## Chapter I

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# D.C. VOLTAGE REGULATORS

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**Introduction**

**1.** This chapter gives a general description of the construction and principle of operation of d.c. carbon pile voltage regulators, together with servicing instructions. For detailed information on individual regulators, and full instructions for testing, reference should be made to the relevant chapter in A.P.4343B, Vol. 1, Book 1.

**Types of d.c. regulators**

**2.** There are two main groups of d.c. voltage regulators in service, as determined by their application, (1) the series type, used for controlling the input voltage supply to such items as airborne radio equipment, gyro gun sights, etc., and (2) the shunt type, used for controlling the output of a shunt-wound d.c. generator.

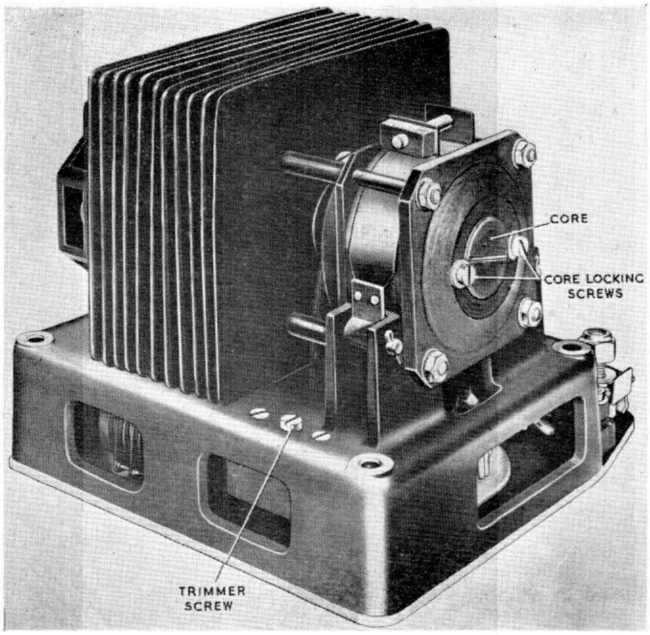


**Fig. 1. Typical voltage regulator**

**3.** With the series type, the pile is connected in series with the input, and the operating coil across the output. An increase in input voltage results in increased current in the operating coil, which causes mechanical pressure on the carbon pile to be reduced. The pile resistance thus increases, so reducing the output voltage to a pre-determined value. Conversely, the pile resistance decreases with a decrease in input voltage, causing the output voltage to increase.

**4.** With the shunt type, the pile is connected in series with the shunt field of the generator, and the operating coil across the generator output. Thus any change in line voltage varies the operating coil current, and consequently the pile resistance, to a value that will bring the generator field current, and thence the output voltage, to the required controlled level.

**5.** In certain voltage regulators, a separate current unit is incorporated. The operating coil of the current unit is connected in series with the generator output, and the carbon pile in series with the pile of the voltage unit and the generator field. The critical value of the current is arranged to correspond to a value slightly in excess of full generator load current.

**6.** For all currents up to this value the pile resistance will remain at a minimum. Currents in excess of this value will reduce the pile pressure and increase its resistance to a value that will alter the generator field current. The line voltage and therefore the load current will be reduced to the critical value. Under these conditions it is not possible to overload the generator beyond safe limits, any attempt to do so resulting only in reduced line voltage.

## DESCRIPTION

### Construction

◀**7.** The majority of voltage regulators incorporate a single carbon pile, though certain later types are of multi-pile construction; such regulators are described in para. 13 to 15. A typical single-pile regulator, the Type 23, is illustrated in fig. 1. The regulator unit consists essentially of a carbon pile and its operating electro-magnet; a sectional view of such a unit is shown in fig. 2.▶

**8.** The electro-magnet is mounted upon the detachable end plate of a cylindrical flanged yoke containing the magnet windings, the end plate being threaded to receive the core of the electro-magnet. The latter is slotted at its threaded end for adjustment, the other end projecting through the magnet winding to operate the armature which is suspended above it. The core can be locked in position by two locking screws and washers.

**9.** The armature, attached to a three-leaved plate spring, rests upon the concave surface of a bi-metal ring housed in a recessed portion of the magnet yoke. The inclusion of the bi-metal ring provides compensation for variations in temperature; with increase of temperature, the bi-metal ring tends to flatten out, so reducing the pressure exerted by the armature spring to compensate for the decrease in the pull of the electro-magnet. A plunger is screwed to, but insulated by mica plates, bushes, and washers, from, the armature, a pressed-up tag, carrying a terminal screw facilitating cable connection to the plunger which, in turn, makes electrical connection with the carbon pile through a carbon insert.

