme temperatures of summer and winter.

If a dry battery is fitted, before putting the tractor into service the battery will require filling with electrolyte and charging as detailed under the heading " Dry Batteries."

Service replacement batteries are of the dry **charged** type and these only require a simple filling operation (see page 4) before the battery is put into service.

For certain export territories twin 6-volt batteries (129 ampere hour capacity at 10-hour rate) are provided, the extra battery being located on the left-hand foot plate.

The extra battery is fitted with a protection cover which will need to be removed when carrying out routine maintenance in order to gain access to the battery filler plugs.

MAINTENANCE

Cleanliness

Keep the battery and the surrounding area, particularly the tops of the cells, clean and dry and brush away any dirt or dust.

Keep the filler plugs tight and clean. Check the gas vents to ensure they are clear.

The terminals should be kept clean and coated with petroleum jelly (not grease).

If distilled water or electrolyte has been spilled on top of the battery, it should be cleaned off immediately, as even weak acid will quickly attack and corrode the cable connections, clamp frame and bolts. Use a rag soaked in a solution of hot water and weak ammonia to neutralise the effect of spilled electrolyte or acid.

Electrolyte Level

When topping up, use clean distilled water. Use only a clean lead, glass or earthenware container.

The correct working level of the electrolyte is shown in Table 3. It is good practice to top up the battery just prior to running the tractor, especially in cold weather, to ensure thorough mixing of the acid and the water and so prevent freezing.

If the battery is found to need an excessive amount of topping up, steps should be taken to determine the reason. For example, the battery may be receiving an excessive charge, in which case the regulator setting should be checked. If one cell in particular needs topping up more than another, it is likely that the case is cracked, in which event the battery must be replaced and the battery carrier cleaned and repainted if necessary.

Specific Gravity

The specific gravity of the electrolyte indicates the state of charge of the battery and should be checked with a hydrometer.

If the level of the electrolyte is so low that a hydrometer reading cannot be taken, no attempt should be made to take a reading after adding distilled water until the battery has been on charge for at least one hour.

Table 1 gives the specific gravity of the electrolyte at various acid temperatures when the battery is fully charged and the low limits of specific gravity when the battery is fully discharged at the normal rate.

Table 1

Temp °F	*Temp* °C	*Specific Gravity*	
		Fully Charged	*Fully Discharged*
110	43	1.264	1.094
100	38	1.268	1.098
80	26	1.276	1.106
70 (Normal)	21	1.280	1.110
60	16	1.284	1.114
40	4	1.292	1.122
20	—7	1.300	1.130
0	—18	1.308	1.138
—20	—29	1.315	1.146

Temperature Correction

Specific gravity varies with temperature and therefore the reading obtained on a hydrometer, at any acid temperature other than the standard of 70°F. (21°C.), must be corrected as follows :—

Add four points (0.004 specific gravity) for every 10°F. (5.5°C.) above 70°F. (21°C.)

Subtract four points (0.004 specific gravity) for every 10°F. (5.5°C.) below 70°F. (21°C.)

Example :—

Hydrometer reading at 80°F. (26°C.) = 1.276

1.276 + 0.004 = 1.280

Therefore battery is fully charged.

Variations in Cell Specific Gravity

When checking the specific gravity at least two readings should be taken of each cell. There should be little variation in the average specific gravity readings from cell to cell on any battery in reasonably good condition. If the variation is greater than 0.025, then the reason should be investigated.

When carrying out the specific gravity test the appearance of the electrolyte drawn into the hydrometer should be observed, if it is very cloudy or contains small particles in suspension, it is probable that the plates are in poor condition.

If acid has been spilled at any time or lost due to a leak, topping up the level with distilled water will lower the specific gravity.

This can be corrected when next charging the battery by adding a solution of sulphuric acid which has an approximate specific gravity of 1.350 or 37° Baumé (tropical batteries 1.245 ; 28.5° Baumé), until the specific gravity of the electrolyte is again standard.

Never use neat or strong acid for this purpose and when diluting always add the acid to the water.

A large variation, which is not the result of acid loss, is probably an indication of an internal short circuit and an early inspection of the battery is advisable.

Checking Battery Condition

There are three methods of checking battery condition ; open circuit voltage test, high rate discharge test and specific gravity test.

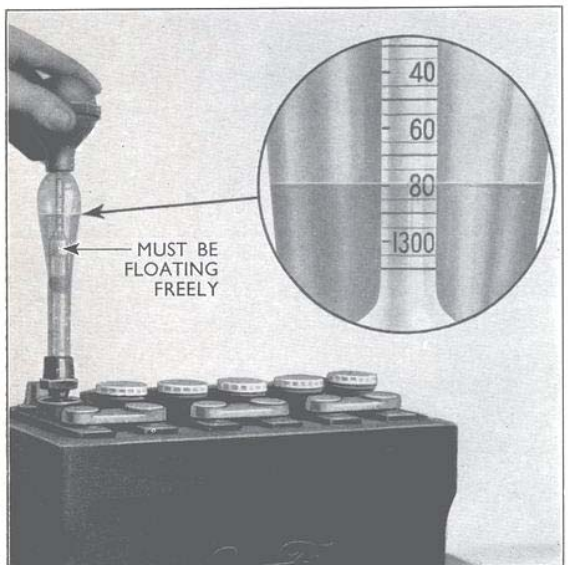

Fig. 1
Checking Battery Specific Gravity

Open Circuit Voltage Test

The open circuit voltage of a battery cell in good condition should be above 2.1 volts (12.6 volts total for a 12 volt battery).

Connect a suitable voltmeter across each cell and note the reading, ensuring that a good contact is made with the terminals.

However, the voltage reading on open circuit is liable to be misleading. If the voltage is low then the cell is definitely in poor condition, but a high voltage reading on open circuit does not necessarily indicate that the cell is in good condition.

High Rate Discharge Test

Never make a high rate discharge test on a battery known to be low in charge.

The high rate of discharge test gives an indication of the condition and capacity of the battery. On a Diagnosis Test Set high rate discharge test, a 12 volt battery should maintain 100 amp. flow for 10 seconds with no appreciable fall in voltage.

Where a hand instrument is used for checking the individual cells of a battery, the actual reading obtained will depend upon the type of instrument used, but the cell voltage on a 5 to 6 seconds test should remain steady between 1.2 and 1.7 volts.

Variations in individual cell readings can indicate faults, but if all cells in any one battery fall below standard, re-charge and again test before rejecting the battery.

Specific Gravity Test

The third method of checking the state of charge of the battery is by means of a specific gravity reading, taken on a suitable hydrometer (see Fig. 1). A fully charged battery should give specific gravity readings of 1.270 to 1.285 (31° to 32° Baumé) when checked with a hydrometer and corrected to 70°F. (21°C.) (see page 1).

General

Never bring a flame or spark near a battery at any time, particularly during or shortly after a charge, as the gases produced may be explosive.

Never add acid to the cells unless :—

1. The specific gravity and voltage at the end of the charge have remained constant over five successive hourly readings.

2. Gas is evolved freely from each cell.

3. The specific gravity is more than 0.010 (10 points) below 1.280 at 70°F. (21°C.), or as given in the fully charged specific gravity table (see page 1).

Never empty acid from a battery to refill with fresh acid unless the battery is fully charged.

Never leave a battery in a discharged condition. It should be recharged as soon as possible.

Avoid high temperatures above 110°F. (43°C.), as electrolyte temperatures above this tend to shorten the life of the battery.

WET BATTERIES

Wet batteries are no longer supplied in service, but if by chance they are removed from tractors and taken into stock it should be remembered that they will, with time, gradually deteriorate.

The actual loss of charge amounts to a fall in specific gravity of approximately 0.0015 in every 24 hours. This means that a fully charged battery having a specific gravity of 1.270 to 1.285 (corrected to 70°F. (21°C.) will, during one month, fall to approximately 1.230 (corrected to 70°F. (21°C.), which is an appreciable drop from the fully charged condition.

For this reason all wet batteries in stock, either on or off tractors, should be recharged at least once per month.

DRY BATTERIES

Dry batteries must not be allowed to stand in an unfilled state after the time period (approximately one year) stamped on the battery label has expired.

When preparing a dry battery for service the following instructions on filling and charging should be strictly adhered to :—

1. Fill each cell with electrolyte of the correct specific gravity (see Table 2) until the electrolyte is at the correct level (see Table 3), above the tops of the separators.

The electrolyte used should be dilute sulphuric acid sufficiently pure for storage battery use and at a temperature not exceeding 90°F. (32°C.).

2. The electrolyte level may fall due to absorption soon after filling, in this case it should be topped-up by adding acid of the correct specific gravity.

3. Replace the vent plugs and allow the battery to stand for 12 hours. If, after 12 hours, the level of the electrolyte has fallen, it should be restored to the correct level by adding further electrolyte.

	6-Volt	*12-Volt*
Normal charge rate and time (dry battery)	10 amps. for 48 hours	6 amps. for 48 hours
Normal charge rate (dry charged battery)	10 amps.	6 amps.
Electrolyte level above separators	$\frac{5}{8}$ in. (15.9 mm.)	$\frac{1}{4}$ in. (6.4 mm.)

Table 3

4. After connecting the positive terminal of the battery to the positive of the charging source and the negative of the battery to the negative of the charging source, charge at the specified rate (see Table 3) until the specific gravity and voltage stop rising.

If this rate of charge is maintained the charging time will be at least 48 hours.

The charge may be interrupted provided the charge periods are of at least eight hours duration and the rest periods do not exceed 16 hours. The battery cannot be considered fully charged until :—

(*a*) It has been charged at the specified rate (see Table 3) for 48 hours.

Should the temperature of the electrolyte reach the maximum figure given in Table 2, reduce the charge current and increase the time proportionately, or suspend the charge.

(*b*) The specific gravity and cell voltage in each cell show no further rise during five hours of continuous charging and all cells gas freely.

Should it be necessary to restore the electrolyte level during charge, top-up with distilled water.

	Temperate Climates	*Tropical Climates*
Specific gravity of electrolyte for filling new batteries	1.260 (30° Baumé)	1.230 (27° Baumé)
Specific gravity of electrolyte at end of charge ..	1.270 to 1.285 (31° to 32° Baumé)	1.240 to 1.255 (28° to 29.5° Baumé)
Maximum permissible temperature of electrolyte during charge	110°F. (43.3°C.)	125°F. (51.7°C.)

