Type SU Primary Relay
With Dynamic Line-Drop Compensator
INSTRUCTIONS

GENERAL

The type SU primary relay with dynamic line-drop compensator is of the alternating current solenoid type and is ruggedly designed. Compounding is obtained by means of a permanent magnet rather than electro-magnets. Adjustments for different values of balance voltage are readily made by shifting a counter weight along a scale which is engraved in volts. In addition, a small coil, energized by rectified current from a current transformer, and attached to the balance arm and operating in a permanent magnetic field, provides a means for compensating for line drop. Usually the only maintenance required is an occasional inspection and dressing of the contacts.

CONSTRUCTION

The relays as used on step type regulators are usually mounted on individual panels and provided with a tight fitting cover having a glass front. Fig. 1 shows a front view without cover and Fig. 2 a schematic diagram of the relay connections, the rectox unit and adjusting rheostat. The operating parts have been combined into a single moving element which is mounted by a square shaft resting on a knife edge. This provides a very sturdy bearing with a negligible amount of possible friction. The shaft and bracket are made of nitrided steel which is exceptionally hard and resistant to wear and corrosion. A damping device is provided which may be adjusted to provide stability to the action of the relay.

The contacts are made of silver which results in long life and smooth contact points. They are designed in such a way that contact sticking is eliminated.

The compounding is accomplished by the use of a permanent magnet acting on a soft iron armature attached to the moving element. The action of the magnet is to hold the relay element in a neutral position until a sufficient change in voltage has taken place to overcome the magnetic pull in the balance position. The moving element requires a pre-determined unbalanced force to overcome the magnet pull which results in a quick and positive movement and contact. After the voltage has been corrected a sufficient amount to cause the contacts to separate, the relay moving element is again drawn back to a neutral or balanced position by the permanent magnet.

The sensitivity of the relay or the amount of voltage change required to close the relay contacts is determined by the air gap between the magnet poles and the moving iron armature. Normal gap spacing is approximately $\frac{1}{32}$ of an inch, but may be adjusted as desired to vary the voltage band setting of the relay. If the gap is decreased, the magnet pull is greater and a greater change of voltage on the solenoid coil is required to operate the relay. If the gap is increased, the magnet pull is less and operation is obtained with a smaller voltage deviation. In this way, the relay sensitivity to voltage change may be controlled.

When the type SU primary relay is used on step type regulators a brass washer is usually used instead of an iron washer to hold the permanent magnet in position, thus increasing the strength of the magnet so that wider bands may be obtained without using air gaps which are too small to give reliable operation.

The balanced voltage setting of the relay is determined by the position of the movable weight on the relay balance arm. The setting may be changed through the use of a knurled adjusting screw which engages the movable weight.

This relay includes a simple dynamic type line-drop compensator. A small coil is attached by a link to the relay balance arm and is located in a permanent magnetic field. A small rectox unit is mounted on the back of the relay panel to rectify the current from the secondary of a current transformer located in the output circuit of the regulator. A rheostat on the back of the panel and operated by a knob on the front, shunts the output of the rectox unit and regulates the current to the compensating coil, thereby providing means for varying the amount of compensation. The scale around the knob is calibrated in volts when referred to a 120 volt circuit. The compensating device also acts as a dampening device to give stability to the relay. When checking operation of the compensator it will be necessary to have a load on the regulator in order to get current from the current transformer to operate the compensator.

INSTALLATION

The relays are usually shipped mounted on the control panel. Before putting in service the blocking should be removed from the relays and they should be checked as follows:

Press down on the relay balance arm so that the pivot shaft is held firmly in the grooved bearing. There should be clearance between the balance arm and the inside of the operating coil, also clearance between the balance arm and the sides of the supporting bearing. To adjust the clearance, loosen the two screws which hold the balance arm to the moving part of the bearing and move the arm until it lines up and then tighten the screws again. The relay contacts should be in line and the adjustment of the stationary contacts should be such that after the regulator has operated and restored the voltage to normal, the relay will return to the balanced position.

If it should be necessary to adjust the relay contacts they should be set so that the final movement of the balance arm is stopped almost entirely by the "backing" springs of the contacts as the springs help to restore the balance arm to the neutral position when the voltage returns to normal.

The compounding magnet is set at the factory for the particular application. If a wider operating band is desired move the magnet closer to the soft iron armature by means of the adjusting screw. If quicker return to neutral is desired increase the tension on the contact springs as well as moving the magnet closer to the soft iron armature. When making adjustments to the contacts the final stop should be against the contacts rather than against the stop in the compensating device.

OPERATION AND AJDUSTMENTS

The voltage regulating relay is usually adjusted to make contact on a plus or minus two or three volt change of voltage across the relay coil. The contacts will break and the relay will return to neutral or balance when the voltage returns to within approximately one volt of balance voltage. For values of setting of relays for any particular regulator, refer to the general instructions in the regulator Instruction Book.

