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WORKSHOP INSTRUCTIONS

CONTROL BOXES

MODELS

RF95, RF96, RF97 and RB106-1



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LUCAS WORKSHOP INSTRUCTIONS

CONTROL BOXES

MODELS RF95, RF96, RF97 AND RB106-1

INCORPORATING C.V.C. REGULATOR TYPE LRT9

1. GENERAL

The control box contains two units—a voltage regulator and a cut-out; also, in the case of model RF95, two externally mounted fuses to protect the circuits of the accessories. Models RF95 and RF96 are normally fitted to cars, whilst model RF97 will usually be found on tractors. Later model RB106-1 is similar to model RF96, but it is designed to permit a slightly higher maximum output current from the generator and is intended for use only with generator models C39PV-2, C45PV-5, C45PVB-5 and C45PVS-5.

Although combined structurally, the regulator and cut-out are functionally independent. Both are accurately adjusted during manufacture, and the cover protecting them should not be removed unnecessarily. Cable connections to models RF95, RF96 and RB106-1 are secured by grub screw terminals, while model RF97 utilises a non-reversible plug-in terminal block.

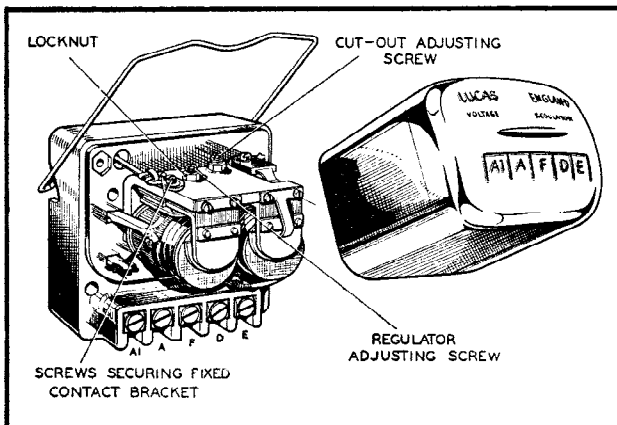


Fig. 1

Control box, Models RF96 and RB106-1, with cover removed

THE REGULATOR

The regulator unit is arranged to work in conjunction with the shunt-wound generators described in SECTION A-2. The regulator is set to maintain the generator terminal voltage between close limits at all speeds above the regulating point, the field strength being controlled

by the automatic insertion and withdrawal of a resistance in the generator field circuit. When the generator voltage reaches a predetermined value, the magnetic flux in the regulator core due to the shunt or voltage winding becomes sufficiently strong to attract the armature to the core. This causes the contacts to open, thereby inserting the resistance in the generator field circuit.

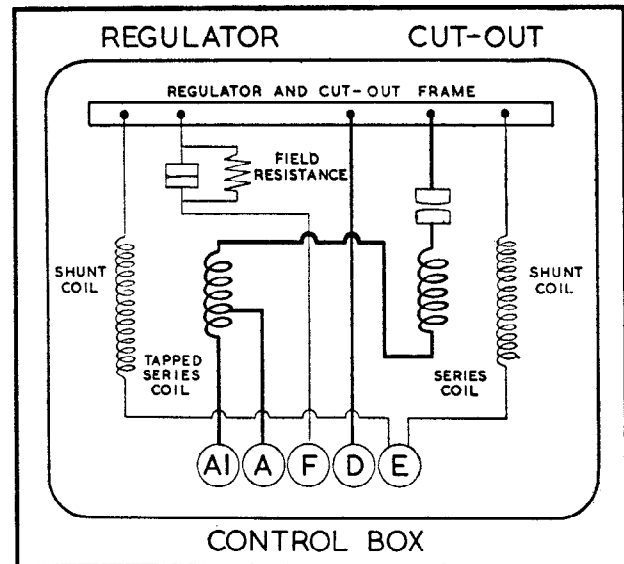


Fig. 2

Internal connections, Models RF96 and RB106-1

The consequent reduction in the generator field current lowers the generator terminal voltage and this, in turn, weakens the magnetic flux in the regulator core. The armature therefore returns to its original position and the contacts close to allow the generator voltage to rise again to its maximum value. This cycle is then repeated, and an oscillation of the armature is maintained.

As the speed of the generator rises above that at which the regulator comes into operation, the periods of contact separation increase in length and, as a result, the mean value of the generator voltage undergoes practically no increase once this regulating speed has been attained.



