INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-5 TIME DELAY RELAY

CAUTION: Before putting relays into service, operate the relay to check the electrical connections. Close the red handle switch last when placing the relay in service. Open the red handle switch first when removing the relay from service.

APPLICATION

The type TD-5 relay is a d-c timing relay for general auxiliary service. It has an overall range of .05 to 30 seconds.

CONSTRUCTION

The type TD-5 relay consists of a reference voltage circuit, a rheostat (T) and scale plate, a voltage biasing potentiometer (P), a printed circuit containing static timing components, an output telephone relay (TR), and an indicating contactor switch (ICS). An auxiliary relay (TX) is supplied on some types to override bounce of the initiating contact.

Reference Voltage Circuits

The reference voltage circuit provides a fixed supply voltage to the R-C time delay circuit and protects the static components from high voltages. It consists of a silicon power regulator and a series resistor (Rs). The silicon power regulator (Z) is a 10 watt Zener diode mounted on an aluminum heat sink. The series resistor (Rs) is a 3½ inch resistor which is tapped for 24/32 volt d-c and 48/125 volt d-c relays.

Rheostat and Scale Plate

The rheostat (T) provides a variable resistance for the R-C time delay circuit. It is of wire-wound construction, which minimizes resistance change with temperature. Do not remove the knob from the rheostat shaft, since it is not easy to replace the knob in the calibrated position. The timing scale is non-linear as explained in the section under Printed Circuit.

Potentiometer

The potentiometer (P), provides a biasing voltage which keeps the silicon controlled rectifier (SCR) turned off until the capacitor voltage reaches the potentiometer brush voltage. It is of wire-wound construction and has a locking nut which should not be loosened unless the relay is being re-calibrated.

Printed Circuit

* The printed circuit contains a diode (D_1) which protects the static components in case the relay is connected with reverse polarity, a limiting timing resistor (R_L), timing capacitor (C), a parallel resistor (R_P) which makes the calibrating scale non-linear, and a silicon controlled rectifier (SCR). The printed circuit also contains a diode (D_2) to reverse bias SCR, a resistor (R_C) and diode (D_3) to protect the static components from the inductive voltage kick associated with the telephone relay coil, and series diodes (D_4, D_5, and D_6) which compensate for the forward voltage drop through SCR and D_2 and zener reference variations.

Telephone Reloy (TR)

The telephone relay (TR) is energized by SCR at the conclusion of the time delay. The coil is energized by at least three times pick-up wattage to insure positive contact operation. The contacts are made of palladium and are suitable for circuit breaker trip duty, as proven by many years of experience in other relays. Two sets of transfer contacts are provided to give a flexible trip circuit arrangement.

Telephone Relay (TX)

The telephone relay (TX) is energized by the application of a d.c. voltage to the relay. Because of its slow dropout characteristic a contact of the TX relay is connected around the contact of the initiating relay to maintain voltage to the timing module of the relay if the contact of the initiating relay bounces. Refer to Fig. 5.

A resistor and diode are connected across the coil of the TX relay to protect the static components

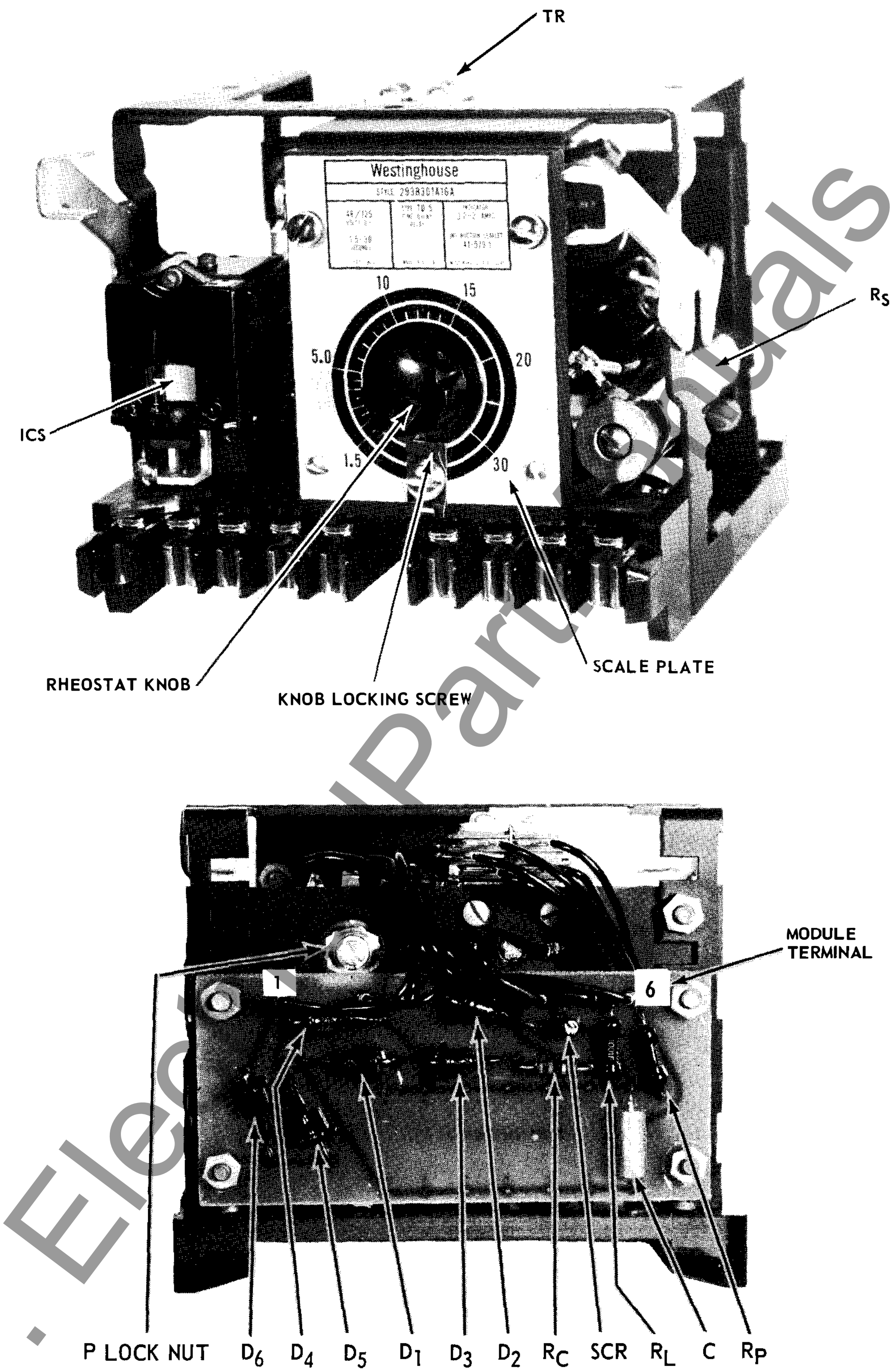

Fig. 1. Type TD-5 Relay Without Case.

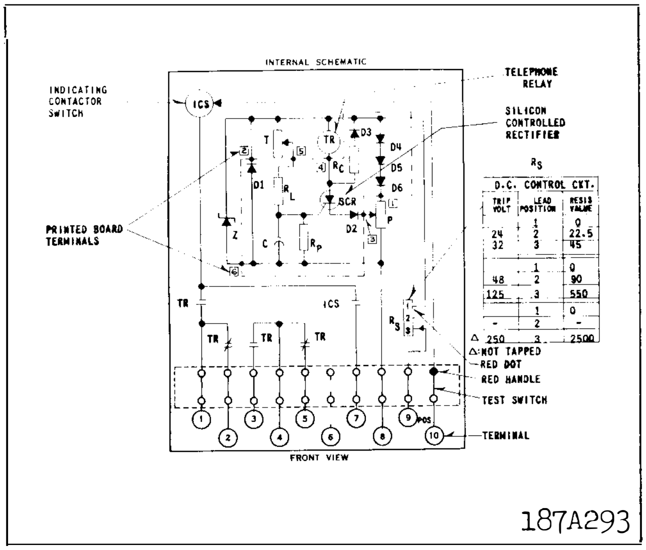

Fig. 2. Internal Schematic of Type TD-5 Relay.

from the inductive voltage kicks associated with the telephone relay (TX) coil. A resistor is connected in series with the coil of the TX relay for use on 48/125 volts. This resistor is jumpered for 48 VDC operation. Operate time is 9ms — 48VDC, 6ms — 125VDC, Dropout time is 15ms.

Indicating Contactor Switch (ICS)

The indicating contactor switch is a small d-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the case.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Operation of the TD-5 relay occurs when a silicon controlled rectifier (SCR) switches from a non-conducting state to a conducting state. In the non-conducting state, the SCR acts as an opened switch to prevent energization of the telephone relay (TR), but in the conducting state acts as a closed switch to connect the telephone relay to the d-c source. To switch the SCR from a non-conducting state to a conducting state requires that a maximum of 20 microamperes flow in the gate of the SCR. This current is produced by the difference in voltage across the capacitor (C) and the brush of the potentiometer (P).

When d-c voltage is first applied to the relay, voltage instantaneously appears across the potentiometer brush but is delayed in building up across the capacitor in accordance with the R-C time constant of the circuit. As long as the capacitor voltage is less than the potentiometer brush voltage, a reverse voltage appears across the diode, D_2, and the SCR to keep the silicon controlled rectifier (SCR) biased off. When the capacitor voltage reaches the potentiometer brush voltage plus approximately one volt (forward voltage drop across SCR and D_2), gate current will flow to the silicon controlled rectifier (SCR). This current switches the SCR to a conducting state to allow the telephone relay (TR) to pickup.

The SCR latches on when it switches and can be reset only by removing voltage from terminals 8 and 9. If a trip coil supervisory indicator lamp is used, when the timer is used with a fault detector to trip a breaker, a breaker "a" contact must be connected between terminal 8 of the relay and negative.

The rate at which the capacitor charges is determined by the rheostat setting. The charging rate is not a linear function of rheostat setting, since R_P gives a parallel resistive path. This has the effect of expanding the scale for short times and thereby permitting more accurate settings.

CHARACTERISTICS

Time Delay Range and Voltage Rating

Time Delay Range (Seconds)	Voltage Rating (Volts d-c)
.05 - 0.4	24/32
.05 - 0.4	48/125
.05 - 0.4	250
.05 - 1.0	24/32
.05 - 1.0	48/125
.05 - 1.0	250
0.2 - 4.0	24/32
0.2 - 4.0	48/125
0.2 - 4.0	250
1.5 - 30	24/32
1.5 - 30	48/125
1.5 - 30	250

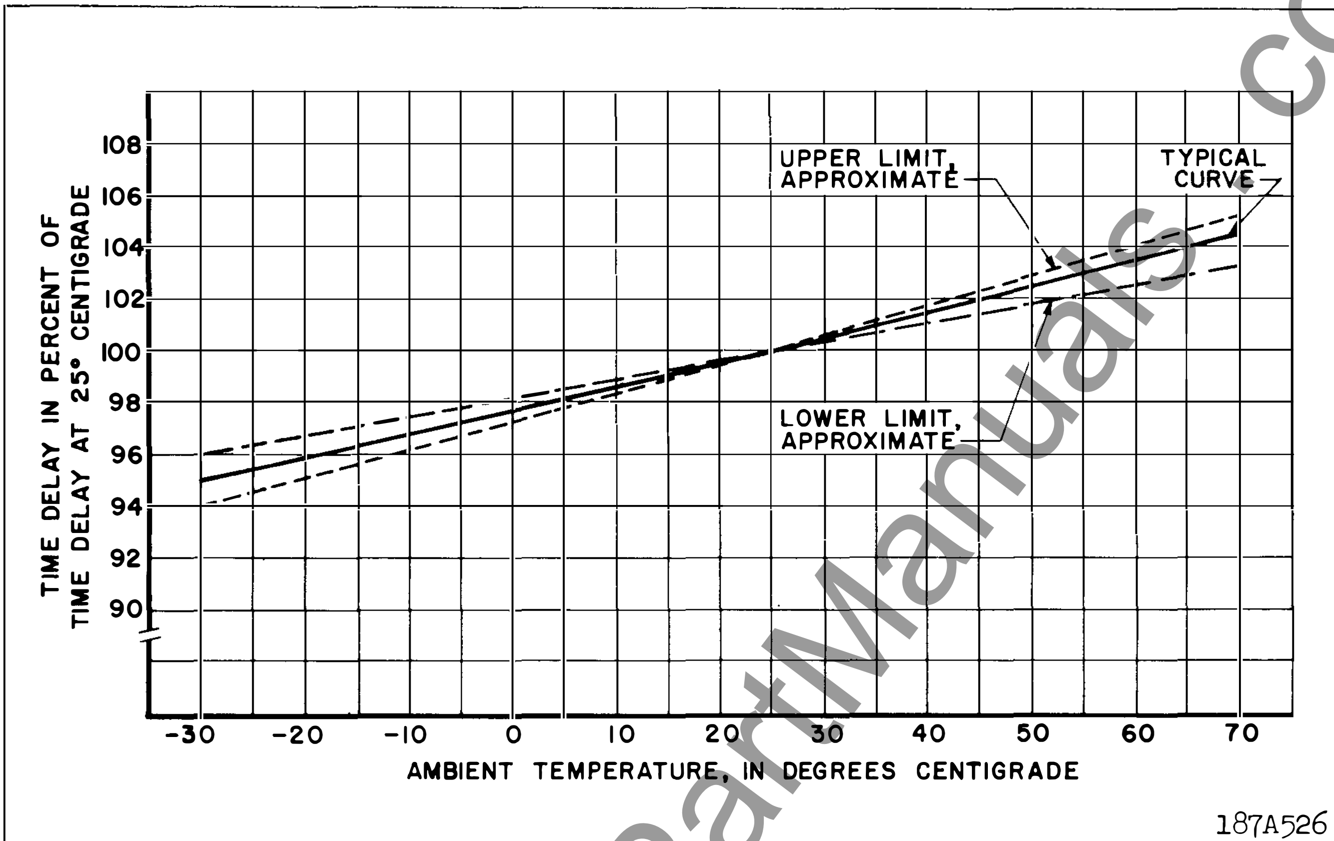

Fig. 3. Timing Variation with Temperature Changes.