Table 2

Specific Gravity of Electrolyte for Filling Dry and Dry Charged Batteries

5. On completion of the charge, the specific gravity should be within the limits shown in Table 2.

If the specific gravity is too low, adjust by removing some of the electrolyte and replace with an electrolyte of about 1.300 specific gravity. If the specific gravity is too high, remove some electrolyte and replace with distilled water.

After adjusting the specific gravity of the electrolyte continue charging until the electrolyte is thoroughly mixed. This may be determined by taking specific gravity readings at 10 minute intervals, and the charge should be continued until three successive readings are the same.

Always wash off any electrolyte that may have been spilled.

DRY CHARGED BATTERIES

The batteries supplied in service are of the dry charged type and may be identified by the part number embossed on the front side of the outer casing. A label is also attached to the battery, and on this label is printed complete filling instructions which must be adhered to when preparing the battery for service use.

At the time of manufacture of a dry charged battery, each battery cell is sealed and it is essential that these seals and the cell filler vent plugs are left in position and not removed in any circumstances, until the battery is to be prepared for actual use. Failure to observe this instruction may result in the battery losing its dry charged characteristics.

It is intended that batteries of this type should only remain in a dry condition for a period of up to six months, and a date by which the battery should be filled and put into use is stamped on the instruction label attached to the battery.

Filling a Dry Charged Battery

1. Remove and discard the seals from each cell filler vent plug.

2. Unscrew and remove each filler vent plug.

3. Fill each cell with electrolyte of the correct specific gravity (see Table 2) until the electrolyte is at the correct level (see Table 3) above the tops of the separators. The electrolyte should be at a temperature preferably between 70 and 90°F. (21 and 32°C.).

The level in each cell will fall rapidly during the first few minutes following filling, and thereafter progressively at a much lower rate.

Allow the battery to stand for approximately ten minutes, then add electrolyte to bring it up to the correct level.

4. Replace the filler vent plugs.

5. Approximately fifteen minutes after initial filling the battery should be ready for service.

Prolonged or unsuitable storage, also low ambient and battery temperatures may result in a longer standing period (up to two hours) being required to ensure sufficient output from the battery for starting a cold or stiff engine. Before installation and if the necessary time and facilities exist, it is beneficial to give a freshening charge for about four hours at the normal charging rate (see Table 3) and then check that all cells are gassing freely. The specific gravity should now approach that of a fully charged battery (see Table 2).

NOTE.—If the battery is put into service after the date shown on the label, it should be dealt with as in paragraphs 1, 2 and 3 above, but a special charge must then be given at the normal charging rate prior to installation in the tractor. This charge should be continued until the voltage and specific gravity of all cells remain constant for five successive hourly readings with all cells gassing freely. The specific gravity of a normal fully charged battery is shown in Table 2.

6. If, owing to unforeseen circumstances, the battery is not put into service immediately after filling, the battery should not be allowed to stand for more than two days before receiving a charge on or off a tractor. Before charging the battery check the electrolyte level in each cell.

7. The electrolyte levels and specific gravity should again be checked within a few days of going into service, and if necessary, the electrolyte levels topped-up.

General

After dry charged batteries have been initially filled and charged, it is possible they may remain idle. If so, they should receive a bench charge, preferably once per month, especially in hot climates, as is the normal practice with wet batteries in store.

It is important that a battery which has been processed for fully dry charge shall be given a charge either on or off a tractor within two days after initial filling. Since there may be a delay in getting the battery into service after it has been filled with electrolyte, it is most desirable that the personnel responsible for filling arrange for the battery to be given a short charge of about four hours duration in every case before despatch, as indicated on the label attached to each battery.

The dry charged characteristics of batteries slowly fall off with time ; hence the limiting date stamped on the label. Such falling off in dry charge characteristics does not mean that the battery which has remained in stock after the expiry of the period given on the label will not have a perfectly normal life in service providing that it is given a sufficient charge before being fitted. It is, however, very much to the Dealer's advantage to see the dry charged batteries are taken from his stock in proper rotation, so that no batteries are kept in his stock for more than six months, and the need to give a lengthy charge before sending a battery out is avoided.

SPECIAL INSTRUCTIONS

Cold Climates

The freezing point of the battery electrolyte will depend upon its specific gravity and, therefore, upon its state of charge. This relationship is shown in the table below.

Sp. Gr. Corrected to 70°F. (21°C.)	*Freezing Point*	*Battery State of Charge*
1.100	18°F. (— 7.7°C.)	Fully discharged
1.150	4°F. (—15.3°C.)	25% charged
1.200	—18°F. (—27.8°C.)	50% charged
1.250	—60°F. (—51.1°C.)	75% charged
1.280	—90°F. (—67.8°C.)	Fully charged

If extreme cold is at all likely it is advisable to keep the battery at least 75 per cent. charged, since it is then extremely unlikely that the electrolyte will freeze.

Topping-up should only be carried out during charging and preferably when the cells are gassing freely, so that the water will mix with the electrolyte before it has time to freeze.

Tropical Climates

Wet batteries supplied with new tractors have an acid specific gravity of 1.270 to 1.285 (31° to 32° Baumé) when in a fully charged condition. These readings are corrected to 70°F. (21°C.).

The specific gravity of the electrolyte in batteries to be used under tropical conditions should, however, be between 1.240 and 1.255 (28° to 29.5° Baumé) on batteries with Porvic separators, when corrected to 70°F. (21°C.). It will, therefore, be necessary to adjust the specific gravity of all wet batteries supplied with new tractors on arrival at their destination.

Methods of Adjusting Specific Gravity in Tropical Climates

1. Immediately the tractor arrives at its destination, check and top up the battery electrolyte level with distilled water. Then place the battery on charge at its normal rate (see Table 3).

2. Continue the charge until the specific gravity has reached its maximum, i.e. until the gravity of each cell remains constant for a period from 2 to 5 hours and all cells are gassing freely.

3. Discontinue the charge, turn the battery upside down and allow it to drain for 10 to 15 minutes.

4. Turn the battery back to its normal upright position and clean the exterior surface of the casing thoroughly, using a cloth moistened with ammonia. This will counteract the effect of spilled acid.

5. With a minimum of delay, refill each cell with acid of 1.200 specific gravity (24° Baumé).

If the cells are not refilled directly after draining, the negative plates will tend to oxidise.

6. Again place the battery on charge at its normal rate and continue the charge for 4 to 6 hours.

7. If the acid specific gravity after the charge is above 1.255 (29½° Baumé) when corrected to 70°F. (21°C.), adjust by withdrawing acid from the cells with a squeezeball and restoring the level with distilled water.

If the specific gravity is below 1.240 (28° Baumé) adjust by adding acid of specific gravity greater than 1.250 (29° Baumé).

8. Following an adjustment to the electrolyte specific gravity, replace the battery on charge at the normal rate until the specific gravity of the acid in each cell has stabilised.

9. Before putting the battery into service, again check the acid levels, adjusting if necessary to the correct level above the separators. Remove acid if the levels are too high or add acid of 1.240 specific gravity (28° Baumé) if too low.

Always give idle batteries a freshening charge at least once a month.

BATTERY CONNECTIONS

If the battery connections are suspected of having a high resistance, the following tests should be applied.

The Earth Strap

Using a 0–3 voltmeter or the leads V— and V+ on the Diagnosis Test Set, connect the negative lead to a good earth on the clutch housing near the battery earth strap.

Connect the positive lead to the positive terminal post (not the battery clamp) whilst the starter motor is cranking the engine with the stop control pulled out.

The reading should be less than 0.1 volts. If it is less than this reading, the connection from the battery to earth is in good condition.

If the reading is more than 0.1 volts, connect the negative lead to the clutch housing end of the earth strap. If the reading is now less than 0.1 volts, the resistance is at the earth strap connection on the clutch housing and the surrounding parts should be cleaned. If the reading is more than 0.1 volts the resistance is at the terminal on the battery which should be cleaned or replaced.

The Starter Motor Connections

Use a 0–15 voltmeter in parallel to the circuit to be tested (on the Diagnosis Test Set, use the leads V— and V+). Connect the negative lead to the battery negative post and clip the positive lead to the field terminal connection on the end of the starter motor, taking care not to touch the starter cable.

The meter should now read full battery voltage. Operate the starter motor with the stop control pulled out when the reading should be less than 0.5 volts.

If the reading is less than 0.5 volts, the connections at the battery, solenoid switch and starter motor are satisfactory.

Should a high reading exist, indicating a high resistance, the positive lead should be connected to the battery terminal of the solenoid switch. Operate the starter (stop control still out), when the reading should be less than 0.5 volts.

If the reading is more than 0.5 volts, connect the negative lead of the voltmeter to the battery negative cable clamp connection to the battery. If the reading is now less than 0.5 volts, the resistance is at the battery cable connection to the battery.

If the upper portion of the negative cable is in order, connect the positive lead to the field connection of the starter motor and the negative lead to the starter terminal of the solenoid. Keep the stop control pulled out and again operate the starter motor when the reading should be less than 0.5 volts. If both readings are less than 0.5 volts, there is a high resistance in the solenoid.

Having determined the location of the high resistance, the part should be cleaned or renewed as necessary.

THE GENERATOR

The generator is of the two-brush type with blade terminal connections and, is used in conjunction with a voltage control regulator mounted in the instrument box. The generator is driven at 1.5 times engine speed.

Prior to tractor serial number 09B728446 a generator of the same overall dimensions but with screwed terminal posts and detail internal differences was used, and where such differences occur these are shown in the repair operations below.

Testing the Generator

Output Test

Disconnect the leads from the "D" and "F" terminals of the generator and join the terminals together with a short piece of wire. Connect a 0–30 voltmeter between this junction and earth. Run the engine at 1,000 r.p.m. when the voltage reading should rise rapidly without fluctuation above 24 volts. Do not increase the engine speed above 1,000 r.p.m. in an endeavour to obtain this voltage, as this will give a false reading.

If there is no reading, check the generator leads, brushes and brush connections. If the reading is very low, the field or armature windings may be suspected.

Motoring Test

If the output reading is incorrect, but does not indicate the cause of the trouble, remove the fan belt by slackening the generator mounting bolts and moving the generator in towards the engine. Connect a 0–30 ammeter between the joined terminals of the generator and the battery negative post.