LUCAS WORKSHOP INSTRUCTIONS

The series or current winding provides a compensation on this system of control, for if the control were arranged entirely on the basis of voltage there would be a risk of seriously overloading the generator when the battery was in a low state of charge, particularly if the lamps were simultaneously in use.

Under these conditions of reduced battery voltage, the output to the battery rises and, but for the series winding, would exceed the normal rating of the generator. The magnetism due to the series winding assists the shunt winding, so that when the generator is delivering a heavy current into a discharged battery the regulator comes into operation at a somewhat reduced voltage, thus limiting the output accordingly. On control boxes RF95, RF96 and RB106-1, a split series winding is used, the tapping carrying the battery charging current while the complete winding carries lighting and ignition loads.

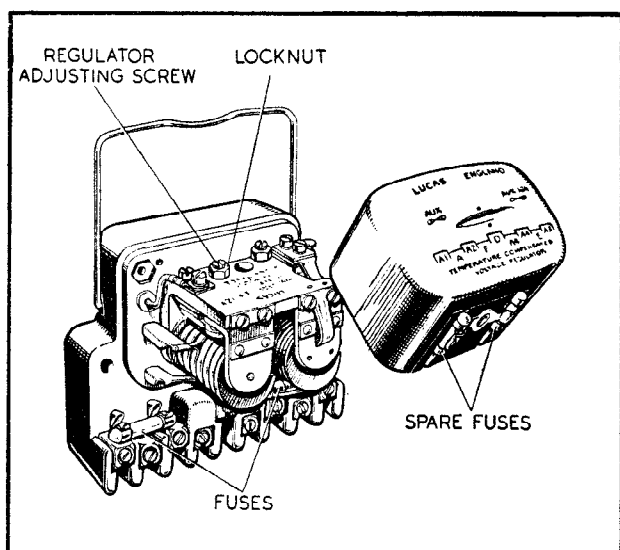


Fig. 3

Control box, Model RF95, with cover removed

By means of a temperature compensation device, the voltage characteristic of the generator is caused to conform more closely to that of the battery under all climatic conditions. In cold weather the voltage required to charge the battery increases, whilst in warm weather the voltage of the battery is lower. The method of compensation takes the form of a bi-metallic spring located behind the tensioning spring of the regulator armature. This bi-metallic spring, by causing the operating voltage of the regulator to be increased in cold weather and reduced in hot weather, compensates for the changing temperature-characteristics of the battery and prevents undue variation of the charging current which would otherwise occur.

The bi-metallic spring also compensates for effects due to increases in resistance of the copper windings from cold to working values.

THE CUT-OUT

The cut-out is an electro-magnetically operated switch connected in the charging circuit between the generator and the battery. Its function is automatically to connect the generator with the battery when the voltage of the generator is sufficient to charge the battery, and to disconnect it when its voltage falls below that of the battery, and so prevent the battery from discharging through, and possibly damaging, the generator windings.

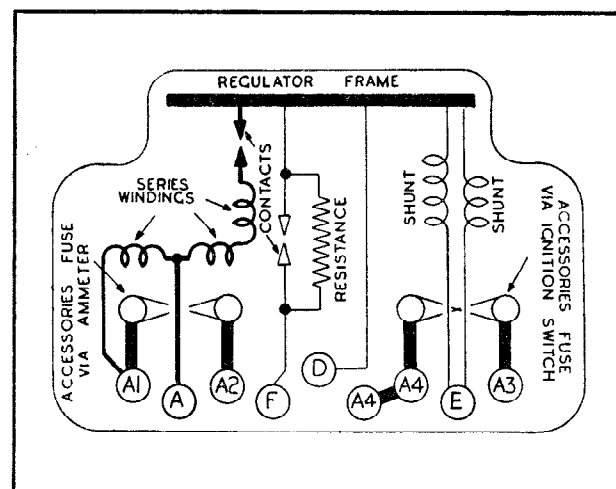


Fig. 4

Internal connections, Model RF95

The cut-out consists of an electro-magnet fitted with an armature which operates a pair of contacts. The electro-magnet employs two windings, a shunt winding of many turns of fine wire, and a series winding of a few turns of heavier gauge wire. The contacts are normally held open and are closed only when the magnetic pull of the magnet on the armature is sufficient to overcome the tension of the adjusting spring.

