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 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. Refer to Fig. 5.

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

SUPERSEDES I.L. 41-579.1L, dated JUNE 1974
Addendum to I.L. 41-579.1L, dated APRIL 1979
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✪ Denotes changed since previous issue.

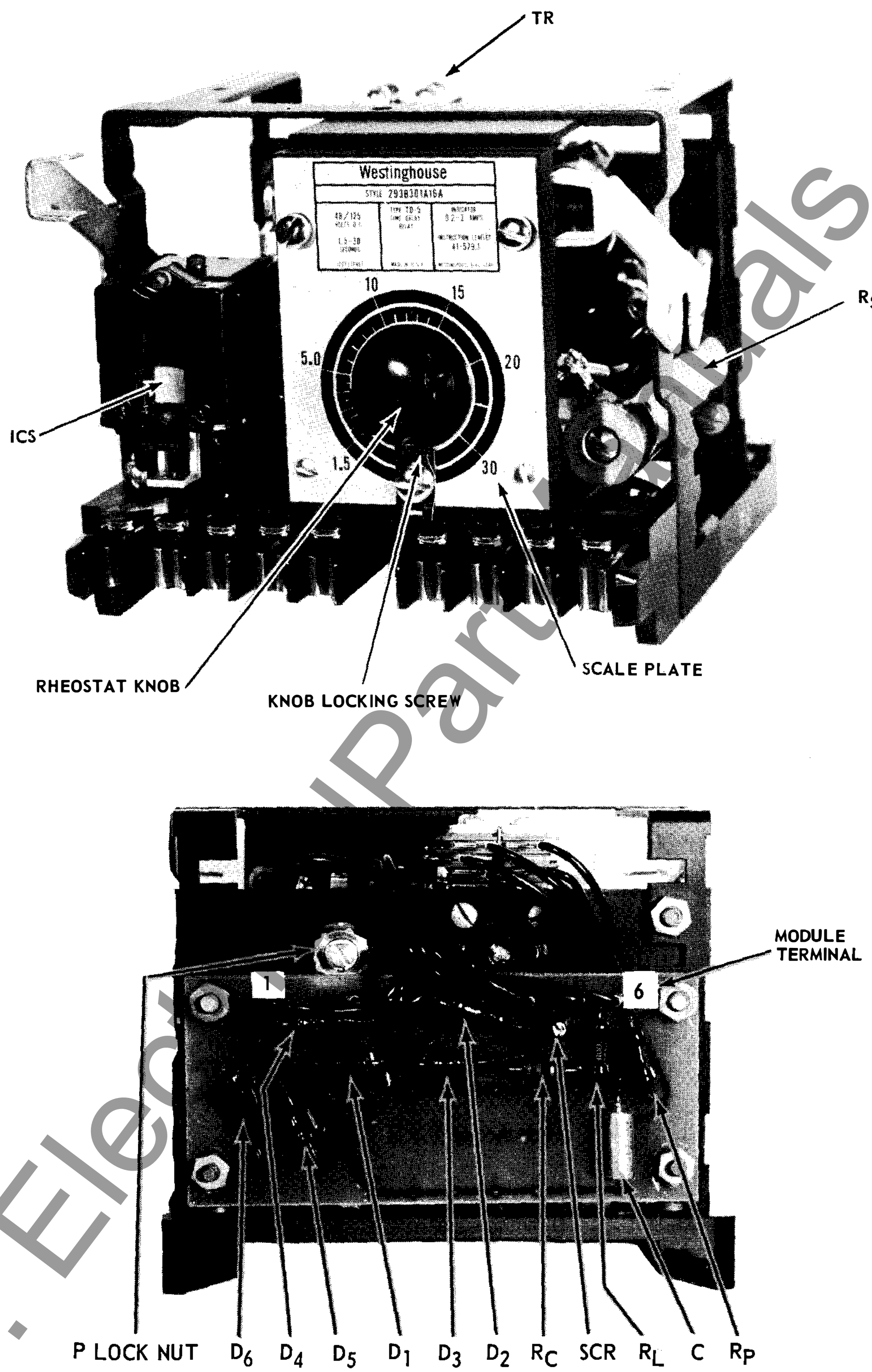

Fig. 1. Type TD-5 Relay Without Case.

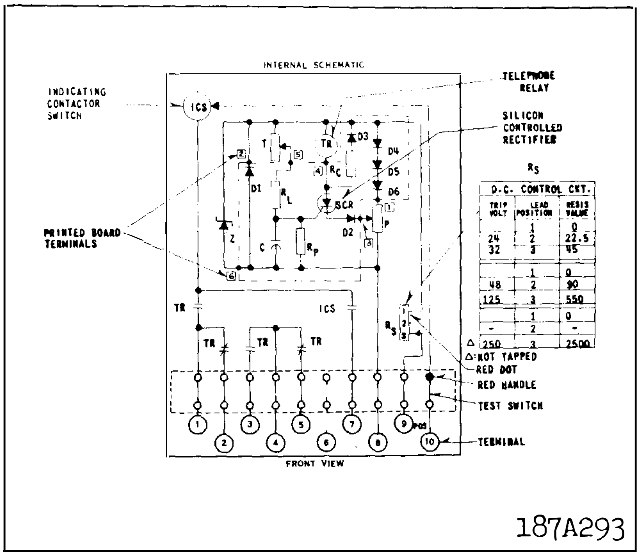

Fig. 2. Internal Schematic of Type TD-5 Relay.

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 cover.

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

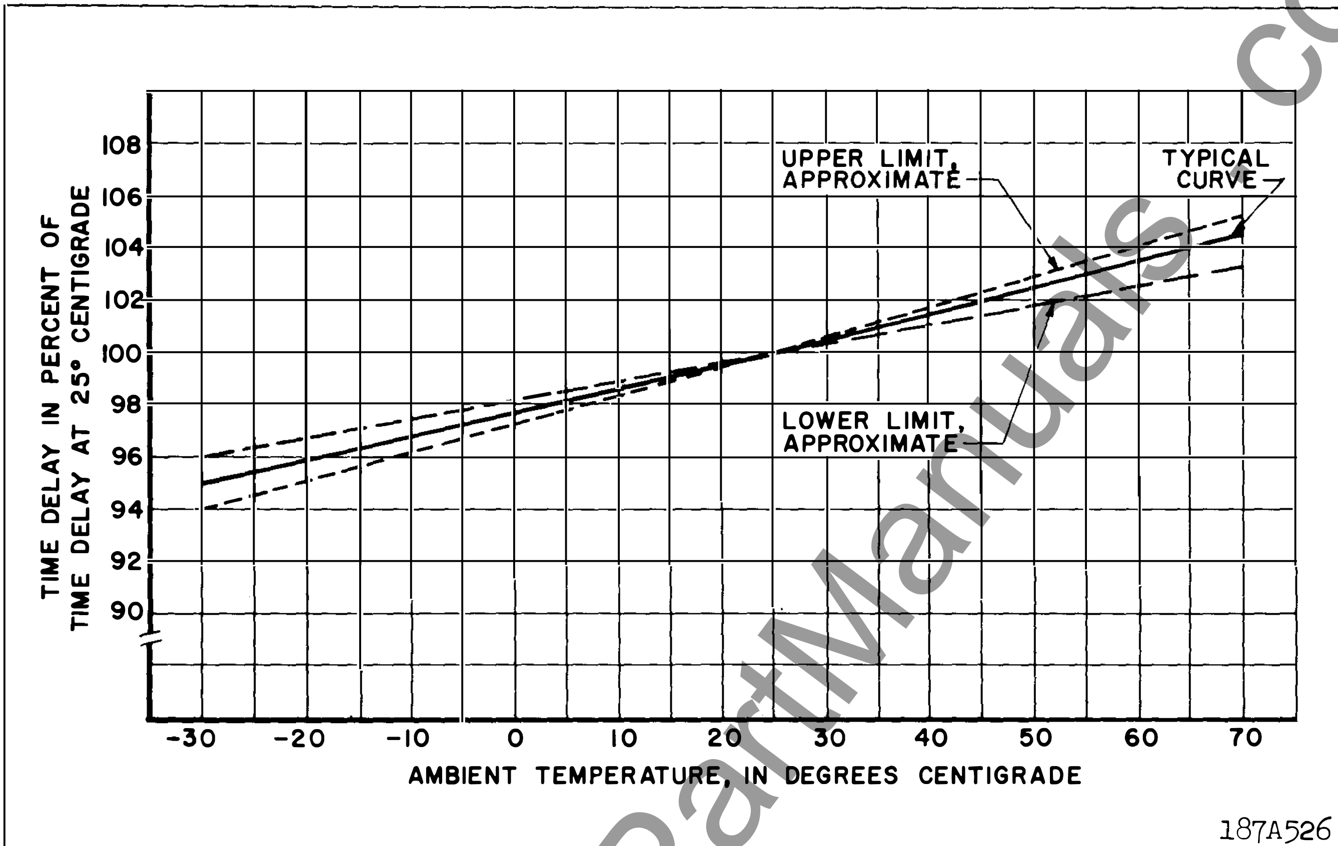

Fig. 3. Timing Variation with Temperature Changes.

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

* TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC		DESCRIPTION	STYLE NUMBER
	DC VOLTS	TIME RANGES		
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

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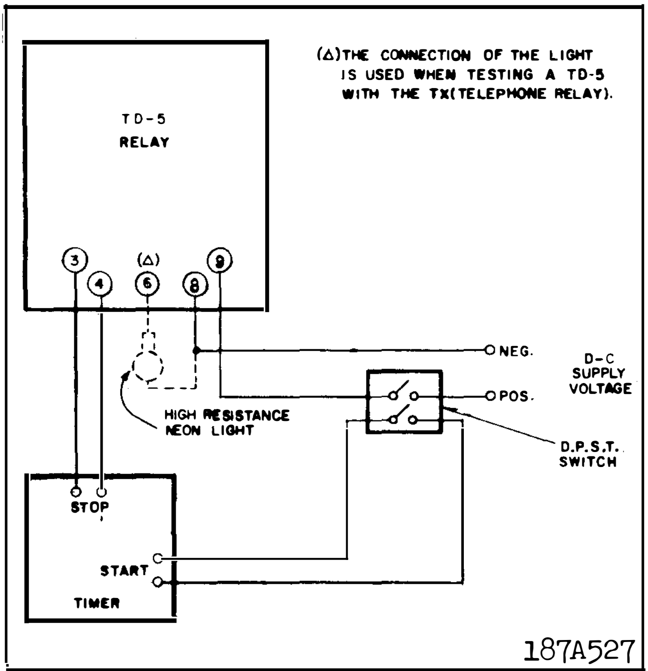

Fig. 4 Test Circuits for Type TD-5 Relay.

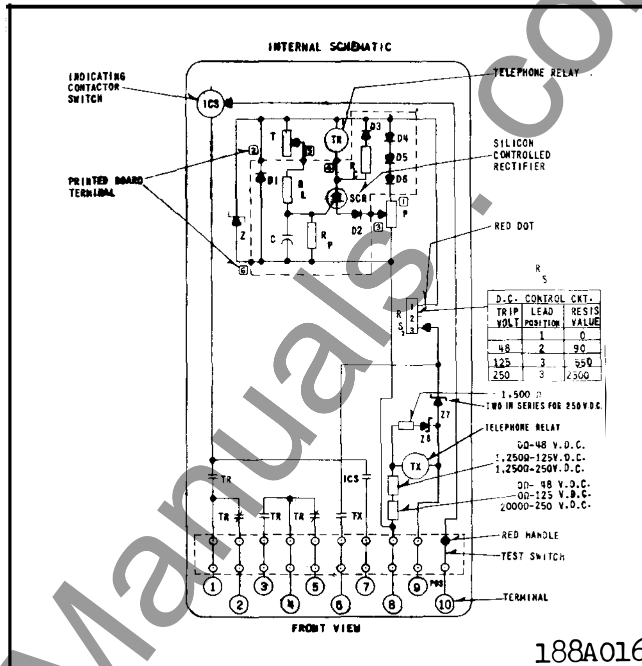

Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

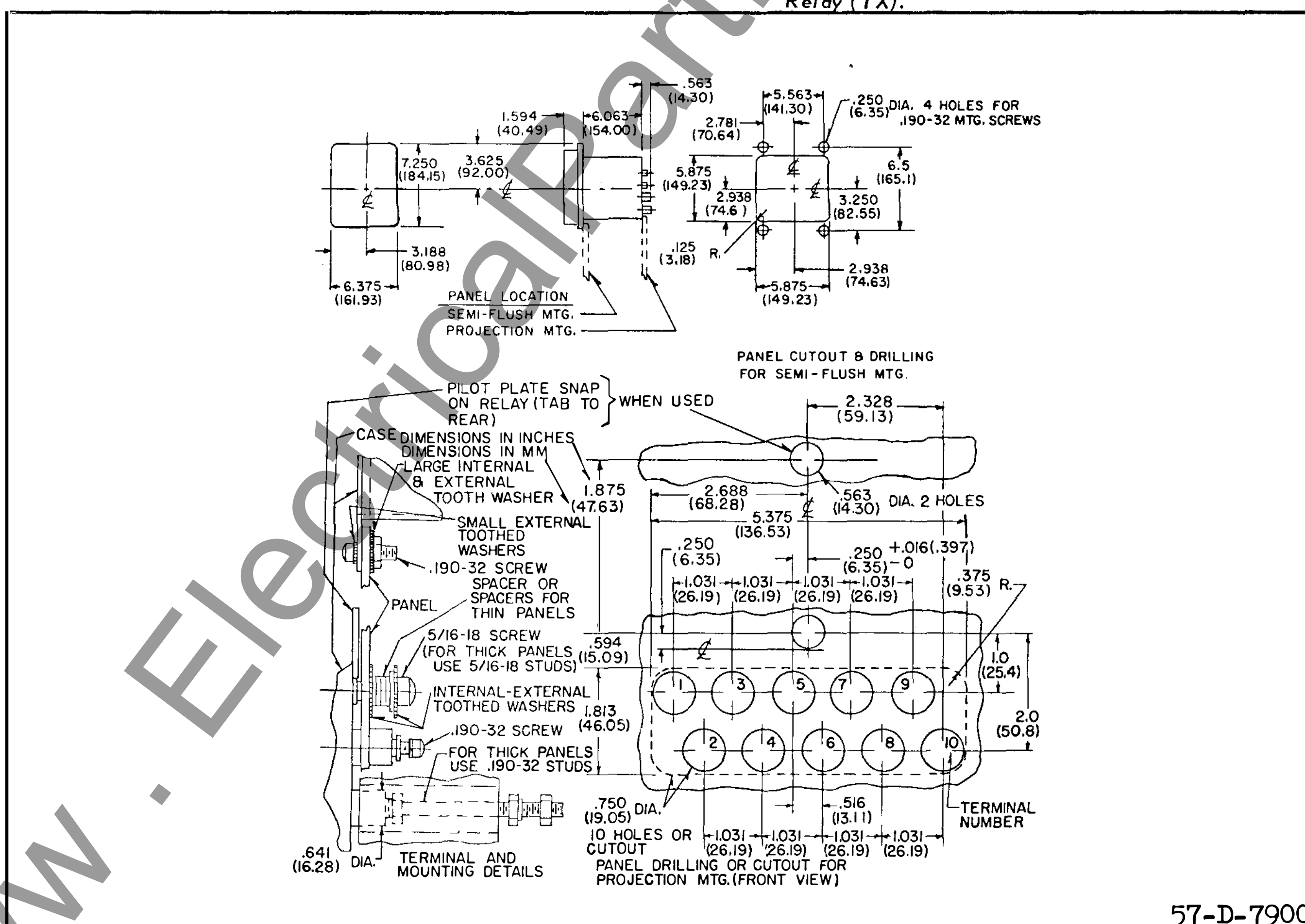

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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 14.0 volts for 24/32 volt relays, between 21.5 and 25.5 volts for 48/125 volt relays, and between 50 and 59 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 wipe should be 1/64" to 3/64" 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.