Battery Drain

	24 Volts d-c	32 Volts d-c	48 Volts d-c	125 Volts d-c	250 Volts d-c
STAND-BY:	0	0	0	0	0
OPERATING:	500 MA	420 MA	270 MA	180 MA	80 MA

NOTE: TD-5 with TX Relay has an extra operating drain of 63 MA at 48 or 125 VDC.

Voltage Rating Over The Temperature Range

The relay can stand 110% voltage continuously over a temperature range of −40°C. to +70°C.

Reverse Polarity

Diode (D_1) limits reverse voltage of the static components to less than one volt d-c, so that no damage is done to the circuit by connecting the relay with reverse polarity. However, the relay will, of course, not operate under this condition, and series resistor (R_S) may over-heat if reverse voltage is applied for approximately 15 minutes or more.

Reset Time

TR drop-out time = 0.1 sec. or less. TR drop-out time of Relay with TX contact is an additional 15 msec.

Discharge of timing capacitor: the discharge of C is essentially instantaneous, the R-C time constant through P being less than 20 milliseconds, in most cases. However, the discharge path through P is limited by silicon voltage drops through SCR and D_2, totalling approximately one volt. Therefore, C discharges rapidly through P down to about one volt and then more slowly through R_P down to zero volts.

Accuracy

The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, and the ambient temperature. Self-heating has a negligible effect on the time accuracy.

(1) Nominal Setting

The first time delay, as measured with the test circuit shown in Figure 4, taken at 25° C. and rated voltage, will be within four milliseconds of its setting for settings of 0.2 seconds or less. For settings above 0.2 seconds, this accuracy will be ±2%.

(2) Consecutive Timings

Incomplete capacitor discharge will cause changes in time delay. These changes are a function of discharge rate. Timing accuracy for slow repetitions will be per Table I.

Table I

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05 - 1.0 seconds	at least 3 seconds	±2%
0.2 - 4.0 seconds	at least 5 seconds	±2%
1.5 - 30 seconds	at least 5 seconds	±2%

Timing accuracy for fast repetitions will be per Table II.

Table II

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05 - 1.0 seconds	instantaneous	±4%
0.2 – 4.0 seconds	instantaneous	±4%
1.5 - 30 seconds	approx. ½ sec.	±4%

(3) Supply Voltage

Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ± 3 milliseconds for settings of 0.3 seconds or less, and no more than ± 1% for settings above 0.3 seconds.

(4) Ambient Temperature

Changes in ambient temperature cause changes in time delay. This variation in time delay is a direct function of capacitance change with temperature. Typical variation of time delay with temperature is shown in Figure 3.

SETTINGS

The time delay is selected by adjusting rheostat, T.

The correct tap on series resistor, R_S, should be selected for the supply voltage being used.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nuts with a wrench.

For detailed FT case information refer to I.L. 41-076.

ADJUSTMENT AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. In particular, do not remove knob from rheostat shaft and do not loosen potentiometer lock nut.

Acceptance Test

A timing check at minimum and maximum settings is recommended to insure that the relay is in proper working order. A recommended test circuit is shown in Figure 4. When testing the TD-5 with a TX telephone relay make the dotted connection as shown in Figure 4. The neon lamp will light if the TX relay is operating properly.

Routine Maintenance

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the TD-5 is not operating correctly.

1. Inspect all wires and connections, paying particular attention to telephone relay and printed circuit terminals.

2. Check the reference voltage circuit. This is done by measuring the d-c voltage across the silicon power regulator, Z. Connect the d-c voltmeter positive terminal to the rear terminal of R_S and the negative terminal to relay terminal 8. Apply rated voltage per the test circuit diagram, Figure 4. The Zener voltage should be between 11.0 and 13.0 volts for 24/32 volt relays, between 21.5 and 24.5 volts for 48/125 volt relays, and between 50 and 58 volts for 250 volt relays.
3. Check the timing capacitor voltage and the potentiometer brush voltage (between printed circuit terminal 3 and relay terminal 8) with a cathode ray oscilloscope or a high resistance d-c voltmeter. It is necessary to scrape varnish from the capacitor positive terminal in order to make a connection at this point. The brush voltage, which is constant until the telephone relay trips, should be approximately one half the reference voltage. The capacitor should gradually change to the potentiometer brush voltage, plus approximately one volt for silicon junction forward voltage drops through SCR and D_2.
4. If reference voltage, capacitor voltage, and potentiometer voltage all appear to behave correctly, the SCR may be the cause of trouble. The anode to cathode voltage, as measured between printed circuit terminals 4 and 3, should be approximately one-half the reference voltage until the capacitor voltage reaches the brush voltage, at which time the anode to cathode voltage should drop to approximately one volt.

Calibration

Use the following procedure for calibrating the relay if the relay adjustments have been disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. Before calibrating, follow the Trouble Shooting Procedure to locate the source of trouble.

1. Telephone Type Relay Adjustment

Adjust the armature gap on the telephone type relay to be approximately .004 inch with the armature closed. This is done with the armature set-screw and lock-nut. Also, adjust contact leaf springs to obtain at least .015 inch gap on all contacts and at least .010 inch follow on all normally open contacts and at least .005 inch follow on all normally closed contacts.

2. Rheostat Knob Adjustment, Same Scale Plate

If it is necessary to replace the rheostat (T) or the silicon power regulator (Z), the relay may be recalibrated with the same scale plate, in most cases. This is done by rotating the rheostat shaft, without knob, until a time delay equal to the minimum scale marking is obtained. Then, align the knob for this delay and tighten the knob set-screw securely. Pause several seconds between readings for all delays above .05 seconds. See section under Accuracy for discussion of this.

3. Scale Plate Calibration, New Scale Plate

If it is necessary to replace the potentiometer (P) or the printed circuit, the relay should be recalibrated with a new scale plate. Use the following procedure:

(a). With the knob off the shaft, set the rheostat (T) at maximum.

(b). Adjust P so that the times are 5% to 10% longer than the maximum scale marking.

(c). Set the rheostat (T) at minimum and check that times are less than or equal to the minimum scale marking. If not, adjust P slightly to reduce times. Tighten lock nut on P.

(d). Place the knob on the rheostat shaft in such a position that the times are symmetrical with respect to the scale plate marking. Tighten the knob set-screw and mark calibration lines on the scale plate. When striking calibration lines for delays above 0.5 second, pause at least 3 seconds between readings. See section under Accuracy for discussion of this.

4. Indicating Contractor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

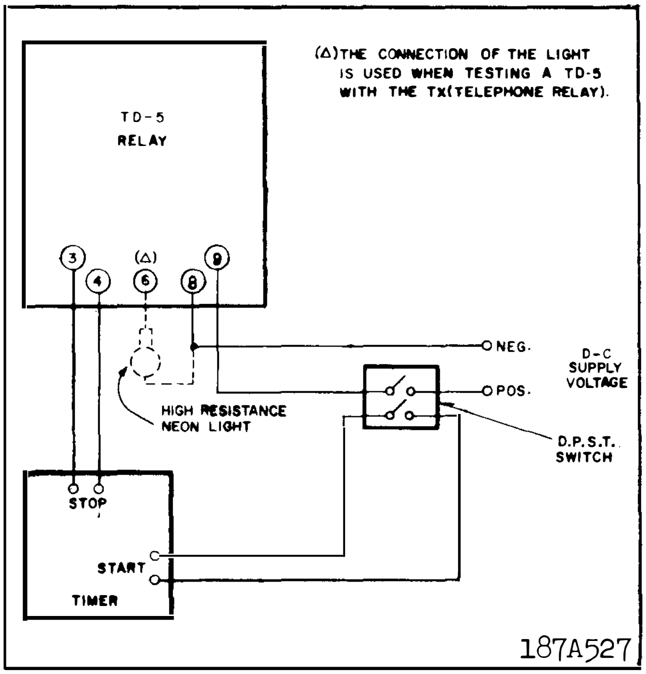

Fig. 4 Test Circuits for Type TD-5 Relay.