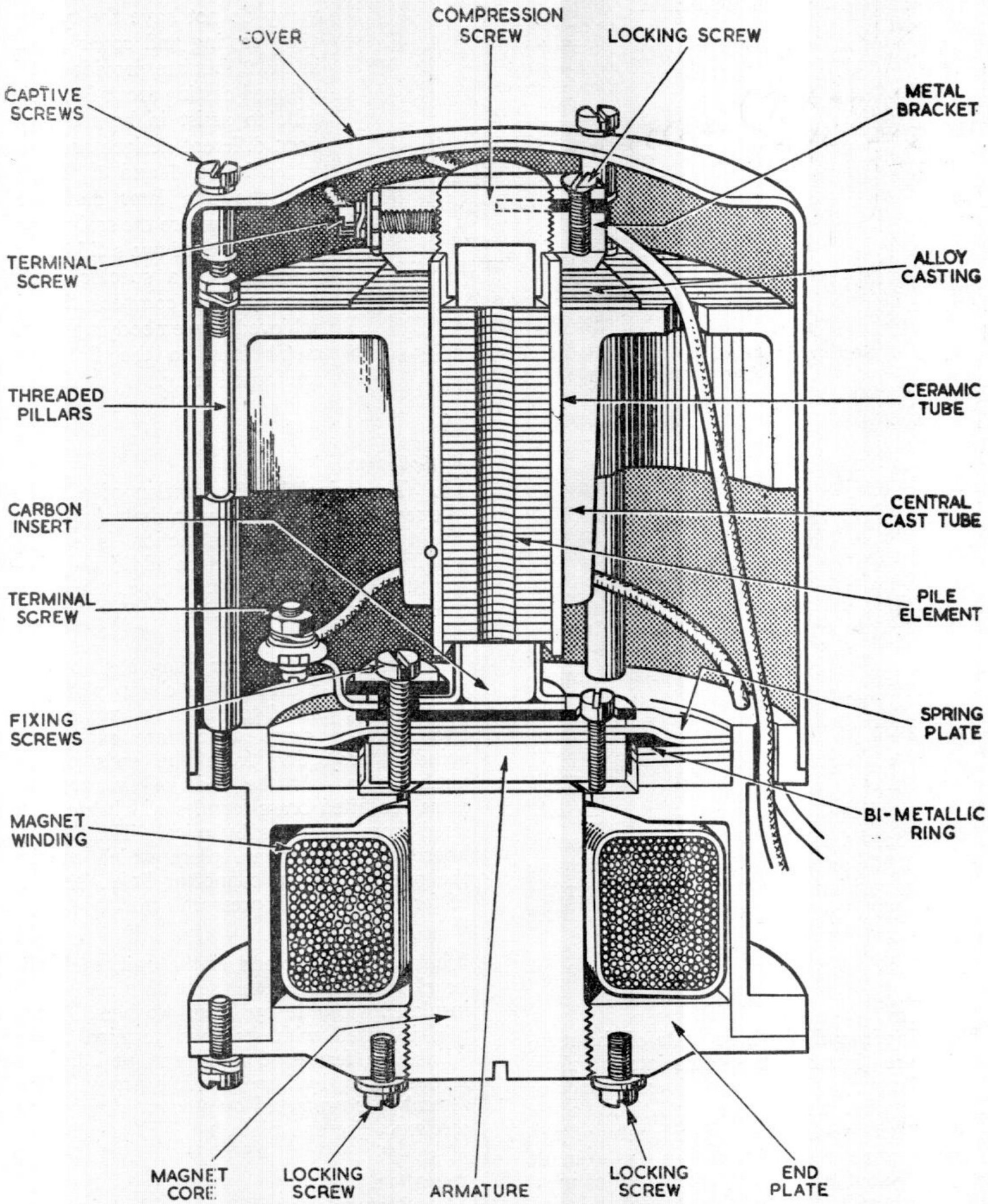


**Fig. 2. Sectional view of regulator unit**

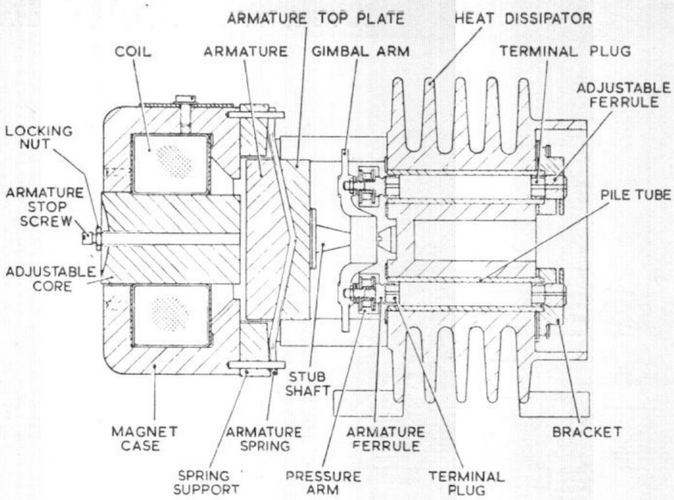


**Fig. 3. Sectional view of multi-pile regulator with flat type armature spring**

◀**12.** Certain regulators differ in some details of construction from the basic design illustrated above. In particular, many do not have the type of alloy casting and cover shown in fig. 2, but are provided with a finned casting around the pile tube to assist in heat dissipation; different designs are illustrated in fig. 1 and 3. Fig. 3 also shows a later design of armature, where the spring support consists of two solid blocks machined to a specific angle. Temperature compensation is achieved by embodying a bi-metal strip in the flat type armature spring.

**10.** Supported above the electro-magnet by three threaded pillars is an alloy casting with a central integrally cast tube; this central tube carries a ceramic tube located by a split pin and in which is housed the carbon pile stack. The carbon-capped plunger on the armature projects into the ceramic tube at the bottom, and there is a similar contact at the top supported by an adjustable compression screw which is held in a threaded bracket attached by screws to the top of the casting. This bracket is insulated from the casting by mica plates, the fixing screws being insulated by mica bushes and washers. It carries a screw terminal for electrical connection to the carbon pile. A gripping screw is provided for locking the pile compression screw in position. A metal cover fits over the carbon pile assembly, and is secured by three captive nuts at the top which engage the threads of screwed pillars.

**11.** Underneath the base plate of the regulator are housed the associated ballast and trimmer resistors, which are connected in series with the operating coil. The ballast resistor is a pre-set resistance, whereby adjustment to the coil current has been made during manufacture; fine voltage adjustment on the aircraft is made by means of the trimmer resistor, which is either incorporated in the regulator or fitted remote from it. A pile diverter resistor is sometimes connected across the pile, to permit power dissipation in excess of that of the pile.

*Multi-pile types*

**13.** The principle of operation of a multi-pile regulator is identical with that of a single-pile type, but the construction is slightly modified to accommodate the additional piles. Fig. 3 illustrates a four-pile type, where the piles are connected in series-parallel.

**14.** To mount the four piles, a stub shaft projects from the armature clamp plate. A gimbal arm, pinned to this stub axle, carries two pressure arms which are pinned to spindles projecting from the ends of the gimbal arm. At the ends of the pressure arms are fitted brass ferrules which are insulated from the arms by mica. The ferrules house carbon terminal plugs which contact the piles. A strap connector links the pair of ferrules on each pressure arm.

**15.** At the other end of the unit, each pile bracket is screwed to the end plate and is insulated from it by mica washers. Each pile is fitted with its own terminal plug, adjustable ferrule, compression and locking screws, and lead connecting screw. The assembly is protected by a cover attached by screws to the end plate.▶

**Operation**

**16.** Suspended over each electro-magnet and directly beneath the pile is a spring-loaded armature, and therefore the action of varying the resistance of the pile is direct and dependent upon the pull of the electro-magnet against the armature. The pull exercised by the magnet is dependent upon the current passing through the operating coil, and for one value of current, corresponding to the controlled voltage level at which the regulator has been set, the pull exactly balances the spring pressure for all positions of the armature. Therefore for this value of current the armature can remain in any position, depending upon the prevailing conditions of generator speed and load. To operate the pile over its full working range, a total variation of 5 per cent in coil current is necessary, with a corresponding variation of 5 per cent in line voltage.

