

**INSTRUCTIONS**

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*Switchgear*

**RELAYS**

**SPEED-MATCHING RELAY**

**TYPE GTL12A**

**IN DRAWOUT CASE**

**GENERAL  ELECTRIC**

# SPEED MATCHING RELAY

## TYPE GTL12A

*These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.*

### GENERAL INFORMATION

#### Application

The GTL12A relay is designed to match the speed of a generator about to be connected to a bus with the speed of the generators already supplying the bus.

#### Construction

The relay consists of two voltage units with associated capacitors and resistors, for connection between the bus and generator terminals; a d-c control circuit consisting of five telephone-type relays, with associated resistors and capacitors, for initiating either speed raising or speed lowering impulses and determining the duration of the impulses; and a motor control circuit for energizing the speed matching motor. This latter circuit includes two telephone-type relays with capacitors, rectifier, potentiometer, and resistors to provide an additional speed raising impulse if a pre-determined interval elapses between speed-matching impulses. All the above mentioned devices are assembled in a three-unit double-end case of drawout construction.

The voltage units are plunger type, with moving contacts fastened directly to the armature assembly. The pickup is adjustable over a wide range by changing the position of the plunger on the aluminum plunger rod; the plunger-type construction assures a high ratio of dropout to pickup. The units have been carefully adjusted at the factory and should not require further adjustment under normal operating conditions.

In the case of drawout construction, the electrical connections between the relay units and the case are made through stationary molded inner and outer blocks between which slides a connecting plug which completes the circuits. The outer block attached to the case has the studs for external connections and the inner block has terminals for the internal connections.

The relay units are mounted in a steel framework called the cradle with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at both top and bottom and by two guide pins at the back of the case. The connecting plug besides making the electrical connections between the respective blocks of the cradle and case also locks the latch in place. The cover, which is drawn to the cradle by thumbscrews, holds the connecting plug in place.

To draw out the cradle, the cover must first be removed. Then the connecting plug can be withdrawn. After this, the latch can be released and the cradle drawn out. To replace the cradle, the reverse order is followed.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel either from its own source of voltage or from other sources. Or, the cradle can be drawn out and the relay replaced by another which has been tested in the laboratory.

#### Operation

The speed-matching feature of the GTL12A relay is dependent entirely upon the sequence of operation of the plunger units, known as 15R and 15L in automatic switching equipment. If the device is connected to the system as indicated in Fig. 2, the operation is briefly as follows: If the generator frequency is below bus frequency, the 15R unit and the associated auxiliaries will operate in such a way as to initiate speed-raising impulses and block speed-lowering impulses. If the generator speed is high, speed-lowering impulses are initiated and speed raising impulses blocked. The sequential operation of the relay is more completely described in the paragraphs that follow.

As shown in Fig. 2, the coils of 15R and 15L are each connected to both bus and generator sources through branched impedances. The coil of 15R is connected to the bus terminal through a series capacitor and resistor, and to the generator terminal through a resistance only. The coil of 15L is connected oppositely to generator and bus terminals through a capacitor and resistors whose values are identical with those used in the 15R circuit. The values of resistance and capacitance are so proportioned that maximum voltage on the relay coils occurs when the displacement between bus and generator voltage is  $45^\circ$  with bus voltage as reference (positive  $45^\circ$  for 15R and negative  $45^\circ$  for 15L). Thus there is a total displacement of  $90^\circ$  between the characteristics of the two relays. Furthermore, each of the relays