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.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-5 TIME DELAY RELAY

This sheet notes changes which should be made in Instruction Leaflet I.L. 41-579.1L dated June 1974.

On page 6, first column, paragraph 2 at top of page which is part of TROUBLE SHOOTING PROCEDURE should read as follows:

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 14.0 volts for 24/32 volt relays, between 21.5 and 25.5 volts for 48/125 volt relays, and between 50 and 59 volts for 250 volt relays.

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EFFECTIVE APRIL 1979

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.

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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 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.

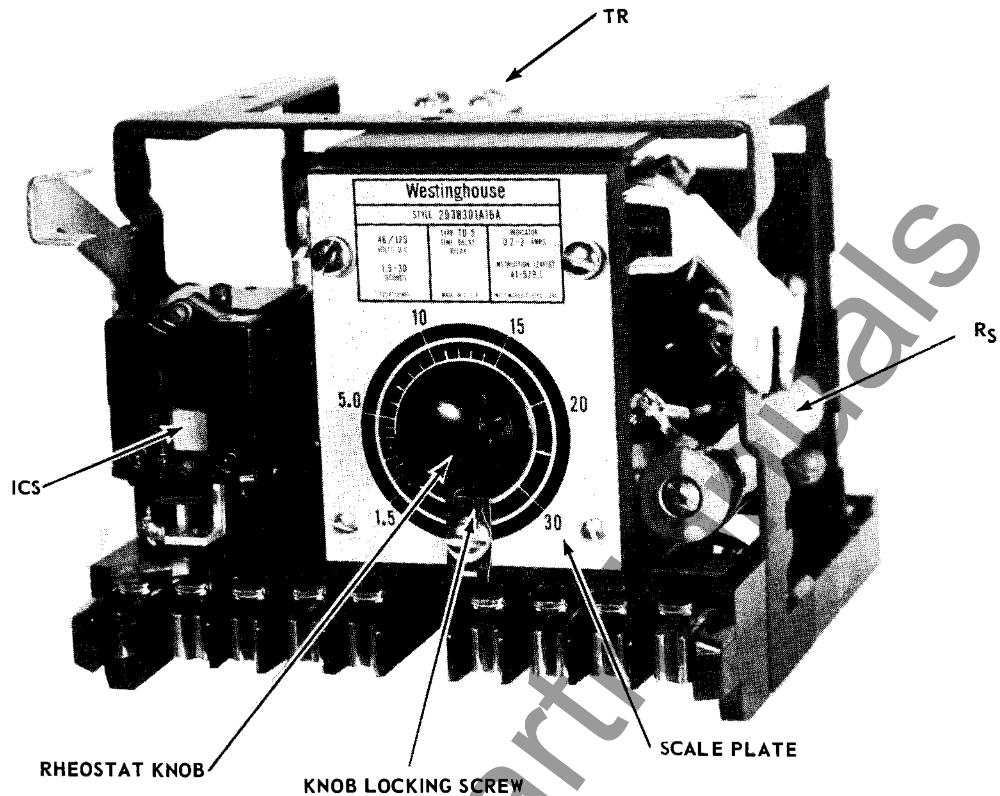
Telephone Relay (TX)

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. Refer to Fig. 5.

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

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

EFFECTIVE JUNE 1974



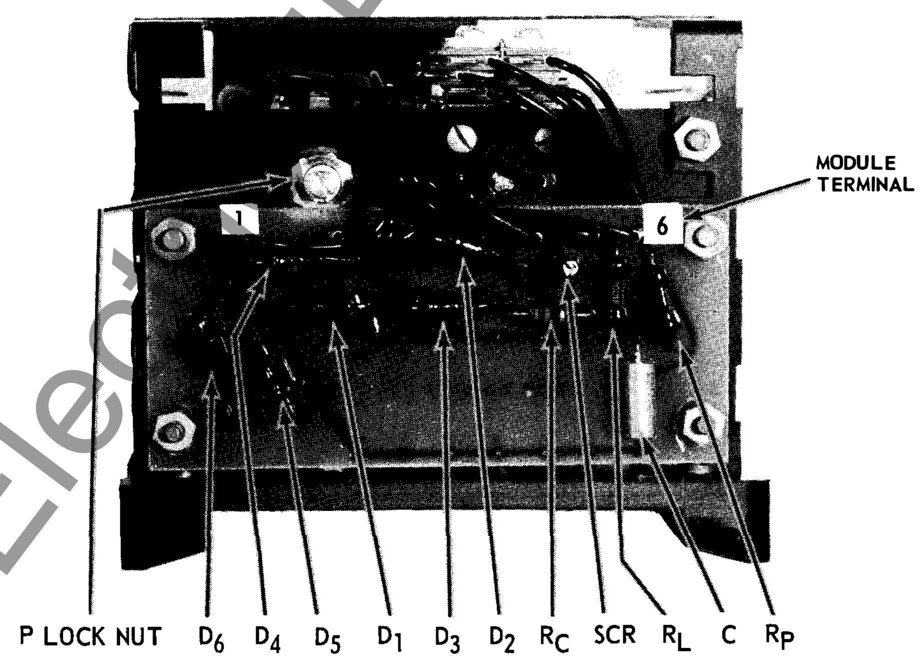


Fig. 1. Type TD-5 Relay Without Case.

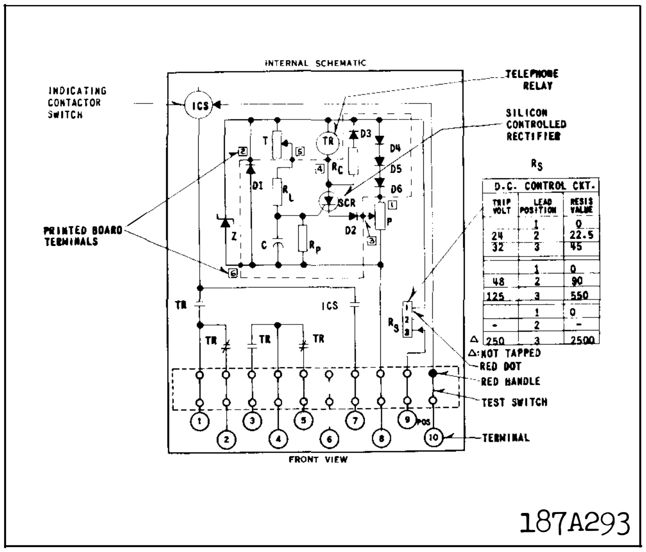


Fig. 2. Internal Schematic of Type TD-5 Relay.

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

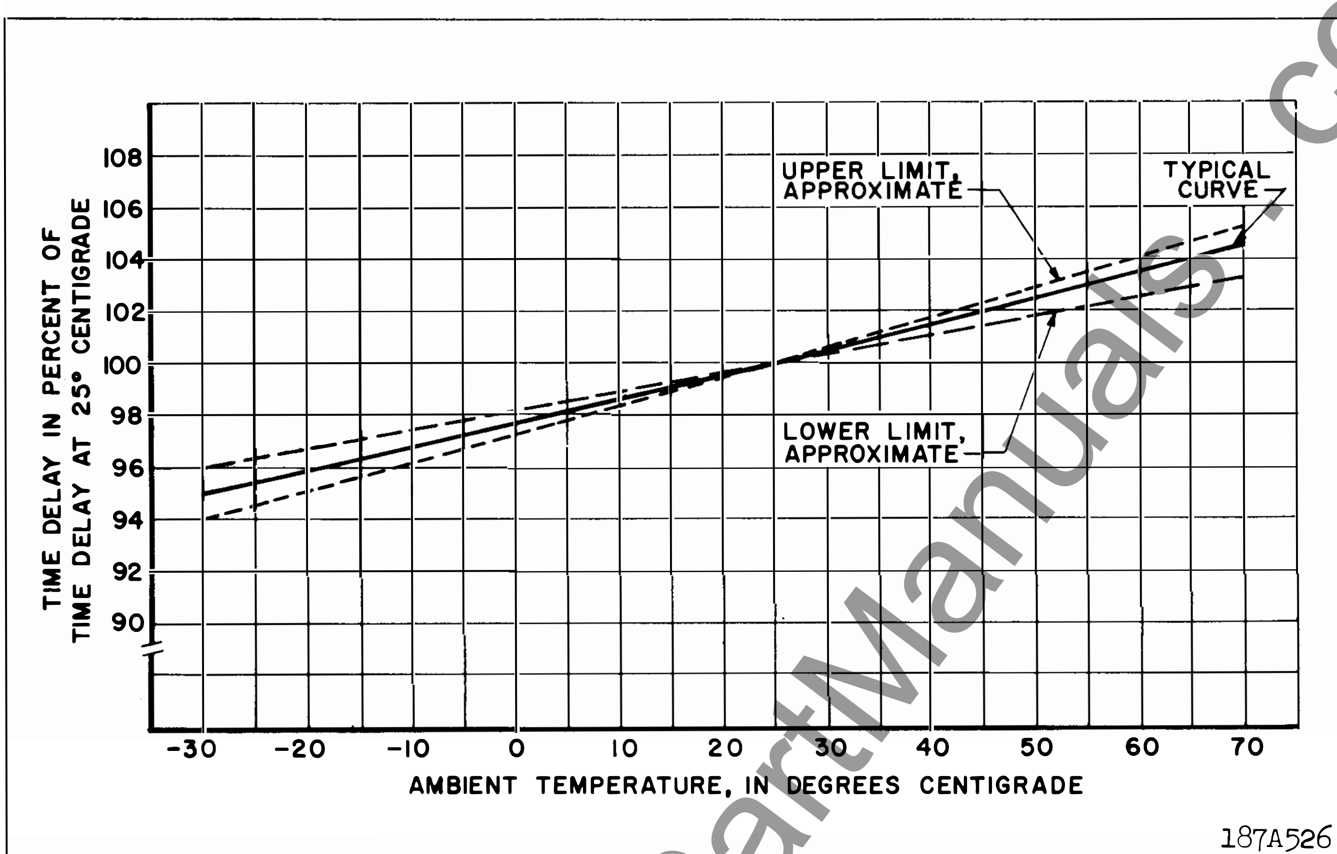


Fig. 3. Timing Variation with Temperature Changes.

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

* TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC		DESCRIPTION	STYLE NUMBER
	DC VOLTS	TIME RANGES		
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

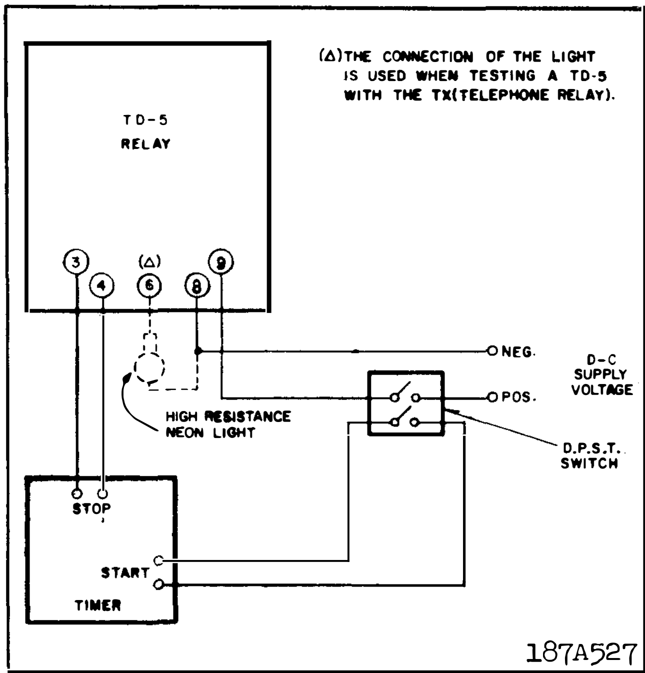


Fig. 4 Test Circuits for Type TD-5 Relay.