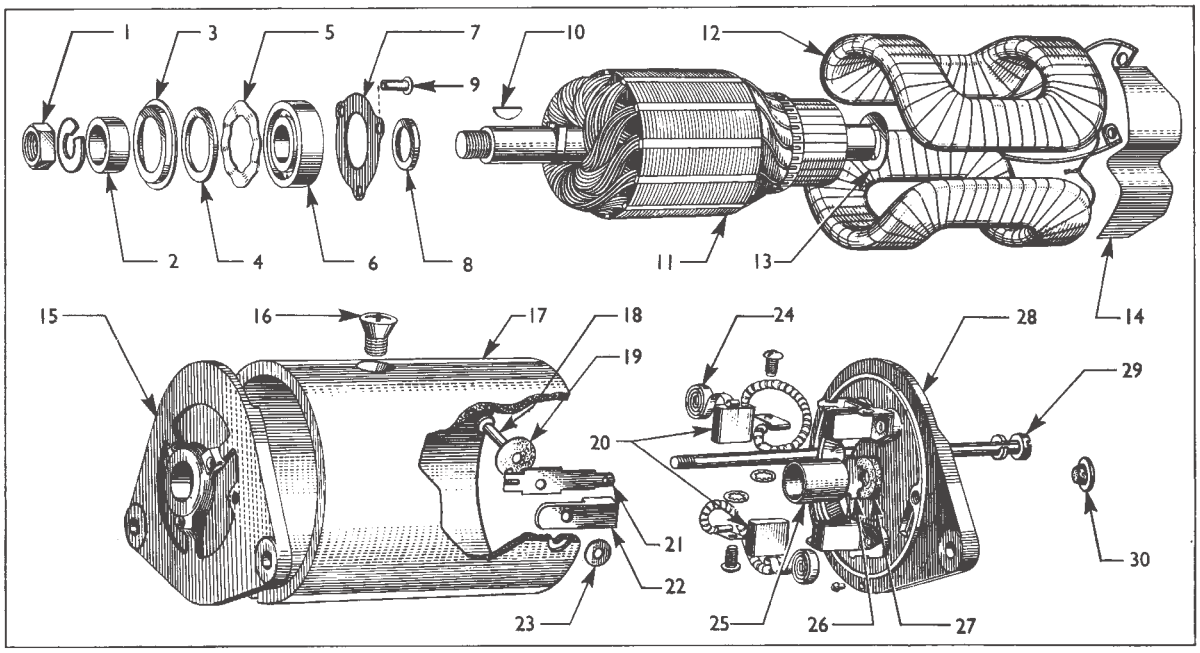

Fig. 2 **Exploded View of the Generator**

1 Nut
2 Collar
3 Retainer
4 Felt
5 Corrugated washer
6 Bearing
7 Retainer plate
8 Ring retainer
9 Rivet
10 Key
11 Armature
12 Field coils
13 Distance washer
14 Insulator
15 Drive end plate
16 Pole piece screw
17 Yoke
18 Rivet
19 Insulator
20 Brushes
21 Field terminal
22 Insulator
23 Insulator
24 Brush spring
25 Bush
26 Retainer
27 Felt
28 Commutator end plate
29 Through-bolt
30 Plug

The generator should now motor and the current consumption should be 4 to 6 amps.

(*a*) A high reading on the ammeter is an indication of tight generator bearings.

(*b*) An excessively high reading will indicate a short circuit.

(*c*) A low reading is a general indication of bad commutation.

Remove the joining wire between the " D " and " F " terminals and refit the fan belt.

Field Coil Resistance

The resistance of the field coils should be calculated by Ohm's law, after taking a reading of the current consumption.

The field coil current consumption should be checked with the generator " D " and " F " leads disconnected and an ammeter connected between the battery negative post and the " F " terminal of the generator.

For an accurate reading, the battery voltage applied to the generator for this test should be 13.5 volts. With this voltage applied, the current reading should be observed and the field coil resistance calculated from Ohm's law, viz. :—

$$R = \frac{E}{I}$$

where R = the field coil resistance in ohms.
E = the applied voltage.
I = the current reading on the ammeter.

The correct field coil resistance is 5.7 to 6.3 ohms at 68°F. (20°C.).

OVERHAULING THE GENERATOR

To Remove

1. Slacken the three securing bolts and move the generator in towards the engine so that the fan belt may be detached.

2. Disconnect the wiring connections from the generator terminals.

3. Remove the three securing nuts and bolts and lift the generator from its supports on the side of the cylinder block.

To Replace

1. Place the generator against its forward support bracket with the drive end plate in front of the support bracket leg and locate it with the three securing bolts. (It may be necessary to slacken the nut securing the generator adjusting strap to the cylinder block.)

2. Refit the fan belt over the generator pulley and move the generator away from the engine until there is 1 in. (25.4 mm.) free movement of the fan belt, measured midway between the generator and crankshaft pulleys. Tighten the adjustment bolt and generator mounting bolts securely.

3. Reconnect the leads to the terminals on the commutator end plate. The red/white tracer wire has the small blade connector which fits the " F " (smaller) terminal and the yellow/white tracer wire has the larger blade connector which fits the " D " terminal.

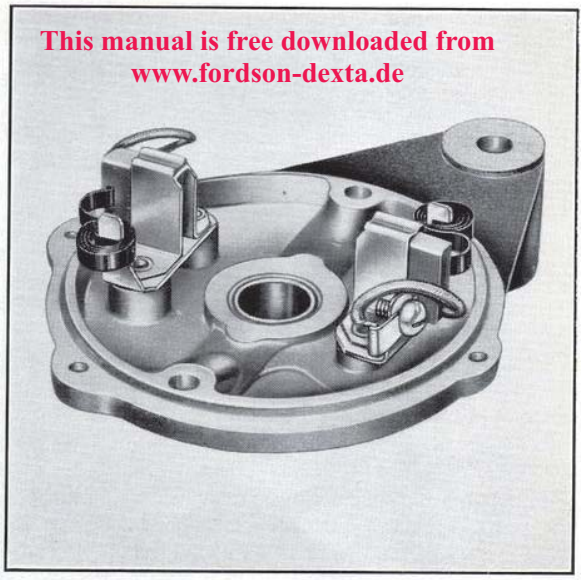

Fig. 3
Brushes Held in the Raised Position

Before Tractor Number 09B728446 :—

Reconnect the leads to the terminals on the commutator end plate. The red/white tracer wire to the " F " (smaller) terminal and the yellow/white tracer wire to the " D " terminal.

To Dismantle

1. Remove the generator as described above.

2. Secure the pulley and unscrew the pulley nut and spring washer. If the pulley is tight on the shaft, it may be removed, using the universal pulley puller CPT.6041. Detach the key and spacer.

3. Unscrew the two through bolts which hold the end plates together. The commutator end plate assembly is now free and can be removed from the yoke.

If it is a tight fit, it should be carefully levered off with a screwdriver.

Do not lose the distance washer on the commutator end of the armature shaft.

4. The drive end plate and armature may now be pulled from the generator yoke.

NOTE.—The drive end plate and armature should not be separated unless the front bearing requires attention.

To remove the field coils, refer to page 9.

To Reassemble

1. Replace the field coils as described on page 9.

2. Place the armature and drive end plate assembly in the generator yoke from the front end, so that the dowel on the bracket locates in the slot in the yoke end face.

3. Replace the distance washer on the commutator end of the armature shaft. Ensure that the insulator strip is fitted between the field coil connections and the generator yoke.

4. Check the brush gear as described under "Generator Brushes." Enter the brushes into their holders securing them in the raised position by locating the brush springs against the sides of the brushes (see Fig. 3).

5. Position the commutator end plate on the armature shaft until the brushes are partially entered over the commutator. Enter a thin screwdriver in the gap between the yoke and the commutator end plate and gently lever the brush springs away from the brushes to allow the brushes to lower fully on to the armature, then locate the spring ends correctly on the top of the brushes.

The commutator end plate may now be pushed home, making sure that the dowel engages in the slot of the yoke end face.

6. Replace the two through-bolts and spring washers from the commutator end, screwing them into the drive end plate. Make sure that the top bolt (looking from the commutator end with the generator positioned as on the tractor) passes between the insulator strip and the generator yoke, thus clearing the field coil bridge connection.

7. Locate the spacing collar on the front of the armature shaft and fit the key in the shaft key-way.

Align the key-way in the pulley with the key on the shaft and gently tap the pulley into position, using a hide mallet. Refit the generator pulley nut and lockwasher and tighten securely.

8. Refit the generator as described on page 7.

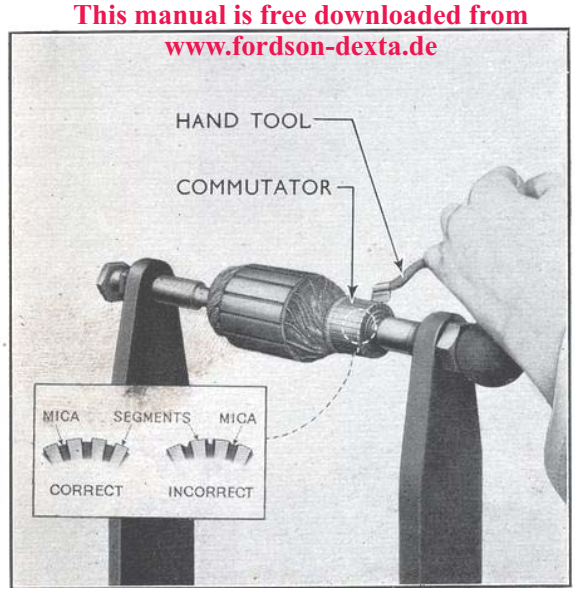

Fig. 4
Undercutting the Generator Commutator Segments

THE GENERATOR BRUSHES

To Remove

1. Remove the generator as described on page 7.

2. Unscrew the two through bolts which hold the end plates together. The commutator end plate assembly is now free and can be removed from the yoke.

3. Raise the brush springs and draw the brushes out of the brush holders.

4. If the brushes are sticking, clean with a petrol-moistened rag and, if necessary, ease the sides by polishing on a smooth file.

If the brushes are worn to 0.35 in. (8.89 mm.) in length or if the brush lead is exposed on the brush face, new brushes must be fitted.

5. Unscrew the brush terminal screw, holding the brush lead, taking care not to lose the lockwasher. The brush may now be removed.

6. Slide the loop on the brush spring off the post and remove the spring if necessary.

To Replace

The contact face of the brush is pre-formed so that bedding to the commutator is unnecessary.

If the original brushes are being replaced, refit in the same positions as removed to maintain correct brush contact with the commutator.