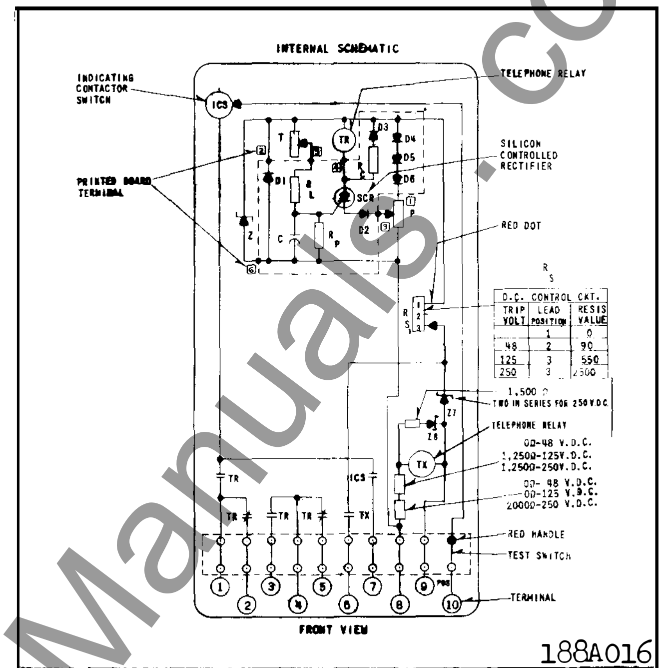

Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

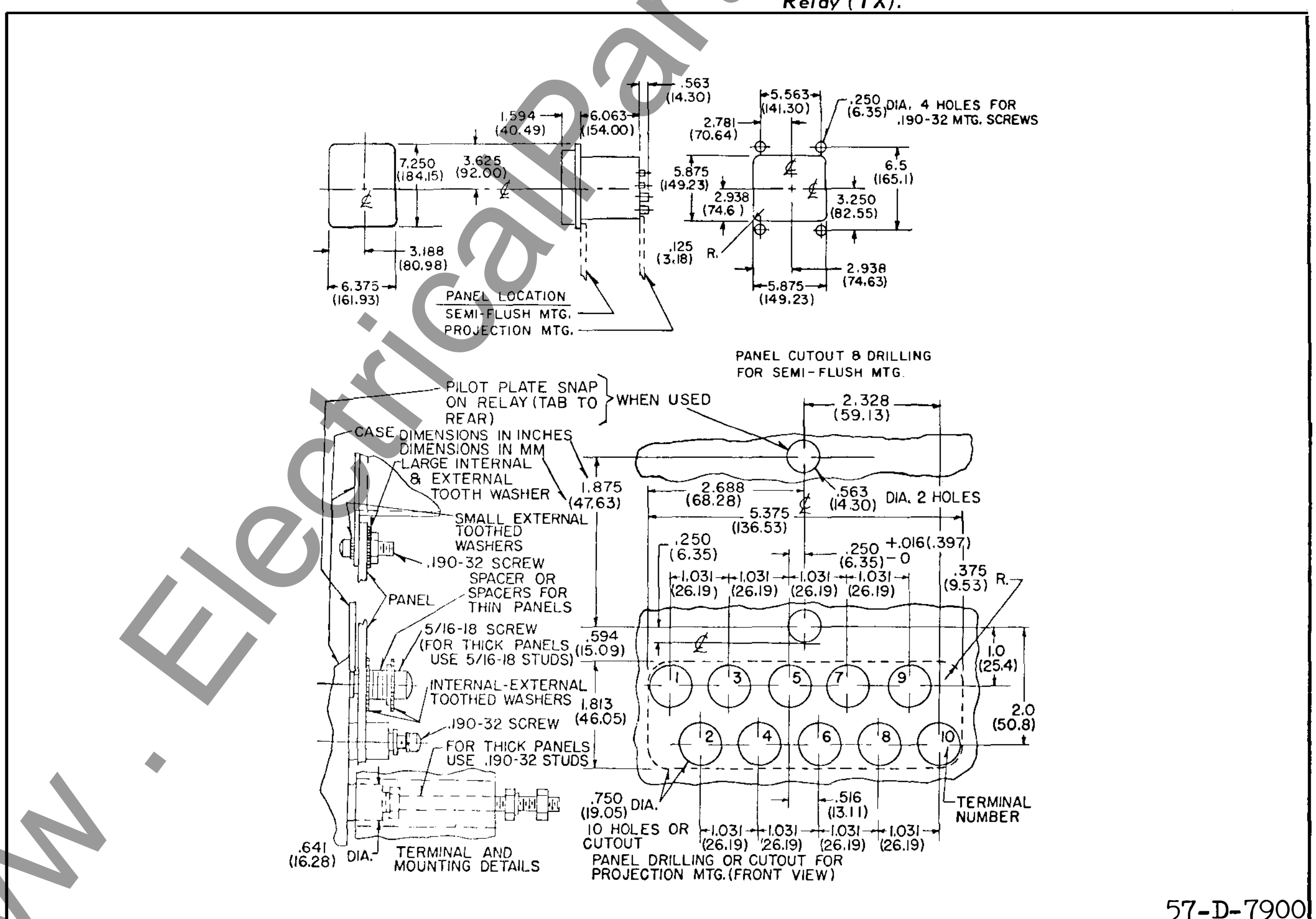

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

* TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC DC VOLTS	RELAY CHARACTERISTIC TIME RANGES	DESCRIPTION	STYLE NUMBER
R_S	24/32	All	Resistor, 40 Watts, 45 ± 5% ohms, center tap	184A064H03
	48/125	All	Resistor, 40 Watts, 550 ± 5% ohms, tap at 95 ohms	187A321H01
	250	All	Resistor, 40 Watts, 2500 ± 5% ohms	1995653
Z	24/32	All	Zener Diode, 1N2977B, 10 Watts, 13 Volts	629A798H02
	48/125	All	Zener Diode, 1N2986B, 10 Watts, 24 Volts	629A798H03
	250	All	Zener Diode, 1N2999B, 10 Watts, 56 Volts	629A798H04
D	All	All	Silicon Diode, 1N4818, 200 Volts, 0.75 Amp	188A342H06
Z7, Z8	All	All	Zener Diode 1N3051 (For TD-5 with T_X only)	187A936H01
T	All	0.05-1	Rheostat, 3 Watt, 40K	184A756H01
	All	0.2 -4	Rheostat, 4 Watt, 100K	184A756H02
	All	1.5 -30	Rheostat, 4 Watt, 100K	184A756H02
	All	.05-.4	Rheostat, 4 Watt, 20K	184A756H04
R_L	24/32	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%	862A376H01
	48/125	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%	862A376H01
	250	0.05-1 & .05-.4	Resistor, 3 Watts, 1K ± 5%	184A636H08
	All	0.2-4	Resistor, 1/2 Watt, 5.6K ± 1%	862A376H73
	All	1.5-30	Resistor, 1/2 Watt, 5.6K ± 1%	862A376H73
C	24/32	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	48/125	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	250	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 50 volts	184A661H17
	24/32	0.2-4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	48/125	0.2-4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	250	0.2-4	Tantalum Capacitor, 22uf, 50 volts	184A661H17
	24/32	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 35 V	184A661H16
	48/125	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 35 V	184A661H16
	250	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 50 V	184A661H17
R_P	All	0.05-1 & .05-.4	Resistor, 1/2 W, 62K ± 1%	184A764H70
	All	0.2-4	Resistor, 1/2 Watt, 267K ± 1%	184A764H85
	All	1.5-30	Resistor, 1/2 Watt, 267K ± 1%	184A764H85
T_R	24/32	All	Telephone Relay, 30 ohm coil	407C614H05
	48/125	All	Telephone Relay, 125 ohms coil	407C614H06
	250	0.05-1 & .05-.4	Telephone Relay, 125 ohm coil	407C614H06
	250	0.2-4	Telephone Relay, 650 ohm coil	407C614H07
	250	1.5-30	Telephone Relay, 650 ohm coil	407C614H07
T_X	48/125	All	Telephone Relay 750 ohm coil	19B1312H09
R_C	24/32	All	Resistor, 1/2 Watt, 56 ± 5% ohms	187A290H19
	48/125	All	Resistor, 1/2 Watt, 270 ± 5% ohms	184A763H13
	250	All	Resistor, 1/2 Watt, 1200 ± 5% ohms	184A763H29
SCR	24/32	All	Silicon Controlled Rectifier, 2N885	185A517H02
	48/125	All	Silicon Controlled Rectifier, 2N885	185A517H02
	250	All	Silicon Controlled Rectifier, 2N886	185A517H03
P	24/32	All	Potentiometer, 4 Watts, 60 ± 10% ohms	185A067H04
	48/125	All	Potentiometer, 4 Watts, 250 ± 10% ohms	185A067H05
	250	All	Potentiometer, 4 Watts, 1300 ± 10% ohms	185A067H06

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**
Printed in U.S.A.

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* switch (ICS). An auxiliary relay (TX) is supplied on some types to override bounce of the initiating contact.

Reference Voltage Circuits

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Rheostat and Scale Plate

The rheostat (T) provides a variable resistance for the R-C time delay circuit. It is of wire-wound construction, which minimizes resistance change with temperature. Do not remove the knob from the rheostat shaft, since it is not easy to replace the knob in the calibrated position. The timing scale is non-linear as explained in the section under Printed Circuit.

Potentiometer

The potentiometer (P), provides a biasing voltage which keeps the silicon controlled rectifier (SCR) turned off until the capacitor voltage reaches the potentiometer brush voltage. It is of wire-wound construction and has a locking nut which should not be loosened unless the relay is being re-calibrated.

Printed Circuit

The printed circuit contains a diode (D_1) which protects the static components in case the relay is connected with reverse polarity, a limiting timing resistor (R_L), timing capacitor (C) a parallel resistor (R_P) which makes the calibrating scale non-linear and a silicon controlled rectifier (SCR). The printed circuit also contains a diode (D_2) to reverse bias SCR, a resistor (R_C) and diode (D_3) to protect the static components from the inductive voltage kick associated with the telephone relay coil, and series diodes (D_4, D_5, and D_6) which compensate for the forward voltage drop through SCR and D_2 and thereby prevent timing variations caused by reference voltage changes due to self-heating of the Zener diode.

Telephone Relay(TR)

The telephone relay (TR) is energized by SCR at the conclusion of the time delay. The coil is energized by at least three times pick-up wattage to insure positive contact operation. The contacts are made of palladium and are suitable for circuit breaker trip duty, as proven by many years of experience in other relays. Two sets of transfer contacts are provided to give a flexible trip circuit arrangement.

* Telephone Relay (TX)

The telephone relay (TX) is energized by the
* application of a d.c. voltage to the relay. Because of its slow dropout characteristic a contact of the TX relay is connected around the contact of the initiating relay to maintain voltage to the timing module of the relay if the contact of the initiating relay bounces.

A resistor and diode are connected across the coil of the TX relay to protect the static components

SUPERSEDES I.L. 41-579.1B
*Denotes change from superseded issue.

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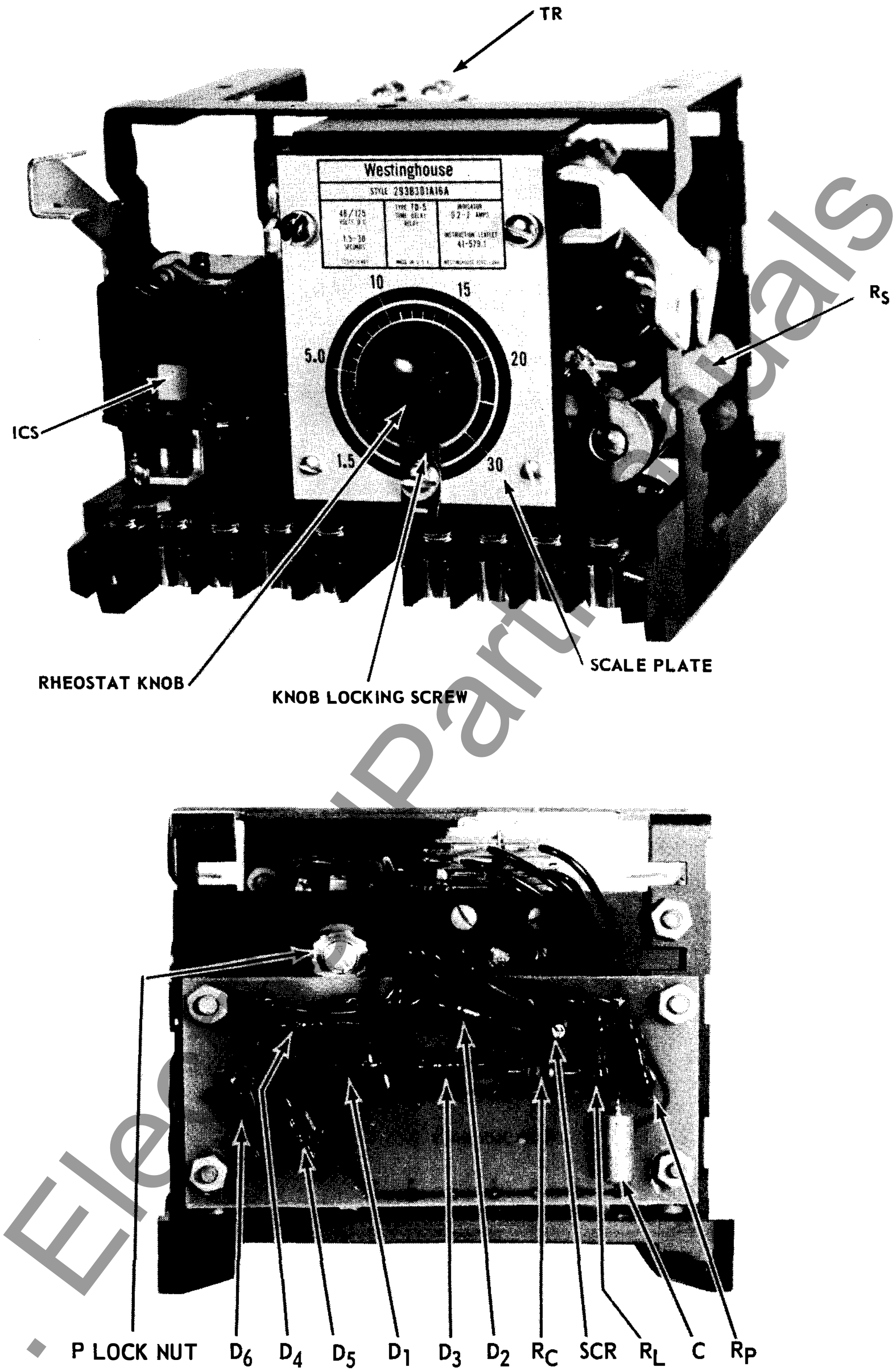

Fig. 1. Type TD-5 Relay Without Case.

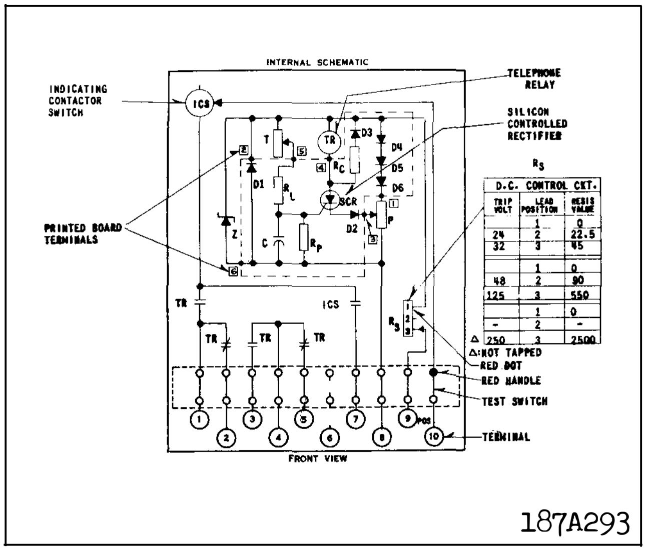

Fig. 2. Internal Schematic of Type TD-5 Relay.

from the inductive voltage kicks associated with the telephone relay (TX) coil. A resistor is connected in series with the coil of the TX relay for use on * 48/125 volts. This resistor is jumpered for 48 VDC operation.

Indicating Contactor Switch (ICS)

The indicating contactor switch is a small d-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the case.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Operation of the TD-5 relay occurs when a silicon controlled rectifier (SCR) switches from a non-conducting state to a conducting state. In the non-conducting state, the SCR acts as an opened switch to prevent energization of the telephone relay (TR), but in the conducting state acts as a closed switch to connect the telephone relay to the d-c source. To switch the SCR from a non-conducting state to a conducting state requires that a maximum of 20 microamperes flow in the gate of the SCR. This current is produced by the difference in voltage across the capacitor (C) and the brush of the potentiometer (P).

When d-c voltage is first applied to the relay, voltage instantaneously appears across the potentiometer brush but is delayed in building up across the capacitor in accordance with the R-C time constant of the circuit. As long as the capacitor voltage is less than the potentiometer brush voltage, a reverse voltage appears across the diode, D_2, and the SCR to keep the silicon controlled rectifier (SCR) biased off. When the capacitor voltage reaches the potentiometer brush voltage plus approximately one volt (forward voltage drop across SCR and D_2), gate current will flow to the silicon controlled rectifier (SCR). This current switches the SCR to a conducting state to allow the telephone relay (TR) to pickup.

The SCR latches on when it switches and can be reset only by removing voltage from terminals 8 and 9. If a trip coil supervisory indicator lamp is used, when the timer is used with a fault detector to trip a breaker, a breaker "a" contact must be connected between terminal 8 of the relay and negative.

The rate at which the capacitor charges is determined by the rheostat setting. The charging rate is not a linear function of rheostat setting, since R_P gives a parallel resistive path. This has the effect of expanding the scale for short times and thereby permitting more accurate settings.

