VOLTAGE REGULATORS
CENTRIFUGAL TYPE—AUTOMATIC
DESCRIPTION

1. GENERAL

1.01 This section covers the KS-5293- and KS-5376-type centrifugal type automatic voltage regulators (Fig. 1), some of which have separately excited d-c or a-c motors while others have permanent magnet type d-c or a-c motors.

1.02 This section is reissued to include the KS-5376-type regulators, the inseparable type bearings, and the permanent type fields. Since this is a general revision, marginal arrows ordinarily used to denote changes have been omitted.

1.03 The voltage of a generator is regulated by rapidly opening and closing a shunt circuit across part of the generator field rheostat, thereby varying the field excitation of the generator. This rapid opening and closing of the shunt circuit is accomplished by the centrifugal type automatic voltage regulator described herein.

1.04 The voltage regulator unit consists of two parts, one a rotating element consisting of a hub, slip ring, spring, weights, and contact for mounting on the motor shaft extension. The other element is a stationary contact adjustment mechanism consisting of an insulating cover, with an adjusting screw, coil spring, contact arm and dial. This adjusting mechanism assembly is mounted on the regulator housing.

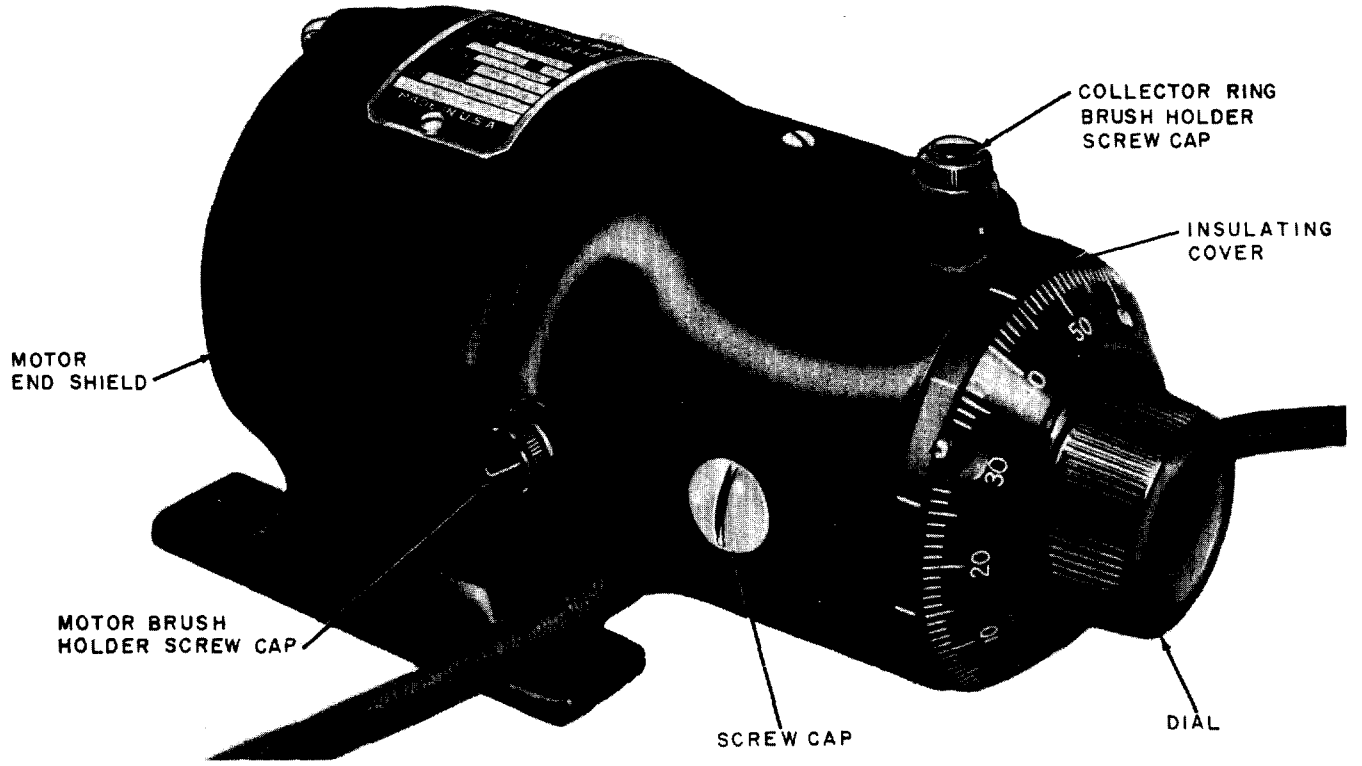

Fig. 1—Automatic Centrifugal Type Voltage Regulator

1.05 Each regulator may be used with an individual generator, a-c or d-c, or with proper switching arrangements, may be used to regulate different generators. In all cases, power for operating the armature of the regulators is obtained from the generator which it regulates.