**17.** Any increase of current will reduce the pressure on the pile, so increasing its resistance, while a decrease in current will cause greater compression of the pile with consequent reduction of its resistance. Thus under steady operating conditions the line voltage will always be maintained at the appropriate controlled level.

**18.** The movement of the armature corresponding to the two extreme positions of the pile, is very small (approximately 0·015 in.), so that, with the voltage unit, the coil of which is connected across the line, any deviation in line voltage within the regulation loop varies the coil current sufficiently to cause the pile to take up a new position, such that the resulting altered pile resistance alters the generator field current to a value that will keep the line voltage within its appropriate limits.

*Stabilizing*

**19.** Voltage stabilization may be assisted by an additional shunt stabilizing coil, connected across the generator field, which acts as a damping device and prevents hunting with rapid changes of speed and load. A series stabilizing coil of low resistance, introduced in series with the pile, counterbalances the effect of the shunt stabilizing coil under steady conditions.

**20.** Another means of voltage stabilization is the incorporation of a stabilizing transformer (*fig.* 4), having its primary winding connected across the generator shunt field, and its secondary in series with the operating coil. Under steady conditions, no voltage is induced in the secondary winding, but when the generator speed increases, a voltage will be induced in the secondary winding such as to oppose the compensating effect of the operating coil and so damp any tendency towards oscillation. A similar action may be achieved by the introduction of a current transformer, which will have a stabilizing effect with variations in generator output current.

*Load sharing*

**21.** When two or more generators are operating in parallel, some means is incorporated of ensuring that the load is shared approximately equally between the generators. This may be done by means of a load sharing or compounding coil on each regulator, wound in the same sense as the operating coil, and interconnected with the load-sharing coils of the other regulators to form an equalizing circuit. Should one generator be overloaded, the voltage developed across the load-sharing coil of its own regulator will act on the pile in such a manner as to decrease the generator output; a comparable action takes place in the other regulators to increase the output of the lightly-loaded generators. Certain regulators incorporate a linkage device, whereby the compounding coil is brought into circuit when two or more generators are operating in parallel.

*Voltage boost*

**22.** Regulators operating in a system which uses a differential voltage cut-out have a voltage boost resistor incorporated. This is used to ensure an adequate differential voltage when bringing a generator on to a busbar already being supplied with current; when the generator has been connected, the resistor is automatically short-circuited.

## INSTALLATION

**23.** Regulators should be located where they are subject to as little vibration as possible, and must, unless otherwise stated, be mounted in an upright position with the terminal block at the bottom. Care must be taken to ensure that nothing is done to prevent free circulation of air round the regulator for cooling.

**24.** The general layout of the cable connections will usually be found in the circuit diagram incorporated in the chapter dealing with the individual regulator, but the correct sequence of connections will be found in the Air Diagram or Aircraft Handbook issued with the particular aircraft in which the regulator is fitted. Where regulators have link

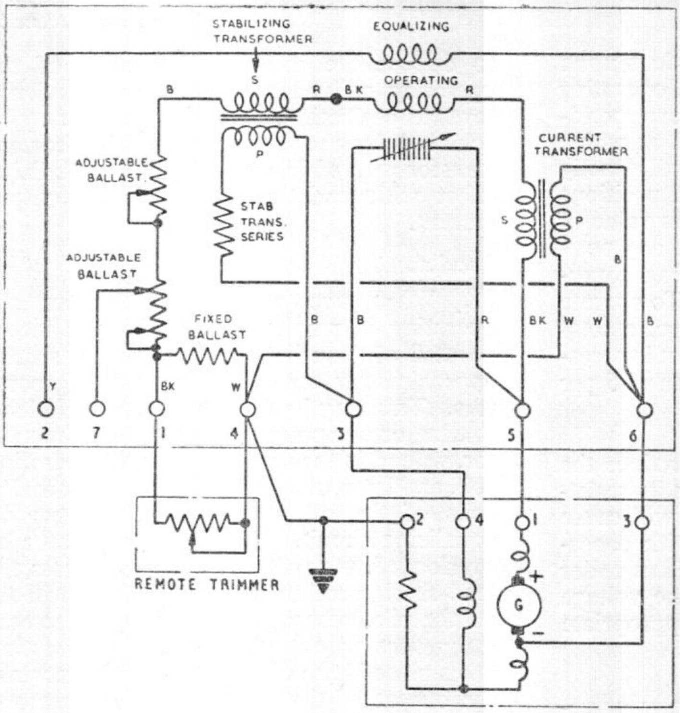


**Fig. 4. Typical circuit diagram**

boxes incorporated, it is essential to see that the link connections are correctly made to suit the specific installation.

## SERVICING

### Tests prior to installation

**25.** On installation, only minor adjustment to the voltage level by means of the trimmer resistor should be necessary. Before adjustment is made the regulator should be dried out by connecting to the appropriate generator and running on no load for approximately 20 minutes at a generator speed of between 3,000 and 4,000 r.p.m. The regulator may then be tested for voltage output and stability as laid down in the appropriate chapter, using the bench testing set specified, details of which will be found in A.P.4343S, Vol. 1, Sect. 13.

### Adjustment of regulators installed in aircraft

**26.** Do not adjust regulators installed in aircraft if this can be avoided. When necessary, however, they may be set to the correct voltage by use of the trimmer resistor. When adjustment is made, the aircraft engine should be running at normal cruising speed, all electrical loads switched off, and the batteries disconnected. Do not use the aircraft voltmeter for voltage readings, but employ a testmeter of known accuracy connected across the G+ and G— terminals of the regulator.

**27.** It is recommended that voltage regulators be checked for voltage level when the aircraft arrives after a flight, otherwise conditions when on dispersal may cause moisture in the pile with consequent rise in voltage, in which case the voltage will return to normal after 20 minutes running.

**28.** The nominal voltage setting for various d.c. regulators is shown in Table 1. Reference should, however, be made to the relevant Aircraft Handbook for the actual setting required, since for regulators controlling the main aircraft power supply this is dependent on the particular installation, and may vary for different aircraft.◀ In aircraft with 112-volt and 28-volt systems which are fitted with lead-acid batteries, Type H, it has been found necessary to set regulators at 110 and 27·5 volts respectively to avoid overcharging of the batteries; in aircraft using other types of lead-acid batteries or alkaline batteries, Type K, regulators are set at 112 volts and 28 volts as appropriate. ▶ No variation, of course, occurs with regulators which control the input to radio and other equipment; these regulators are always set to the voltage required by the equipment.