CHARACTERISTICS

* Time Delay Range and Voltage Rating

Time Delay Range (Seconds)	Voltage Rating (Volts d-c)
.05 – 0.4	24/32
.05 – 0.4	48/125
.05 – 0.4	250
.05 – 1.0	24/32
.05 – 1.0	48/125
.05 – 1.0	250
0.2 – 4.0	24/32
0.2 – 4.0	48/125
0.2 – 4.0	250
1.5 – 30	24/32
1.5 – 30	48/125
1.5 – 30	250

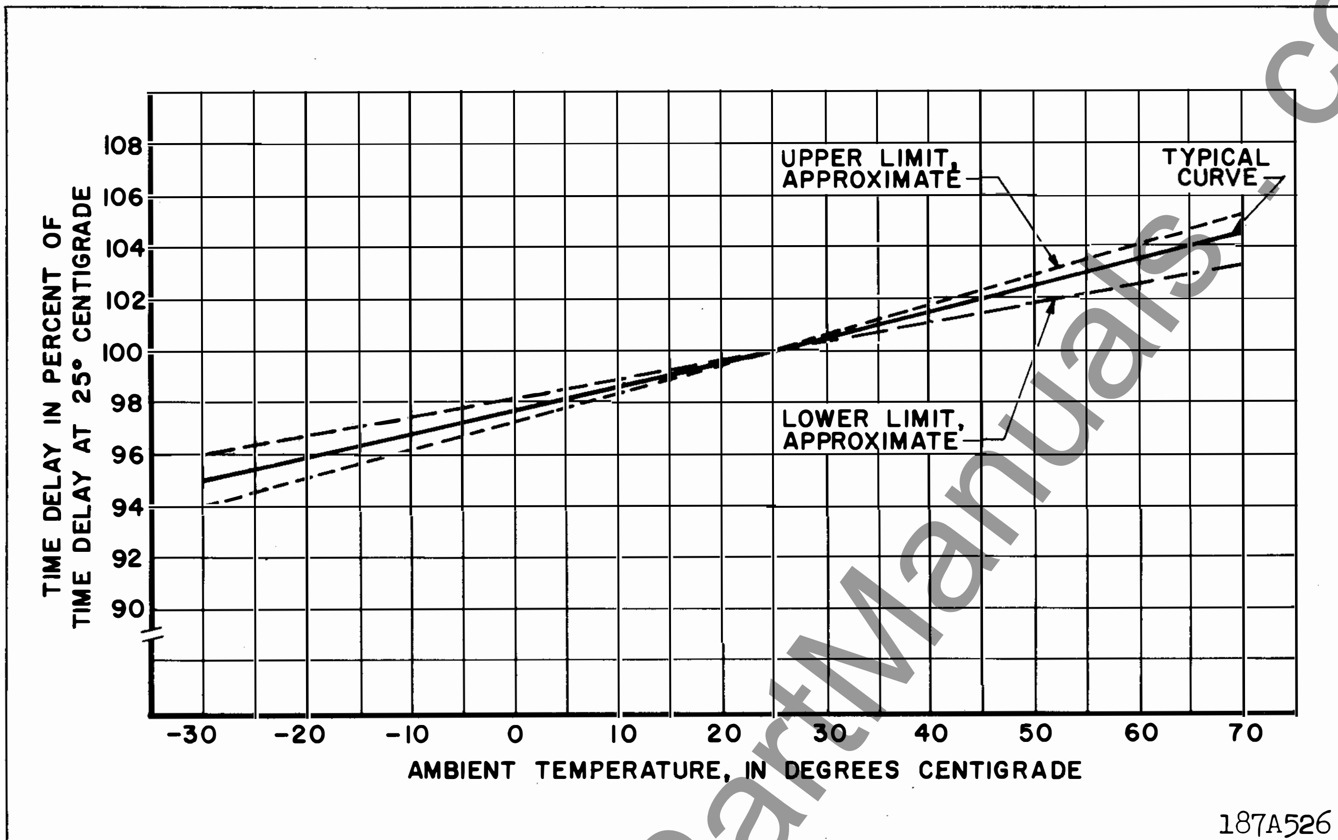

Fig. 3. Timing Variation with Temperature Changes.

Battery Drain

	24 Volts d-c	32 Volts d-c	48 Volts d-c	125 Volts d-c	250 Volts d-c
STAND-BY:	0	0	0	0	0
OPERATING:	500 MA	420 MA	270 MA	180 MA	80 MA

NOTE: TD-5 with TX Relay has an extra operating drain of 63 MA at 48 or 125 VDC.

Voltage Rating Over The Temperature Range

The relay can stand 110% voltage continuously over a temperature range of −40°C. to +70°C.

Reverse Polarity

Diode (D_1) limits reverse voltage of the static components to less than one volt d-c, so that no damage is done to the circuit by connecting the relay with reverse polarity. However, the relay will, of course, not operate under this condition, and series resistor (R_S) may over-heat if reverse voltage is applied for approximately 15 minutes or more.

Reset Time

TR drop-out time = 0.1 sec. or less.

Discharge of timing capacitor: the discharge of C is essentially instantaneous, the R-C time constant through P being less than 20 milliseconds, in most cases. However, the discharge path through P is limited by silicon voltage drops through SCR and D_2, totalling approximately one volt. Therefore, C discharges rapidly through P down to about one volt and then more slowly through R_P down to zero volts.

Accuracy

The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, and the ambient temperature. Self-heating has a negligible effect on the time accuracy.

(1) Nominal Setting

The first time delay, as measured with the test circuit shown in Figure 4, taken at 25°C. and rated voltage, will be within four milliseconds of its setting for settings of 0.2 seconds or less. For settings above 0.2 seconds, this accuracy will be ±2%.

(2) Consecutive Timings

Incomplete capacitor discharge will cause changes in time delay. These changes are a function of discharge rate. Timing accuracy for slow repetitions will be per Table I.

Table I

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05-1.0 seconds	at least 3 seconds	± 2%
0.2-4.0 seconds	at least 5 seconds	± 2%
1.5-3.0 seconds	at least 5 seconds	± 2%

Timing accuracy for fast repetitions will be per Table II.

Table II

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05-1.0 seconds	instantaneous	± 4%
0.2-4.0 seconds	instantaneous	± 4%
1.5-3.0 seconds	approximately ½ sec.	± 4%

(3) Supply Voltage

Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ± 3 milliseconds for settings of 0.3 seconds or less, and no more than ± 1% for settings above 0.3 seconds.

(4) Ambient Temperature

Changes in ambient temperature cause changes in time delay. This variation in time delay is a direct function of capacitance change with temperature. Typical variation of time delay with temperature is shown in Figure 3.

SETTINGS

The time delay is selected by adjusting rheostat, T.

The correct tap on series resistor, R_S, should be selected for the supply voltage being used.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nuts with a wrench.

For detailed FT case information refer to I.L. 41-076.

ADJUSTMENT AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. In particular, do not remove knob from rheostat shaft and do not loosen potentiometer lock nut.

Acceptance Test

A timing check at minimum and maximum settings is recommended to insure that the relay is in proper working order. A recommended test circuit is shown in Figure 4. When testing the TD-5 with a TX telephone relay make the dotted connection as
* shown in Figure 4. The neon lamp will light if the TX relay is operating properly.

Routine Maintenance

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the TD-5 is not operating correctly.

1. Inspect all wires and connections, paying particular attention to telephone relay and printed circuit terminals.

2. Check the reference voltage circuit. This is done by measuring the d-c voltage across the silicon power regulator, Z. Connect the d-c voltmeter positive terminal to the rear terminal of R_S and the negative terminal to relay terminal 8. Apply rated voltage per the test circuit diagram, Figure 4. The Zener voltage should be between 11.0 and 13.0 volts for 24/32 volt relays, between 21.5 and 24.5 volts for 48/125 volt relays, and between 50 and 58 volts for 250 volt relays.
3. Check the timing capacitor voltage and the potentiometer brush voltage (between printed circuit terminal 3 and relay terminal 8) with a cathode ray oscilloscope or a high resistance d-c voltmeter. It is necessary to scrape varnish from the capacitor positive terminal in order to make a connection at this point. The brush voltage, which is constant until the telephone relay trips, should be approximately one half the reference voltage. The capacitor should gradually change to the potentiometer brush voltage, plus approximately one volt for silicon junction forward voltage drops through SCR and D_2.
4. If reference voltage, capacitor voltage, and potentiometer voltage all appear to behave correctly, the SCR may be the cause of trouble. The anode to cathode voltage, as measured between printed circuit terminals 4 and 3, should be approximately one-half the reference voltage until the capacitor voltage reaches the brush voltage, at which time the anode to cathode voltage should drop to approximately one volt.

Calibration

Use the following procedure for calibrating the relay if the relay adjustments have been disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. Before calibrating, follow the Trouble Shooting Procedure to locate the source of trouble.

1. Telephone Type Relay Adjustment

Adjust the armature gap on the telephone type relay to be approximately .004 inch with the armature closed. This is done with the armature set-screw and lock-nut. Also, adjust contact leaf springs to obtain at least .015 inch gap on all contacts and at least .010 inch follow on all normally open contacts and at least .005 inch follow on all normally closed contacts.

2. Rheostat Knob Adjustment, Same Scale Plate

If it is necessary to replace the rheostat (T) or the silicon power regulator (Z), the relay may be recalibrated with the same scale plate, in most cases. This is done by rotating the rheostat shaft, without knob, until a time delay equal to the minimum scale marking is obtained. Then, align the knob for this delay and tighten the knob set-screw securely. Pause several seconds between readings for all delays above .05 seconds. See section under Accuracy for discussion of this.

3. Scale Plate Calibration, New Scale Plate

If it is necessary to replace the potentiometer (P) or the printed circuit, the relay should be recalibrated with a new scale plate. Use the following procedure:

(a). With the knob off the shaft, set the rheostat (T) at maximum.

(b). Adjust P so that the times are 5% to 10% longer than the maximum scale marking.

(c). Set the rheostat (T) at minimum and check that times are less than or equal to the minimum scale marking. If not, adjust P slightly to reduce times. Tighten lock nut on P.

(d). Place the knob on the rheostat shaft in such a position that the times are symmetrical with respect to the scale plate marking. Tighten the knob set-screw and mark calibration lines on the scale plate. When striking calibration lines for delays above 0.5 second, pause at least 3 seconds between readings. See section under Accuracy for discussion of this.

4. Indicating Contractor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

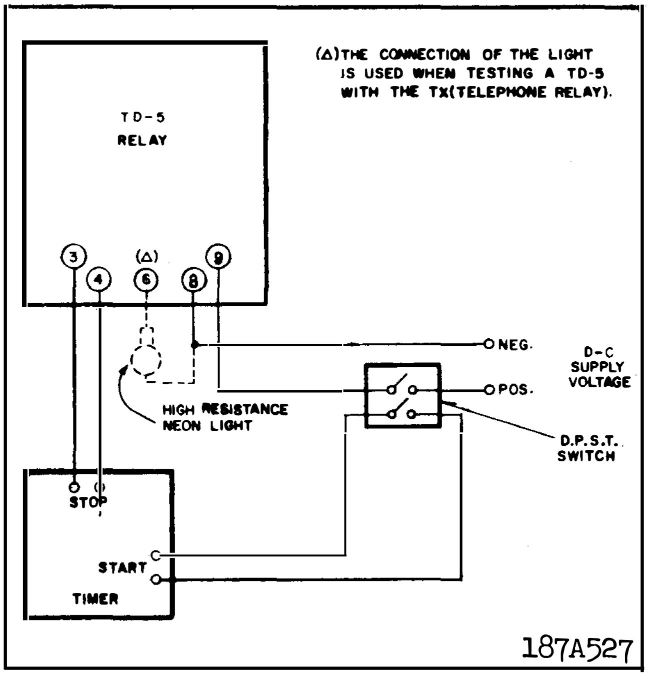

Fig. 4 Test Circuits for Type TD-5 Relay.

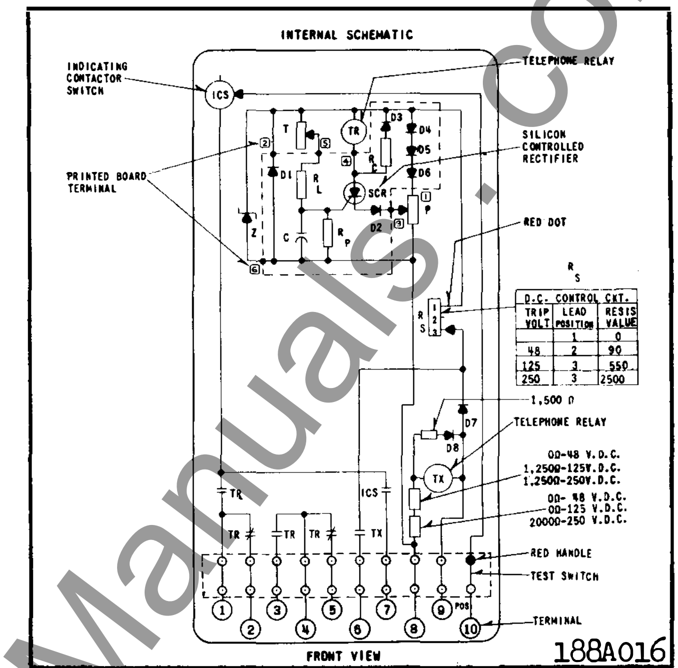

Fig. 5 Internal Schematic of TD-5 with Telephone Relay.