The operation of the cut-out is as follows:

The shunt coil is connected across the generator. When the vehicle is starting, the speed of the engine, and thus the voltage of the generator, rises until the electro-magnet is sufficiently magnetised to overcome the spring tension and close the cut-out contacts. This completes the circuit between the generator and the battery through the series winding of the cut-out and the contacts. The effect of the charging current flowing through the cut-out windings creates a magnetic field in the same direction as that produced by the shunt winding. This increases the magnetic pull on the armature so that the contacts are firmly closed, and cannot



LUCAS WORKSHOP INSTRUCTIONS

be separated by vibration. When the vehicle is stopping the speed of the generator falls until the generator voltage is lower than that of the battery. Current then flows from the battery through the cut-out series winding and generator in a reverse direction to the charging current. This reverse current through the cut-out will produce a differential action between the two windings and partly demagnetise the electro-magnet. The spring, which is under constant tension, then pulls the armature away from the magnet and the contacts open and prevent further discharging of the battery through the generator.

Like the regulator, operation of the cut-out is temperature-controlled by means of a bi-metallic tensioning spring.

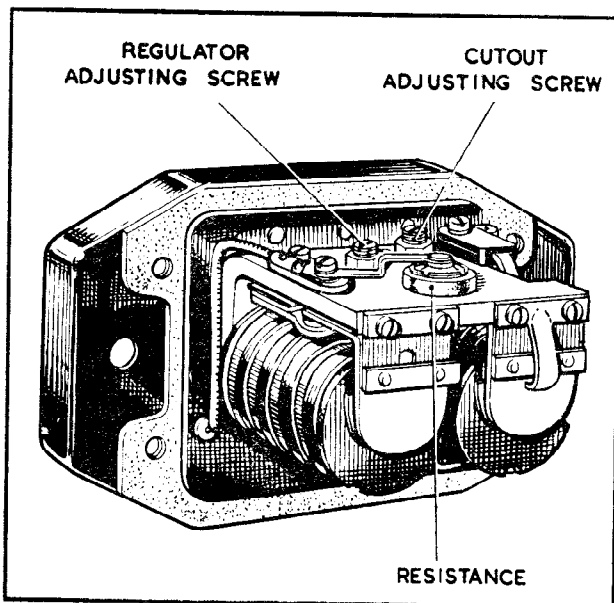


Fig. 5
Control box, Model RF97, with cover removed

2. SETTING DATA

The control box must be checked with the bobbin axes horizontal and the adjusting screws uppermost.

(a) REGULATOR

Open circuit setting at 20°C.

| | |
|----------------------|-----------------|
| 12-volt units | 15.6—16.2-volts |
| 6-volt units | 7.6— 8.0-volts |

Note: With ambient temperatures other than 20°C., the following corrections should be made to the above setting for 12-volt units:

For every 10°C. (18°F.) above 20°C., subtract 0.3-volt.
For every 10°C. below 20°C., add 0.3-volt.

Equivalent corrections for 6-volt units can be made by subtracting or adding 0.1-volt to the nominal setting for every 10° above or below 20°C.

(b) CUT-OUT

| | 12-volt | 6-volt |
|------------------|----------------|--------------|
| Cut-in voltage | 12.7—13.3-volt | 6.3—6.7-volt |
| Drop-off voltage | 8.5—10.0-volt | 4.5—5.0-volt |
| Reverse current | 3.5—5.0 amp. | 3.5—5.0 amp. |

Note: A few instances occur from time to time where, due to special running conditions, regulator settings differ from the figures quoted above. Details of these will be found in SECTION F-1.

3. SERVICING

(a) TESTING IN POSITION TO LOCATE FAULT IN CHARGING CIRCUIT

If the generator and battery are in order, check as follows:

(i) Ensure that the wiring between battery and regulator is in order. To do this, disconnect control box terminal 'A' and connect the end of the wire removed to the negative terminal of a voltmeter.

Connect the positive voltmeter terminal to an earthing point on the chassis. If a voltmeter reading is given, the wiring is in order and the regulator must be examined.

(ii) If there is no reading, examine the wiring between battery and control box for defective cables or loose connections.

(iii) Re-connect the wire to terminal 'A'.