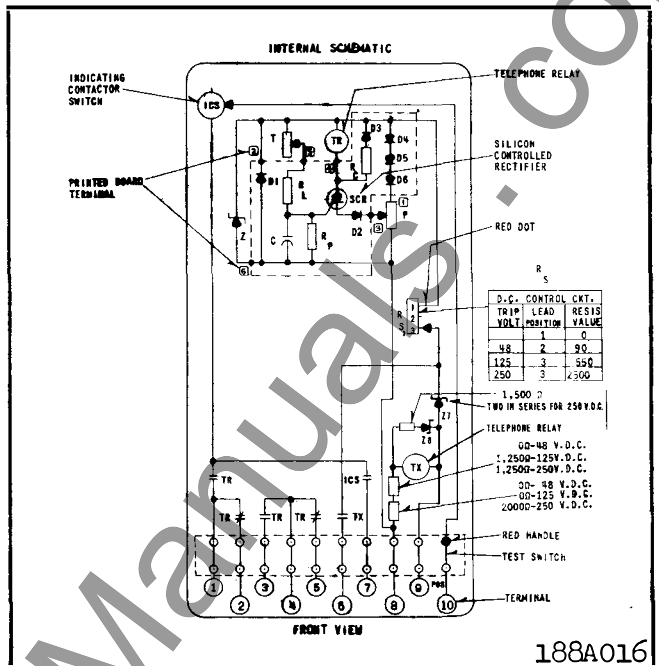


Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

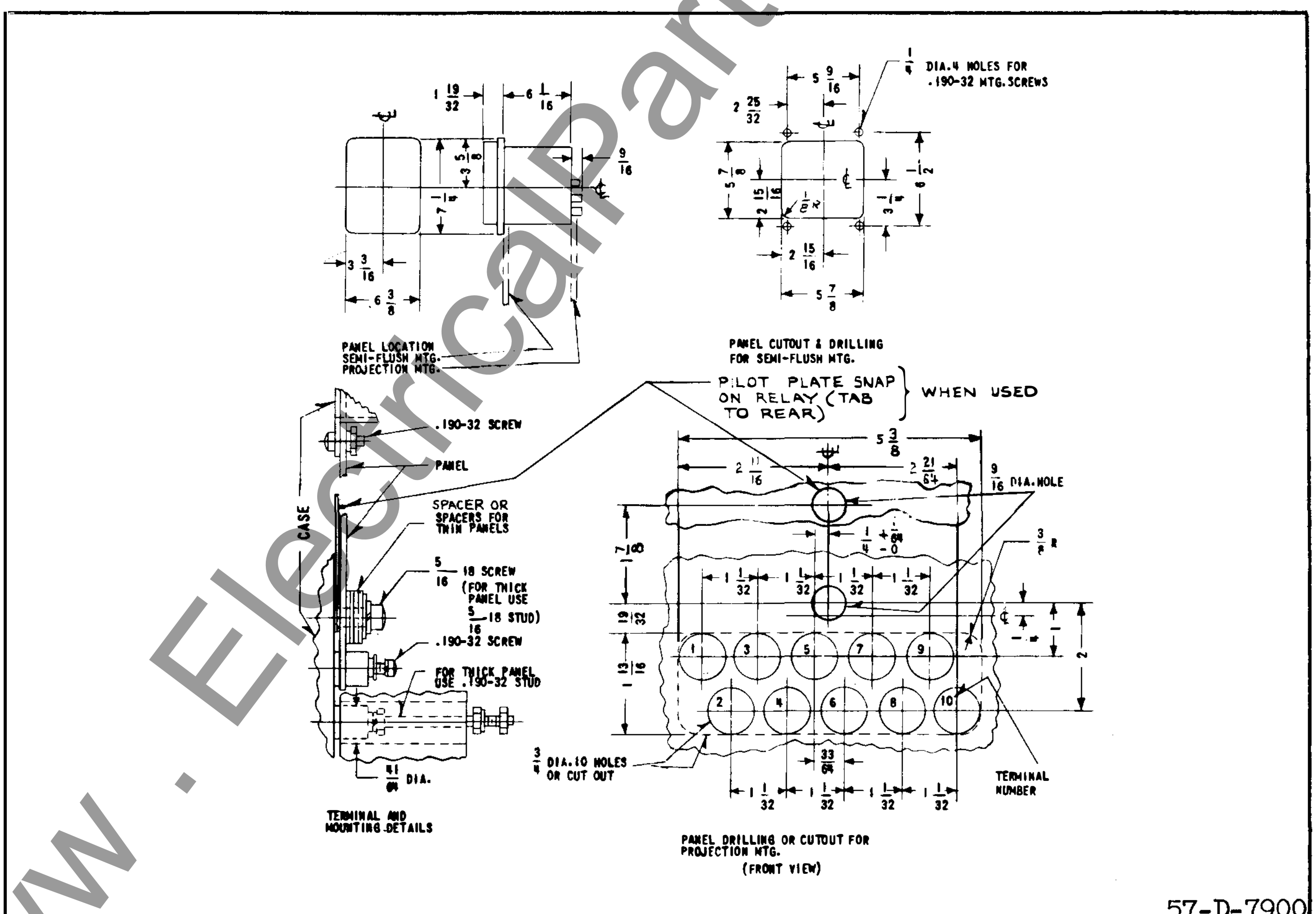


Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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 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. Refer to Fig. 5.

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

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

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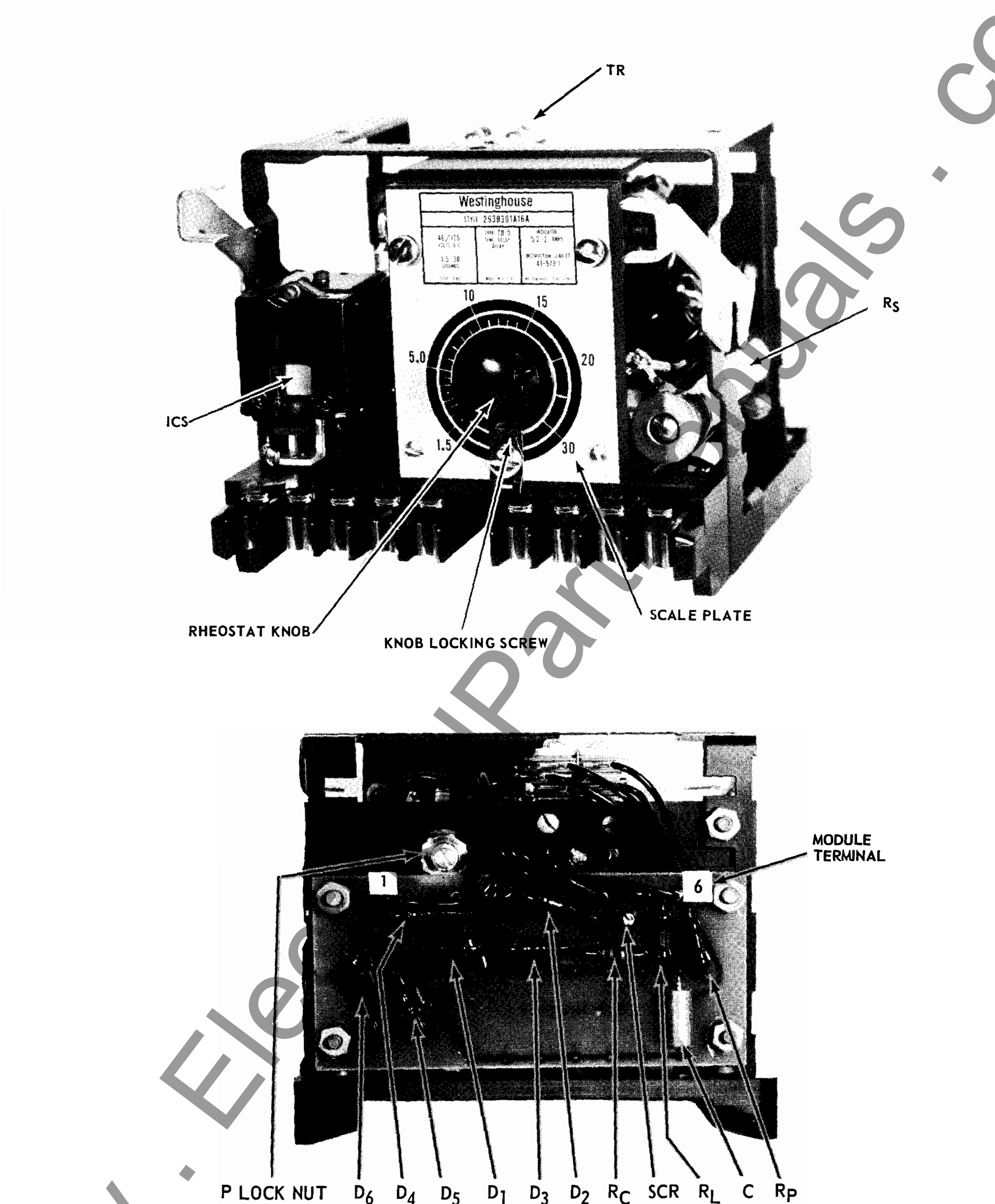

Fig. 1. Type TD-5 Relay Without Case.

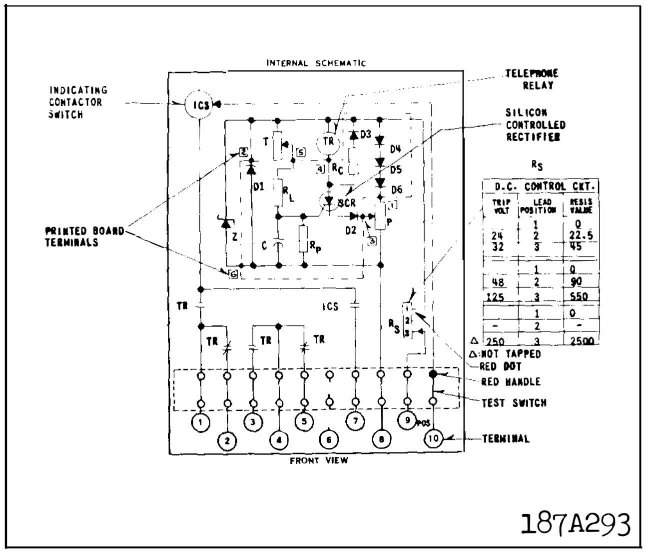

Fig. 2. Internal Schematic of Type TD-5 Relay.

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. 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

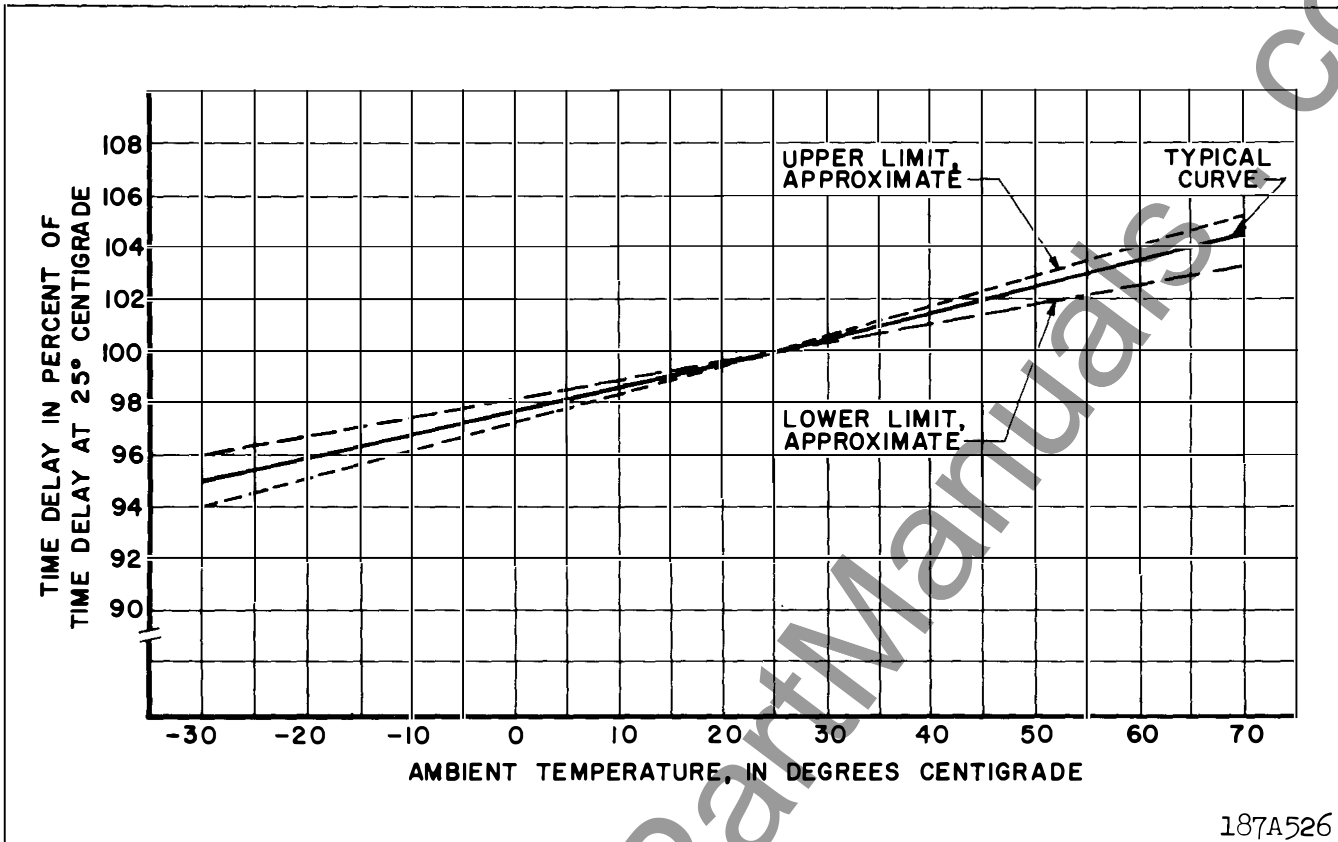

Fig. 3. Timing Variation with Temperature Changes.

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

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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts
	250	All	Zener Diode, IN2999B, 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
	All	.05-.4	Rheostat, 4 Watt, 20K
R_L	24/32	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%
	48/125	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%
	250	0.05-1 & .05-.4	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 & .05-.4	Tantalum Capacitor, 22uf, 35 volts
	48/125	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 35 volts
	250	0.05-1 & .05-.4	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 & .05-.4	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 & .05-.4	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, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885
	250	All	Silicon Controlled Rectifier, 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

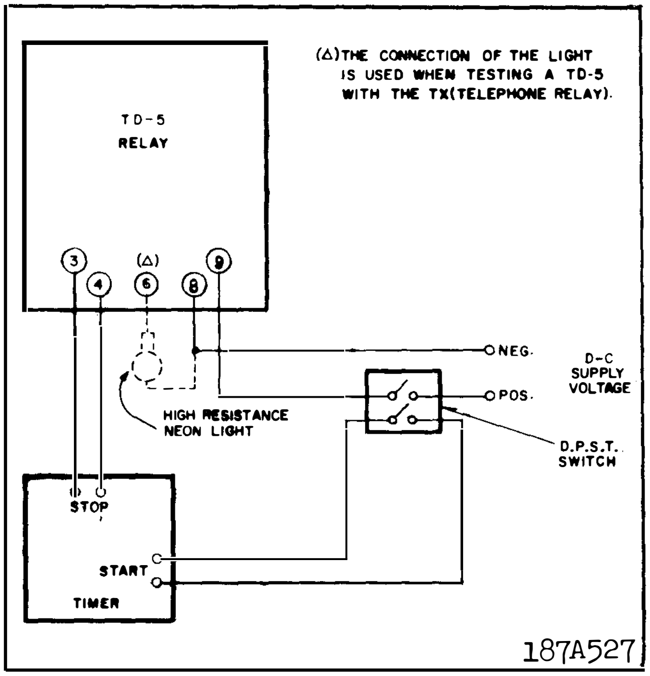

Fig. 4 Test Circuits for Type TD-5 Relay.