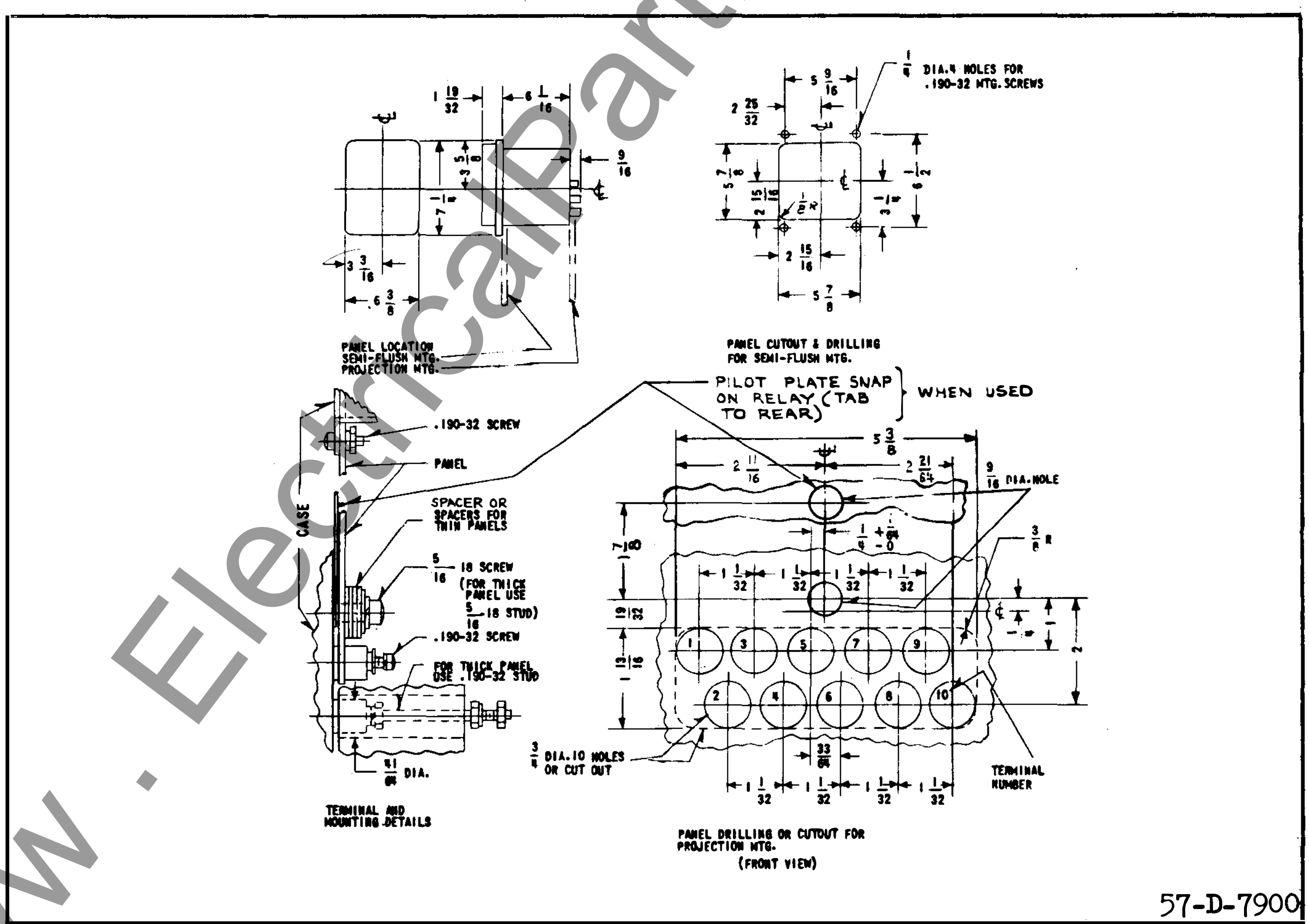

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC		DESCRIPTION
	DC VOLTS	TIME RANGES	
R_S	24/32	All	Resistor, 40 Watts, 45 ± 5% ohms, center tap
	48/125	All	Resistor, 40 Watts, 550 ± 5% ohms, tap at 95 ohms
	250	All	Resistor, 40 Watts, 2500 ± 5% ohms
Z	24/32	All	Zener Diode, 1N1816A, 10 Watts, 13 Volts
	48/125	All	Zener Diode, 1N1822A, 10 Watts, 24 Volts
	250	All	Zener Diode, 1N1813A, 10 Watts, 56 Volts
D	All	All	Silicon Diode, 1N538, 200 Volts, 0.75 Amp
T	All	0.05-1	Rheostat, 3 Watt, 40K
	All	0.2-4	Rheostat, 4 Watt, 100K
	All	1.5-30	Rheostat, 4 Watt, 100K
R_L	24/32	0.05-1	Resistor, 1/2 Watt, 1K ± 1%
	48/125	0.05-1	Resistor, 1/2 Watt, 1K ± 1%
	250	0.05-1	Resistor, 3 Watts, 1K ± 5%
	All	0.2-4	Resistor, 1/2 Watt, 5.6K ± 1%
	All	1.5-30	Resistor, 1/2 Watt, 5.6K ± 1%
C	24/32	0.05-1	Tantalum Capacitor, 22uf, 35 volts
	48/125	0.05-1	Tantalum Capacitor, 22uf, 35 volts
	250	0.05-1	Tantalum Capacitor, 22uf, 50 volts
	24/32	0.2-4	Tantalum Capacitor, 22uf, 35 volts
	48/125	0.2-4	Tantalum Capacitor, 22uf, 35 volts
	250	0.2-4	Tantalum Capacitor, 22uf, 50 volts
	24/32	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 35 V
	48/125	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 35 V
	250	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 50 V
R_P	All	0.05-1	Resistor, 1/2 Watt, 62K ± 1%
	All	0.2-4	Resistor, 1/2 Watt, 270K ± 1%
	All	1.5-30	Resistor, 1/2 Watt, 270K ± 1%
T_R	24/32	All	Telephone Relay, 30 ohm coil
	48/125	All	Telephone Relay, 125 ohms coil
	250	0.05-1	Telephone Relay, 125 ohm coil
	250	0.2-4	Telephone Relay, 650 ohm coil
	250	1.5-30	Telephone Relay, 650 ohm coil
TX	48/125	All	Telephone Relay, 760 ohm coil
R_C	24/32	All	Resistor, 1/2 Watt, 56 ± 5% ohms
	48/125	All	Resistor, 1/2 Watt, 270 ± 5% ohms
	250	All	Resistor, 1/2 Watt, 470 ± 5% ohms
SCR	24/32	All	Silicon Controlled Rectifier, 1/2 Watt, 2N885
	48/125	All	Silicon Controlled Rectifier, 1/2 Watt, 2N885
	250	All	Silicon Controlled Rectifier, 1/2 Watt, 2N886
P	24/32	All	Potentiometer, 4 Watts, 60 ± 10% ohms
	48/125	All	Potentiometer, 4 Watts, 250 ± 10% ohms
	250	All	Potentiometer, 4 Watts, 1300 ± 10% ohms

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**
Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

CAUTION *Before putting relays into service operate the relay to check the electrical connections. Close the red handle switch last when placing the relay in service. Open the red handle switch first when removing the relay from service.*

APPLICATION

The type TD-4 static timing relay provides time delay for the second and third zone contacts of the KD and KD-1 distance relays. The proper delay period is selected by whichever zone relay operates.

CONSTRUCTION

* The Type TD-4 relay consists of an auxiliary circuit for initiating the time delay, a reference voltage circuit, and a time delay circuit. A diode is added around the TX-Z2 and TX-Z3 coils on some types to override bounce of the initiating contact.

Auxiliary Circuit for Initiating Time Delay

The auxiliary circuit consists of two telephone-type relays (TX-Z2 and TX-Z3) and two tapped resistors (R_2 and R_3).

Reference Voltage Circuit

The reference voltage circuit consists of a silicon power regulator (DZ_1) and a tapped resistor (R_T).

Time Delay Circuit

The time delay circuit consists of a timing circuit module (M) a telephone type relay (TR) and two rheostats (T_2 and T_3). The timing circuit module consists of an R-C timing circuit, a zener diode for voltage sensing, and a transistorized amplifying circuit.

OPERATION

The type TD-4 relay is connected to the d-c trip bus as shown in the external schematic, Fig. 4 and the timer control circuit, Fig. 5.

Timing Circuit Operation

The R-C timing circuit in Fig. 5 delivers an increasing voltage to the sensing zener diode (DZ_2). This zener diode breaks down at approximately 63% of the reference voltage which is supplied by DZ_1. The rate of voltage rise is determined by the resistance (T2 or T3) in series with the timing capacitor. Therefore, the rheostat setting of T2 or T3 directly determines the time delay, as shown in Fig. 6.

When capacitor C changes to the voltage value e, DZ_2 breaks down to provide base drive for transistor TR_2 causing it to conduct. Emitter current of TR_2 provides base drive for transistor TR_1. Transistor TR_1 conducts, energizing output relay TR to the trip the breaker.

1. Zone 2 Operation, Non-Carrier

For a zone 2 fault, both zone 2 and zone 3 KD contacts close, energizing both TX-Z2 and TX-Z3. This completes the D. C. reference voltage circuit through DZ_1. The time delay circuit is energized through rheostat T_2. When the time delay is completed, telephone relay, TR, is energized and completes the trip circuit path through the normally open TX-Z2 contact.

2. Zone 2 Operation, Carrier

This case is similar to paragraph 1, except that the zone 2 KD contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

For a zone 3 fault the zone 3 KD-1 contact only is closed. This energizes TX-Z3 and completes the timing circuit through rheostat T_3. At the end of the time delay, TR is energized and completes the trip path through the normally closed TX-Z2 contact.

SUPERSEDES I.L. 41-579E
*Denotes change from superseded issue

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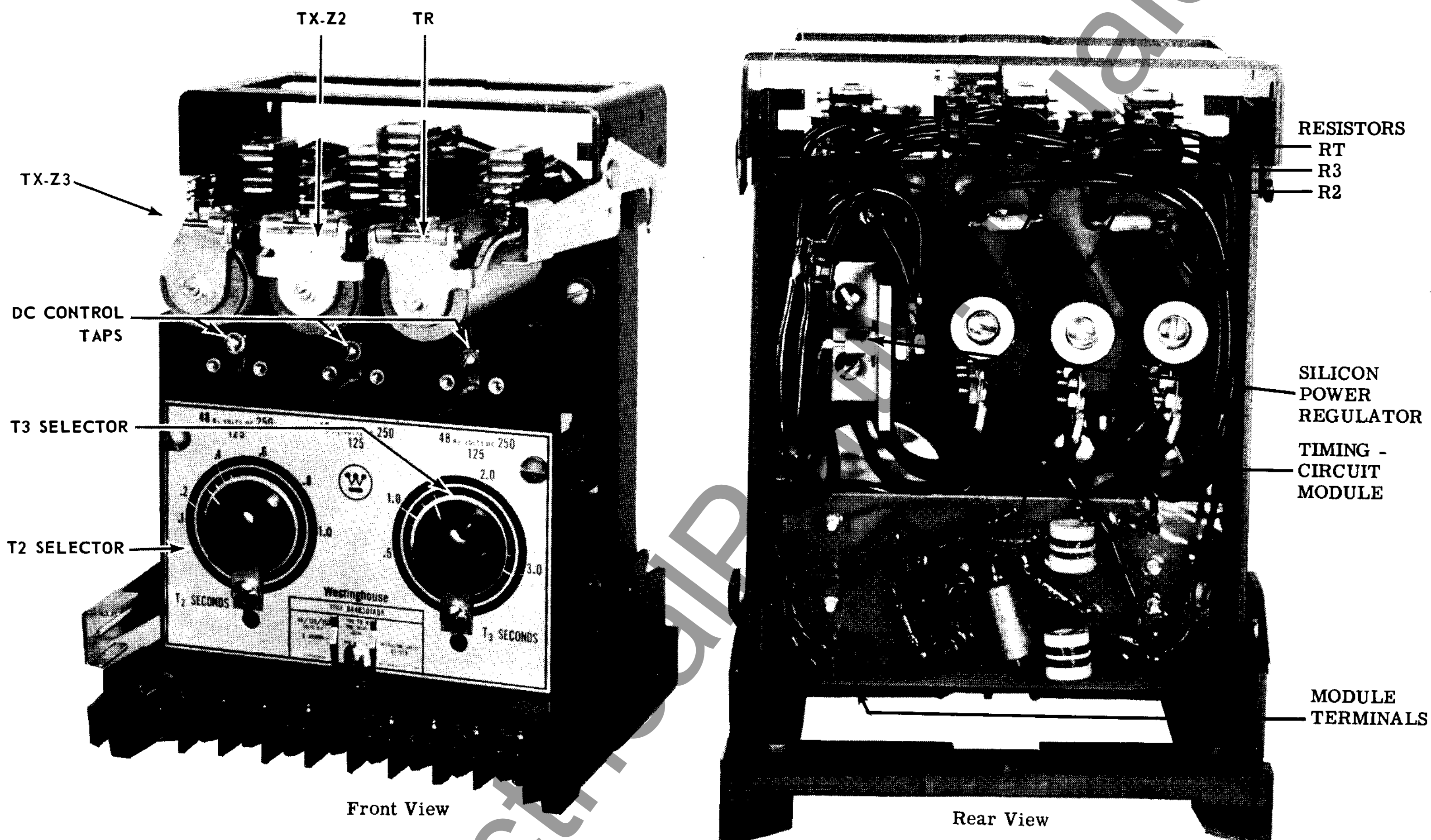
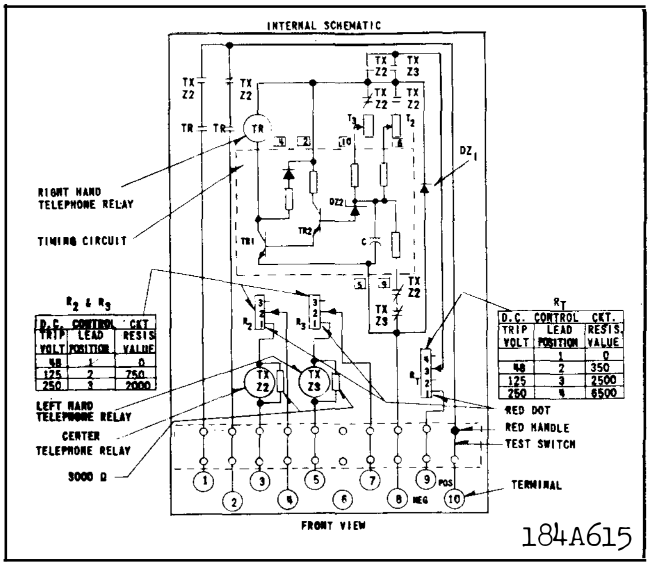


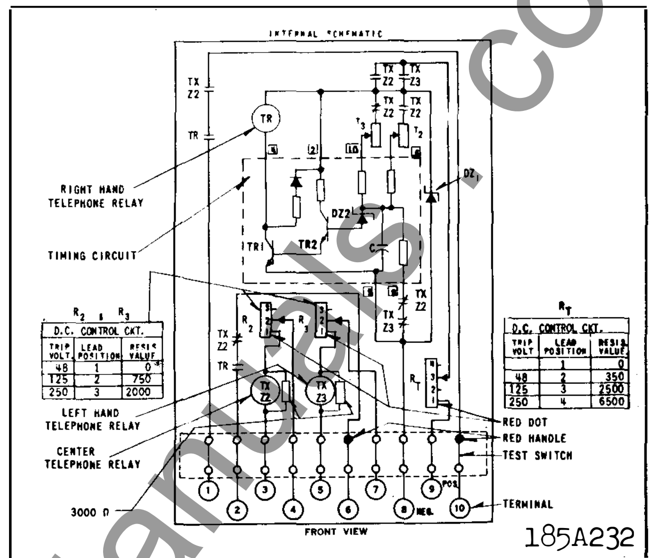
Front View

Rear View

* *Fig. 1. Type TD-4 Relay without case.*



* *Fig. 2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)*



* *Fig. 3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)*

4. Operation on a Zone 2 Fault Which Appears as a Zone 3 Fault, Due to Infeed

A zone 2 fault may appear to a distance relay as a zone 3 fault. This condition occurs when current infeed changes the apparent impedance as seen by the distance relay.