The action of the compensator is such that when rectified current is passed through the coil, on the lower end of the plunger, a force is produced on the plunger in opposition to that produced by the field of the main operating coil, thus requiring a higher voltage on the operating coil to maintain a balance. The result is a compensation effect which is substantially proportional to the load and which, at a given load and compensator setting, is a constant value independent of the phase relation of the current and voltage of the load.

The balance weight on the moving element of the voltage relay should be set, by means of the calibrated plate, for the value of non-compensated or load center voltage it is desired to maintain. After the regulator has operated several hours continuously and the voltage relay is at exact balance with zero line drop compensation, the value of voltage shown on the calibrated plate may be checked against that read on a voltmeter connected to the test terminals. If a discrepancy is found, the plate may be adjusted by loosening the screws in the slotted holes and moving the plate as required to indicate the same value as that read on the voltmeter.

If narrow operating bands such as 1 to 1½ volts are required, the brass washer which holds the small permanent magnet should be changed to iron, and the

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magnet moved closer to the soft iron armature. This reduces the magnetic pull and makes for more accurate adjustment.

In making a complete adjustment of an SU voltage relay the stationary contacts should at first be set very wide apart so they will restrict the action of the balance arm as little as possible. The position of the compounding magnet should then be adjusted so the air gap between its poles and the armature on the balance arm will be about $\frac{1}{32}$ in., when the armature is directly opposite the magnet and the pivot bearings are pressed down firmly in place.

The first permanent adjustment to be made is that for no load balance. If the regulator is carrying load, the line drop compensation, if used, should be set at zero for this adjustment. First be sure to place the SS in the off position so as not to energize the main transformer and then apply, a 115 or 120 volt AC voltage, that can be adjusted over a plus or minus 5 volts, to the test terminals. Make an approximate setting of the balance weight by applying the desired normal voltage to the test terminals and adjust the weight until the armature comes to rest opposite the permanent magnet. Now cause the armature to pull away from the compounding magnet both for raising and lowering of the voltage. The voltages at which these movements take place should be measured with a voltmeter connected to the voltage testing terminals on the panel. The balance voltage for the relay is then that midway between the voltage required to produce movement of the balance arm upward and that required to produce movement of the balance arm downward. Note: This balance value of voltage does not necessarily cause the armature on the balance arm to stand squarely opposite the poles of the compounding magnet. If the value of voltage balance, found in the way just described, is not that desired, then the voltage adjusting weight should be moved by means of the voltage setting adjusting screw to require more or less voltage to balance the relay. After the relay balances at the desired value of voltage, this value should be compared with that on the calibrated plate on the balance arm as read from the vertical mark on the movable weight. If the value read on the calibration plate does not agree with that obtained from the voltmeter readings, the calibration plate should be moved so it will indicate the true balance voltage. Any future changes of no load balance voltage may then be made by changing the position of the voltage adjustment weight to the new value desired as read on the calibration plate.

The next adjustment should be the operating band or the variation of voltage from the balance value to cause