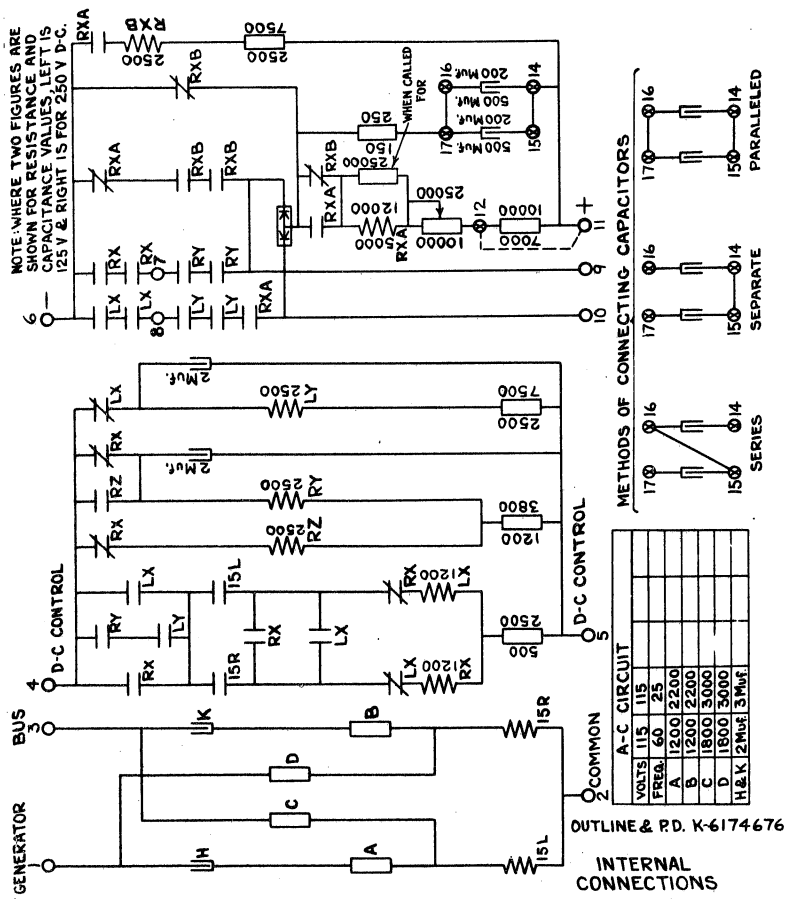
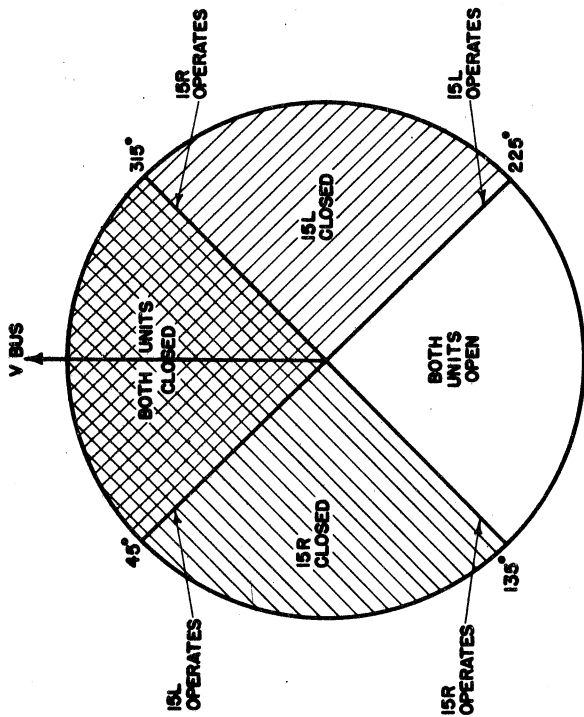


FIG. 2  
ELEMENTARY DIAGRAM OF THE TYPE GTL12A RELAY.



IF GENERATOR IS SLOW READ DIAGRAM IN CLOCKWISE DIRECTION.  
IF GENERATOR IS FAST READ DIAGRAM IN COUNTER CLOCKWISE DIRECTION.

FIG. 1  
SEQUENCE OF OPERATION OF 15R AND 15L IN THE TYPE GTL12A RELAY.

receives zero voltage at 135° displacement (positive for 15L and negative for 15R). These statements assume equal voltages of normal value on machine and bus.