1.06 There are two types of voltage regulators currently available. The KS-5293-02 L3 with voltage range of 125-135 volts d-c and the KS-5376-01 L11 with a voltage range of 76-108 volts a-c.

1.07 The KS-5293 type voltage regulators derive their input from a d-c source whereas the KS-5376-type voltage regulators derive their input from an a-c source. In the case of the KS-5376-01 L11 type regulators, they are supplied with a transformer and selenium rectifier for converting the a-c input to d-c to operate the armature.

1.08 Early models of the voltage regulators, those with separately excited d-c motors, have associated with them a ballast lamp and in some cases also a fixed field resistance unit. The resistance unit should only be used with the regulator having the same serial number. Where the regulator field is excited from a 24-volt source, the resistance unit is not needed. Voltage regulators which have a permanent magnet type field do not require either the ballast lamp or the resistance unit.

2. DESCRIPTION OF APPARATUS

2.01 ***Armature:*** The armature is built up of steel laminations or punchings. These laminations are assembled to form slots in the periphery into which windings are inserted. The ends of the windings are connected to commutator bars or segments. The commutator is made of hard drawn copper segments insulated from each other and from ground by mica or micanite. The armature is wound for the particular voltage range in which the regulator is to operate.

2.02 ***Regulator Housing:*** The regulator is semi-enclosed having on one end a bearing housing which is part of the motor frame. This same end has a regulator housing upon which is mounted the insulating cover and dial. The other end consists of an end shield which is removable. The end shield contains the bearing housing for the other motor bearing.

2.03 ***Magnetic Field:*** There are two types of magnetic fields.

(a) Older models of the voltage regulator have a field coil mounted upon a field yoke. The field consists of laminations pressed together and riveted. The field and field yoke is secured to the motor housing by a setscrew on the side of the housing. This screw, however, should not be loosened in the field since it involves a factory adjustment.

(b) New models of the voltage regulator are equipped with a permanent magnet type field. This field is secured to the motor housing by a setscrew in the side of the housing. With the permanent magnet type field, whenever the armature is withdrawn, it should be replaced with a keeper which will prevent the field from losing its magnetism.

2.04 ***Bearings:*** There are two types of bearings, the separable and the inseparable.

(a) The older models of voltage regulators are equipped with ***separable-type bearings*** which are of the ball bearing type. A bearing consists of three parts as follows: the inner ball race on the shaft, the balls and retainer, and the outer ball race which in both ends of the motor has a sliding fit in the bearing housing. In the commutator end the outer ball race bears against a felt washer retaining washer. In turn the retaining washer bears against a shoulder in the bearing chamber which contains another felt washer. In the opposite end, the outer ball race bears against a felt washer retaining washer which contains another felt washer. An inside bearing plate with a copper washer and a felt washer is drawn up against each bearing housing between the housing and the armature by means of four screws through holes in the end shields. This makes the housing tight and prevents the lubricant from escaping from the bearings to the inside of the regulator. No provision is made for lubrication as the motor can only be lubricated when it is disassembled.

(b) Later models of the voltage regulators are equipped with ***inseparable sealed type ball bearings*** which are suitably lubricated at the factory. The inner ball race has a light press fit sufficient to cause it to remain fixed on the shaft. The outer ball race has a slip fit in its

housing or retainer. The bearings, shaft, and bearing housings are designed to prevent lubricant from leaking out on the regulator parts or windings. On the commutator end the outer ball race bears against a shim washer (if needed for adjustment) in the bearing housing in the motor frame. On the opposite end the outer ball race bears against a thrust spring which in turn bears against a shim washer in the bearing housing in the end shield. The thrust spring takes up the end play of the motor shaft. The end shield has an opening through which speed reading can be taken. This opening is covered by a removable cap.