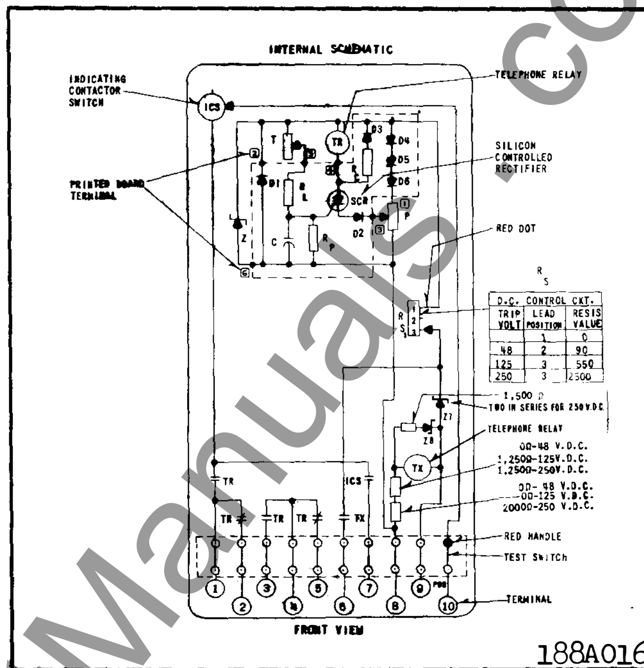

Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

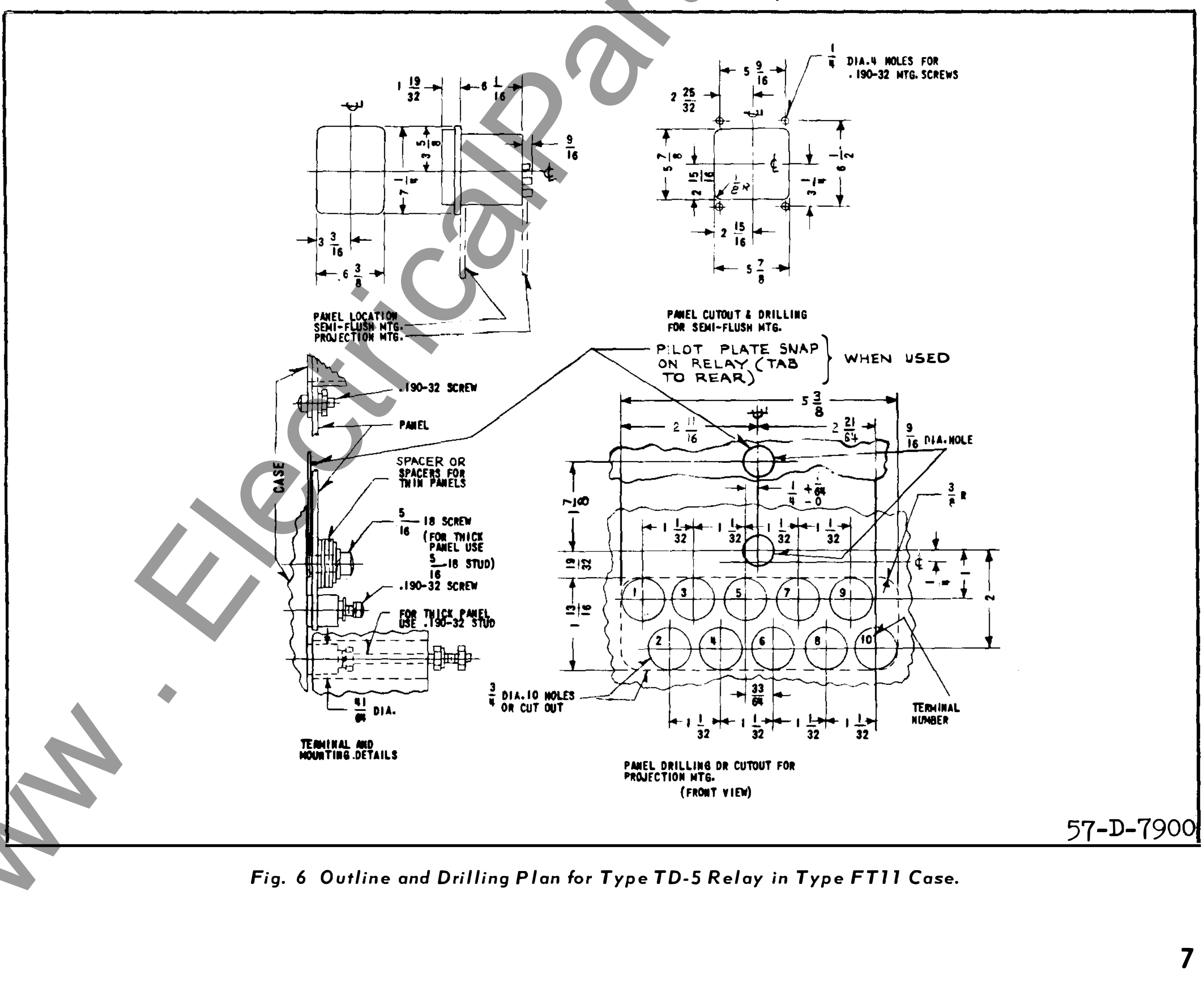

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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 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. Refer to Fig. 5.

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

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

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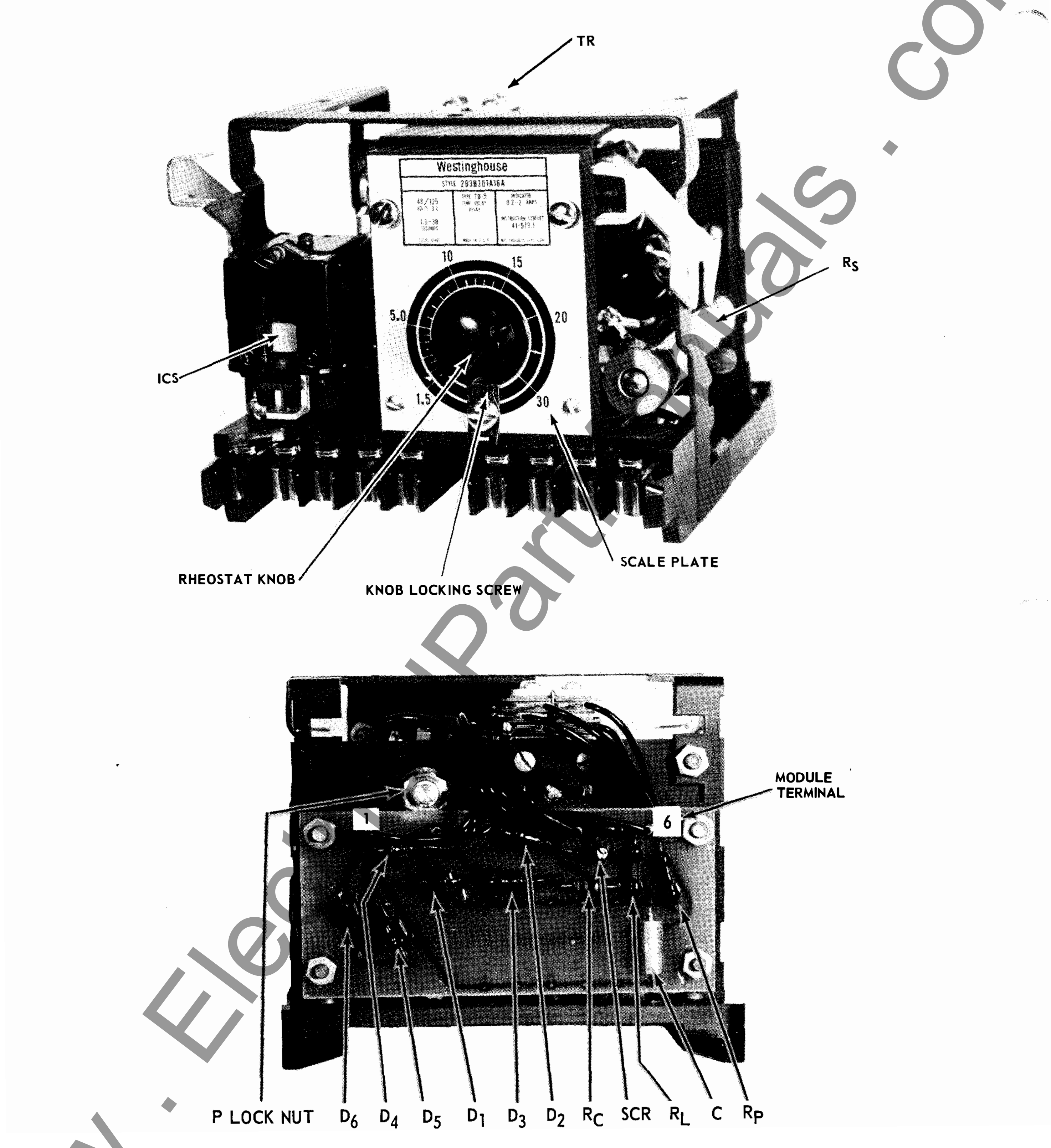

* *Fig. 1. Type TD-5 Relay Without Case.*

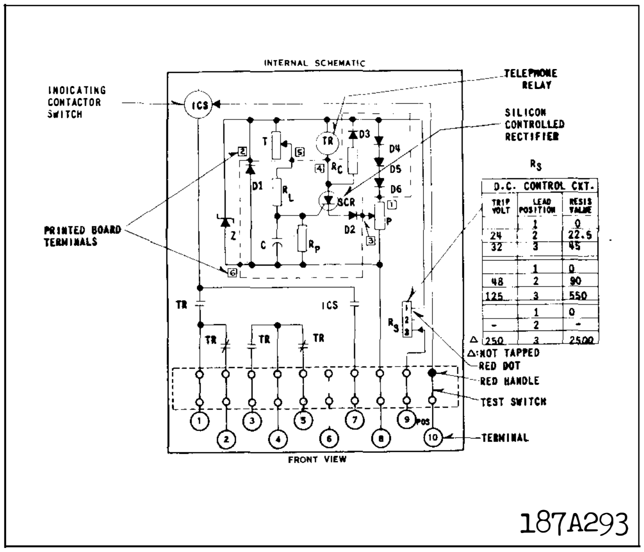

Fig. 2. Internal Schematic of Type TD-5 Relay.

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. 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

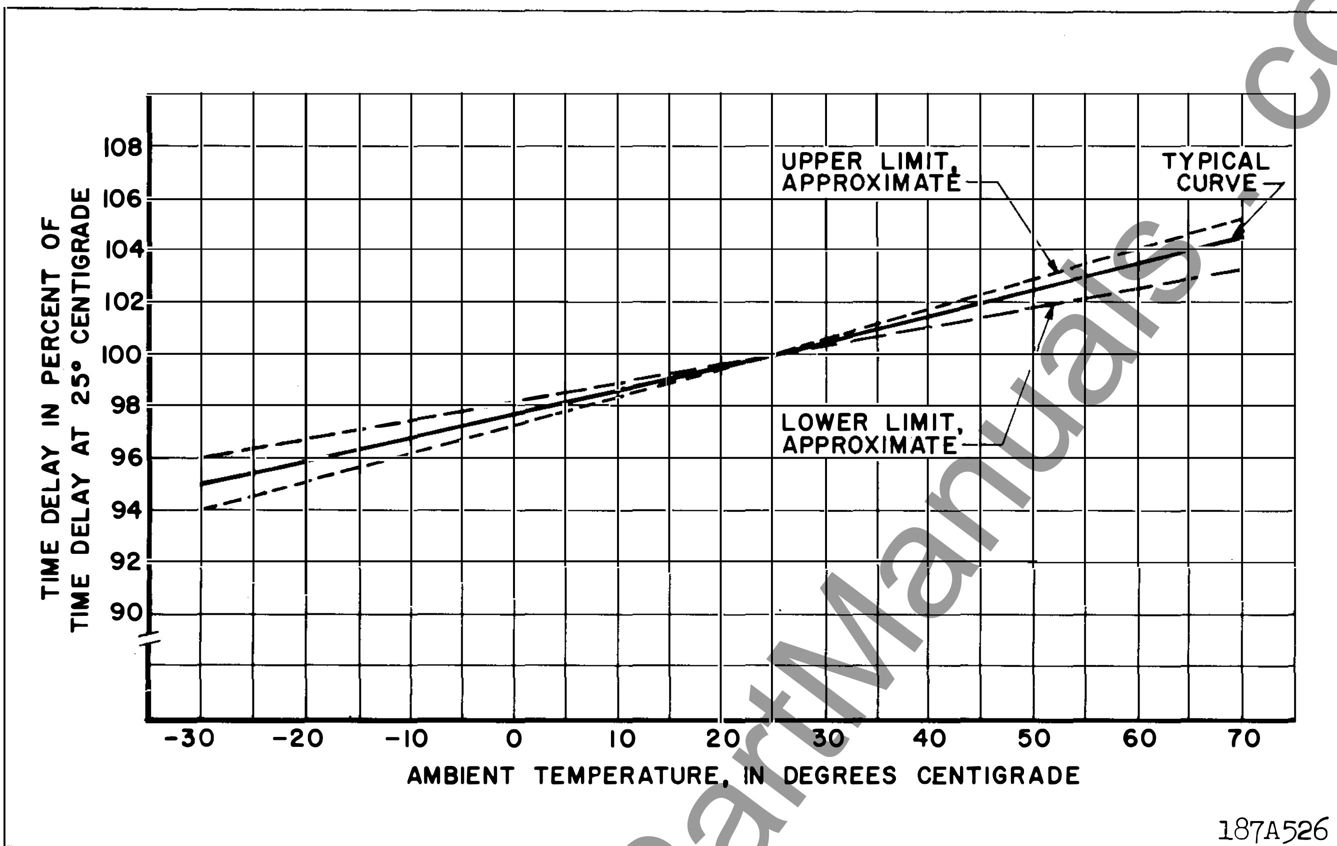

Fig. 3. Timing Variation with Temperature Changes.

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

* 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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts
	250	All	Zener Diode, IN2999B, 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
	All	.05-.4	Rheostat, 4 Watt, 20K
R_L	24/32	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%
	48/125	0.05-1 & .05-.4	Resistor, 1/2 Watt, 1K ± 1%
	250	0.05-1 & .05-.4	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 & .05-.4	Tantalum Capacitor, 22uf, 35 volts
	48/125	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 35 volts
	250	0.05-1 & .05-.4	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 & .05-.4	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 & .05-.4	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, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885
	250	All	Silicon Controlled Rectifier, 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

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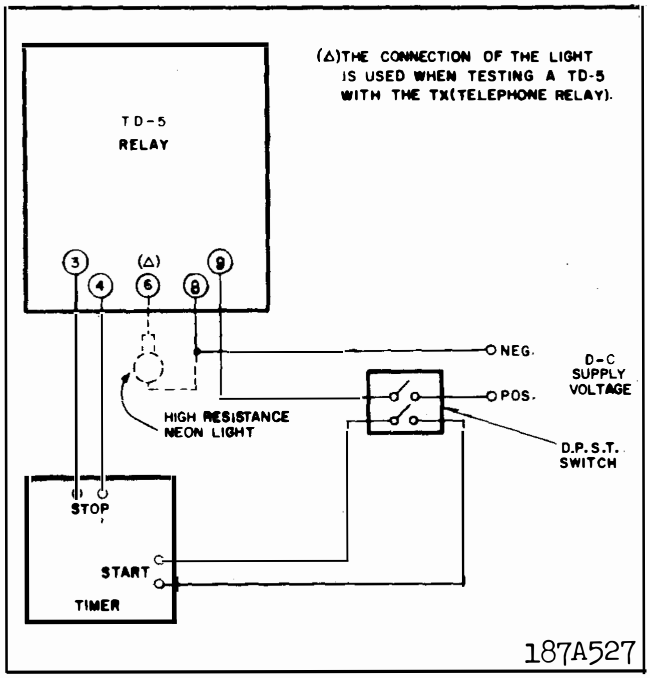

Fig. 4 Test Circuits for Type TD-5 Relay.