### Fitting a new carbon pile (*fig.* 5)

**29.** If the regulator is known to be in a dry condition, but is completely out of adjustment and fails to pass the installation test, the following procedure should be adopted.

(1) Slacken the screw locking the pile compression screw.

(2) Remove the compression screw and carbon insert.

(3) Remove the pile from the ceramic tube. Remove the washers by sliding them on to a stiff rod or screwdriver, and do not handle them more than is absolutely necessary. Should the washers be badly burned or pitted, a new pile must be fitted.

(4) If the carbon insert in the compression screw is pitted or burnt it should be smoothed with the finest grade glass paper or other light abrasive material



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and finished off with velvet. It is essential that the contact surface should be kept absolutely flat and square.

(5) To smooth the carbon insert in the spring armature assembly, disconnect the lead from the terminal on the end bracket in which the pile compression screw is threaded, remove the nuts holding the heat dissipator and lift it off its base. The insert may then be treated as in sub-para. (4).

(6) Use the reverse procedure to re-assemble the unit, fitting a new pile if necessary.

**Note . . .**

*When re-fitting a pile in regulators having silver contact discs, the armature should be held down to ensure that the top silver disc is flat and completely inside the ceramic tube; the armature should be released only when the pile compression screw is replaced. If the armature is not held down, the silver disc is liable to overlap the ceramic tube, and when the pile compression screw is fitted the disc may move sideways and touch the cooler assembly, so causing a short-circuit.*

**30.** Details of the carbon piles fitted in various types of d.c. regulators are given in Table 2. The length of the pile and the number of washers which are normally used are given in each instance. When 1 mm. or 0·5 mm. washers are concerned, however, the figure quoted is the minimum number, and it may be found that an additional washer is necessary to give the correct pile length.

**Setting up**

**31.** The following paragraphs describe in detail the setting-up procedure, which will

**Table 1**
**Data for d.c. voltage regulators**

| Regulator Type | Stores Ref. | Voltage (nominal) | Pile range (ohms) | Coil current (amp.) at nominal voltage at room temperature |
|---|---|---|---|---|
| D | 5UC/1024 | 14 | 6—90 | 1·0—1·1 |
| F12 | 5UC/191 | 14 | 3—35 | 1·0—1·1 |
| F24 | 5UC/192 | 28 | 10—90 | 0·5—0·6 |
| J | 5UC/522 | 28 | 2—25 | 1·1—1·21 |
| J2 | 5UC/2573 | 28 | 2—25 | 1·1—1·21 |
| J4A | 5UC/5076 | 28 | 2·5—25 | 1·1—1·21 |
| 13 | 5UC/537 | 22 | | 0·25 |
| 22 | 5UC/2166 | 22 | 1·2—10·8 | 0·3—0·33 |
| 22A | 5UC/5797 | (1) 15 (2) 19 | | 0·47—0·5 |
| 23 | 5UC/2844 | 23 | 1·5—20 | 1·18—1·22 |
| 32 | 5UC/2899 | 28 | 1·5—10 | 0·75 |
| 43 | 5UC/4269 | 14 | 3—35 | 1·0—1·1 |
| 57 | 5UC/5201 | 28 | 1·5—25 | 1·35—1·4 |
| 60 | 5UC/5418 | 19 | 0·6—7 | 0·25—0·275 |
| 66 | 5UC/5524 | 28 | 2·5—24 | 0·6—0·66 |
| 70 | 5UC/6014 | 28 | 1·7—37 | 0·82—0·88 |
| 79A | 5UC/6346 | 28 | 2—30 | 1·05—1·1 |
| 91 | 5UC/5522 | 112 | 15—180 | 0·6—0·66 |
| 92 | 5UC/5721 | 28 | 0·4—1·8 | 2·0—2·1 |
| 94 | 5UC/5937 | 28 | 0·7—22 | 1·8—2·2 |
| 96 | 5UC/6031 | 28 | 0·5—4·5 | 2·0—2·2 |
| 98A | 5UC/6544 | 200 | 5—30 | 0·105—0·115 |
| 100 | 5UC/ | 12 | *1·11—4·6 | 0·7—0·77 |
| 105 | 5UC/6178 | 28 | 1·5—20 | 1·18—1·22 |
| 111 | 5UC/6289 | 28 | 1·0—15 | 1·05—1·1 |
| 114 | 5UC/6360 | 28 | 2—30 | 1·05—1·1 |
| 50/42909E | 5UC/6137 | 24·5 | 1—12 | 0·63—0·65 |
| 22/50836 | 5UC/6138 | 28 | 0·6—6 | 0·47—0·5 |
| 1555A | 5UC/6007 | 19 | 2·5—11 | 0·22—0·24 |
| 1809 | 5UC/6131 | 19 | | |
| 228-LU-14D | 5UC/6010 | 19 | | |

*Including 0·75 ohm series resistance.

normally ensure that the regulators will pass specification tests. After any adjustment other than by means of the trimmer resistor, the regulator must be subjected to the full range of tests before being returned to service. This is essential to prove that the re-setting procedure has been done correctly, and that the regulator is in good order.

**32.** When setting up a regulator, the operator should bear in mind the function of the two adjustable parts, as follows.

*Pile compression screw*

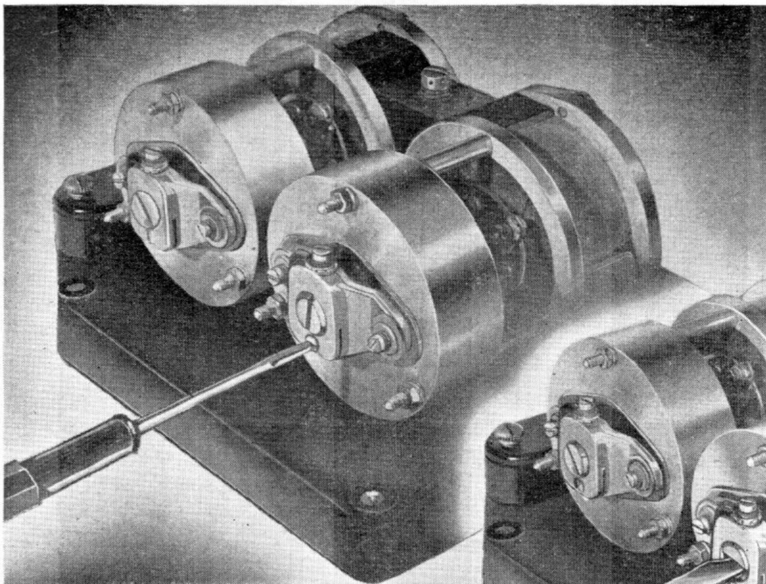
**33.** The setting of this screw determines the rate of the armature spring, and thus the characteristics of the regulator. An over-compressed spring will be very stable, but will give poor regulation; an under-compressed spring, however, will result in hunting. In a given regulator there is only one position for the spring which will give satisfactory regulation and stability.