2.05 ***Regulator Unit:*** The regulator unit consists of a fixed contact and a rotating contact. The fixed contact is normally stationary but moves axially when the dial is adjusted. The fixed and rotating contacts are dissimilar metals. This combination gives minimum mechanical and electrical wear and reduces sparking. Both contacts are cored or hollowed centered in order to secure a relatively uniform wear over the entire contact surface. The fixed element has a metal contact mounted on the inner end of an adjustable screw. This screw is concentrically mounted on an insulating cover which is mounted on the regulator housing. The adjusting screw has a dial mounted on its outside end. No locknuts are required with the construction used. The adjusting screw has a movement in an axial direction only controlled by the dial, rotation of the screw being prevented by a small shear pin sliding in a keyway. A coil spring assembled under the head of the adjustable screw on the inside of the insulating cover serves to push the adjustable screw and contact in the direction of the rotating contact as far as the position of the dial at the setting used will permit. The rotating element has a contact centrally mounted on a flat spring which is assembled with weights on a collecting ring. This rotating element is mounted on the motor shaft extension inside of the regulator housing of the motor. A fixed contact post mounted in the regulator housing makes contact with a fixed contact arm which is part of the insulating cover of the voltage regulator assembly. Both the rotating and fixed contacts can be replaced by simply unscrewing them from their mountings and replacing them with new contacts.

2.06 ***Theory of Operation:*** In normal operation, the contact between the fixed contact and the rotating contact is rapidly made and broken maintaining the voltage very closely. As the generator voltage becomes low, the regulator motor slows down and the contacts close. This short circuits part of the generator field resistance thus strengthening the field and increasing the generator voltage. This increase in the generator voltage causes the regulator motor to speed up. The centrifugal action of the weights on the rotating element then causes the contacts to open and the generator field resistance is again inserted in the circuit, thus weakening the generator and decreasing the generator voltage. The rapid cutting in and out of resistance in the generator field circuit provides an effective excitation which gives the desired voltage.

2.07 ***Resistance Unit (Fig. 2):*** The fields of regulators equipped with separately excited field windings are the same, i.e., wound for separate excitation from 24 volts with an 8-A ballast lamp connected in series. This same field can be used on a nominal 48- or 130-volts by using a resistance of approximately 87.4 or 317.5 ohms, respectively, connected in series with the field and ballast lamp.

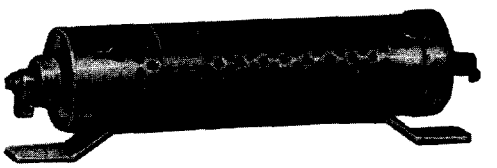

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Fig. 2—Resistance Unit

The resistance, when provided, is an enameled tube resistance with a suitable protective guard. It is adjusted at the factory for normal running temperature of the motor whose speed is nominally 2000 rpm. The resistance unit has a number of taps, the proper tap being ascertained and marked at the

factory. To prevent interchanging resistance, the serial number of the motor is marked on the resistance unit with which it is to be used. The resistance unit is mounted on the rear of the panel board. These units are not used with voltage regulators which have a permanent magnet type field.

2.08 ***Ballast Lamp (Fig. 3):*** Older models of voltage regulators which have separately excited field windings use an 8-A ballast lamp connected in series with the motor field for the purpose of securing practically constant excitation. Because of this feature, changes in impressed voltage produce corresponding changes in the speed of the armature. Ballast lamps are not necessary with voltage regulators which have a permanent magnet type field.

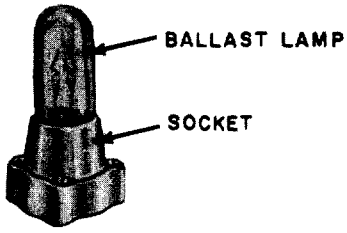

Fig. 3—Ballast Lamp

2.09 Fig. 4 shows the schematic diagram of connections of centrifugal type d-c voltage regulators which have separately excited magnetic fields. When the source of the excitation of the field is 24 volts, only a ballast lamp is connected in series with it. Where the excitation is from a 48-volt or 130-volt source, a resistance of approximately 87.4 ohms or 317.5 ohms, respectively, is connected in series with the ballast lamp as mentioned in 2.07.