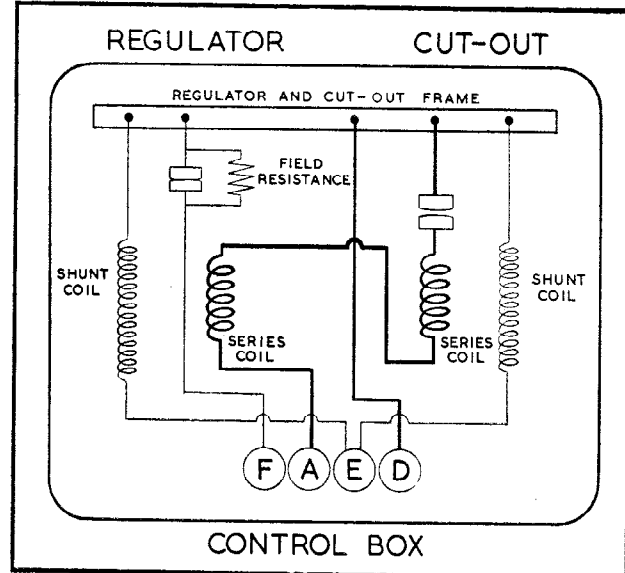


Fig. 6
Internal connections, Model RF97

(b) REGULATOR ADJUSTMENT

The regulator is carefully set during manufacture and, in general, it should not be necessary to make further adjustment. If, however, the battery does not keep in



LUCAS WORKSHOP INSTRUCTIONS

a charged condition, or if the generator output does not fall when the battery is fully charged, the setting should be checked and, if necessary, corrected.

It is important before altering the regulator setting to check that the low state of charge of the battery is not due to a battery defect or to slipping of the generator belt.

(i) Electrical Setting

It is important that only a good quality MOVING COIL VOLTMETER (0—20-volts) is used when checking the regulator. The electrical setting can be checked without removing the cover from the control box.

With models RF95, RF96 and RB106-1 withdraw the cables from terminals 'A' and 'A1' at the control box and connect these cables together.

(With model RF97 control box, owing to the terminal arrangement it is necessary to remove the negative connector from the battery. If coil ignition equipment is fitted, run a temporary connection from the negative battery terminal to the SW terminal of the coil and, with the ignition switch in the OFF position, start the engine by hand.)

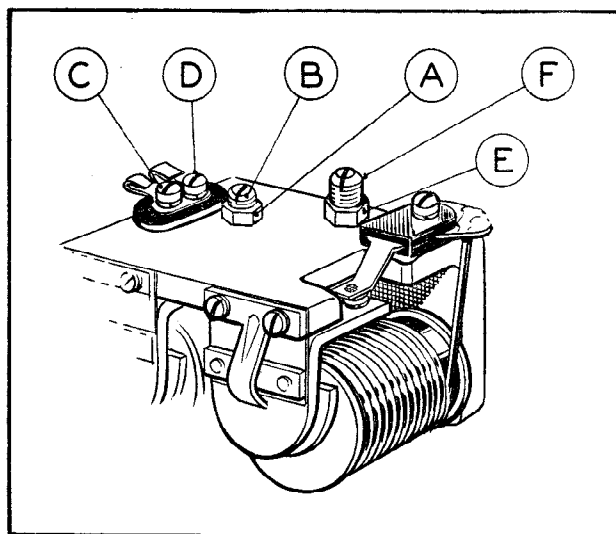


Fig. 7

Cut-out and regulator assembly

Connect the negative lead of the voltmeter to control box terminal 'D' and connect the other lead to terminal 'E'.

Slowly increase the speed of the engine until the voltmeter needle 'flicks' and then steadies. A steady voltmeter reading should lie between the appropriate limits given in Para. 2(a) according to the ambient temperature.

If the voltage at which the reading becomes steady occurs outside these limits, the regulator must be adjusted. Before doing this, refer to SECTION F-1 and see if special regulator settings are specified for the unit under test.

Shut off the engine and remove the control box cover.

Note: To remove the cover from model RF97, it will be necessary to remove the control box from its mounting, disconnect the plug-in connectors by removing the two fixing screws, and drill out the four rivets securing the cover to the base, using a cutter or a $\frac{1}{4}$ " drill with a slow lead. Temporarily remake the connections. When refitting the cover to this unit, see that it locates on the rubber sealing washer and firmly secure the cover with four suitable screws, washers and nuts.

Release locknut A (see Fig. 7) of adjusting screw B 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. 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. Remake the original connections.

A generator run at high speed on open circuit will build up a high voltage. Therefore, when adjusting the regulator, do not run the engine up to more than half speed or a false setting will be made.