**Table 2**

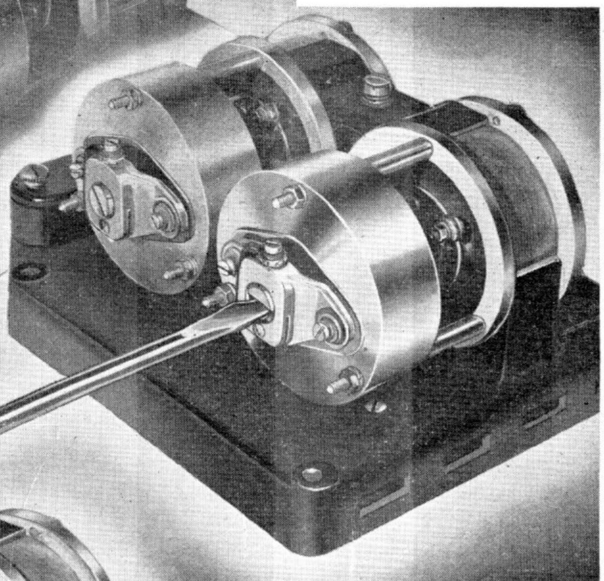
**Data for carbon piles**

| Regulator Type | Stores Ref. of pile | Pile length (in.) | No. of washers | * Dimensions of washers (mm.) |
|---|---|---|---|---|
| D | 5UC/1021 | 1·5 | 76 (min.) | 10·9×5×0·5 |
| F12 | 5UC/365 | 1·5 | 38 (min.) | 10·9×5×1 |
| F24 | 5UC/1021 | 1·5 | 76 (min.) | 10·9×5×0·5 |
| J | 5UC/3279 | 1·875 | 47 (min.) | 17·9×5×1 |
| J2 | 5UC/3279 | 1·875 | 47 (min.) | 17·9×5×1 |
| J4A | 5UC/3279 | 1·875 | 47 (min.) | 17·9×5×1 |
| 13 | 5UC/2164 | 1·5 | 9<br>10 } (interleaved) | 10·9×5×1<br>10·9×5×3 |
| 22 | 5UC/3365 | 1·5 | 10<br>11 } (interleaved) | 10·9×5×0·5<br>10·9×5×3 |
| 22A | 5UC/365 | 1·5 | 38 (min.) | 10·9×5×1 |
| 23 | 5UC/4260 | 2·875 | 72 (min.) | 17·9×5×1 |
| 32 | 5UC/3841 | 42 mm. | 42 (min.) | 18×11·5×1 |
| 43 | 5UC/365 | 1·5 | 38 (min.) | 10·9×5×1 |
| 57 | 5UC/4260 | 2·875 | 72 (min.) | 17·9×5×1 |
| 60 | 5UC/6046 | 1·5 | 9<br>10 } (interleaved) | 10·9×5×1<br>10·9×5×3 |
| 66 | 5UC/6338 | 1·5 | 38 (min.) | 10·9×5×1 |
| 70 | 5UC/6165 | 2·5 | 50<br>6 } (interleaved) | 17·9×5×1<br>17·9×5×3 |
| 79A | 5UC/ | 4 | 103 (min.) | 17·9×5×1 |
| 91 | 5UC/6150 | 2·5 | 130 (min.) | 10·9×5×0·5 |
| 92 | 5UC/6151 | 2·5 | 21 | 10·9×5×3 |
| 94 | 5UC/ | | | |
| 96 | 5UC/6152 | 2·6 | 19<br>9 } (interleaved) | 10·9×5×3<br>10·9×5×1 |
| 98A | 5UC/ | 1·875 | 94 (min.) | 17·9×5×0·5 |
| 100 | 5UC/ | 2·875 | 18<br>17 } (interleaved) | 17·9×5×3<br>17·9×5×1 |
| 105 | 5UC/4260 | 2·875 | 72 (min.) | 17·9×5×1 |
| 111 | 5UC/6425 | 4 | 26<br>50 } (interleaved) | 17·9×5×3<br>17·9×5×0·5 |
| 114 | 5UC/ | 4 | 50<br>26 } (interleaved) | 17·9×5×1<br>17·9×5×2 |
| 50/42909E | 5UC/6254 | 4 | 50<br>26 } (interleaved) | 17·9×5×0·5<br>17·9×5×3 |
| 22/50836 | 5UC/2164 | 1·5 | 9<br>10 } (interleaved) | 10·9×5×1<br>10·9×5×3 |
| 1555A | 5UC/6035 | 1·125 | 22<br>2 } (exact) | 10·9×5×1<br>10·9×5×3 |
| 1809 | 5UC/5811 | | | |
| 228–LU–14D | 5UC/5811 | | | |

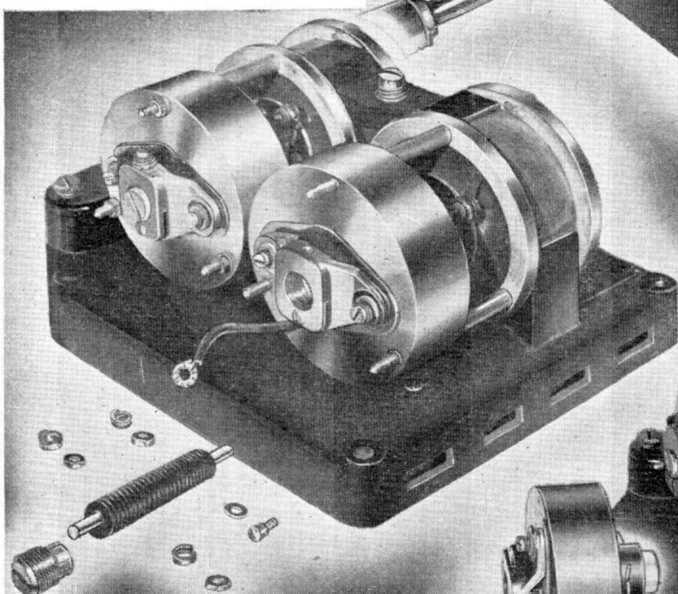
* Outside diameter × inside diameter × thickness.