2.10 Fig. 5 shows the schematic diagram of connections of one typical application of the older type regulators for the 24-volt filament or a 130-volt plate circuit. It will be noted that the field is excited by a 24-volt battery in the case of the 24-volt or 130-volt generator and therefore a regulator field resistance is not necessary. The contacts of the regulator are connected to the main plate of the generator field rheostat and the regulator armature terminals are connected to the

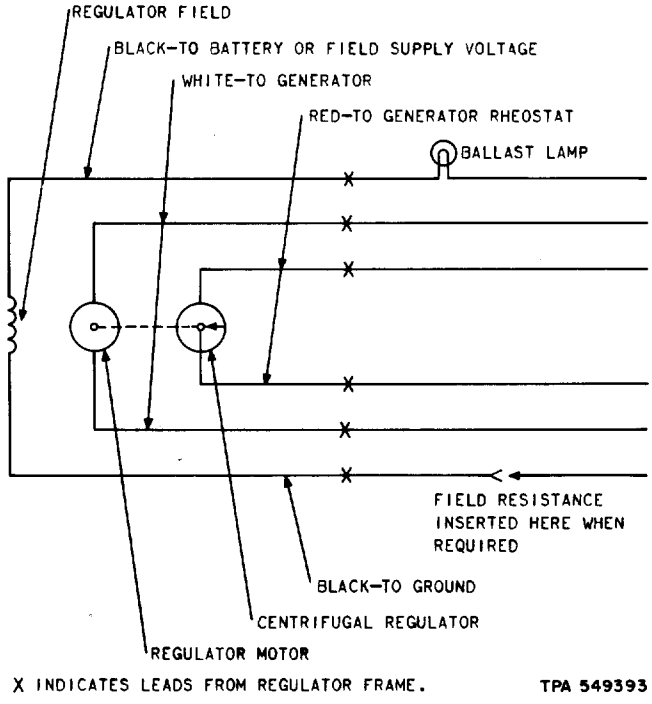

Fig. 4—Schematic Diagram-Voltage Regulator With Separately Exicited Field

generator terminals. A spare generator is shown and the switching is so arranged that the regulator may be connected to its associated generator or the spare generator. Only one generator can be connected to the regulator at one time however. Disconnect switches are usually provided for each generator, so that the generators may be operated with hand regulation if it is desired to take the regulator out of service. All regulator leads are soldered to punchings located on the rear of the panel in proximity to the holes through which these leads are brought. This will permit easy replacement or removal of the regulator should occasion demand. In the case of the positive and negative grounded telegraph plants, there will be two regulators, one for each polarity and the spare generator which can be used on either polarity would be capable of use with either regulator.

2.11 Fig. 6 and 7 show typical input arrangements to the KS-5293-02 L3 and KS-5376-01 L11 voltage regulators, respectively.