When this fault occurs, the zone 3 distance relay energizes TX-Z3 and starts the timing function at the zone 3 rate, as described in paragraph 3. As soon as the infeed is removed, the zone 2 distance relay operates to energize TX-Z2. The timing function now continues at the zone 2 rate. The total time delay depends on the T_2 setting, the T_3 setting, and the time at which the breaker clears the infeed. In any event the trip time following zone 2 KD operation will be less than the T_2 setting.

CHARACTERISTICS

* **Time Delay Range**

Zone 2: 0.1 sec. – 1.0 sec.; 0.1 – 1.0 sec.
Zone 3: 0.5 sec. – 3.0 sec.; 0.3 – 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less
TX-Z2 and TX-Z3 – Drop Out Time: 0.06 sec. or less
Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

* For the relay with slow dropout the reset time is:

TX – Z2 dropout time = 0.45 – .075 sec.
TX – Z3 dropout time = .090 – 0.15 sec.

Voltage Rating Over The Temperature Range

48, 125 or 250 volts d-c. The relay can stand 110% voltage continuously, from –20°C. to 70°C.

Battery Drain

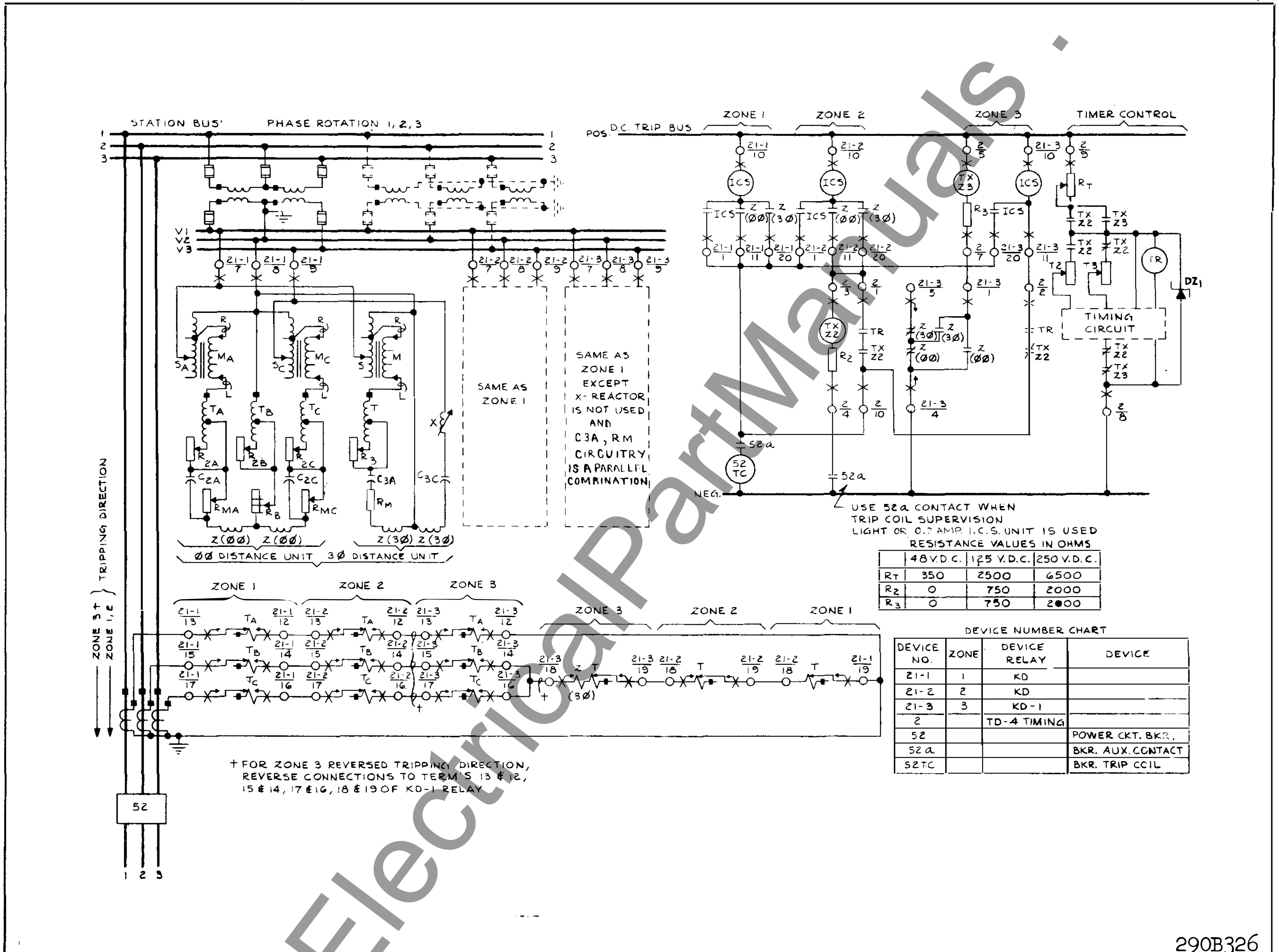
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, and the ambient temperature. Self-heating has a negligible effect on the timing accuracy.

(1) Nominal Setting

The first time delay, as measured with the test circuit shown in Fig. 7, taken at 25°C, and rated voltage (48, 125, or 250 V.D.C.), will be within 6 milliseconds of its setting for settings of .3 seconds and .7 seconds; this accuracy will be ±2%. For settings of .7 seconds or more, this accuracy will be ± 1½%.



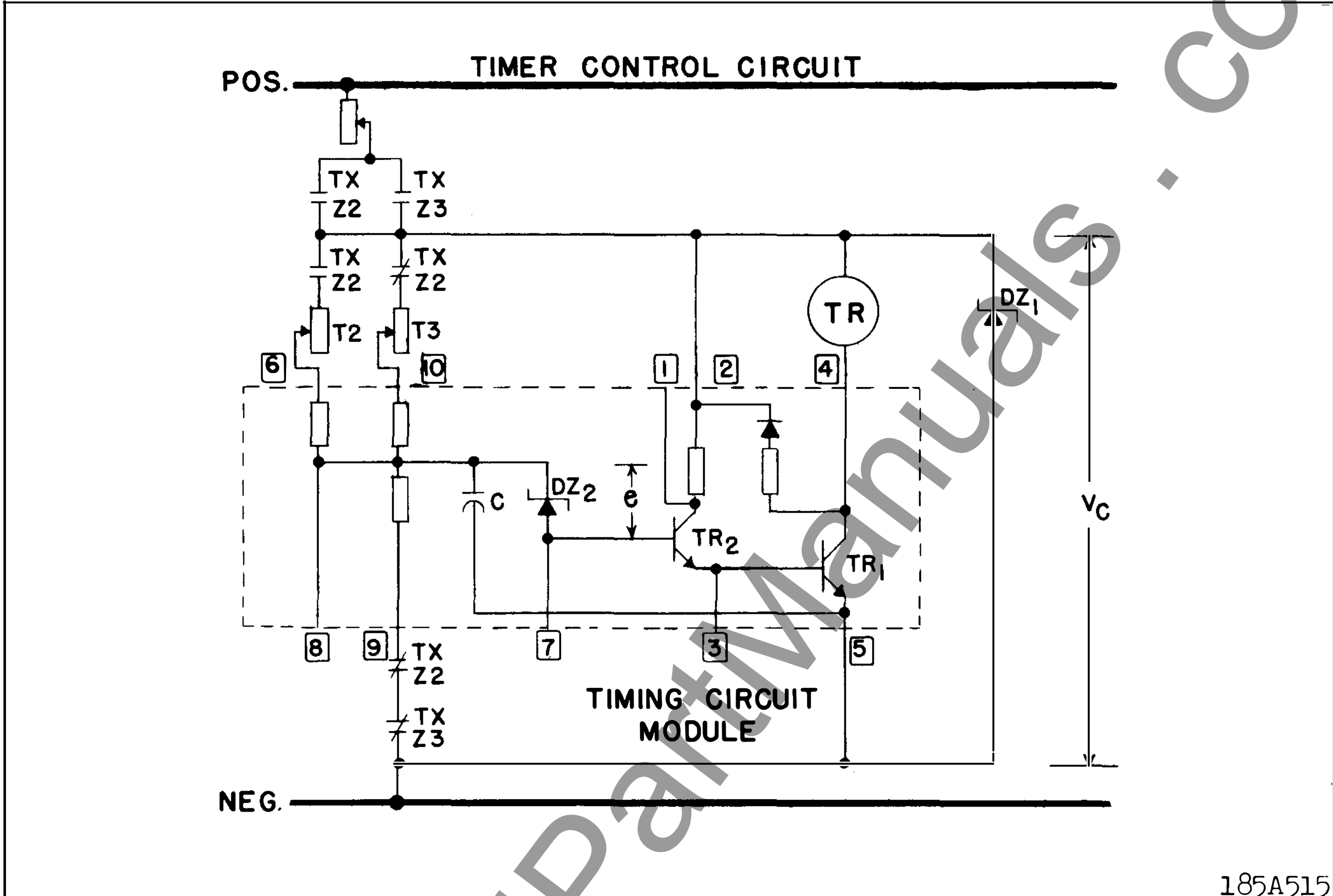
RESISTANCE VALUES IN OHMS

	48 V.D.C.	125 V.D.C.	250 V.D.C.
R_T	350	2500	6500
R_2	0	750	2000
R_3	0	750	2000

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD	
21-2	2	KD	
21-3	3	KD-1	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

*** *Fig. 4. External Schematic of the type TD-4 Relay***



* *Fig. 5. Timer Control Circuit*

(2) Consecutive Timings

If consecutive time checks are made at any given setting, the readings decrease. This change of time delay is due to the "voltage recovery" of the timing capacitor. Voltage recovery is a characteristic which all capacitors possess; it has been minimized by the selection of the timing capacitor in the TD-4.

The amount of change in time delay depends upon the pause, or duration of capacitor discharge between timings. If a pause of at least 3 seconds is observed between readings, the timing will repeat consistently, so that the total spread between the highest and lowest readings will be no more than 2% of the setting.

If timings are repeated rapidly, the decrease in time delay is considerable, between 3% and 4% in most cases. In no case will this decrease be more than 5% of the setting.

(3) Supply Voltage

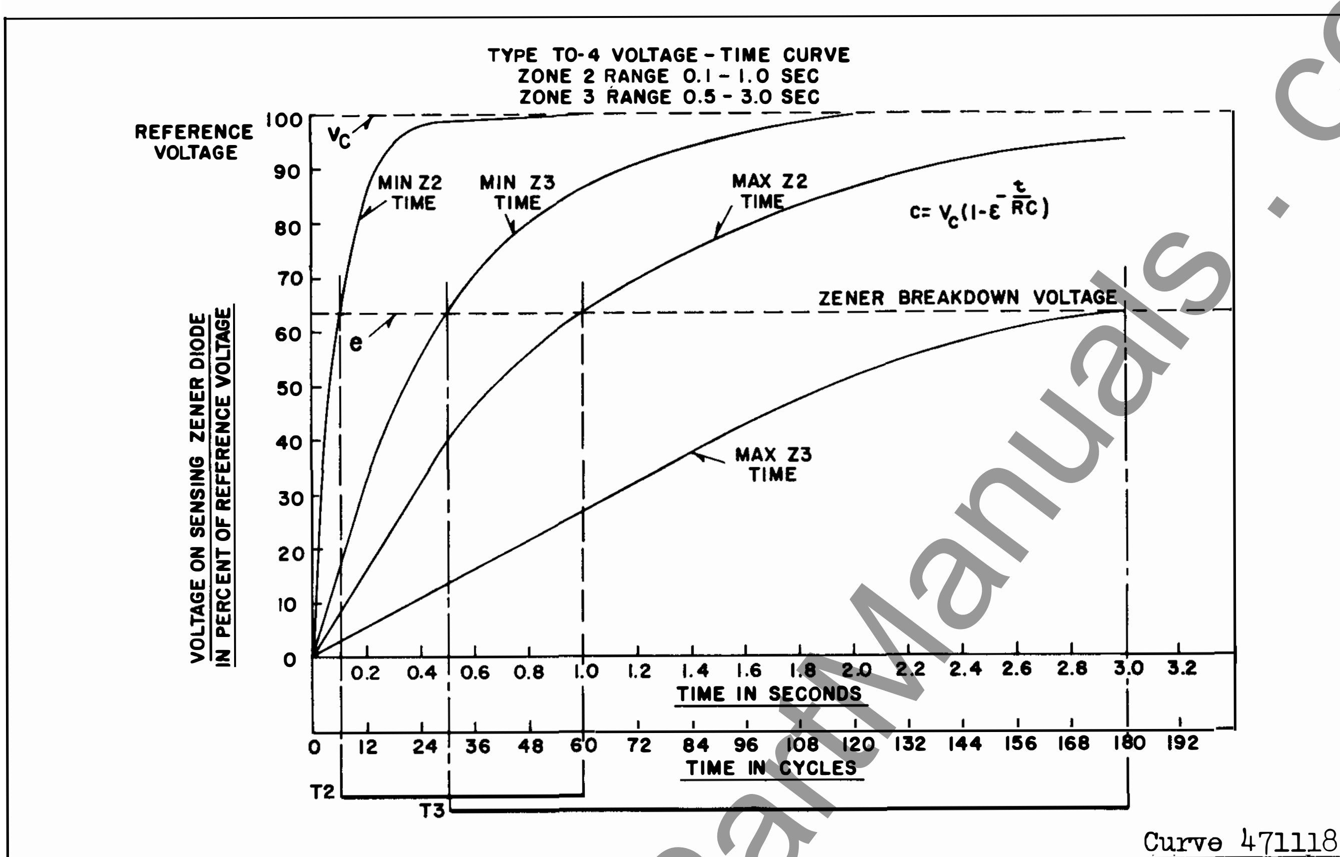
Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ±5 milliseconds for settings of .5 seconds or less, and no more than ±1% for settings above .5 seconds.