The settings of the two plunger units are made so that each has a zone of 180° during which the device is picked up. Since the two relay characteristics are 90° apart, one slip cycle is divided approximately into 90° zones as follows: Both devices open, 15R closed, both devices closed, 15L closed. The diagram in Fig. 1 illustrates more clearly the operation of the plunger units as the vector representing generator voltage shifts through 360° with respect to bus voltage. If the generator frequency is low the angle by which generator voltage leads bus voltage will be decreasing, and the diagram should be read in a clockwise direction. If generator frequency is high the angle of lead will be increasing and the diagram is read in a counter-clockwise direction.

A more detailed description of the sequential operation of 15R and 15L follows, with reference to the chart in Fig. 1 and the elementary diagram in Fig. 2. As an example, assume that generator frequency is below bus frequency and that the relay is first excited when the generator voltage is in the 180° lead position. Device 15R will operate at 135°. Its normally open contact will operate auxiliary RX through the normally open contacts of RY and LY, now closed because RY and LY are picked up, and the normally closed contact of LX. When RX operates, it seals itself in around RY and LY contacts, de-energizes relay RZ, and completes the circuit to the synchronizing motor through the normally open contacts of RY, giving the motor a speed raising impulse. The speed raising impulse is maintained for the time interval required for the RZ-RY combination to drop-out, opening the RY contacts between studs 7 and 9. At approximately 45° device 15L operates, closing its normally open contact. However, the speed lowering auxiliary LX is blocked by a contact of RX and no speed lowering impulse is given. At 315° device 15R drops out, but RX remains energized through contacts of 15L and RX. At 225° device 15L drops out, de-energizing RX and returning the circuit to its initial condition. It should be noted that a normally closed contact of RX by-passes the normally open contact of RZ so that both RZ and RY coils are re-energized simultaneously. If the generator speed is high, the operation is the same except that 15L operates first, operating LX, de-energizing time-delay relay LY, and initiating a speed lowering impulse. The adjustment of the time-delay relays RZ, RY, and LY is discussed in the section on adjustments and inspection.

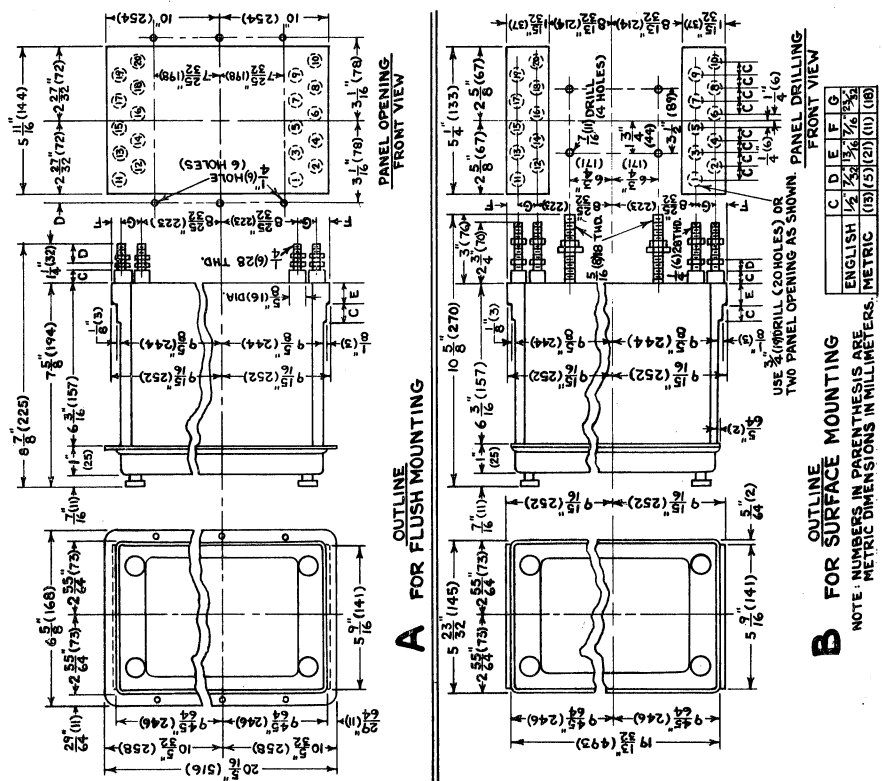
The duration of the speed matching impulses is equal to about 3/4 of one slip cycle, or to the time setting of LY unit or RZ-RY combination, whichever is the smaller. It is possible for the initial impulse to