1. Replace the brush spring on the post and "wind-up" the spring until it exerts pressure on the top of the brush holder.

2. Raise the brush spring and locate the brush into the holder, ensuring that it is free to slide. Place the end of the brush spring on the top of the brush.

3. Connect the brush lead to the terminal on the holder and secure with a screw and lockwasher.

4. Refit the commutator end cover as previously described.

5. Replace the generator as previously described.

THE COMMUTATOR

The commutator should be inspected when the generator is dismantled. A commutator in good condition will be smooth and free from pits or burned spots.

Clean the commutator with a petrol-moistened cloth. If this is ineffective, carefully polish it with a strip of very fine glass paper, *not emery cloth*, while the armature is rotated.

If the commutator is badly worn or scored, mount the armature, with or without the drive end bracket, in a lathe, rotate at high speed and take a light cut with a very sharp tool, removing only the minimum of metal.

Polish the commutator with very fine glass paper. Undercut the mica insulation between the segments to a depth of $\frac{1}{32}$ in. (0,8 mm.) with a hacksaw blade

Fig. 5
Testing Field Coils for Continuity

ground down to the thickness of the mica (see Fig. 4), i.e. to the width of the spaces between the commutator segments, if the proper equipment is not available.

Finally, polish the commutator with fine glass paper and remove all copper dust. Check the armature for short circuits to the shaft or core.

THE ARMATURE

If the armature is suspected of being faulty and no signs of burning, arcing or broken connections are visible, it should be checked on suitable armature testing equipment or by substitution.

No attempt should be made to machine the armature core or true a distorted shaft.

GENERATOR FIELD COILS

To Test the Field Coils

To check field coils suspected of being faulty it is necessary to drill out the rivet securing the terminal post to the yoke in order to be able to isolate the two field coil tappings.

To ensure correct alignment of the post when refitting, the commutator end plate should be temporarily placed in position before final peening over the end of the rivet.

Continuity

Connect the prods of a suitable continuity tester between the two coil tappings. If the proper equipment is not available, use a 6 or 12 V. battery and voltmeter as shown in Fig. 5.

If the bulb lights or a reading is given on the meter, it indicates a complete circuit through the field coils.

Earth

Connect the test prods between one tapping and the generator yoke. If the bulb lights, the coils are earthing.

It is also advisable to examine the terminal post insulation for the possibility of earthing.

To Remove the Field Coils

1. Dismantle the generator as described on page 7.

2. Remove the insulation strip which prevents the junction of the field coils contacting the yoke and through-bolts.

3. Mark the yoke and pole pieces in order that they can be refitted in their original positions. Make the marks on each pole piece distinguishable from the others, so that they cannot be refitted in the wrong position and thus alter the residual magnetic polarity of the generator.

4. Carefully mark the two wires connected to the terminal post, as the wire nearest the yoke (red) is earthed while the other wire (yellow) is insulated.

Remove the terminal post and unsweat the terminals from the field coil wires.

5. To expand the pole pieces, use a pole piece expander. Locate the expander inside the yoke and tighten the end nut securely (see Fig. 6).

6. Mount the yoke and pole piece screwdriver CPT.9504 in a vice, as shown in Fig. 7, when the pole piece screws can be slackened off and finally removed.

7. Remove the pole piece expander, when the pole pieces and field coils can be withdrawn from the generator yoke.

To Replace

1. Place the new field coils over the pole pieces and position them in the generator yoke. The pole

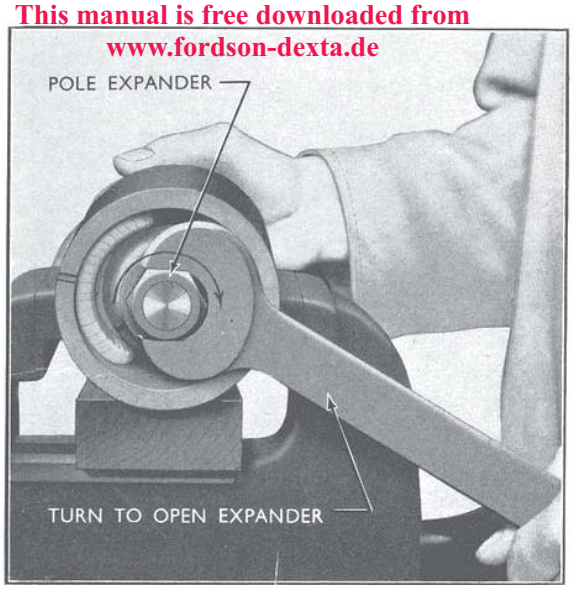

Fig. 6
Expanding the Pole Pieces

pieces must be refitted in the same position from which they were removed and the field coil wires must point towards the apertures in the yoke and be on the same side as the terminal post. Take care not to trap the wires between the pole pieces and the yoke.

2. Replace the pole piece screws, tightening them up to retain the field coils in position.

3. Insert the pole piece expander and open it up to its fullest extent, tightening the pole pieces as much as possible.

4. Mount the yoke and pole piece screwdriver in a vice, and tighten the screws fully.

5. Remove the pole piece expander.

6. Replace the insulator strip between the field coil connections and the yoke.

7. Re-solder the two field coil connections to their correct terminal tags ; refit the terminal post and secure with a new rivet.

8. Reassemble the generator as previously described.

NOTE.—It may be necessary to provide residual magnetism in the field coils after the generator has been replaced on the tractor.

Before Tractor serial number 957E–58225, flick the cut-out points together with the generator connected up.

From Tractor serial number 957E–58225, a sealed regulator has been fitted. With this type of regulator, momentarily connect together the " D " and " A " terminals on the regulator, with the generator connected up.

Fig. 7
Removing the Pole Piece Screws

DRIVE END PLATE BEARING

To Remove

1. Remove the pulley, key and collar and dismantle the generator.

2. Press the armature shaft out of the drive end plate.

3. Drill out the rivets which secure the bearing retainer plate to the end plate and remove the plate.

4. Press the bearing out of the end plate and remove the bearing washer, felt washer and retainer from the bearing housing.

To Replace

1. Clean the bearing housing and bearing and lubricate with high melting point grease.

2. Place the retainer, felt washer and bearing washer in the housing.

3. Locate the bearing in the housing and press it home, using an adaptor of sufficient diameter to take the thrust on the outer race of the bearing.

4. Fit the bearing retainer plate. Insert four new rivets from the outside of the end bracket and open the rivet ends by means of a punch to secure the plate rigidly in position.

5. Ensure that the metal clip and retainer are located in the groove on the armature shaft and press the drive end plate on to the shaft so that the retainer plate abuts the clip.

6. Reassemble the generator and refit the pulley.

COMMUTATOR END PLATE BEARING

To Remove

1. Remove the generator commutator end plate and remove the brushes.

2. Remove the bearing bush by screwing a $\frac{5}{8}$ in. tap into the bush for a few turns and pulling out the bush with the tap. Screw the tap squarely into the bush to avoid damage to the end plate.

3. Remove and clean the felt ring and aluminium four-lobed washer.

To Replace

NOTE.—Before fitting the new bush it should be allowed to stand for about 24 hours, immersed in thin engine oil. The bush is of the porous bronze type, and this will allow the pores of the bush to be filled with lubricant. Do not drill a lubricating hole through the bush or attempt to ream it.

1. Insert the felt ring and aluminium four-lobed washer.

2. Refit the bush in the end plate, using the driver CPT.9507, so that the top of the bush is flush with the bottom of the chamfer.

3. Reassemble the generator.

THE VOLTAGE CONTROL REGULATOR

The regulator unit consists of a cut-out and voltage regulator. Normally, the regulator requires very little attention in service.

However, should it be suspected that it is not functioning correctly, tests should be made to ensure that the rest of the electrical circuits are in good condition and are not affecting the operation of the regulator.

Important points which can give a false indication of a regulator fault are given below, and should be carefully checked before attempting to effect any replacements.

The regulator is fitted inside the instrument panel immediately below the rear of the fuel tank. To gain access to the regulator, disconnect the proofmeter drive and the engine stop control cable from the fuel injection pump, remove the instrument panel side plates and extract the two set-screws securing the instrument panel to the fuel tank rear support bracket. Draw the panel towards the rear of the tractor and turn it to gain access to the regulator.

Preliminary Checks

Fan Belt

Make certain that the generator support brackets are securely tightened in position. Check the fan belt and ensure that it is adjusted correctly without the slightest suspicion of belt "slip." A slipping belt may cause an erratic or low charging rate. Ensure that the fan belt is correctly aligned and that the pulleys are not damaged.

Battery

Check the battery condition as previously described. Top up if necessary. Clean off any corrosion from the battery terminals and cable ends and make certain that the top of the battery is clean and dry.

A sulphated battery or corroded terminals will result in a low output even though the open circuit setting of the regulator may be correct. (Both these conditions will probably result in unsatisfactory starter motor operation.)

If a battery has a short-circuited cell, or the top of the battery has become soaked with acid, or is in a poor condition due to abuse or prolonged service, it will result in a high charging rate.

Check the earth connections from the battery and the regulator to ensure that they are tight and in good condition.

Generator and Connections

Check that the generator is functioning satisfactorily and ensure that the leads "D" and "F" are not crossed either at the regulator or generator. If the leads are crossed, the regulator points will have "welded" together the moment the engine was started. Make sure that the leads are not broken or damaged and that the connections are tight.

Test the generator as previously described.

TESTING AND ADJUSTING THE REGULATOR (After Serial No. 957E–58225)

From Tractor Serial No. 957E–58225 a new regulator has been fitted and due to the unit being sealed it is not possible to make repairs to it, but the following tests are given to enable the regulator to be checked and, on current units which have adjustment apertures, for adjustments to be carried out when determining electrical system faults.

As the new regulator has no "A1" terminal (necessitating a new wiring loom) and different mounting bolt dimensions, it cannot be used as a direct replacement for the previous regulator, except by the fitting of a new instrument panel (or modifying the existing panel) and the new wiring loom.