(4) Ambient Temperature

Changes in ambient temperature cause changes in time delay. This variation in time delay is a direct function of capacitance change with temperature. Typical variation of time delay with temperature is shown in Fig. 8.

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms
M Module	– Timing Circuit



* *Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings*

SETTINGS

Proper time delay is selected by turning the knobs of rheostats T_2 and T_3. Refer to Fig. 1.

The correct taps for R_2, R_3, and R_T should be selected for the supply voltage being used.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from moisture. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel-panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. For detailed FT Case information, refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

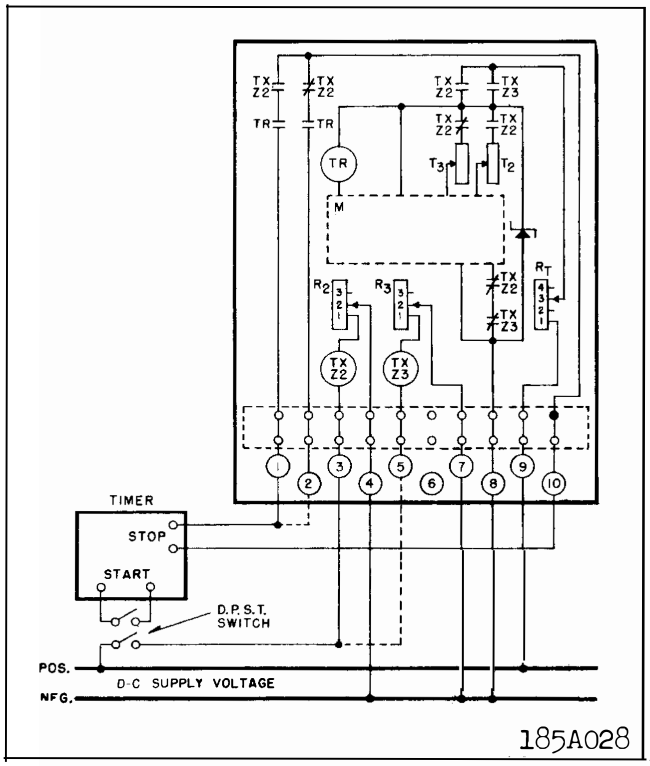
The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. Do not remove the knobs on the T_2 and T_3 rheostats unless the rheostats are to be replaced as this will upset the relay calibration.

Acceptance Tests

A timing check at minimum and maximum settings is recommended to insure that the relay is in proper working order. A recommended test circuit is shown in Fig. 7.

Routine Maintenance

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for



*** *Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).***

cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus, impairing the contact.

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the TD-4 is not operating correctly.

1. Apply rated voltage between relay terminals 3 and 4 and visually check TX-Z2 contact operation. (Apply voltage between terminals 5 and 7 and check TX-Z3 operation.)

2. Check reference voltage circuit. This is done by measuring the voltage between module terminal 2 (positive) and relay terminal 8 (negative) with a d-c voltmeter. Module terminal numbers are shown in Fig. 1. This voltage should be zero before TX-Z2 and TX-Z_3 operation, and between 27 and 32 volts d-c after TX-Z2 or TX-Z3 operation.

3. Checks rheostats, T_2 and T_3, and tripping telephone relay, TR, with an ohmmeter. The readings should be as follows:

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0 - 100,000 ohms
T_R	2 and 4	2,000 ohms

4. If the above checks do not determine the source of trouble, either the wiring or the module, M, is faulty.

Calibration

Use the following procedure for calibrating the relay if the relay adjustments have been disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. Before calibrating, follow the Trouble Shooting Procedure to locate the source of trouble.

1. Telephone Type Relay Adjustment

Adjust the armature gap on the three telephone type relays to be approximately .004" with the armature closed. This is done with the armature set-screw and lock-nut. Also, adjust contact leaf springs to obtain at least .015" gap on all contacts and at least .010" follow on all normally open contacts and at least .005" follow on all normally closed contacts.

2. Rheostat Knob Adjustment, Same Scale Plate

If it is necessary to replace the T_2 or T_3 rheostats, the relay may be recalibrated with the same scale plate. This is done by rotating the shaft, without knob, until a 1.0 second delay is measured for T_2, or a .5 second delay is measured for T_3. Then, align the knob for this delay and tighten the knob set-screw securely. There should be a pause of several seconds between readings for all time delays above .5 seconds. See section under Accuracy for discussion of this.

3. Scale Plate Calibration, New Scale Plate

If it is necessary to replace the silicon power regulator (DZ_1), or the module (M), the relay should be recalibrated with a new scale plate.

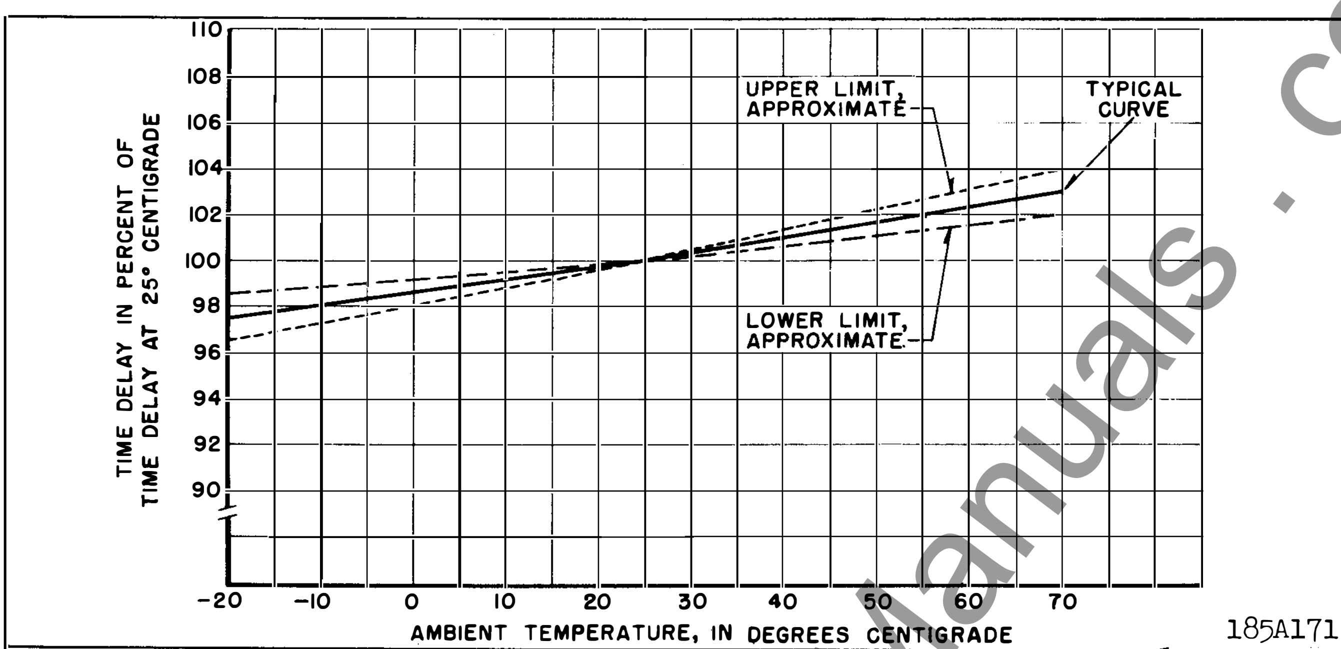
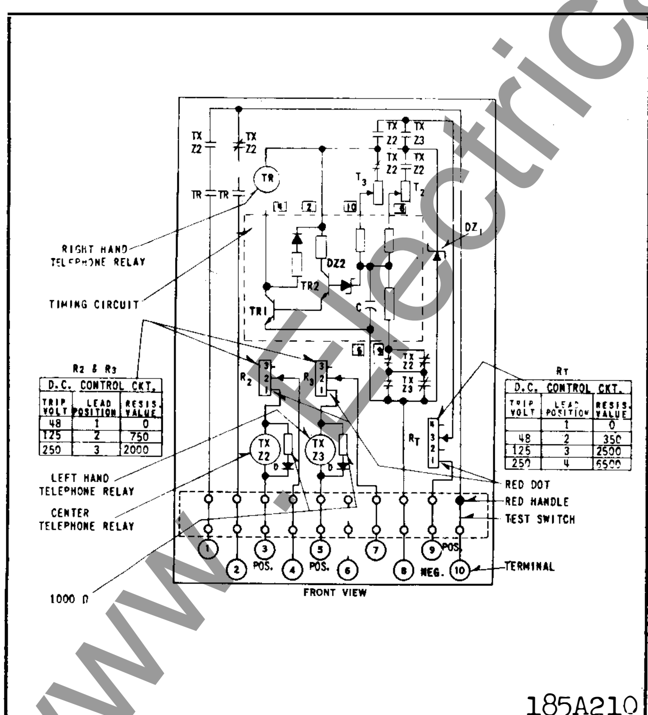


Fig. 8. Timing Variations with Temperature Changes

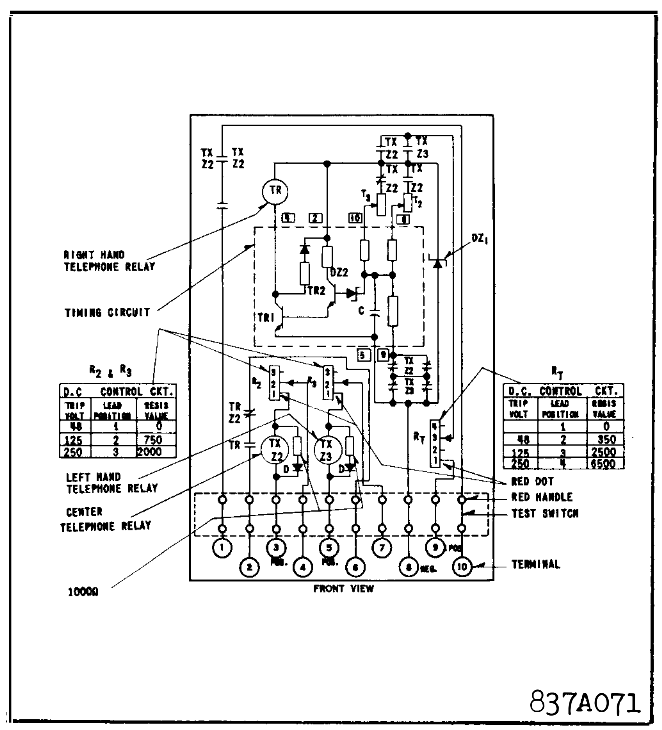
The first step should be to insure that the knob is approximately vertical for the mid-scale time time delay (.550 sec. for T_2 and 1.75 sec. for T_3 This will locate the calibration lines symmetrically around the scale plate. After centering and securely locking the knob on the rheostat shaft, new calibration lines may be marked on the scale plate. When scribing calibration lines for delays above .5 sec., there should be a pause of at least 3 seconds between readings. See section under Accuracy for discussion of this.

RENEWAL PARTS

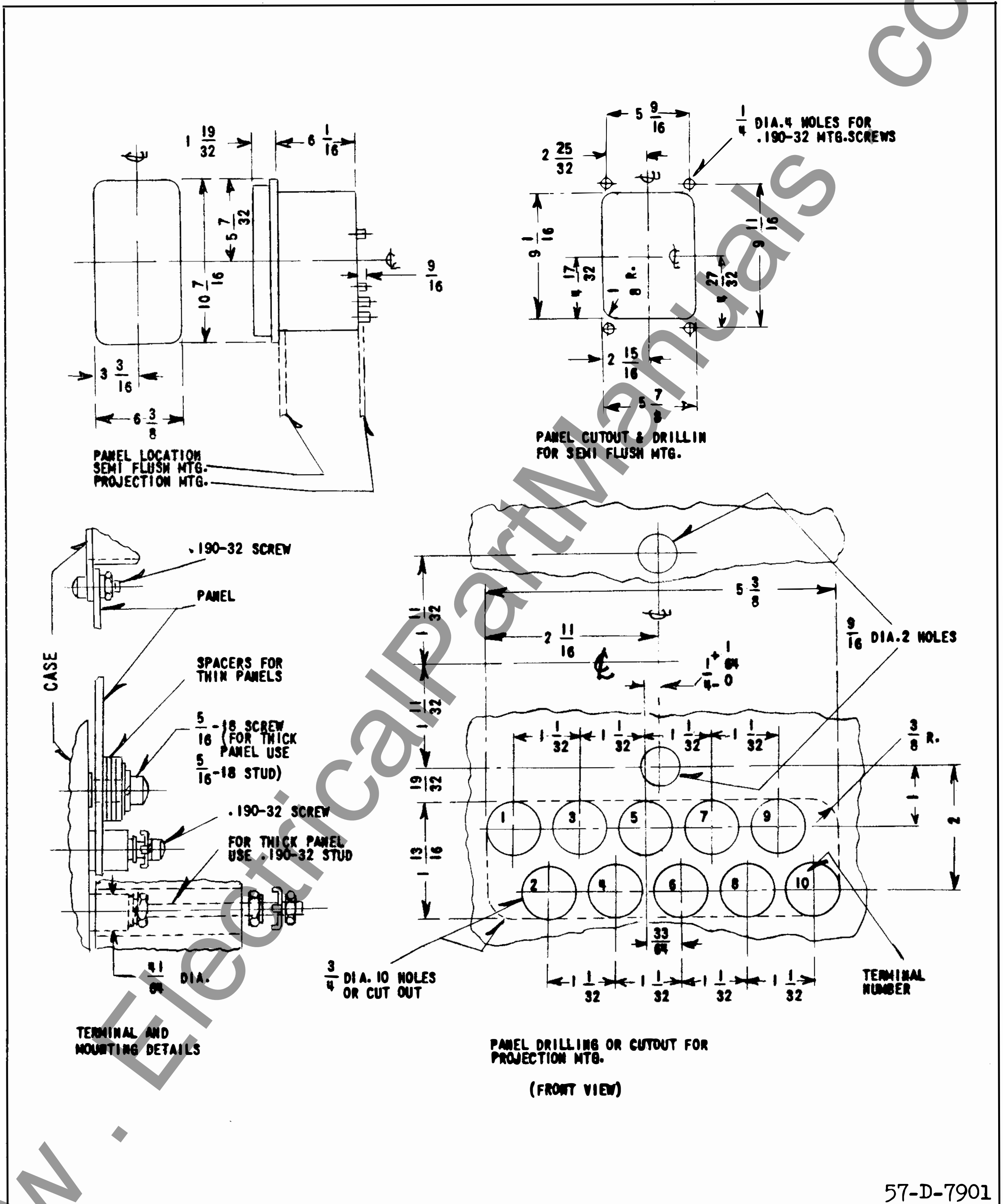
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