accelerate the synchronizing motor in the wrong direction. If the relay is energized when the generator voltage vector is in the 45° to 315° zone there will be a race between devices 15R and 15L, since both are normally picked up in this zone. It is possible for the wrong device to operate first blocking the other circuit, and initiating an impulse in the incorrect direction. This condition is automatically corrected, however, after one slip cycle.

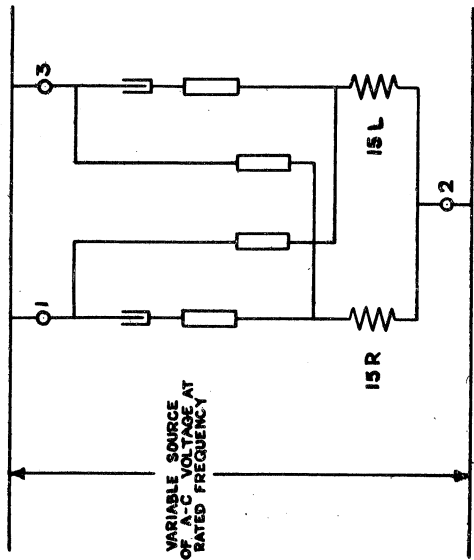
It should be emphasized that the angles shown in the diagram in Fig. 1 are only approximate values. They will be most nearly realized when the generator and bus voltages are at their normal values. If generator and bus voltages are unequal or vary from their normal values, the angles may deviate from the values shown. However, for the values of abnormal voltage usually encountered, one slip cycle will be divided into four zones that are near enough to being equal to assure satisfactory operation. Adjustments of 15R and 15L are such that the following conditions are maintained.

1. There is enough time between the pickup of 15R and 15L to allow auxiliary RX or LX to pick up.
2. Devices 15R and 15L must overlap in the picked-up position for sufficient time to hold up RX or LX.
3. Devices 15R and 15L must both be dropped out long enough for RX or LX to dropout.

Whenever a generator is matched with a bus there is the possibility of too perfect matching, which may result in the generator voltage being held at the same frequency as the bus voltage, but 180° out of phase with it. To prevent this from occurring a feature has been incorporated in the motor control circuit which initiates an additional speed raising impulse if a predetermined interval of time, adjustable from 5 to 15 seconds, elapses between speed matching impulses. Referring again to Fig. 2, it will be noted that when the circuit between studs 6 and 11 is energized (with indicated polarity) relay RXA is energized through the normally closed contacts of RXB. Relay RXA picks up, energizing RXB, completing the circuit through the rectifier to the LX-LY and RX-RY contact circuits, and opening its normally closed contact in the circuit paralleling the RX-RY combination. Relay RXB then operates de-energizing RXA which is held in the picked up position by the discharge current from the capacitors in parallel with its coil. The completion of the circuit through either the RX-RY or LX-LY contact combination, initiating a speed raising or speed lowering impulse, will cause the capacitors to be recharged through the rectifier, and will maintain RXA in the picked up position. If the interval between speed matching impulses exceeds the drop-out time of the RXA coil-