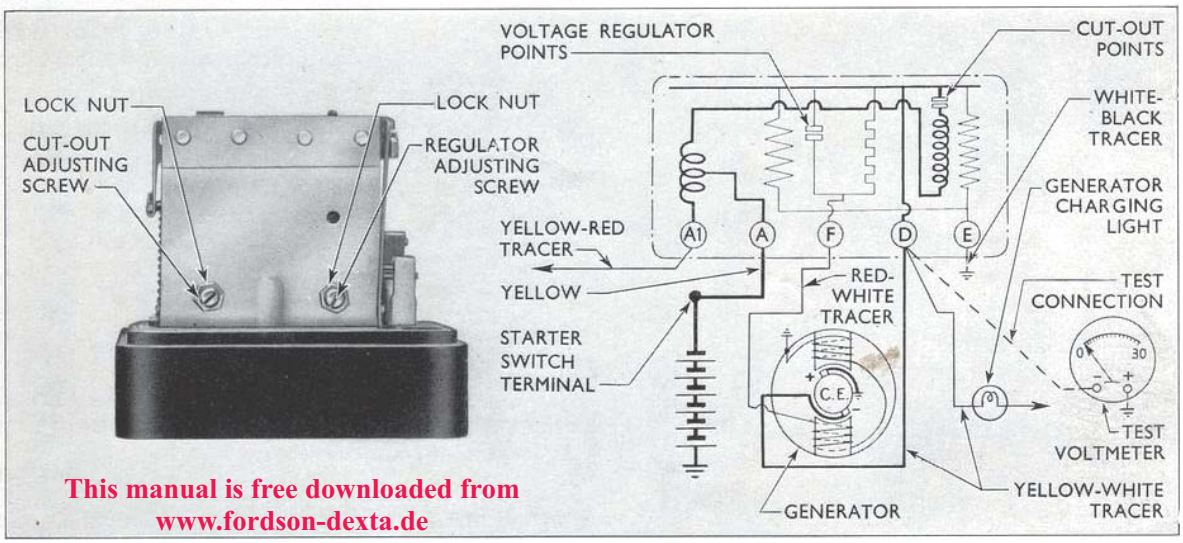

Fig. 8
Regulator and Wiring Diagram

Open Circuit Voltage Test

1. Withdraw the cable from terminal marked " A."

2. Connect the negative lead of a test voltmeter (0–30 V) to terminal " D " on the regulator and the positive lead to a good earth or the terminal " E."

3. Tests must be made with the regulator cold, i.e. immediately on starting the engine, the atmospheric temperature should be noted by means of a thermometer.

4. Start the engine and increase its speed to maximum engine r.p.m.

5. Observe the voltmeter reading, it should lie between the limits given below for the approximate temperature of the regulator unit.

Atmospheric Temperature	*Regulator Setting Volts*
50°F. (10°C.)	16.1—16.7
68°F. (20°C.)	16.0—16.6
86°F. (30°C.)	15.9—16.5
104°F. (40°C.)	15.8—16.4

6. If the voltage at which the reading becomes steady occurs outside these limits the regulator must be adjusted. This operation can be carried out by means of a screwdriver with an insulated blade passed through the right-hand of the two holes on the regulator unit. A screwdriver with a bare blade should not be used due to the risk of a short circuit.

Ampere Output Test

1. With the lead to the " A " terminal disconnected, connect an ammeter in series with the lead " A " and terminal " A."

Fig. 9
Voltage Regulator

2. Speed up the engine and observe the charging rate. This will vary according to the state of charge of the battery, up to a maximum of 11 amps.

Cut-out Test

1. Connect the voltmeter between the " D " terminal and a good earth or the " E " terminal.

2. Switch on an electrical load (e.g. the headlights).

3. Start the engine and slowly increase its speed, at the same time observing the voltmeter needle. When the cut-out contacts close, a slight flick of the needle will be noticed, and this should occur within the cut-in voltage limits of 12.7—13.3 volts. If necessary the cut-out can be adjusted by means of an insulated screwdriver passed through the left-hand of the holes in the casing.

TESTING AND ADJUSTING THE REGULATOR (Before Serial No. 957E–58225)

Before Tractor Serial No. 957E–58225 a regulator with a removable cap and consequently, fully adjustable, was used and details of the checking and adjustment of this regulator are given below.

1. Insulate the cut-out points with a thin strip of mica or withdraw the cables from the terminals marked " A " and " A1 " (see Fig. 8) and join them together.

2. Connect the negative lead of the test voltmeter (0–30 V.) to terminal " D " on the regulator and the positive lead to a good earth.

3. Adjustment must be made with the regulator cold, i.e., immediately on starting the engine the atmospheric temperature should be noted by means of a thermometer.

4. Start the engine and gradually increase the speed until the voltmeter needle " flicks " and then steadies.

This should occur at a voltmeter reading between the limits given below for the approximate temperature of the regulator unit.

Atmospheric Temperature	*Regulator Setting Volts*
50°F. (10°C.)	16.1—16.7
68°F. (20°C.)	16.0—16.6
86°F. (30°C.)	15.9—16.5
104°F. (40°C.)	15.8—16.4

If the reading is not between these limits, the regulator is in need of adjustment.

5. Increase the speed gradually to maximum r.p.m. when the voltmeter needle should not rise more than 0.5 volt above the tabulated readings.

If the voltmeter reading continues to rise as the engine speed is increased, possibly swinging the needle right over, it is indicative that either the regulator points are not opening or there is a poor or no earth between the regulator and the body.

If the points are not opening, the regulator should be renewed, as it is probably that they are " welded " or shorted, or there is an open circuit in the shunt coil.

6. If the voltage at which the reading becomes steady occurs outside these limits the regulator must be adjusted.

Shut off the engine and remove the cover. Slacken the lock-nut of the regulator adjusting screw (see Fig. 8), and turn the screw in a clockwise direction to raise the setting or in an anti-clockwise direction to lower the setting. Turn the screw only a fraction of a turn at a time and then tighten the locknut. Again run up the engine and repeat as above until the correct setting is obtained.

Adjustment of regulator open-circuit voltage should be completed within 30 seconds, otherwise heating of the shunt winding will cause false settings to be made.

A generator run at high speed on open circuit will build up a high voltage. Therefore, when adjusting the regulator, increase engine speed *slowly* until the regulator operates, otherwise a false setting may be made.

7. Reconnect the wires to terminals " A " and " A1 " or remove the insulation from the cut-out points.

Ampere Output Test

1. Connect a test ammeter in series with the lead " A " and terminal " A."

2. Speed up the engine and observe the charging rate. This will vary according to the state of charge of the battery.

To Clean the Regulator Points

These must be removed for cleaning, and this should be carried out as follows :—

1. Slacken the locknut securing the fixed contact and screw to its bracket. Unscrew and remove the fixed contact and screw.

2. Remove the two armature screws and lockwashers (see Fig. 9) and detach the metal strip.

3. Move the fixed contact mounting over slightly, enabling the moving contact bracket to be lifted out. Take care not to lose the insulating strips positioned on either side of the fixed contact mounting bracket.

4. Clean the contact points with a suitable cleaning fluid or carborundum paper operated in a circular movement. Carefully wipe away all traces of dirt or other foreign matter. Finally, wipe both points with methylated spirits (de-natured alcohol).

5. Replace the points in the reverse sequence to that described above in paragraphs (1) to (3), and reset the air gaps as described later.

In the event of the regulator not functioning correctly after adjustment, re-examine the regulator contacts. Any pitting or dirt must be removed as a clean smooth surface is essential.

Fig. 10
Cut-out Points
(Setting the Fixed Contact)

Resetting the Regulator Armature

The armature or moving contacts should not normally be removed, as the air gaps between the core and the frame are accurately set and are of great importance to the satisfactory operation of the regulator. If, for any reason, however, the armature has been removed, or its setting altered, it should be reset as follows :—

1. Disconnect the battery.

2. Slacken the fixed contact screw locknut and unscrew the contact screw until it is clear of the armature moving contact (see Fig. 9).

3. Slacken the regulator adjusting screw locknut and unscrew the adjusting screw until it is completely clear of the armature tension spring.

4. Slacken the two armature assembly securing screws. Using a 0.015 in. (0.381 mm.) feeler blade, wide enough to cover the complete core face, insert the blade between the armature and core shim, taking care not to damage or burr the edge of the shim.

5. Press the armature **squarely** down against the blade and, holding it firmly, retighten the two armature assembly securing screws.

6. With the blade and armature still in the above position, screw the adjustable contact down until it just touches the armature contact. Re-tighten the locking nut.

7. Reset the regulator adjusting screw as described in " Testing and Adjusting the Regulator."

8. Reconnect the battery.

If the contact points are found to be badly worn, replace the regulator.

Fig. 11
Cut-out Points
(Setting Armature Stop Arm)

THE CUT-OUT

Examine the cut-out points and, if necessary, clean with a suitable cleaning fluid or carborundum paper. Ensure that the points are meeting correctly (see Figs. 10 and 11).

To Test and Adjust the cut-out

1. Connect the voltmeter between the "D" terminal and a good earth, or the "E" terminal.

2. Speed up the engine slowly and note the voltage immediately before the points close.

This voltage should be 12.7 to 13.3 volts. The voltage may be adjusted by slackening the locknut and turning the cut-out adjusting screw (see Fig. 8), in an anti-clockwise direction to decrease the voltage and vice versa. Turn the adjusting screw a little at a time, tighten the locknut and re-test as above.

Resetting the Cut-out Armature

If it is suspected that the above setting is incorrect and the cut-out points setting has been disturbed, proceed as follows :—

1. Slacken the adjusting screw locknut and unscrew the cut-out adjusting screw until it is clear of the armature tension spring.

2. Slacken the two armature securing screws.

3. Press the armature down **squarely** against the copper-coated core face and, holding it there, retighten the armature securing screws.

4. Still holding the armature down against the core, bend the armature stop arm so that a gap of 0.025 to 0.040 in. (0.635 to 1.016 mm.) exists between it and the armature tongue (see Fig. 11).

5. Insert the end of a 0.010 to 0.020 in. (0.254 to 0.508 mm.) feeler blade between the outer end of the armature and core face, and set the fixed contact, by bending the arm, so that the points are **just** touching (see Fig. 10).

6. Reset the cut-out adjusting screw as described in "To Test and Adjust the Cut-out."

THE STARTER MOTOR

The starter motor is mounted on the front of the flywheel housing on the right-hand side of the engine.

The motor has four pole pieces and four sets of field coils. Four commutator brushes are fitted, two of which are earthed ; the other two are insulated and connected to the field coils. The armature shaft is supported in an outboard bearing in the starter motor drive housing.

The solenoid switch is located on the lower right-hand forward corner of the fuel tank front support and is controlled by a relay switch mounted on top of the starter motor drive housing, which is operated by the pinion actuating lever and starter control lever.