(ii) Mechanical Setting

The mechanical or air-gap settings of the regulator, shown in Fig. 8, are accurately adjusted before leaving

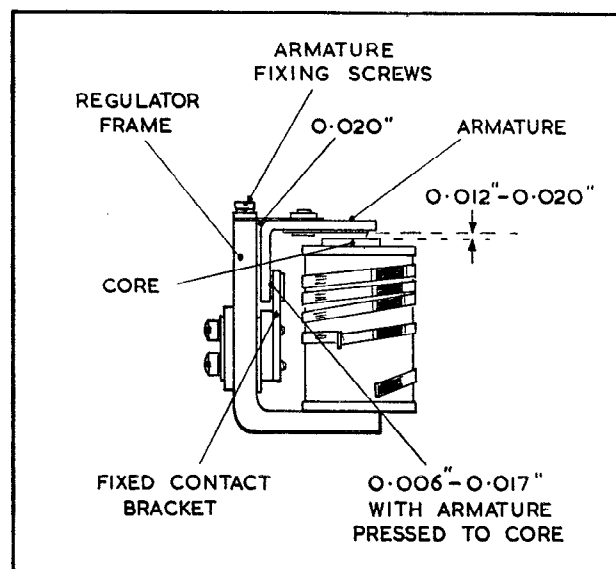


Fig. 8

Mechanical setting of regulator

the works and, provided that the armature carrying the moving contact is not removed, these settings should not be tampered with. If, however, the armature has



LUCAS WORKSHOP INSTRUCTIONS

been removed, the regulator will have to be reset. To do this proceed as follows:

Slacken the two armature fixing screws (Fig. 8) and also adjusting screw B (Fig. 7). Insert a 0.020" feeler gauge between the back of the armature and the regulator frame. It is permissible for this gap to taper, either upwards or downwards, between the limits of 0.018" to 0.022".

With gauge in position, press back the armature against the regulator frame and tighten the two armature fixing screws. Remove the gauge and check the gap between the shim on the underside of the armature and the top of the core. This gap should be 0.012"-0.020".

On earlier regulators, fitted with a stop rivet, this gap should be 0.022"-0.030" (not under the stop rivet). If the gap is outside these limits, correct by carefully bending the fixed contact bracket or, with earlier types, by adding or removing shims.

Remove the gauge and press the armature down, when the gap between the contacts should be 0.006"-0.017".

(iii) Cleaning Contacts

After long periods of service it may be found necessary to clean the regulator contacts. The contacts are made accessible by slackening the screws securing the fixed contact bracket. It will be necessary to slacken screw C a little more than screw D (see Fig. 7) so that the contact bracket can be swung outwards. Clean the contacts by means of fine carborundum stone or silicon

with methylated spirits (de-natured alcohol). Reposition the fixed contact bracket and tighten the securing screws.

(c) CUT-OUT ADJUSTMENT

(i) Electrical Setting

If the regulator is correctly set but the battery is still not being charged, the cut-out may be out of adjustment. To check the cut-out, remove cables from control box terminals 'A' and 'A1' (ensuring that the bared ends do not come into contact with the chassis). Remove the voltmeter lead from terminal 'D' and connect it to terminal 'A'. Connect a resistance load (use a 3-ohm resistor with 12-volt units or a 1.5-ohm resistor with 6-volt units) between terminals 'A' and 'E'. Start the engine and slowly increase its speed until at a fairly low engine speed the voltmeter needle flicks back slightly. Note the voltage at which this occurs. This should be 12.7-13.3-volts for 12-volt units or 6.3-6.7-volts for 6-volt units. If operation of the cut-out takes place outside these limits, it will be necessary to remove the cover and adjust.

To adjust the cut-in voltage, slacken locknut E (Fig. 7) and turn screw F in a clockwise direction to raise the voltage 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. Test after each adjustment by increasing the engine speed and noting the voltmeter reading at the instant of contact closure. Electrical settings of the cut-out, like the regulator, must be made as quickly as possible because of temperature-rise effects. Tighten the locknut after making the adjustment. If the cut-out does not operate, there may be an open circuit in the wiring of the cut-out and regulator unit, in which case the unit should be removed for examination or replacement.