**FIG. 4**  
**OUTLINE AND PANEL DRILLING FOR THE THREE-UNIT, DOUBLE-END DRAWOUT CASE**



**FIG. 3**  
**TEST CONNECTIONS FOR TESTING 15R AND 15L IN THE TYPE GTL12A RELAY.**

capacitor combination, RXA will drop out completing the circuit in parallel with RX-RY, thus initiating a speed raising impulse and opening the RXB coil circuit. Relay RXB drops out after a short time delay opening the circuit in parallel with RX-RY and thus terminating the speed raising impulse; also when RXB drops out the RXA coil and the capacitors are re-energized. The setting of the drop-out time of RXA, which is adjustable from 5 to 15 seconds, and the setting of RXB, adjustable over a range of .10 to .35 seconds are described thoroughly under "Adjustments and Inspection".

Ratings

The GTL12A relay is available in the 115 volt rating at all standard frequencies,

Angle G Leads B	25 cycles		50 cycles		60 cycles	
	V-A	P.F.	V-A	P.F.	V-A	P.F.
0	2.0	65% lag	8.1	86% lag	6.8	85% lag
45	1.8	22% lead	4.1	93% lead	3.5	95% lag
90	5.1	39% lead	9.42	63% lead	7.2	62% lead
135	7.8	68% lead	15.3	74% lead	12.2	73% lead
180	9.1	90% lead	19.2	90% lead	15.4	88% lead
225	*9.2	99% lead	*20.5	99% lead	*16.6	99% lead
270	7.7	96% lag	18.7	98% lag	15.3	99% lag
3.5	5.3	80% lag	14.2	91% lag	11.8	92% lag

\* Indicates maximum burden in v-a.

In the case of the d-c control and motor control circuits the resistance values of the coils and resistance units are shown on the internal connection diagram in Fig. 2.

**SHIPPING - UNPACKING - STORAGE**

Immediately upon receipt of the relay an examination should be made for any damage sustained during shipment. If injury or rough handling is evident a damage claim should be filed at once with the transportation company and the nearest General Electric Sales Office should be notified.

**INSTALLATION**

Location and Mounting

The relay should be mounted on a vertical surface in a location reasonably free from excessive heat, moisture, dust, and vibration. The relay case may be grounded if desired using at least No. 12 B. & S. gauge copper wire. The panel drilling for the GTL12A is given in Fig. 4.

Connections

The internal connections of the GTL12A relay are shown in Fig. 2.

Adjustments and Inspection

The relay has been adjusted at the factory to secure the performance described

with control circuits rated at 125 or 250 volts D-C.

The contacts of auxiliaries RX, RY, LX and LY in the synchronizing motor circuit (between studs 6 and 9, or 6 and 10) will make, break and carry 1 ampere at 250 V. d-c or 2 amperes 125 d-c inductive.

Burdens

The burden of the A-C circuit, with branched impedances, varies with the angle of displacement between bus and generator voltages, as well as with the frequency. The following table gives values of burdens with power factor for various angles of displacement for the standard frequencies.

under "Operation"; all adjustments were made for operation at the voltages shown on the nameplate.

For normal operation it should not be necessary to change the adjustments of the plunger type units in any way. However, if the relay is to be operated at an A-C voltage that differs substantially from the nameplate rating the plunger units should be recalibrated.

Connect the relay as indicated in the test connection diagram in Fig. 3. Set the plunger units to pick up at approximately 70% of the desired source voltage. The pick-up value is decreased when the plunger is moved towards the top of the plunger rod, and is increased when it is moved the opposite way.

The telephone relays RZ-RY and LY have been adjusted for time delay dropout as follows: Relay LY from 1/4 to 3/8 seconds. Relays RZ and RY from 5/8 to 3/4 seconds measured from the time RZ is de-energized until RY drops out.