* *Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).*



* *Fig. 10 Internal schematic of the type TD-4 relay with slow dropout relay (independent trip circuits).*



* *Fig. 11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

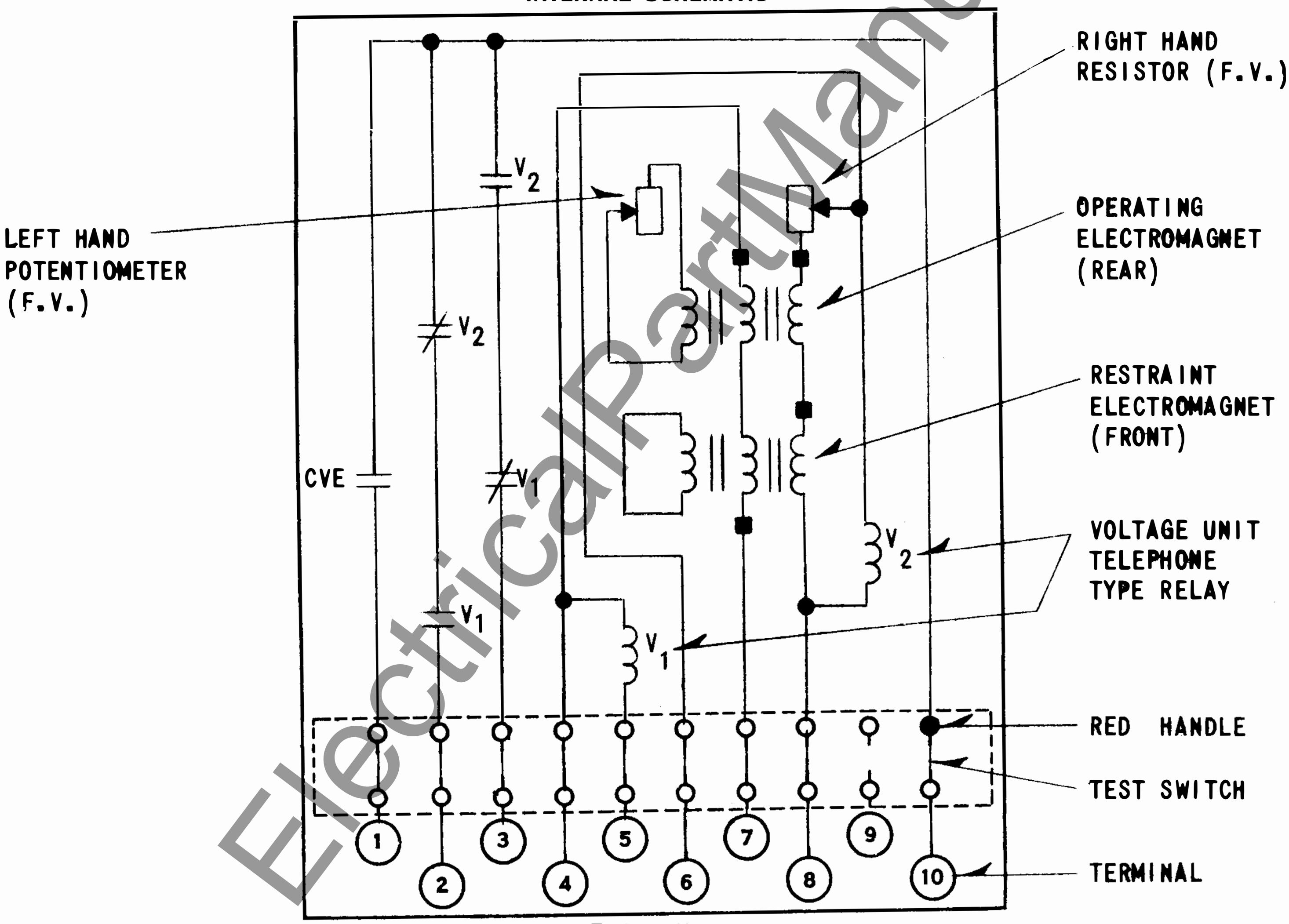
Printed in U.S.A.

DWG. NO. 880A496

DATES	
	D-SPEC. 6299217-10
3/16/71	DRAFTSMAN
3/16/71	CHECKER
3/17/71	APPROVED ERH
3/17/71	APPROVED AC

RELAY TYPE CVE-1 SYNCHRO-VERIFIER WITHOUT COMMONED POTENTIAL COILS IN TYPE FT-21 CASE

INTERNAL SCHEMATIC



FRONT VIEW

FT.21

WESTINGHOUSE ELECTRIC CORPORATION - RELAY-INSTRUMENT DIVISION-NEWARK, N.J., U.S.A.

MFG. DWG. 205C234 REF.

4100

DWG. NO. 880A496

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

CAUTION *Before putting relays into service operate the relay to check the electrical connections. Close the red handle switch last when placing the relay in service. Open the red handle switch first when removing the relay from service.*

APPLICATION

The type TD-4 static timing relay provides time delay for the second and third zone contacts of the KD-4 and KD-41 distance relays. The proper delay period is selected by whichever zone relay operates.

CONSTRUCTION

The Type TD-4 relay consists of an auxiliary circuit for initiating the time delay, a reference voltage circuit, and a time delay circuit. A diode is added around the TX-Z2 and TX-Z3 coils on some types to override bounce of the initiating contact.

Auxiliary Circuit for Initiating Time Delay

The auxiliary circuit consists of two telephone-type relays (TX-Z2 and TX-Z3) and two tapped resistors (R_2 and R_3).

Reference Voltage Circuit

The reference voltage circuit consists of a silicon power regulator (DZ_1) and a tapped resistor (R_T).

Time Delay Circuit

The time delay circuit consists of a timing circuit module (M) a telephone type relay (TR) and two rheostats (T_2 and T_3). The timing circuit module consists of an R-C timing circuit, a zener diode for voltage sensing, and a transistorized amplifying circuit.

OPERATION

The type TD-4 relay is connected to the d-c trip bus as shown in the external schematic, Fig. 4 and the timer control circuit, Fig. 5.

Timing Circuit Operation

The R-C timing circuit in Fig. 5 delivers an increasing voltage to the sensing zener diode (DZ_2). This zener diode breaks down at approximately 63% of the reference voltage which is supplied by DZ_1. The rate of voltage rise is determined by the resistance (T2 or T3) in series with the timing capacitor. Therefore, the rheostat setting of T2 or T3 directly determines the time delay, as shown in Fig. 6.

When capacitor C changes to the voltage value e, DZ_2 breaks down to provide base drive for transistor TR_2 causing it to conduct. Emitter current of TR_2 provides base drive for transistor TR_1. Transistor TR_1 conducts, energizing output relay TR to the trip the breaker.

1. Zone 2 Operation, Non-Carrier

* For a zone 2 fault, both zone 2 and zone 3 KD-41 contacts close, energizing both TX-Z2 and TX-Z3. This completes the D. C. reference voltage circuit through DZ_1. The time delay circuit is energized through rheostat T_2. When the time delay is completed, telephone relay, TR, is energized and completes the trip circuit path through the normally open TX-Z2 contact.

2. Zone 2 Operation, Carrier

This case is similar to paragraph 1, except that * the zone 2 KD-4 contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

* For a zone 3 fault the zone 3 KD-41 contact only is closed. This energizes TX-Z3 and completes the timing circuit through rheostat T_3. At the end of the time delay, TR is energized and completes the trip path through the normally closed TX-Z2 contact.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-579K
...erseded issue.

EFFECTIVE APRIL 1973

WESTINGHOUSE ELECTRIC CORPORATION

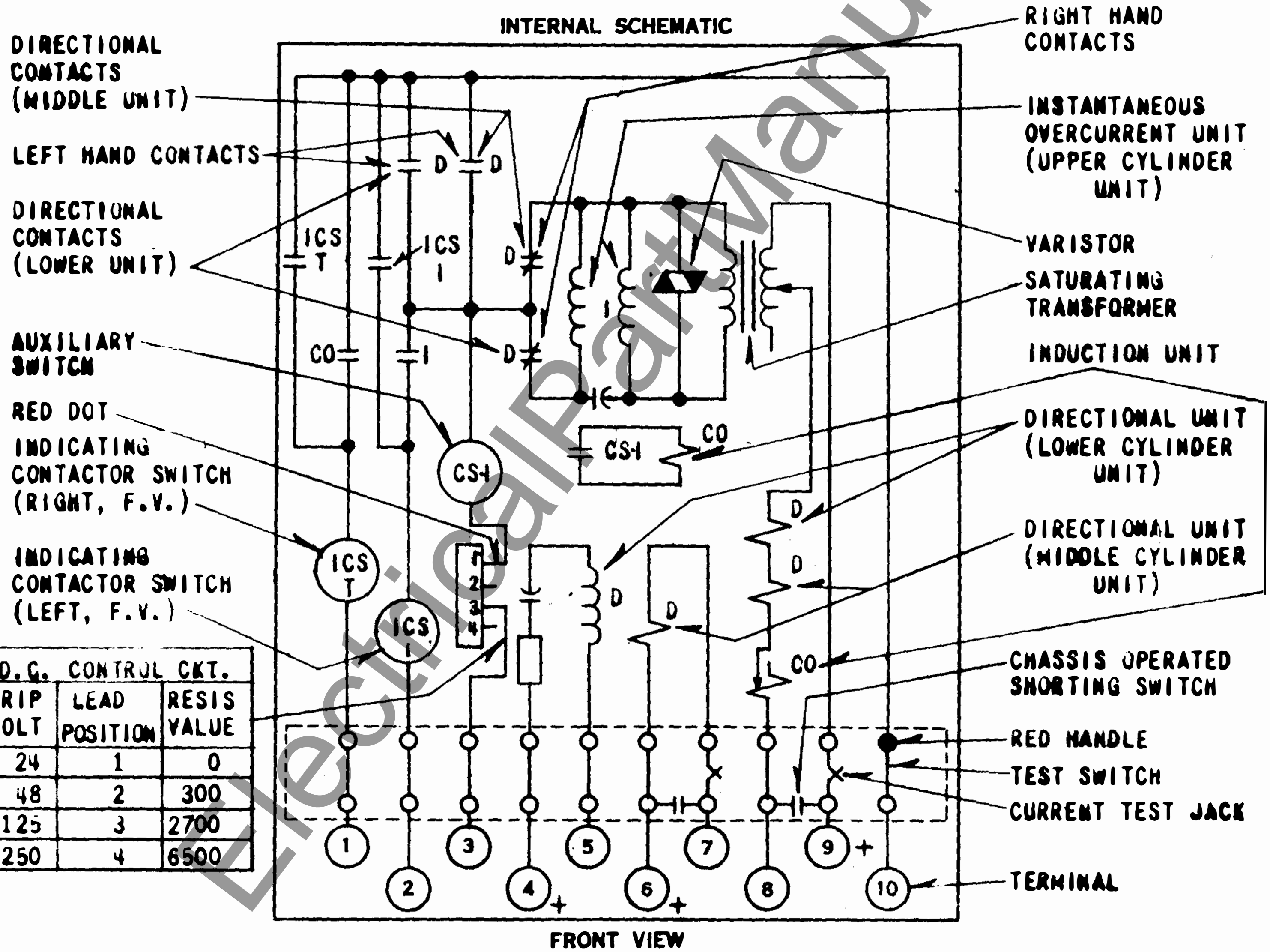
RELAY-INSTRUMENT DIVISION

CORAL SPRINGS, FL

WESTINGHOUSE ELECTRIC CORPORATION — METER DIVISION, NEWARK, N. J., U. S. A.

DWG. NO. 185A358 | B-SPEC. S#1962654 | DRFT. A. SCERBO 6-5-61 | CHECK. | APPD. | ME 43 IAC

RELAY - TYPE IRD - DUAL POLARIZED DIRECTIONAL OVERCURRENT GROUND RELAY WITH NONTAPPED ICS - IN TYPE FT 41 CASE



D.C. CONTROL CKT.		
TRIP VOLT	LEAD POSITION	RESIS VALUE
24	1	0
48	2	300
125	3	2700
250	4	6500

WITH RELATIVE INSTANTANEOUS POLARITY AS SHOWN, THE DIRECTIONAL UNIT CONTACT CLOSES TO THE LEFT.

FT41

MFG. DWG. 407C625 REF.

DWG NO 185A358