(ii) Mechanical Setting

If for any reason the cut-out armature has to be removed from the frame, care must be taken to obtain the correct air-gap settings on reassembly (see Fig. 9). These can be obtained as follows:

Slacken the two armature fixing screws, adjusting screw F and the screw securing the fixed contact. Insert a 0.014" gauge between the back of the armature and the cut-out frame. Press the armature back against the gauge and tighten the armature fixing screws. (The air gap between the core face and the armature shim should now measure 0.011"-0.015". A 0.005" brass shim is fitted to the underside of the armature, and the gap must be measured between the core face and the underside of this shim. On earlier cut-outs, fitted with a stop rivet instead of a shim, the gap between the core face and the armature itself—not the stop rivet—should measure 0.016"-0.020". If it does not, fit a new armature assembly). With the 0.014" gauge still in position, set the gap between the armature and the stop plate arm to 0.030"-0.034"

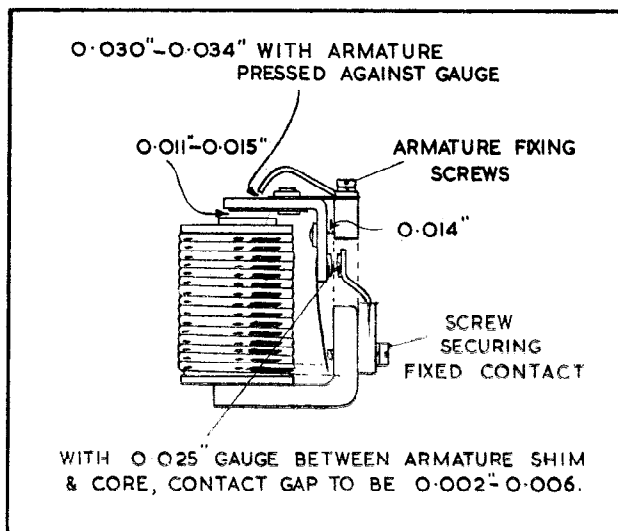


Fig. 9

Mechanical setting of cut-out

carbide paper. Contact cleaning materials should be clean and free from grease. After cleaning, carefully wipe away all traces of dust or other foreign matter



LUCAS WORKSHOP INSTRUCTIONS

by carefully bending the stop plate arm. Remove the gauge and tighten the screw securing the fixed contact. Insert a 0.025" gauge between the core face and the armature (0.030" for earlier cut-out with stop rivet). Press the armature down on to the gauge. The gap between the contacts should now measure 0.002"—0.006" and the drop-off voltage should be between the limits given in para. 2(b). If necessary, adjust the gap by carefully bending the fixed contact bracket.

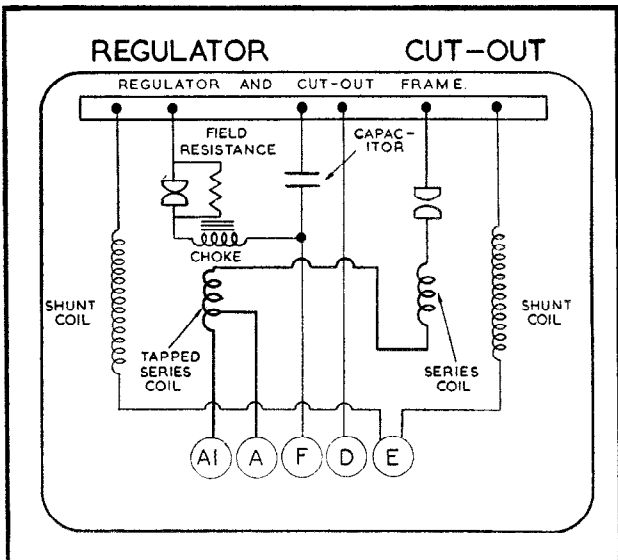


Fig. 10

Internal connections, Models RF96S and RB106S, incorporating radio filter circuit

(iii) Cleaning Contacts

If the cut-out contacts appear rough or burnt, place a strip of fine glass paper between the contacts—then, with the contacts closed by hand, draw the paper through. This should be done two or three times with the rough side towards each contact. Wipe away all dust or other foreign matter, using a clean fluffless cloth moistened with methylated spirits (de-natured alcohol).

Do not use emery cloth or a carborundum stone for cleaning cut-out contacts.

(d) RADIO INTERFERENCE SUPPRESSION

Radio interference due to sparking at the regulator contacts can be recognised by periods of continuous crackle. This can be remedied either by fitting a suppressed control box or by connecting a Suppressor Unit Model WS12 in the associated wiring. In no circumstances should a capacitor be connected to control box terminal 'F', to the generator field terminal, or in parallel with the regulator contacts. Attempts to correct regulator interference in this way can affect the proper functioning of the charging system and may cause damage to the regulator.

Fig. 10 shows the internal connections of suppressed control boxes intended for fitting to radio-equipped vehicles. A filter circuit comprising a capacitor and a choke is incorporated in the design. The electrical values of the filter components are critical, both in regard to regulator performance and to the frequency ranges over which suppression is required, and if renewal becomes necessary only authorised replacements should be used.