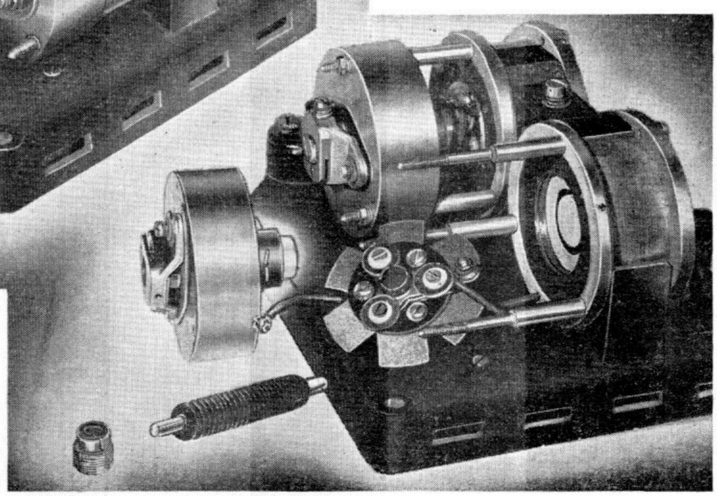
*Left:* The compression plug must be removed when fitting a new carbon pile. To carry out this operation, the locking screw must first be slackened off.



*Right:* The compression plug may now be completely removed.



*Left:* Carbon pile must be treated with care and retained on a rod or wire. Cleanliness is important.



*Right:* Carbon inserts and washers should be examined for pitting before re-assembling. A pitted pile must be renewed but inserts may be smoothed down.

**Fig. 5. Fitting a new carbon pile**

**34.** Suppose, for example, a regulator is hunting; by turning the pile screw slowly " in " (i.e. clockwise), a point will be reached at which hunting stops. This is the point at which the regulator will give flattest regulation. It cannot, however, be left to operate at this setting, because 0·001 in. pile wear would cause hunting to start; the pile screw is therefore turned " in " from this optimum point and the armature spring compression is increased. The amount of extra compression from the optimum point varies with the type of regulator, and is given in the chapter on that regulator. Briefly, then, the pile compression screw is the means by which the spring rate is adjusted to match the magnetic pull over the operating range.

*Magnet core (fig. 6)*

**35.** Adjustment of the magnet core affects only the voltage level at which the regulator works. When adjusting the voltage level by means of the core, the voltage should rise when the core is turned "out" (increasing the air gap), and fall when the core is turned " in " (decreasing the air gap). If the opposite occurs, it is certain that the core is touching the armature and preventing free movement. In this case, the core should be turned " out " till the voltage stops falling and starts to rise.

*Principle of dip method of setting*

**36.** If a regulator, with the pile compression screw completely slackened off, is connected to an engine-driven generator running at a constant speed within its working range, the generator will fail to excite due to the high resistance of the uncompressed pile in the field circuit. When the pile compression screw is turned " in ", the pile resistance will be reduced, and the generator will then excite, the voltage across the generator terminals being determined by the resistance of the pile and the speed of the generator.

**37.** If the compression screw is turned "in" still further, a decrease instead of an increase in generator voltage will be observed due to the pull of the electro-magnet, which at this stage increases at a greater rate than the opposing spring forces. This decrease in voltage will continue as the compression screw continues to be turned in a clockwise direction until a minimum voltage value is reached.

**38.** Further rotation of the screw will then result in an increase of generator voltage, due to the opposing spring force increasing at a greater rate than the pull of the electro-magnet. It will be appreciated that at one position the spring force and the magnetic pull will exactly balance; this is the position of minimum voltage, and is known as the dip position. On one side of this position the magnetic pull will predominate, and on the other side the spring force.

**39.** Presuming that the spring angle and the spring support angle are of the same ratio, the dip position will always come to the exact compression point when the generator is running at any speed within its working range. In practice, however, the ratio may not be exact, due to working tolerances allowed in production, and therefore the final setting of the compression screw is determined by the stability tolerance called for to allow for pile wear in service.

*Coil current*

**40.** The regulator has been set during manufacture, by suitable adjustment of the ballast resistor, so that the value of current in the operating coil is correct, and it should not be necessary to adjust this unless the regulator fails to respond to other adjustments and tests.

*Preliminary mechanical setting*

**41.** To set the magnet core in the flush position the following procedure should be adopted.

(1) Slacken the two core-locking screws on the base of the magnet pot, and turn the core " out " until two threads are protruding from the base.

(2) Slacken the screw locking the pile compression screw. Turn the pile compression screw " in " as far as it will go, without using undue force and crushing the pile.

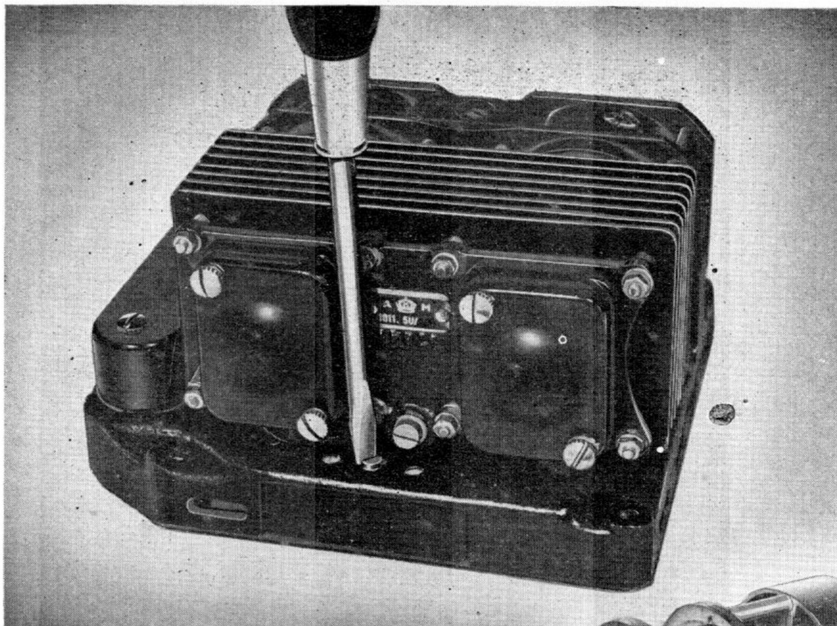
(3) Turn the core " in " until it comes in contact with the armature or spring support assembly, i.e., until resistance to further movement of the core is felt. This is the flush or zero gap position of the assembly.