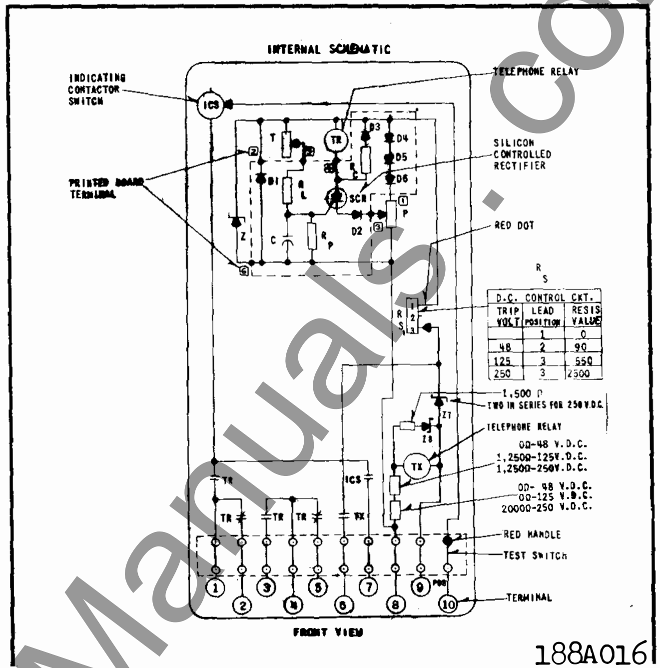

Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

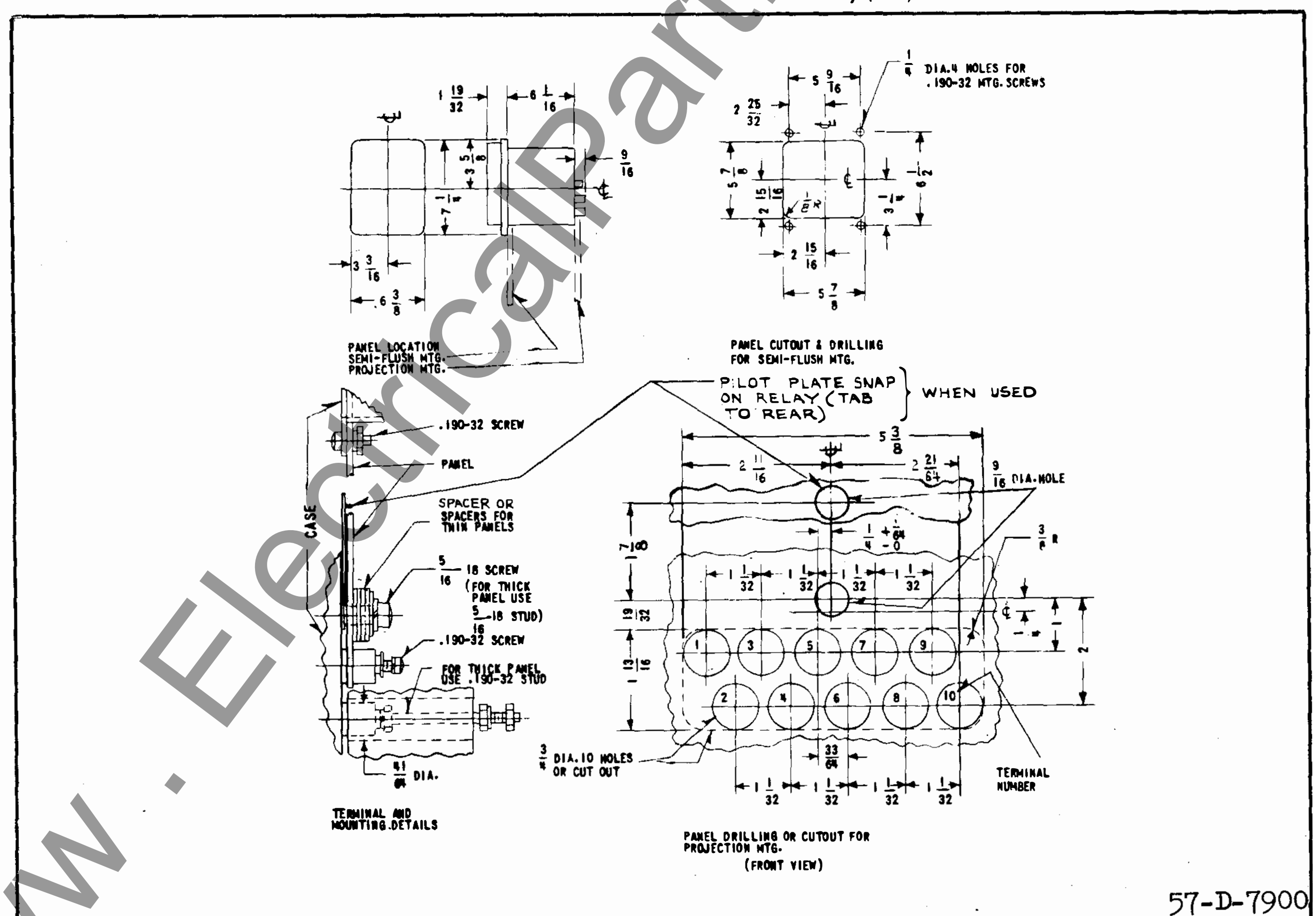

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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 silicon power regulator (Z) — series resistor (Rs) reference voltage circuit, a theostat (T) and scale plate for adjusting the time delay, a voltage biasing potentiometer (P) used in calibrating the relay, a printed circuit containing static timing components, an output telephone relay (TR), and an indicating contactor switch (ICS).

Reference Voltage Circuit

The silicon power regulator (Z) is a 10 watt zener diode mounted on an aluminum heat sink. Series resistor (Rs) is a 3½ inch resistor which is tapped for 24/32 volt d-c and 48/125 volt d-c relays. The reference voltage circuit protects the static components from high voltages and improves timing accuracy by providing a fixed supply voltage.

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 resister (R_L), timing capacitor (C) which is actually seven capacitors in parallel for the 30 second relay, a parallel resistor (R_P) which makes the calibrating scale non-linear (making possible move accurate settings at the low end of the scale), and a silicon controlled rectifier (SCR) with a 20 micro-ampere maximum gate-current-to-fire rating. The printed circuit also contains a diode (D_2) to prevent charging C through P, a "free-wheeling" circuit consisting of R_c and D_3 which protects 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 silicon 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

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.

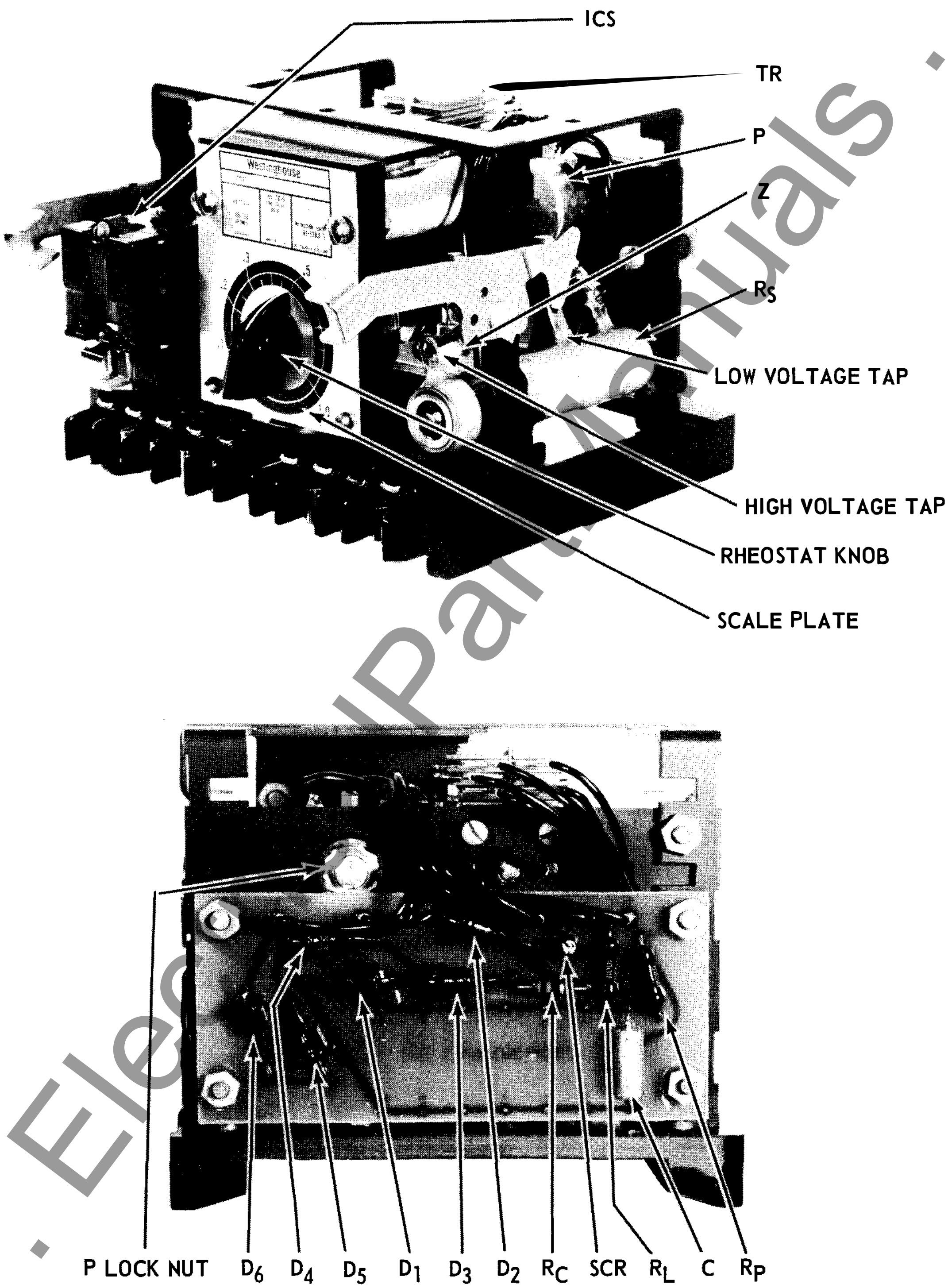

Fig. 1. Type TD-5 Relay Without Case.

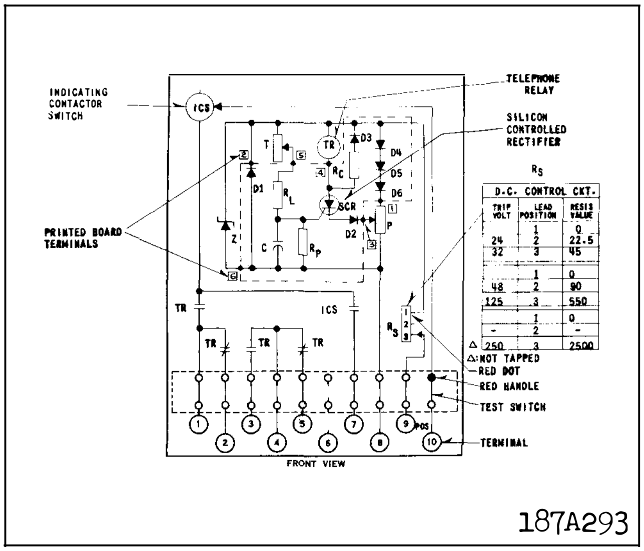

Fig. 2. Internal Schematic of Type TD-5 Relay.

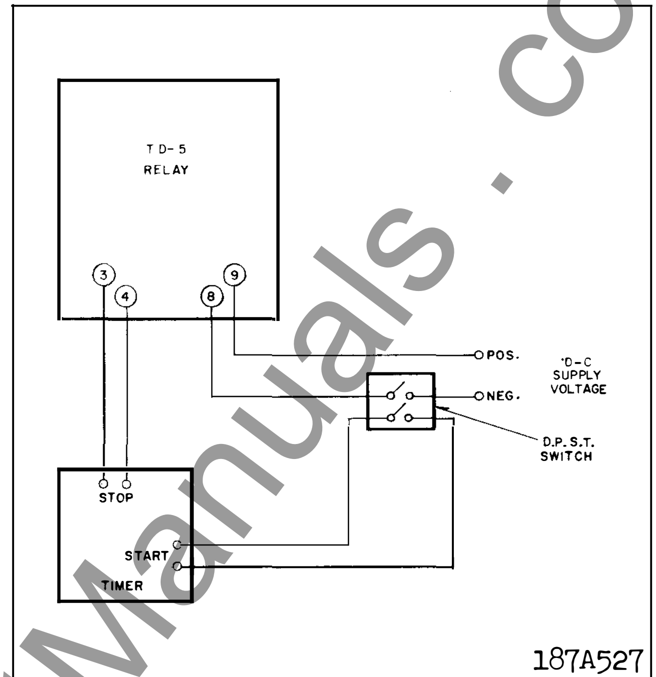

Fig. 3. Test Circuits for Type TD-5 Relay.

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

When d-c voltage is applied to relay terminals 8 and 9, the capacitor voltage increases until it reaches the voltage at the brush of potentiometer (P) plus approximately one volt forward drop through SCR and D_2, at which time positive current flows through the gate of SCR and the telephone relay is energized. As long as V_C is less than V_P, a small amount of negative gate current passes through D_2 in the reverse direction, keeping SCR biased off. This permits the use of a very sensitive, high gain SCR which switches instantaneously from an open-circuit to a short-circuit condition, thus giving the relay an inherently accurate time delay.

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

Relay Style Number	Time Delay Range (Seconds)	Voltage Rating (Volts d-c)
291B868A09A	.05 — 1.0	24/32
291B868A10A	.05 — 1.0	48/125
291B868A11A	.05 — 1.0	250
291B868A12A	0.2 — 4.0	24/32
291B868A13A	0.2 — 4.0	48/125
291B868A14A	0.2 — 4.0	250
291B868A15A	1.5 — 30	24/32
291B868A16A	1.5 — 30	48/125
291B868A17A	1.5 — 30	250

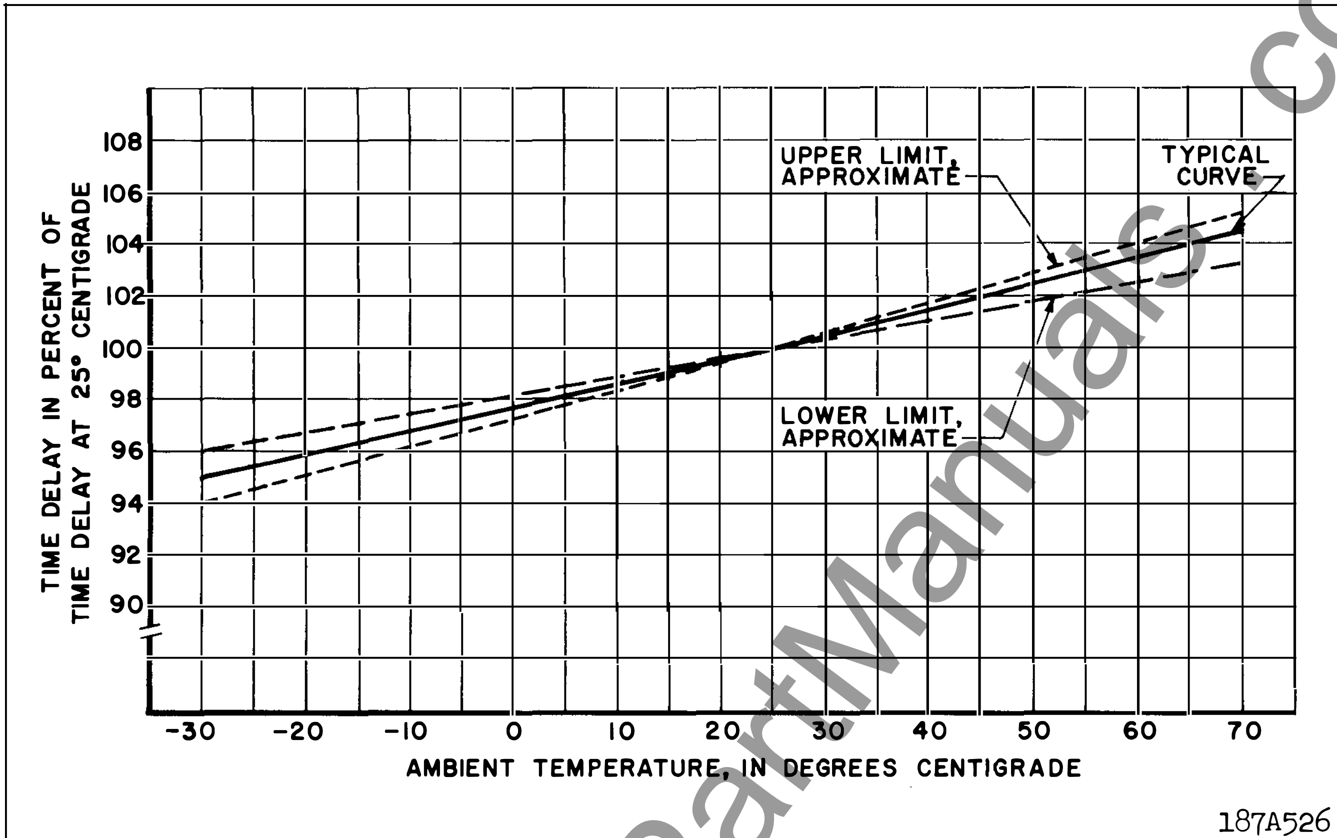

Fig. 4. Timing Variation with Temperature Changes.