Prior to Tractor Serial No. 09A315817 the key in the centre of the lighting switch controlled the starter relay switch circuit.

From Tractor Serial No. 09A315817 the starter relay circuit key switch has been moved from the centre of the light switch and re-located on the right-hand side of the instrument panel, the light switch remaining in the original location.

The change of the switch necessitated a new wiring loom, for tractors with lights, and the previous loom is no longer serviced. When fitting a current loom to tractors with lights before 09A315817 with the previous switch arrangements, it is necessary to make the following modifications to the loom :—

(i) Tape up the ignition switch feed, colour brown which has terminal part No. ET6–14477 and is no longer required.

(ii) Remove existing heater switch to ignition switch wire 3.5 in. (88.90 mm.) long, colour brown, and replace with 28/.012 in. wire, 11 in. (279.4 mm.) long.

(iii) Change the terminal on the ignition switch return, colour red, from Part No. ET6–14477 to E1ADDN–14469.

To Test the Starter on the Tractor

If the starter armature does not rotate when the control lever is depressed ensure that the switch key is in the "on" position and check the condition of the battery and connections.

If these are in good condition run a lead from the battery negative terminal to the small terminal of the starter solenoid. If the starter now operates, check the relay switch, switch key and their connections.

If the starter motor does not operate check the solenoid and starter motor connections. Ensure that the starter motor has a good earth connection.

If the starter motor still does not operate it should be removed for examination.

To Remove the Starter Motor

1. Disconnect the positive (earthed) terminal of the battery and the cable at the terminal on the end of the starter motor.

2. Disconnect the two leads from the relay switch.

3. Remove the split pin and clevis pin securing the operating rod to the starter actuating lever.

4. Supporting the starter motor, unscrew the starter motor securing bolts evenly and detach the starter motor.

To Replace

1. Pass the drive end of the starter motor into the flywheel housing aperture and locate the motor on the mounting flange.

2. Supporting the starter motor in this position, replace the bolts, nuts and spring washers and tighten evenly.

3. Refit the clevis pin and split pin securing the operating rod to the starter actuating lever.

4. Reconnect the two leads to the relay switch.

5. Reconnect the cable to the starter motor, on later starter motors there are two terminals on the end plate—the cable should be connected to the upper terminal (the lower one being used as an earth in other applications).

Reconnect the cable to the battery.

THE STARTER MOTOR DRIVE

The starter motor drive is of the mechanical pre-engagement type operated by linkage connected to the starter control lever. The linkage is adjusted so that the relay switch contacts are closed when the pinion is almost fully meshed with the flywheel ring gear.

A multi-plate metal clutch in the pinion and clutch assembly is interposed between the armature shaft and the pinion to protect the starter motor from damage due to overloading should the engine backfire.

The clutch is set to slip at a pre-set torque figure which is approximately three times the normal full starting torque of the starter motor.

The clutch also only allows torque to be transmitted from the starter motor pinion to the flywheel ring gear, and therefore, should the pinion be inadvertently held in mesh with the ring gear whilst the engine is running, and if the engine tends to over-run the starter motor, the clutch will free-wheel and no damage will occur to the starter motor.

The clutch slipping torque is adjustable by means of shims placed between the backing ring and the clutch plates and must be reset after the clutch and pinion assembly has been overhauled.

To Remove the Pinion and Clutch Assembly

1. Remove the four dowelled screws securing the relay switch bracket to the starter motor body, and remove the bracket and cover

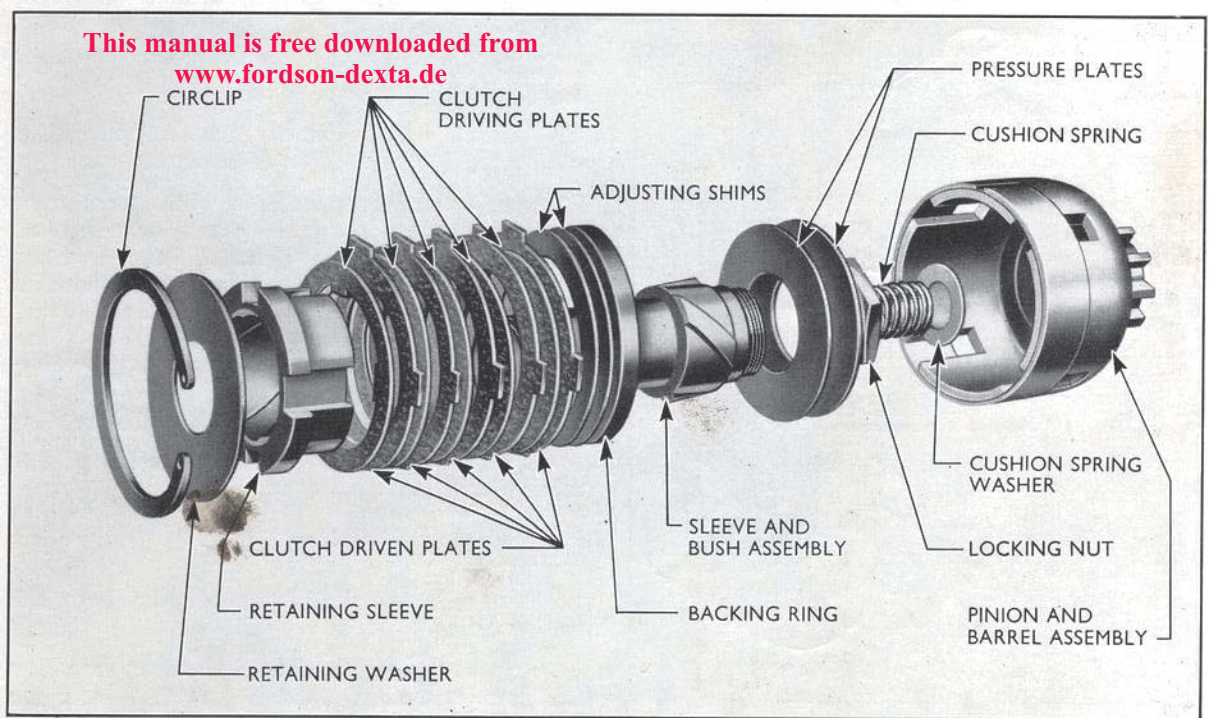

Fig. 12
Exploded View of Starter Drive

2. Release the ends of the lever return spring from under the flange in the housing.

3. Remove the starter switch actuating lever pivot pin retaining dowel, located in a drilling in the top of the starter drive housing. Remove the pivot pin.

On previous starter motors the actuating lever pivot arrangement consisted of a threaded bolt secured with a nut and lockwasher.

4. Remove the return spring, two spacers and the two halves of the actuating lever.

On current starter motors a new starter switch actuating lever and relay switch retaining nut have been introduced. The new nut can be identified by an increase in thickness from 0.312 in. (7.925 mm.) to 0.437 in. (11.100 mm.) and the new lever by the shape of the actuating plate on its front face which was rectangular and is now circular. The new lever must only be used in conjunction with the new nut, otherwise incorrect starter engagement will occur.

5. Remove the two through bolts securing the starter motor drive housing to the starter motor body and remove the drive housing.

6. Remove the thrust washer and slide the pinion and clutch assembly off the armature shaft.

To Refit the Pinion and Clutch Assembly

1. Refit the pinion and clutch assembly to the armature shaft and refit the thrust washer.

2. Replace the starter motor drive housing, ensuring that the dowel is correctly located. Enter the two through bolts and spring washers and securely tighten.

3. Locate the lower half of the actuating lever with the thrust shoes offset away from the pinion. Fit the upper half of the actuating lever with the plain face towards the pinion. Refit the return spring and two spacers with the loop in the spring downward and away from the starter body (see Fig. 13), and enter the lever pivot pin (or bolt). Locate the spring ends in the housing behind the flange.

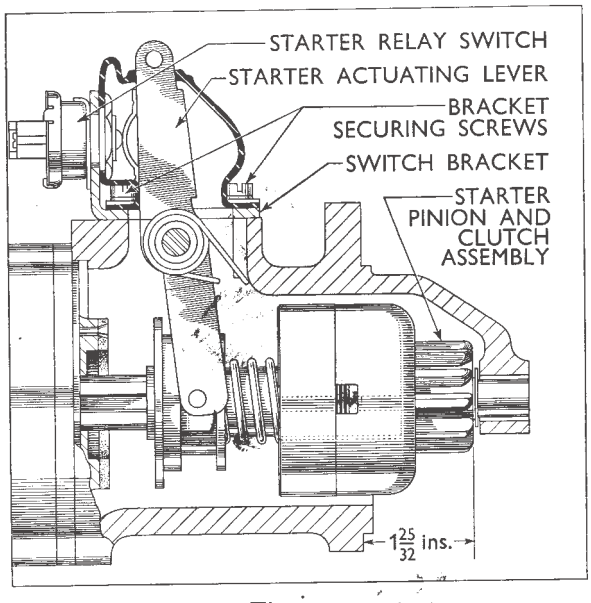

Fig. 13
Starter Actuating Mechanism in the Operating Position

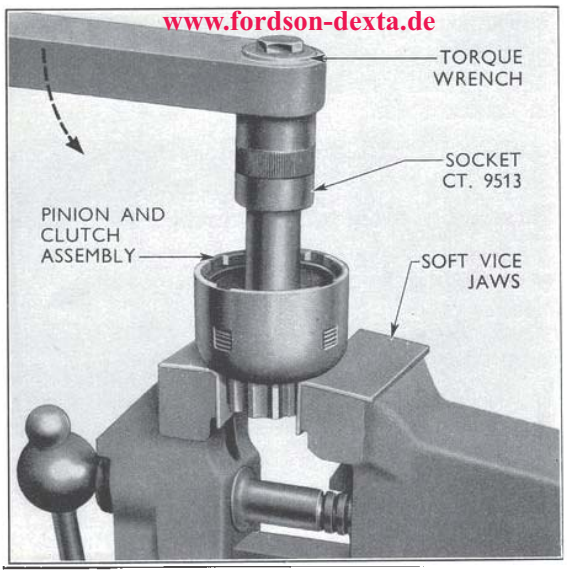

Fig. 14
Checking Starter Drive Slip Torque

NOTE.—The pivot pin (or bolt) will not enter if the lower half of the actuating lever is incorrectly located.