(4) Turn the pile compression screw " out " $\frac{3}{4}$ turn and half lock.

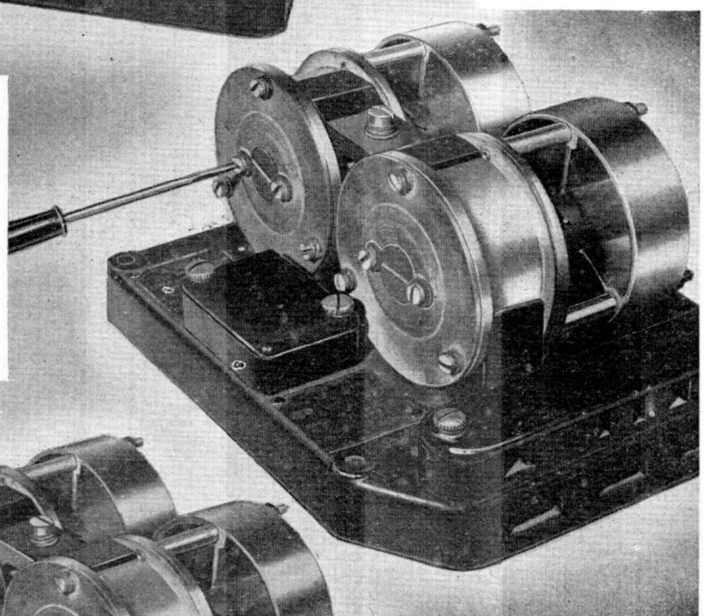
(5) Turn the magnet core " out " $\frac{1}{4}$ turn and lock.

◀ **Note . . .**

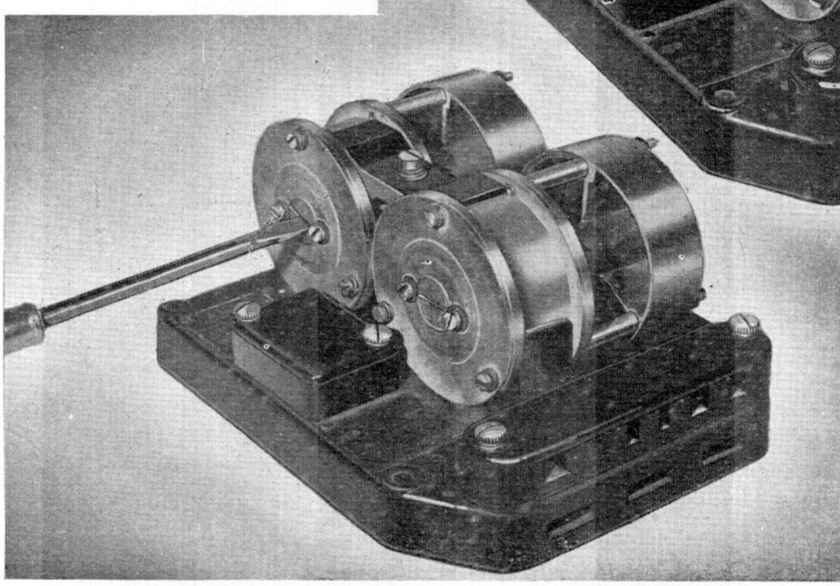
*When resetting the pile compression screw in regulators which have the flat type armature spring (fig. 3), a feeler gauge of the appropriate thickness may be inserted between the core face and the armature, the pile being compressed to give this air gap. To ascertain the*



*Left:* If a trimmer screw is fitted, this adjustment MUST be used first. Only if this method fails to give the required results should magnet core be adjusted to alter the voltage level.



*Right:* Before turning the core, slacken the two locking screws.



*Left:* Only a very small movement of the core should be made at any one time. Tighten the locking screws after core adjustment.

**Fig. 6. Magnet core adjustment**

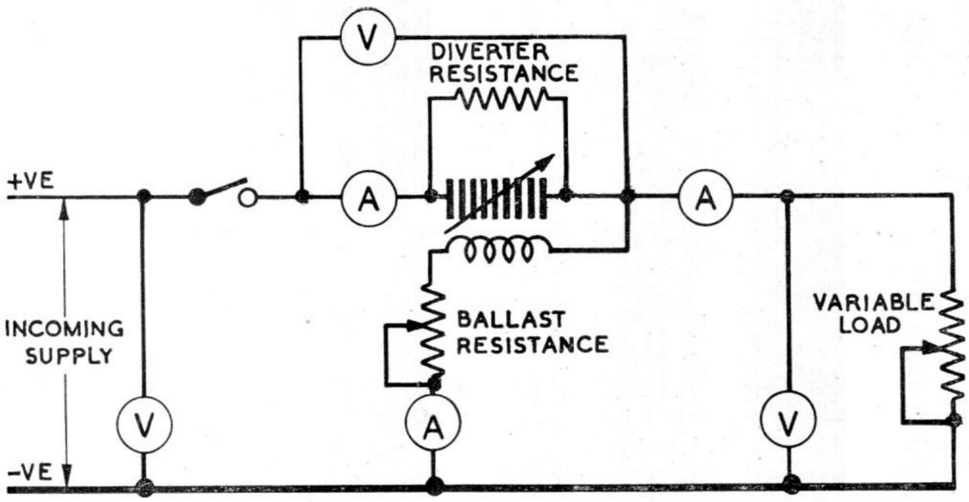


**Fig. 7. Typical test circuit diagram (series regulator)**

*correct thickness of feeler gauge, the original air gap should be measured before making any adjustment. The same procedure applies to multi-pile regulators, but care must be taken to ensure that the pressure arms are horizontal.* ▶

*Final voltage adjustment*

**42.** Connect the regulator in the test circuit shown in the relevant chapter of A.P.4343B, Vol. 1, Book 1, using the appropriate generator driven by a bench testing set with a suitable switchboard and loading panel. A typical test circuit diagram for each type of regulator is given in fig. 7 and 8. The regulator trimmer resistor, if fitted, must be in the mid position, the diverter resistor open-circuited and the series resistor short-circuited. With the generator running on no load and at approximately 5,000 r.p.m., adjust the controlled voltage level to the specified voltage by means of the core. To reduce the voltage level turn the core " in ", and to increase, turn the core " out ".