Because of the various characteristics of different governors and synchronizing motors, it may sometimes be desirable to change these settings. It is recommended that, if these time settings are changed, the difference between them be maintained at such a value that their ratio remains approximately the same. The time delay may be

adjusted by loosening the locknut on the front of the armature and changing the position of the brass residual screw. This screw should be backed out to increase time delay, or turned in to decrease the time delay. The residual screw should be locked securely in place after each time adjustment. After the position of the residual screw has been changed, the contact operating arm should be bent so as to restore the contact pressures to their original values. To check contact pressure, bend contact operating arm so that, with a .006" feeler gage between armature and pole piece, the normally open contacts just make when the armature is operated by hand to the picked up position. If this adjustment is not made, the change in contact pressure resulting from the change in armature travel may offset the effect of the residual screw adjustment.

Telephone relay RXB has been adjusted at the factory to have a drop-out time of approximately 0.3 seconds. Since this adjustment determines the duration of the additional speed raising impulse it may sometimes be necessary to change this setting. This adjustment should be made and the contact gaps and pressures readjusted as described in the preceding paragraph.

As previously mentioned, relay RXA in conjunction with its capacitors has a drop-out adjustable from 5 to 15 seconds. This adjustment is made by means of the rheostat in series with the RXA coil, and by varying the capacitor combination in parallel with the coil. This capacitor combination consists of two electrolytic capacitors connected to dummy terminals 15-17 and 14-16.

A very coarse adjustment of the time delay is obtained by connecting the capacitors either in parallel for a long delay, in series for a short delay, or one capacitor alone for an intermediate delay. With any particular capacitor combination a fine adjustment to the exact time desired may be obtained by means of the series rheostat. The time range with any given capacitor combination may be extended by removing the jumper from between terminals 11 and 12, inserting an additional resistor into the RXA coil circuit. The three available capacitor combinations are shown in Fig. 2, and may be changed by drawing the relay from its case and placing the jumpers between the appropriate capacitor terminals as indicated in Fig. 2.

## MAINTENANCE

An operation test and mechanical inspection of the relay and its connections should be made at least once every six months. If the contacts require cleaning file lightly with a clean, fine, thin file. Do not use crocus or emery cloth as they tend to embed insulating particles in the contact surfaces. Avoid touching the contact surfaces with the fingers.

## RENEWAL PARTS

Orders for renewal parts should be addressed to the nearest Sales Office of the General Electric Company, giving the name or a description of part wanted, quantity required, and complete nameplate data. If possible give the General Electric Company's requisition number on which the relay was furnished.

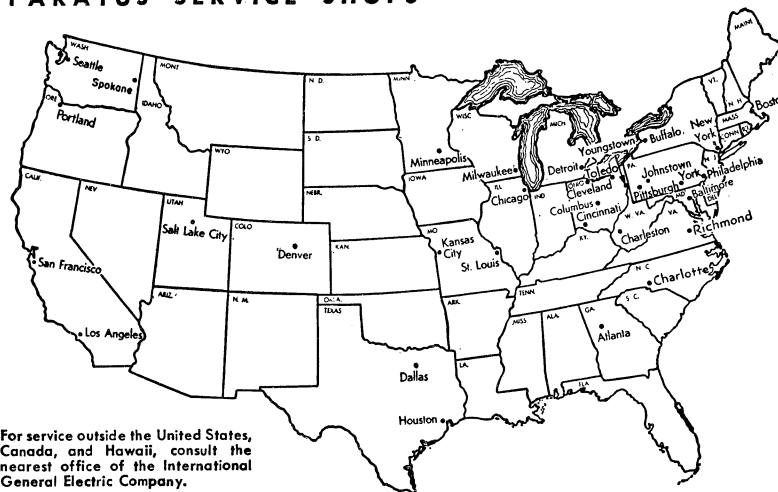
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 Wichita 2, Kan. . . . . 200 E. First St.  
 Williamston, N. C. . . . . 115 E. Main St.  
 Wilmington 98, Del. . . . . 1326 N. Market St.  
 Worcester 8, Mass. . . . . 507 Main St.  
 York, Pa. . . . . 56 N. Harrison St.  
 Youngstown 5, Ohio . . . . . 272 E. Indianola Ave.

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