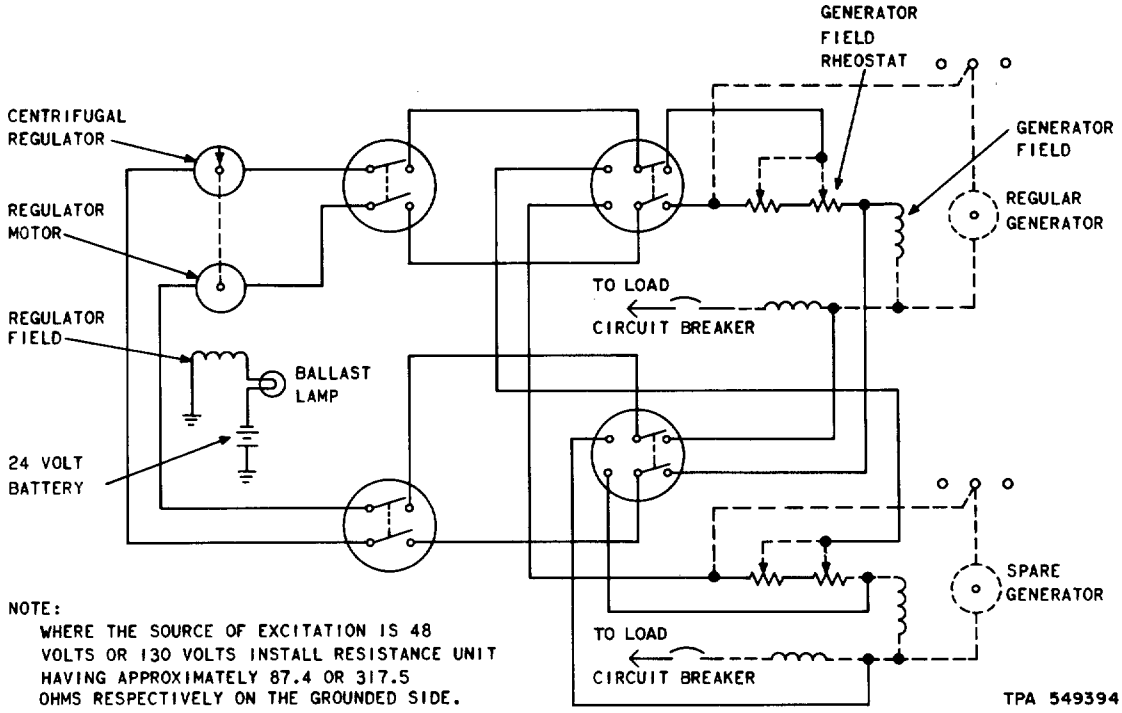

Fig. 5—24-Volt Filament or 130-Volt Plate Regulating Circuit

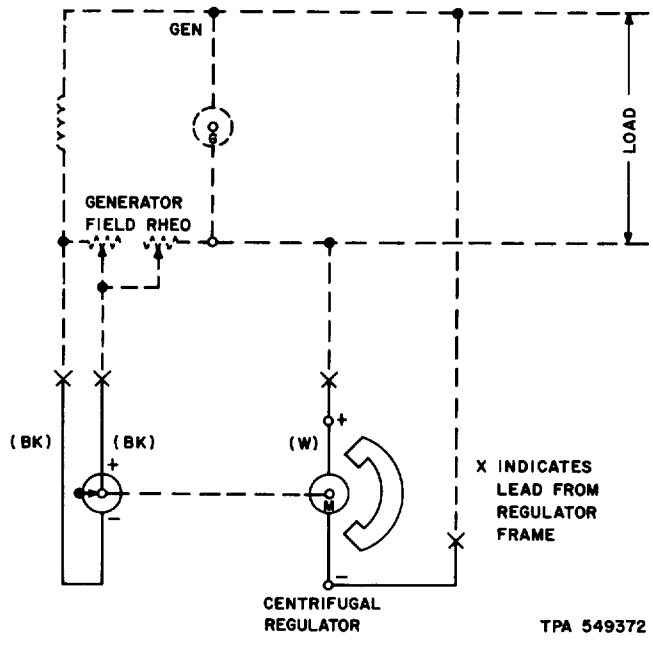

Fig. 6—KS-5293-02 L3 D-C Regulator With Input

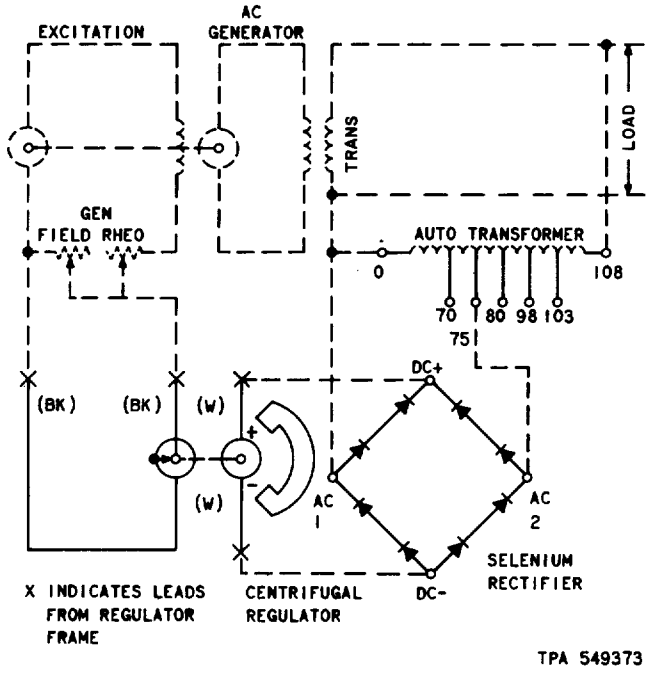

Fig. 7—KS-5376-01 L11 A-C Regulator With Input