4. Refit the pivot pin locating dowel (or spring washer and nut to the pivot bolt).

5. Refit the relay switch cover and switch bracket assembly and enter the four dowelled screws.

6. Depress the actuating lever until the distance from the rear face of the pinion teeth to the starter motor mounting flange is $1\frac{25}{32}$ in. (81.6 mm.) as shown on Fig. 13). Adjust the relay switch bracket until the contacts are just closed with the pinion at this setting. Securely tighten the retaining screws. Check that the contacts are closed by means of a battery and bulb.

To Dismantle the Pinion and Clutch Assembly

1. Open the retaining cup securing the lock ring on the pinion and clutch assembly.

2. Depress the brake plate and remove the lock ring and retaining cup.

3. Remove the brake plate, operating bush and tension spring.

4. Remove the large internal circlip from the pinion and barrel assembly, and withdraw the sleeve and bush assembly complete with the clutch unit.

5. Remove the cushion spring and thrust washer from inside the pinion and barrel assembly.

6. The clutch unit can now be completely dismantled by removing the retaining washer, retaining sleeve, clutch plates, adjusting shims and backing ring.

7. The nut retaining the two pressure plates is secured by peening and it should only be removed if the plates require renewing.

8. Clean all parts and inspect the pinion teeth and clutch plates for wear. Ensure that the clutch plates are free to move in their respective engagement splines. Check the cushion spring and tension spring for any signs of weakness.

Renew all parts that are worn or damaged in any way.

To Reassemble the Pinion and Clutch Assembly

1. If they have been removed, replace the pressure plates, fit the locking nut and secure by peening.

2. Replace the clutch plates on the retaining sleeve and refit this assembly with the adjusting shims and backing ring on to the sleeve and bush assembly. Care should be taken to ensure that the clutch plates are in the correct order (see Fig. 12) and that the ground face on the backing ring is adjacent to the adjusting shims. The clutch plates and helices on the inside of the retaining sleeve should be smeared with a thin coating of high melting point grease before assembly.

3. Fit the flat washer and cushion spring inside the pinion and barrel assembly so that they are positioned centrally over the pinion bearing bush.

4. Install the clutch unit in the pinion and barrel assembly, fit the retaining washer and secure in position with an internal circlip.

Fig. 15
Starter Motor Commutator End Plate

5. Position the pinion and clutch assembly in a vice so that the pinion is securely clamped in soft metal vice jaws and the assembly is upright.

6. Using the special socket (Tool No. CT.9513) and a suitable torque wrench apply an anti-clockwise torque to a central sleeve of the assembly (see Fig. 14). The clutch should not slip until the torque applied is between 65 and 80 lb. ft. (8.983 and 11.056 kg.m.).

7. If the clutch slips at below the minimum slip torque, dismantle the pinion and clutch assembly and add shims until the correct slip torque is obtained.

If the clutch slips at above the upper torque limit, dismantle the clutch and remove shims until the correct slip torque is obtained.

There are three thicknesses of shims available : 0.004 in. (0.102 mm.), 0.005 in. (0.127 mm.), 0.006 in. (0.152 mm.).

8. Replace the tension spring, operating bush and brake plate over the sleeve and bush assembly, and compress the tension spring.

9. Position a new lock ring retaining cup on the shaft and fit a new lock ring.

10. Release the pressure compressing the spring and close the outer edge of the retaining cup inwards over the lock ring.

To Examine the Brushes

1. Remove the starter motor.

2. Loosen the screw and slide the brush cover band away from the brush apertures.

3. Lift the brush springs, using a piece of wire shaped into a hook and check the movement of the brushes in the holders.

4. If the brushes are sticking, clean them with a petrol-moistened cloth and, if necessary, ease the sides of the brushes by polishing on a smooth file. When satisfactory, replace the starter.

NOTE.—If the brushes are worn so that they do not bear on the commutator or the brush lead is exposed on the wearing face, new brushes must be fitted.

If the commutator is blackened or dirty, clean by holding a petrol-moistened cloth against it while the armature is rotated.

To Remove the Commutator End Plate and Brushes

1. Remove the starter motor.

2. Slacken the cover band screw and slide the cover band away from the brush apertures.

3. Lift the brush springs and draw the brushes out of their holders.

4. Unscrew the starter cable terminal nuts and detach the spring, flat and fibre washers.

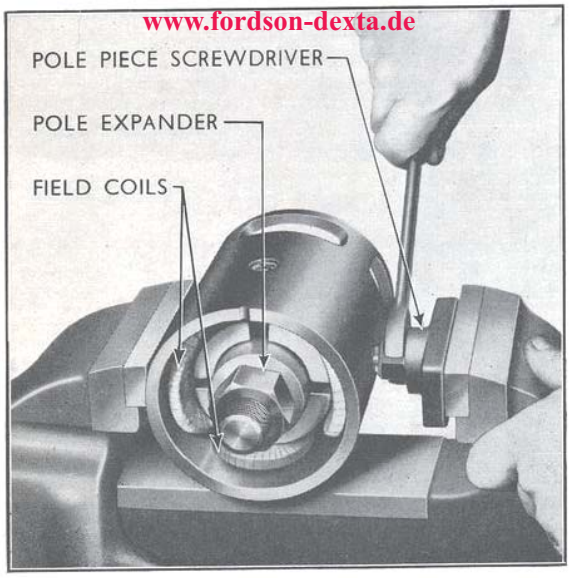

Fig. 16
Pole Piece Screwdriver and Pole Expander

5. Unscrew the two through-bolts and carefully pull the commutator end plate from the starter motor, together with the earthed brushes. Remove the armature if necessary.

6. The brush leads are soldered into tags on the earthed brush holders on the end plate and to the ends of the field coils. Carefully unsweat the brush leads from their connections and detach the brushes.

To Replace

1. Re-solder the brush leads to the field coils and earthed brush holders.

2. Before fitting the end plate, check the brush springs and renew if necessary.

It is also advisable to check the insulated brush holders to ensure that they are not earthing. Use a battery and bulb for this test.

3. Check that the fibre washers are fitted on the field coil terminal post and an insulating bush is located in the terminal post hole in the commutator end plate.

4. Check that the insulator band is located between the yoke and the end of the field coils, and pass the Insulated brushes through the apertures in the yoke.

5. Replace the commutator end plate on the starter motor yoke, passing the earthed brushes through the other apertures in the yoke and engage the dowel pin in the end plate with the notch in the yoke end.

6. Replace a fibre washer, flat washer, spring washer, nut, spring washer and nut (in that order) on the field coil terminal post and tighten the inner nut securely.

7. Replace the armature and drive end plate, if removed, lining up the notch in the plate with the notch in the yoke. Ensure that the thrust washer is fitted to the commutator end of the armature.

8. Refit the pinion and clutch assembly as previously described.

9. Lift the brush springs and insert the brushes into their holders, ensuring that they slide freely. (The field coil brushes locate in the insulated brush holders.)

10. Slide the brush cover band over the brush apertures and tighten the screw.

11. Replace the starter motor as previously described.

STARTER COMMUTATOR

The commutator should be inspected when the starter motor is dismantled. A commutator in good condition should be smooth and free from pitting or burned spots.

Clean the commutator with a petrol-moistened cloth. If this is ineffective, carefully polish with a strip of fine glass paper, *not emery cloth*, while the armature is rotated.

If the commutator is badly worn or scored, remove the starter drive and detach the drive end plate. Mount the armature in a lathe, rotate at high speed, and take a light cut with a very sharp tool.

Polish the commutator with very fine glass paper. Do not undercut the mica insulation between the segments as is the normal practice with generators.

Check that the commutator segments are not earthing to the armature shaft and core by checking with a battery and bulb.

STARTER ARMATURE

The armature can be inspected after it has been removed from the starter motor yoke. Visual examination will, in many cases, reveal any cause of failure.

A damaged armature must be replaced in all cases (see table on Page 20 for interchangeability of bushes).

No attempt should be made to machine the armature core or to true a distorted armature shaft.

Armature Shaft Bushes

The bushes in the starter motor drive housing and in the commutator end plates are serviced, and can be renewed if they are found to be excessively worn or scored.

On current starter motors the armature drive end bushes have been increased in size, as shown below, and must only be used with their respective armature journals.

Before fitting any new bushes they should be completely immersed in thin engine oil for at least 24 hours.

To renew the bushes, stepped drivers should be made to suit.

After reassembling the starter motor, check that the armature shaft is free to rotate in the bushes without binding.

STARTER FIELD COILS

To Test

1. Remove the commutator end plate and withdraw the armature and drive end plate as previously described.

2. Test the field coils for continuity and earth as follows :—

Check for continuity between the two ends of the field coils, using a mains operated line tester, having a suitable bulb in circuit. Alternatively, the test prods on the Diagnosis Test Set can be used.

If the lamp does not light, there is an open circuit in one of the field coils. If the lamp lights, it does not necessarily mean that the field coils are in order, as it is possible that one of the coils may be earthing to the pole pieces or starter yoke.

This may be checked by touching one of the test prods on the starter yoke and the other on to one of the field coil tappings. If the bulb now lights, the coils are earthed.

NOTE.—The field coils are not serviced separately, as invariably it is found that if one fails the others are affected.

To Remove

1. Mark the yoke and pole pieces so that they can be refitted in their original positions.

2. Detach the fibre insulating washers and sleeve from the field coil terminal post and the insulation band from the commutator end of the yoke.

3. Holding the pole pieces with a suitable expander, mount the starter yoke and pole piece screwdriver (CPT.9504) in a vice and slacken the pole piece screws one at a time. Finally remove the screws with a crosshead screwdriver.

4. Withdraw the field coils and pole pieces from the yoke and carefully unsweat the field coil tappings from the terminal post.