**43.** Slacken the pile locking screw just sufficiently to permit movement of the pile screw. Turn the pile screw " in ", observing the voltmeter very carefully, until the voltage decreases to a minimum value. Should the voltage rise as the pile screw is turned " in ", reverse the direction of pile screw rotation and slowly turn the pile screw " out " until the voltage falls to a minimum and just begins to rise again. This position of minimum voltage, i.e., the dip, is the correct setting of the regulator for optimum performance. The pile adjusting screw must then be locked securely in this position. The adjustment of the pile screw is delicate, and must be made with the greatest care to obtain this setting.

**44.** The level of the voltage in the dip position should be 14 volts $\pm\frac{1}{2}$ volt, 19 volts $\pm$ 1 volt, 28 volts $\pm$ 1 volt, or 112 volts $\pm$ 4 volts, as appropriate. If the dip voltage is outside these limits, the line voltage must be adjusted as necessary by the magnet core, and the dip adjustment repeated until the dip is obtained within the stated limits.

**Note . . .**

*It will be noted that in the preliminary setting, the pile screw had been slackened back $\frac{3}{4}$ turn from the zero gap position. It will be found in practice that the minimum voltage or dip position will be very close to this point. This preliminary adjustment also avoids taking the pile screw through the " violent hunting " position to find the dip.*

**45.** The regulator can now be assumed to be adjusted to give the optimum regulation with speed and load change, and is ready for full regulation and stability tests, details of which are given in the individual chapters in A.P.4343B, Vol. 1, Book 1. The regulation test may be made either by varying the generator speed, or by manipulation of series

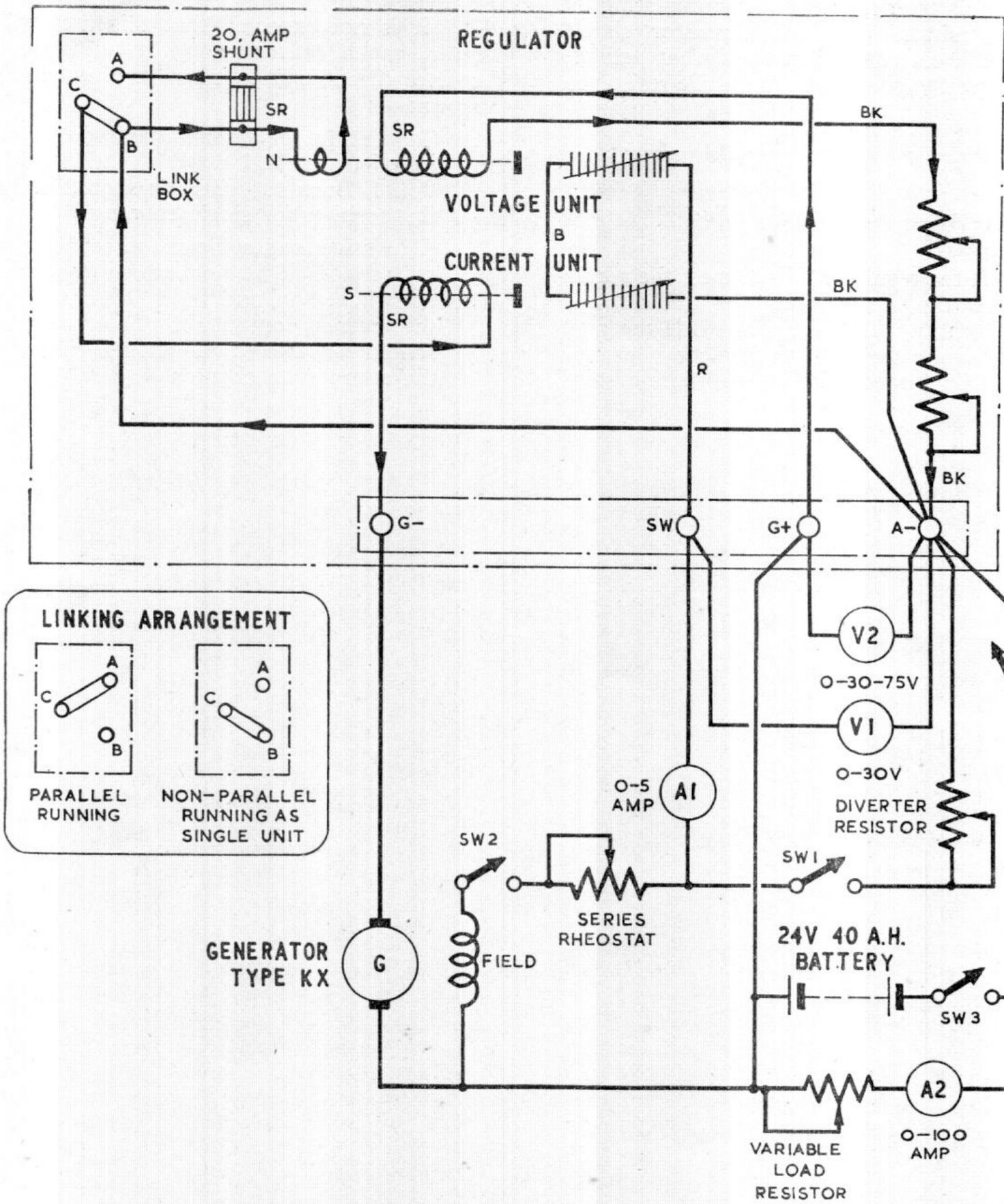



**Fig. 8. Typical test circuit diagram (shunt regulator with voltage and current units)**

and diverter resistors to operate the pile over its full working range. The maximum pile resistance is obtained by shorting the series resistor and manipulating the diverter resistor, and the minimum resistance by open-circuiting the diverter resister and manipulating the series resistor. The series resistor should always be set at 0 ohms except when actually being used to obtain minimum pile resistance.

**Note . . .**

*The diverter resistor should always be switched in or out at full resistance to ensure minimum disturbance on the line.*

**46.** If the regulator fails to meet the regulation test, the pile screw may be turned " out " $\frac{1}{16}$th turn and the test repeated. If the regulator fails on the stability test, the pile screw should be turned " in " until hunting stops, and then turned " in " a further $\frac{1}{8}$th turn or $\frac{3}{16}$th turn (depending on type) and locked. After any re-adjustment, the regulator must again be fully tested.

*Current unit*

**47.** It is not expected that this unit will require much attention, but if adjustment becomes necessary, it must be tested as follows:—

(1) Connect the regulator to the appropriate generator as laid down in A.P.4343B, Vol. 1, Book 1. The link should be in the position for single running.

(2) A resistive load sufficient to reduce the voltage to half the nominal value should be switched on, and under this condition the current output of the generator should not exceed the values given in the appropriate chapter.