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

Temperature Limits

The relay can stand 110% voltage continuously over a temperature range of -40°C. to +100°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 3, 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 4.

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.

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 3.

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

3. 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.

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.

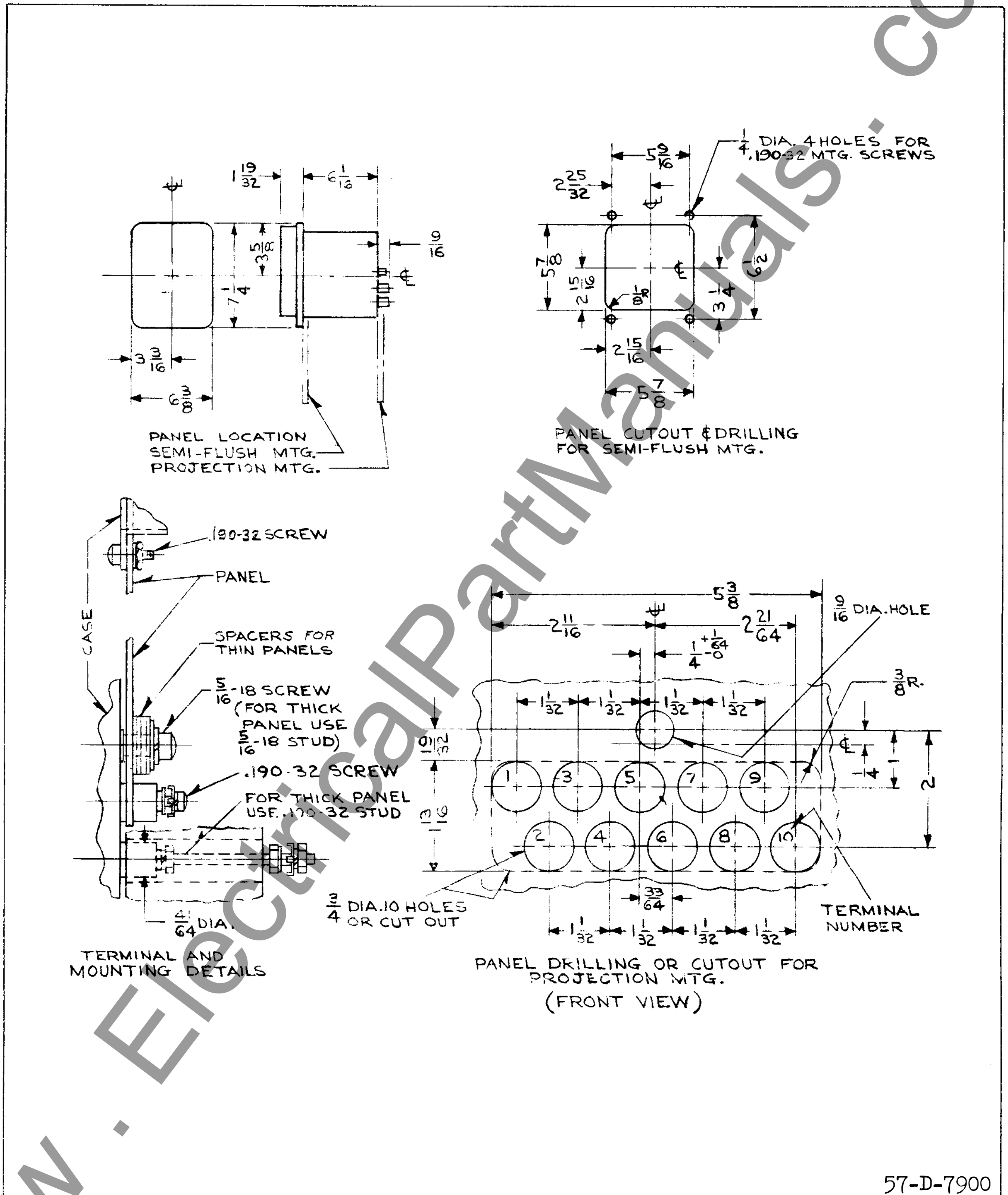

Fig. 5. Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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

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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 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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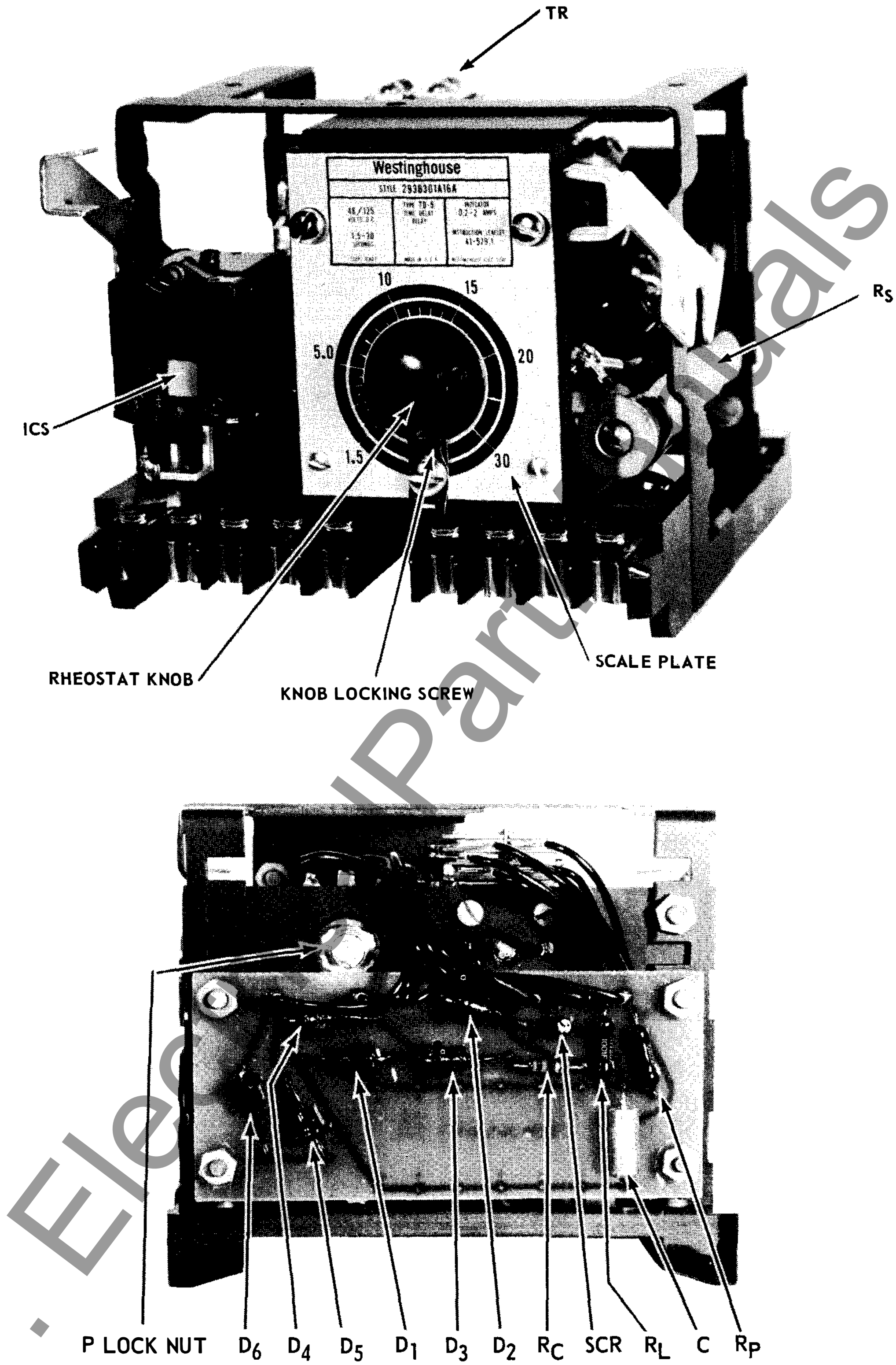

Fig. 1. Type TD-5 Relay Without Case.

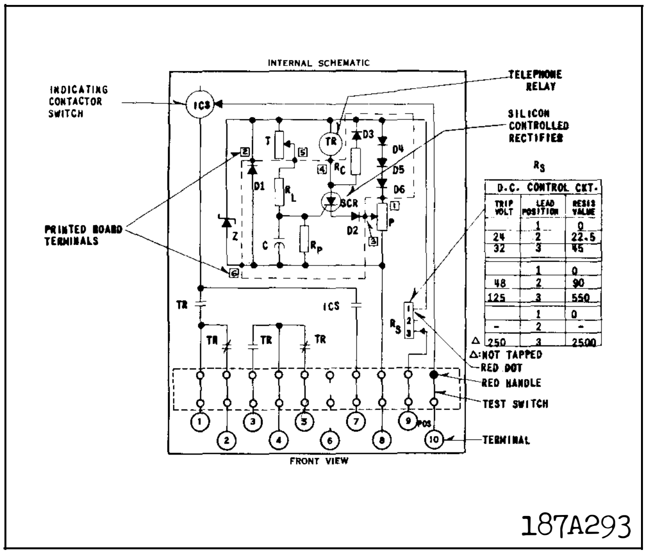

Fig. 2. Internal Schematic of Type TD-5 Relay.

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

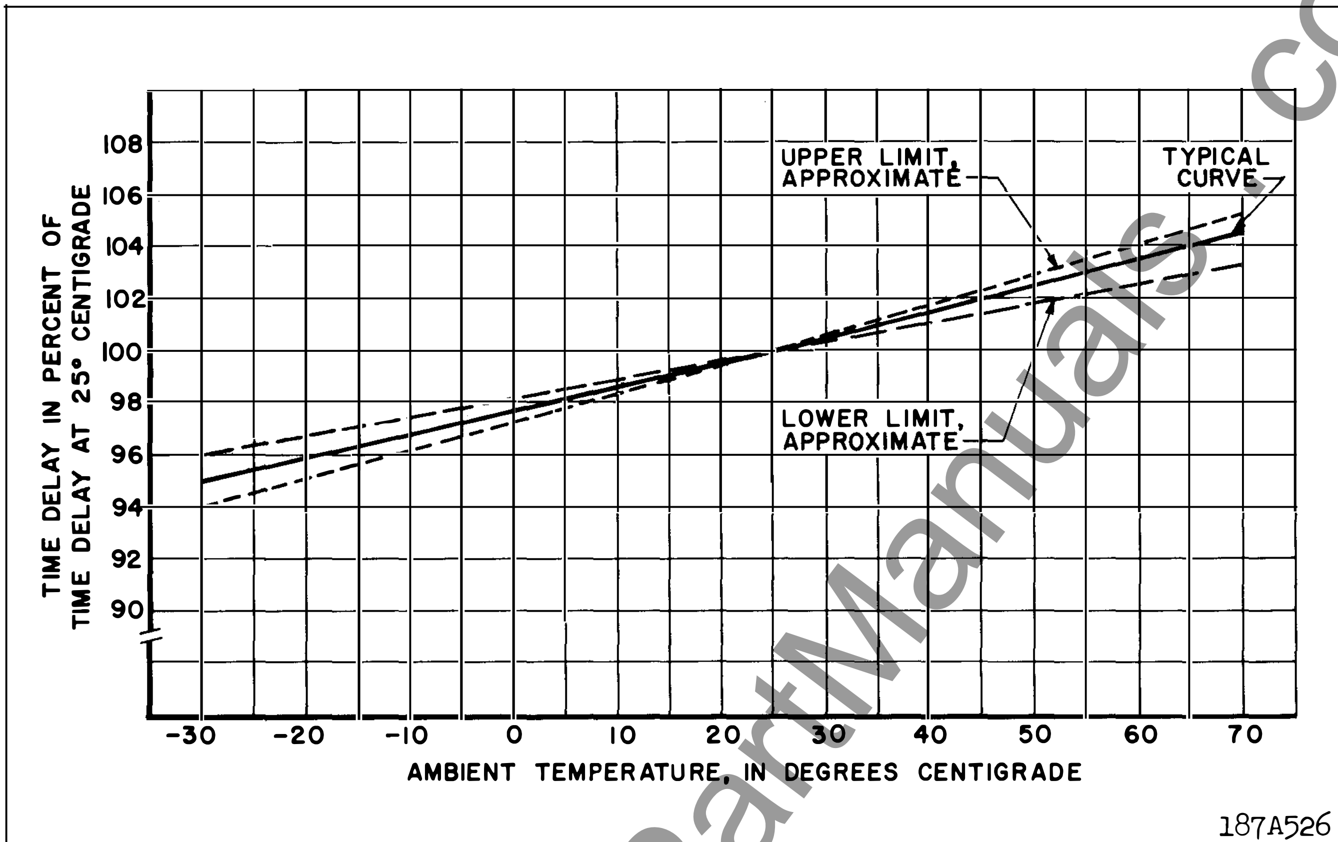

Fig. 3. Timing Variation with Temperature Changes.

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

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

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

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 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. 41-579.1C
*Denotes change from superseded issue.