To Replace

1. Locate the ends of the field coil tappings in the slot of the terminal post and solder them in position.

2. Solder new brush leads to the smaller connections on the field coils.

3. Temporarily replace the commutator end plate

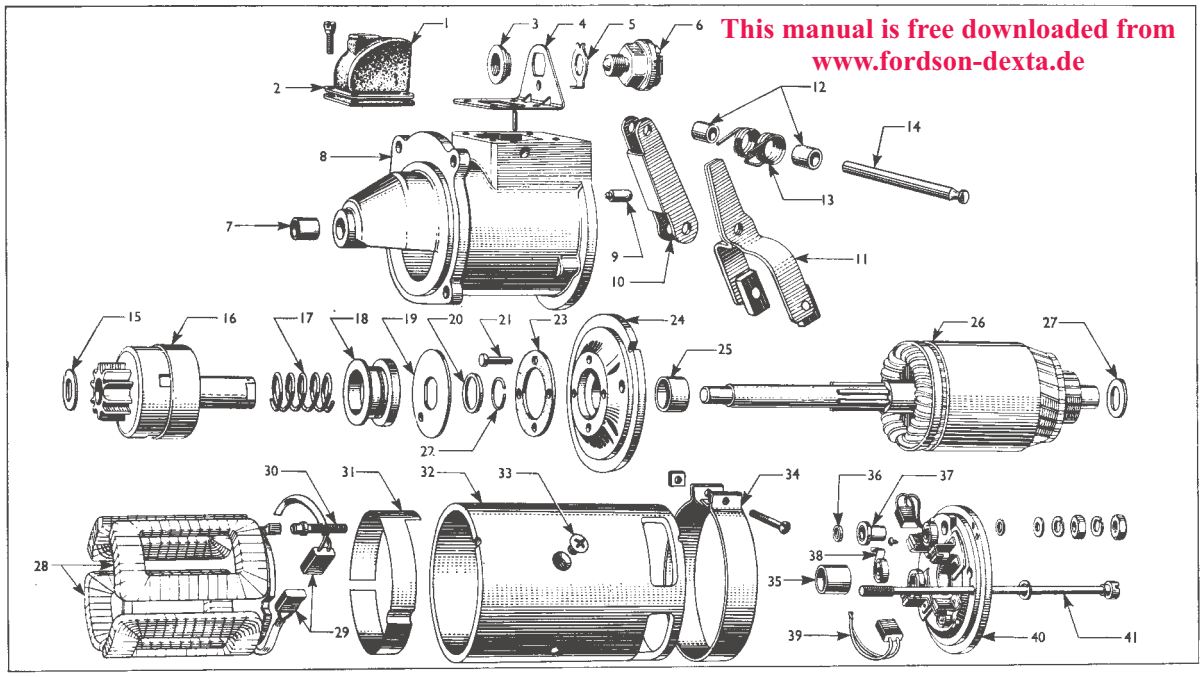

Fig. 17 **Exploded View of Starter Motor, Drive and Controls**

1 Dust cover
2 Plate
3 Nut
4 Bracket
5 Lockwasher
6 Relay operating switch
7 Drive housing bush
8 Drive housing
9 Dowel
10 Actuating lever
11 Lever and shoe assembly
12 Spacers
13 Lever return spring
14 Lever pivot
15 Thrust washer
16 Drive pinion and clutch assembly
17 Tension spring
18 Pinion and clutch operating bush
19 Pinion and clutch brake plate
20 Lock ring
21 Rivet
22 Circlip
23 Brake lining
24 Drive end plate
25 Drive end plate bush
26 Armature
27 Thrust washer
28 Field coils
29 Brushes
30 Field terminal
31 Insulator
32 Yoke
33 Pole piece screw
34 Cover band
35 Commutator end plate bush
36 Washer
37 Insulator
38 Brush spring
39 Brush
40 Commutator end plate
41 Through-bolt

on the starter yoke and note the position of the field coil terminal in relation to the yoke. Reassemble the pole pieces to the field coils so that the mating marks on the yoke and pole pieces are together.

4. Insert the field coils and pole pieces into the starter yoke, align the securing screw holes and locate the pole pieces with the cross-head screws.

5. By the use of a suitable expander press the pole pieces against the yoke.

6. Place the starter yoke and pole piece screwdriver (CPT.9504) in a vice and tighten the screws securely.

7. Remove the expander.

8. Replace the insulation band around the commutator end of the field coils between the coil tappings and the yoke.

9. Replace the insulator sleeve and washers on the field coil terminal post and check that the post is pointing along the axis of the yoke.

10. Replace the armature and commutator end plates and brushes as previously described.

Description	*Previous Dimensions*	*Current Dimensions*
Armature, (drive housing end) spigot journal diameter	0.4980 to 0.4985 in. (12.649 to 12.662 mm.)	0.5475 to 0.5483 in. (13.907 to 13.927 mm.)
Drive housing, spigot bearing, bush, length ..	0.656 in. (16.662 mm.)	0.766 in. (19.465 mm.)
Internal diameter of bush when assembled in housing	0.5012 to 0.5017 in. (12.730 to 12.743 mm.)	0.5519 to 0.5529 in. (14.020 to 14.045 mm.)
Armature (drive housing end plate) journal diameter	0.9960 to 0.9980 in. (25.298 to 25.349 mm.)	0.9970 to 0.9982 in. (25.323 to 25.354 mm.)
Drive housing end plate bearing bush length ..	0.684 in. (17.373 mm.)	0.850 in. (21.59 mm.)
Internal diameter of bush when assembled in housing	1.001 to 1.003 in. (25.425 to 25.476 mm.)	1.0005 to 1.0015 in. (25.41 to 25.435 mm.)

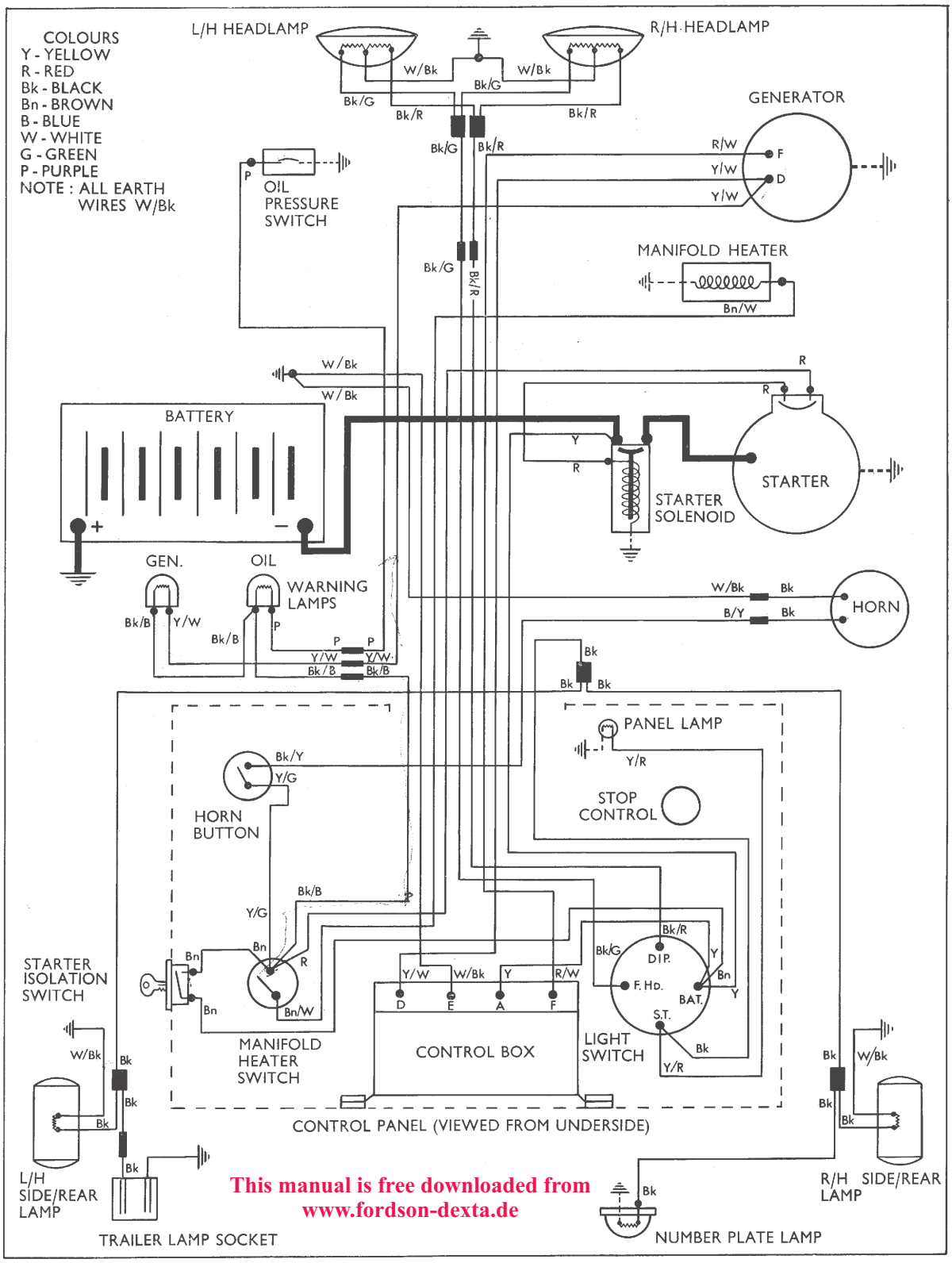

Fig. 18
Wiring Diagram

There are existing different wiring diagrams. I will make an update for this manual soon!
Es existieren verschiedene Schaltpläne, ich werde demnächst ein Update dafür erstellen!

ELECTRICAL SYSTEM SPECIFICATIONS

Battery—12 Volt

Voltage	12 volt
Actual capacity in ampere hours when discharged in 10 hours	80
Specific gravity charged	1.270 to 1.285

Battery—6 Volt

Voltage	6 volt
Actual capacity in ampere hours when discharged in 10 hours	129
Specific gravity charged	1.270 to 1.285

Generator

Brushes :	
Number	2
Length	0.625 in. (15.87 mm.)
Wear limit	0.35 in. (8.89 mm.)
Regulation	C.V.C.
Maximum output	11 amps.
Cut-in volts	12.7 to 13.3
Cut-in speed (engine r.p.m.)	620
Maximum reverse current	6 amps.
Regulating voltage at 68°F. (20°C.)	16.0 to 16.6
Effective pulley diameter :	
Engine	5.22 in. (132.6 mm.)
Generator	3.48 in. (88.4 mm.)
Ratio to engine speed	1 : 1.5

Starter Motor

Current draw at normal temperature	450 amps.
Gear ratio	11.09 : 1
Teeth on pinion	11
Teeth on ring gear	122
Lock torque	28 lb. ft.
Normal cranking speed with engine warm	200 r.p.m.

Lamp Bulbs

Headlamp (double filament, double contact) :	
Main beam	12 V—36 W
Dipped	12 V—24 W
Side and tail lamp (double contact)	12 V— 6 W
Warning lights (single contact)	12 V—2.2 W
Instrument light (single contact)	12 V—2.2 W
Voltage drop through wires	.5 V (max.)