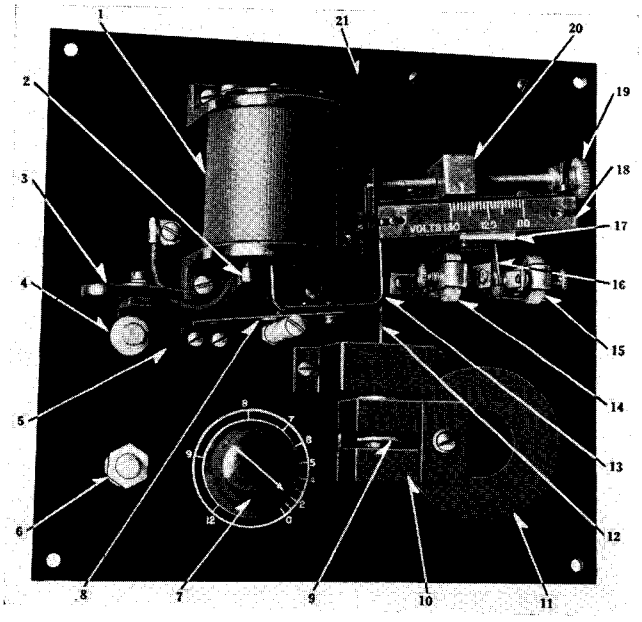

FIG. 1—TYPE SU PRIMARY RELAY, COVER REMOVED

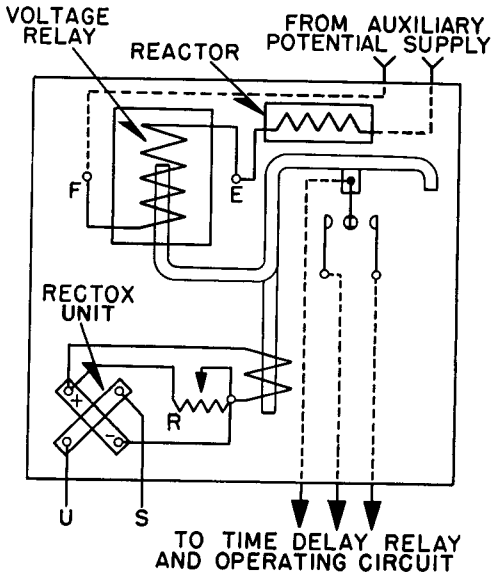

FIG. 2—WIRING DIAGRAM TYPE SU PRIMARY RELAY

LEGEND

1—Relay main operating coil
** 2—Connection to temperature compensator loading coil*
3—Permanent magnet
4—Permanent magnet air gap adjusting screw
5—Permanent magnet supporting bracket
6—Mounting stud for rectox unit for compensator
7—Compensating rheostat operating knob
8—Soft iron armature
9—Compensator operating coil
10—Compensator magnet poles
11—Compensator permanent magnet
12—Link connecting compensator coil to balance arm
13—Balance Arm
14—"Lower" contact
15—"Raise" contact
16—Moving contact
17—Bearing block
18—Voltage calibrated plate
19—Voltage setting adjusting screw
20—Voltage adjusting weight
21—Micarta panel

* Used only in older models.

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contact to be made. This band will usually be between two and three volts above or below the balance voltage. Adjustment of the relay to meet the value required is made by moving the permanent compounding magnet to vary the air gap between the magnet poles and the moving armature. A small air gap requires a greater force on the armature to pull it away from the magnet and consequently causes a wider operating band. A large air gap requires a small pull and causes a narrower operating band. On panels not equipped with a micrometer adjusting device for the compounding magnet, it is necessary to slightly loosen the screw holding the magnet to the supporting arm so that by a twisting movement about the mounting screw, the magnet may be moved closer to or farther from the moving armature. While doing this, the balance arm should be held down firmly on the pivot bearings with the moving armature opposite the magnet pole tips so the amount the magnet has been moved can be readily judged.

On panels equipped with the micrometer adjusting device, the change in air gap may be made with the adjusting screw after the locking nut has been loosened. On this equipment, turning the adjusting screw clockwise increases the width of the operating band and turning counter-clockwise decreases its width.

The final adjustment is that of the stationary contacts. They should be set to make positive contact, when the armature pulls away from the magnet and yet compress the spring so that when the voltage is restored within 1 to 1½ volts of balance the springs will push the armature into the field of the permanent magnet. It should then snap into the balance position. This snap action is required to prevent chattering of the contacts on a slightly fluctuating voltage.

ADJUSTMENT OF COMPENSATOR

No provision is made for independent adjustment of resistance and reactance compensation as this device has a fixed ratio of these values, but the total amount of compensation may be readily adjusted to any value within the usual range. On feeders of small capacity a resistance drop equal to twice the reactance drop is a common ratio. With this ratio the compensation of the dynamic compensator is within the accuracy of setting of a standard full size line-drop compensator with both X and R compensation for load power factors between 70 and 98 per cent.

The correct setting is found by the following formula:

$$C = \frac{120}{\text{Line Voltage}} (IX \sin \varnothing + IR \cos \varnothing)$$

C = Compensator setting in volts.

$\varnothing$ = Angle of lag of current behind voltage at the prevailing full-load power factor.

*IX = Reactive voltage in line to be compensated.

*IR = Resistance voltage in line to be compensated.

* For single-phase circuits, use twice the values found for a single wire.

MAINTENANCE

The amount of relay maintenance which may be required will depend largely upon the voltage conditions existing on the circuit and the degree of sensitivity to which the voltage regulating relay is adjusted. It is recommended that during the first few months of service, inspection be made at rather frequent intervals to prevent excessive tap changer operation. After satisfactory operation is once established, inspections at periods of six months to one year should be sufficient.

It is not necessary to keep the voltage relay contacts on the SU relay polished as it is on older types of relays, since contact on the SU relay is made by rolling rather than by sliding action.

If the contacts on the voltage regulating relay should become worn to an uneven shape, they may be smoothed and reshaped with fine sandpaper and readjusted.

If the operation of the relay is sluggish examine the compensator coil to be sure there is no friction between it and the permanent magnet.

Caution: Do not lubricate bearings. Keep cover on tight.

RENEWAL PARTS

Order renewal parts from nearest Westinghouse Electric and Manufacturing Company Office or from the Sharon, Pa. Works giving style or S.O. number and serial number as stamped on name plate of regulator and description of parts required. See Fig. 1.

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