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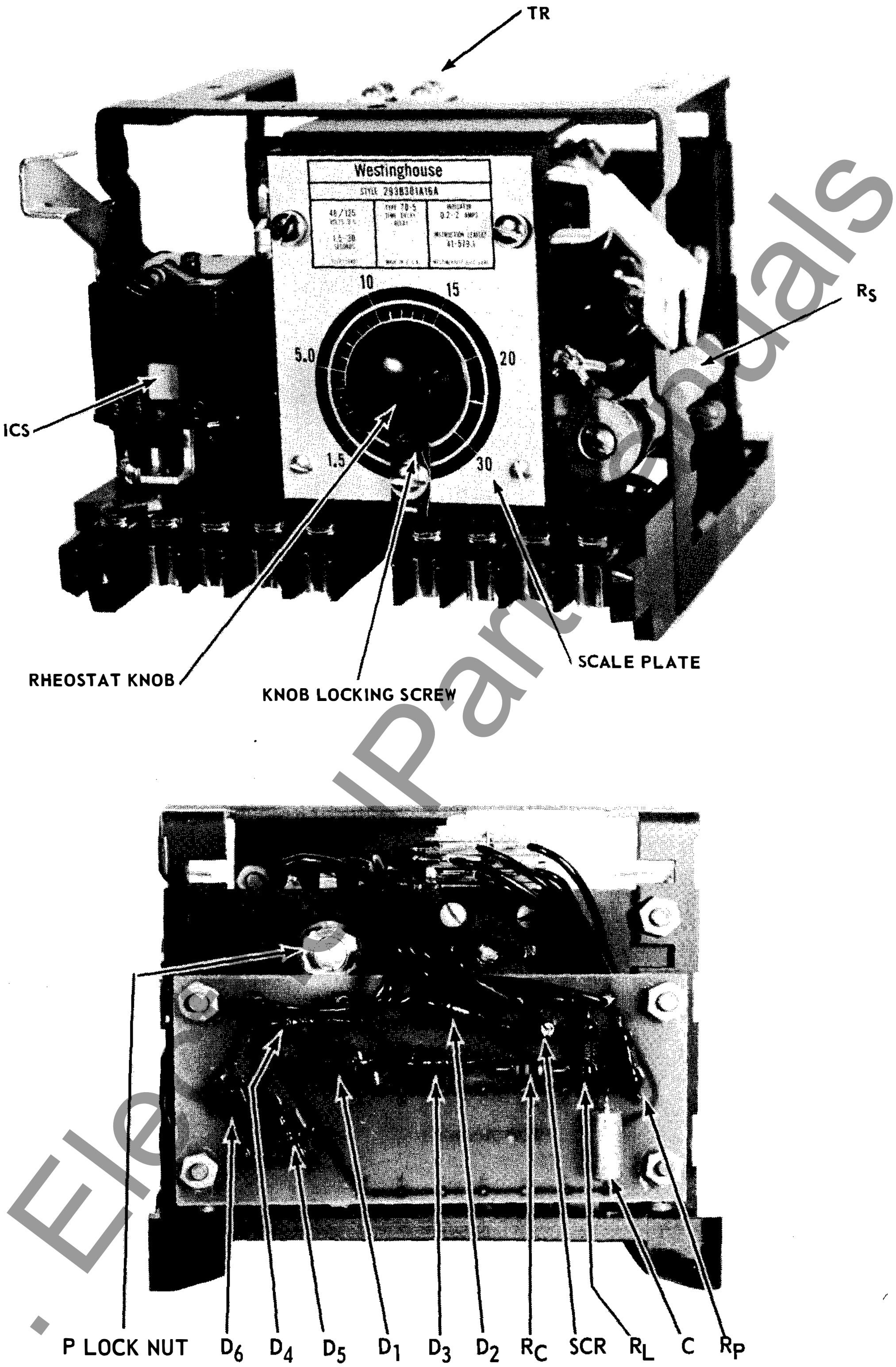

Fig. 1. Type TD-5 Relay Without Case.

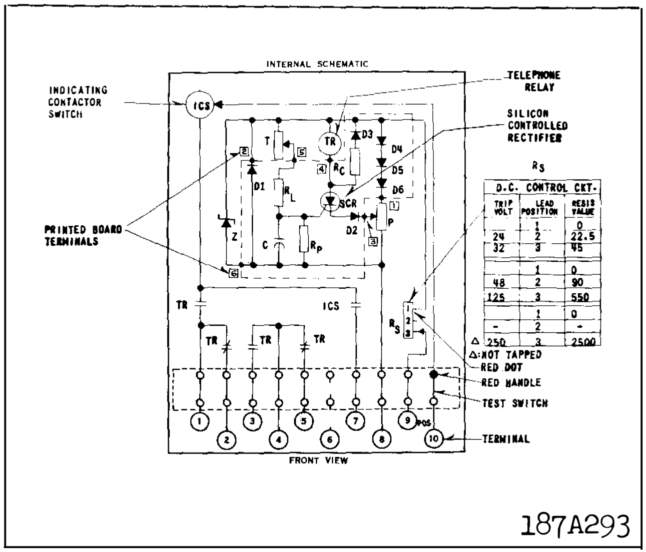

Fig. 2. Internal Schematic of Type TD-5 Relay.

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

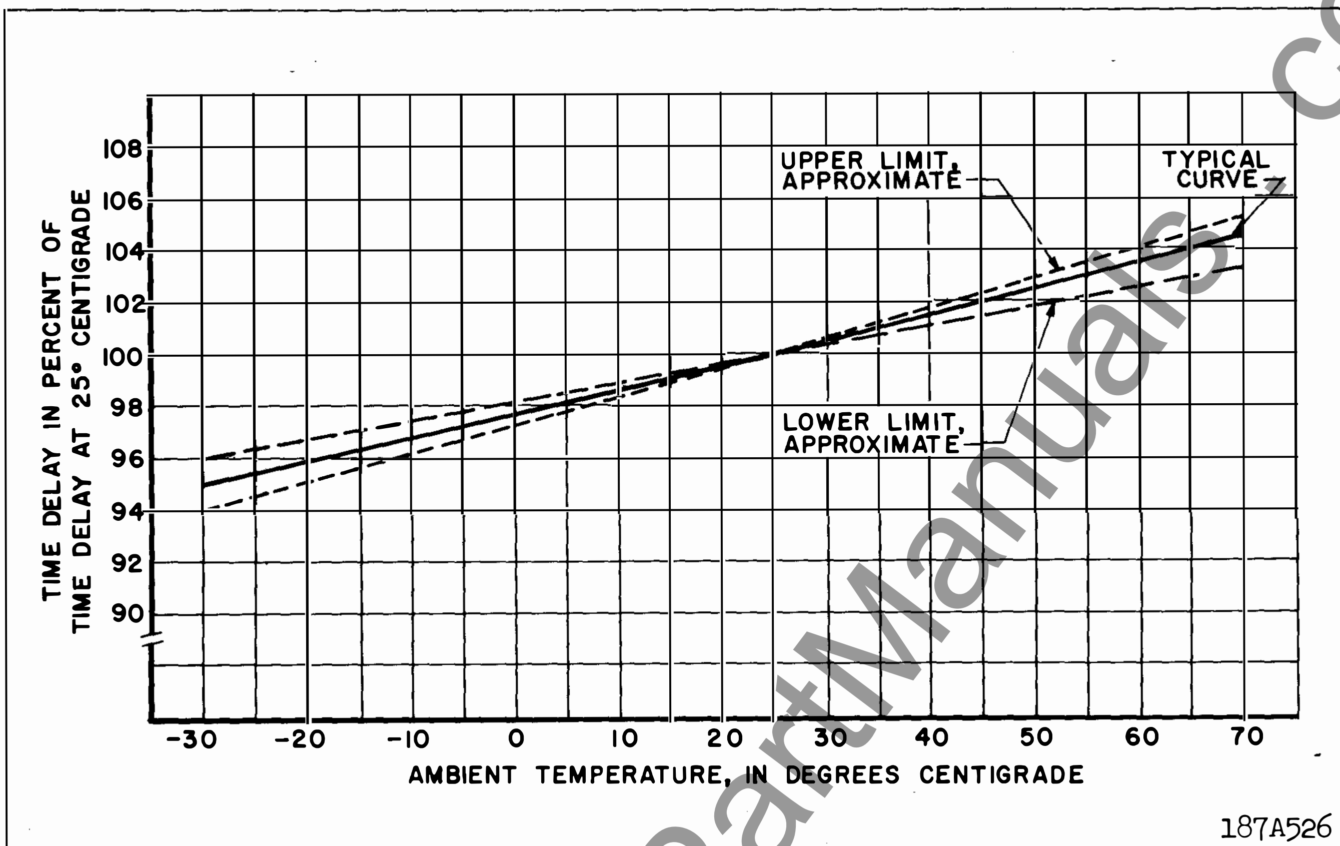

Fig. 3. Timing Variation with Temperature Changes.

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

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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts *
	250	All	Zener Diode, IN2999B, 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, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885 *
	250	All	Silicon Controlled Rectifier, 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

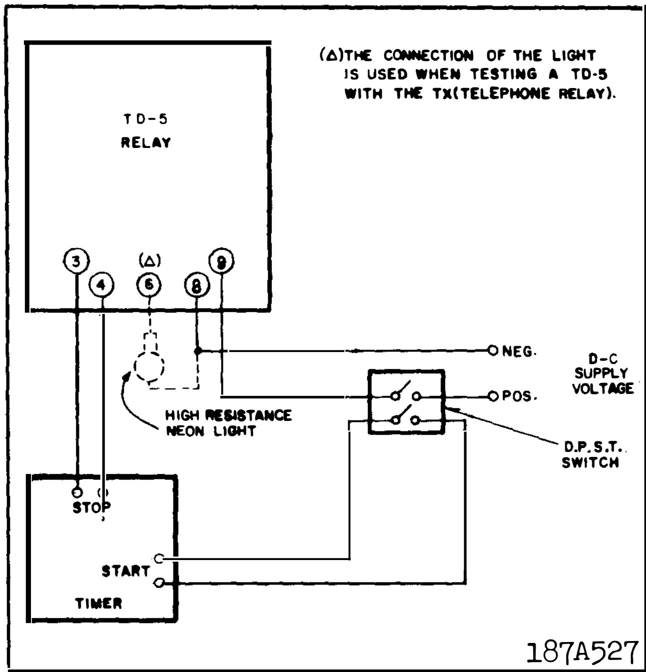

Fig. 4 Test Circuits for Type TD-5 Relay.

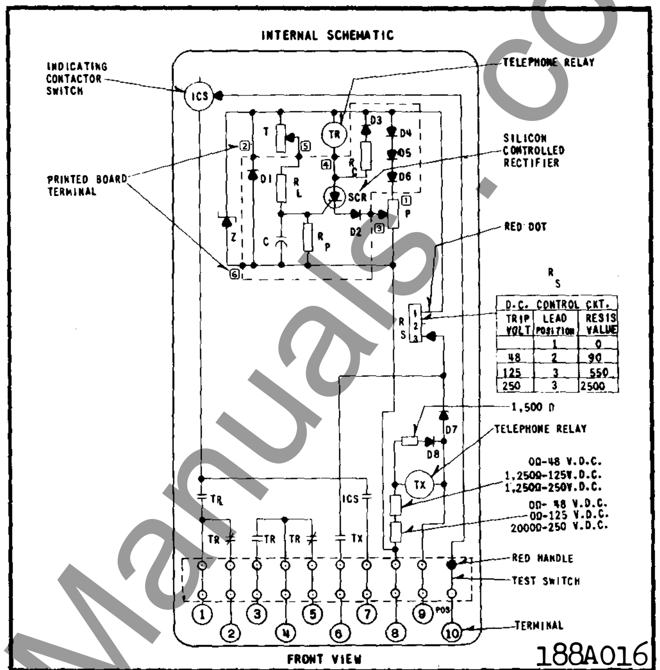

Fig. 5 Internal Schematic of TD-5 with Telephone Relay.

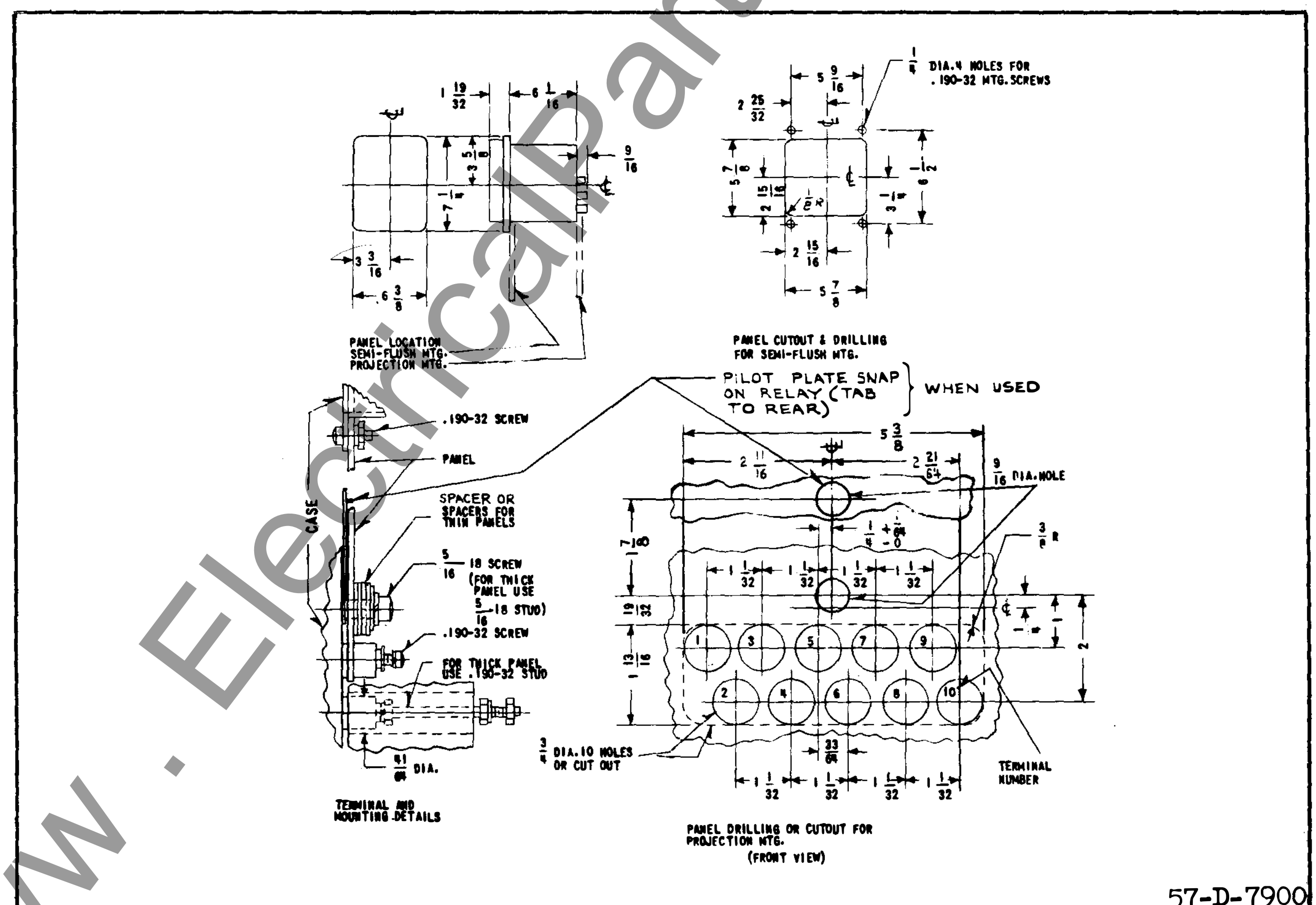

Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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 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. Refer to Fig. 5.

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

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

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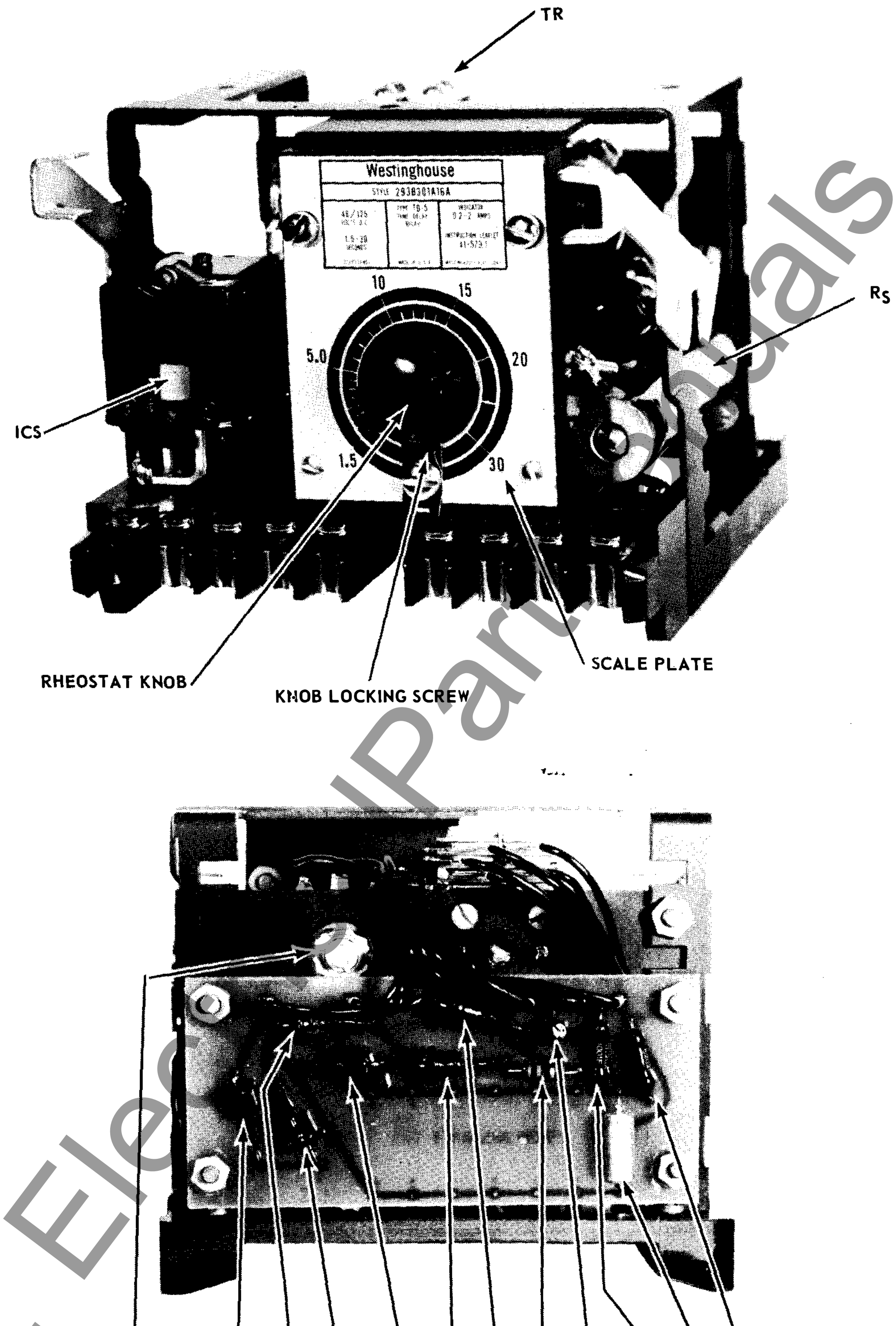


Fig. 1. Type TD-5 Relay Without Case.

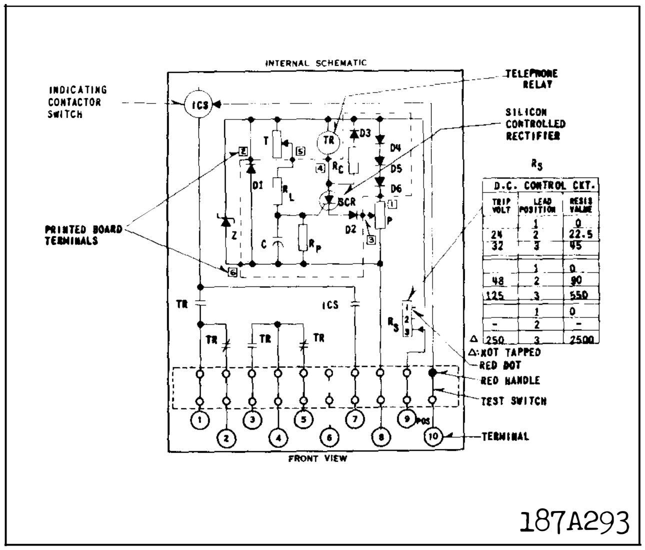


Fig. 2. Internal Schematic of Type TD-5 Relay.

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. 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

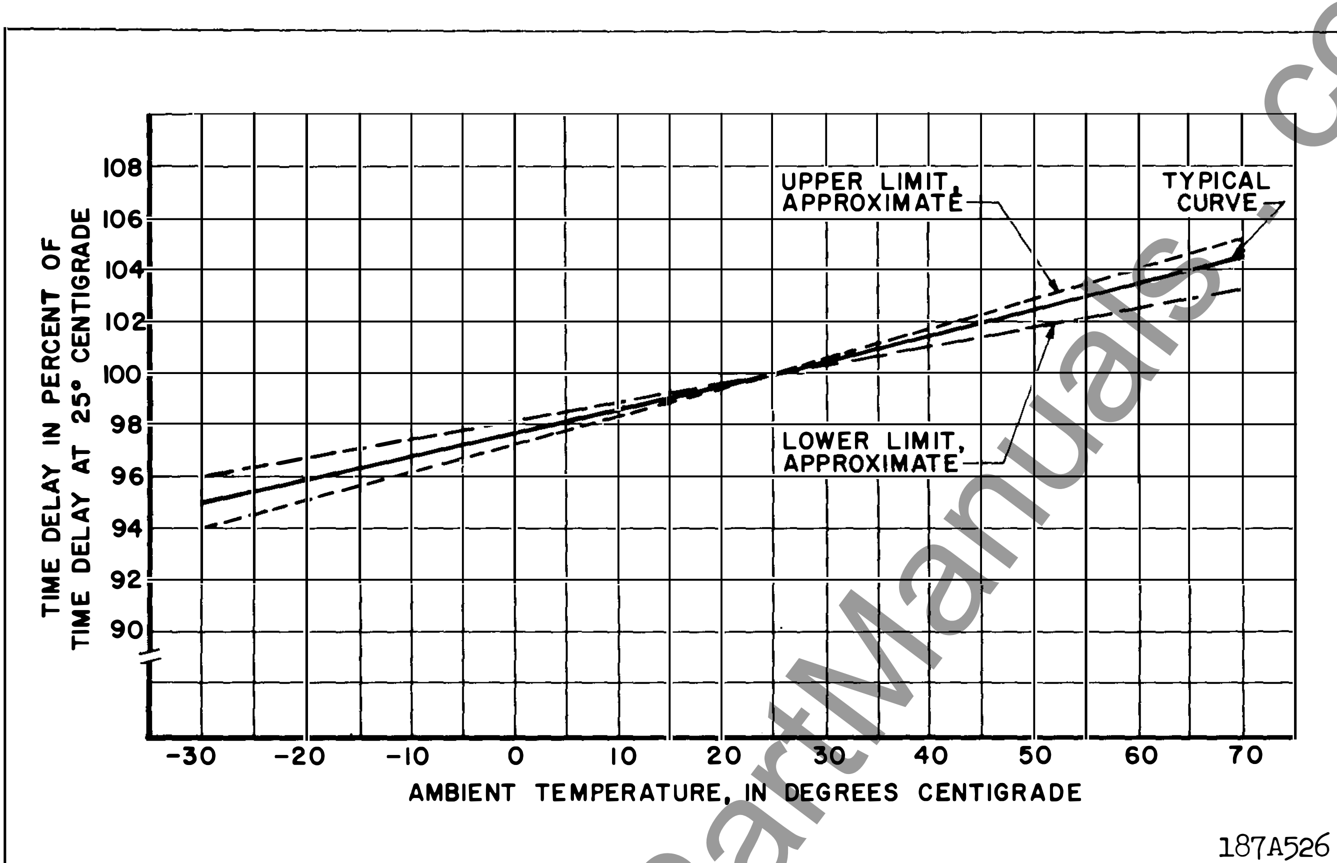


Fig. 3. Timing Variation with Temperature Changes.

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

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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts
	250	All	Zener Diode, IN2999B, 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, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885
	250	All	Silicon Controlled Rectifier, 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.

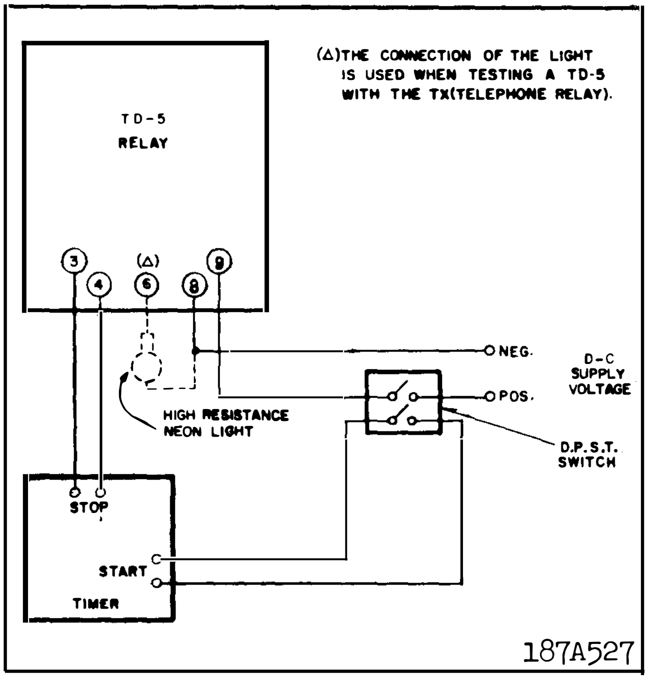


Fig. 4 Test Circuits for Type TD-5 Relay.

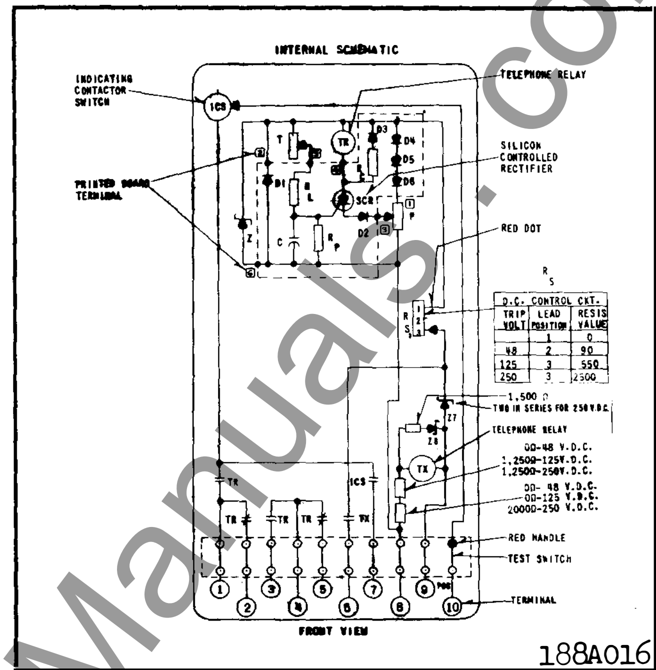


Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

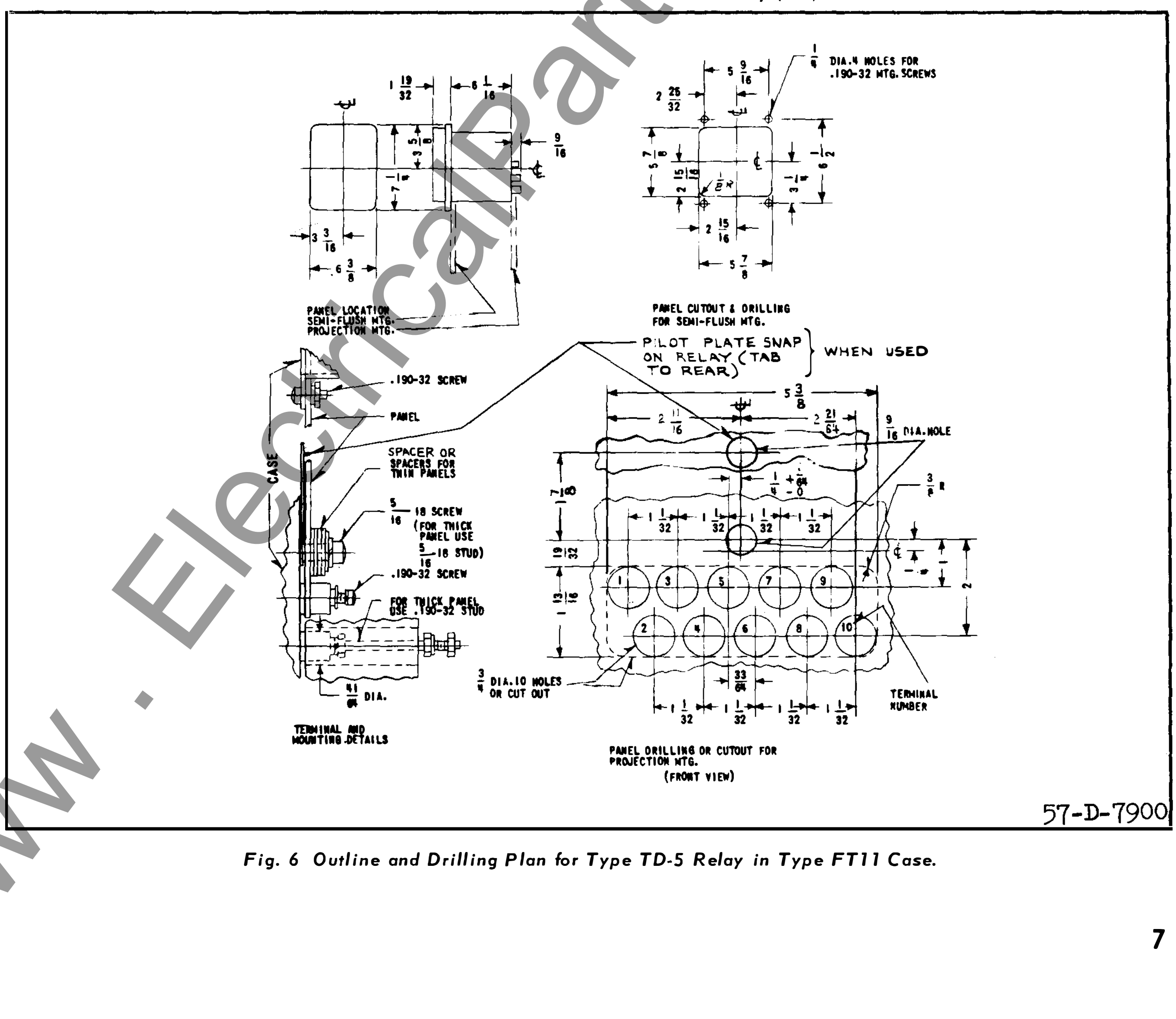


Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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.

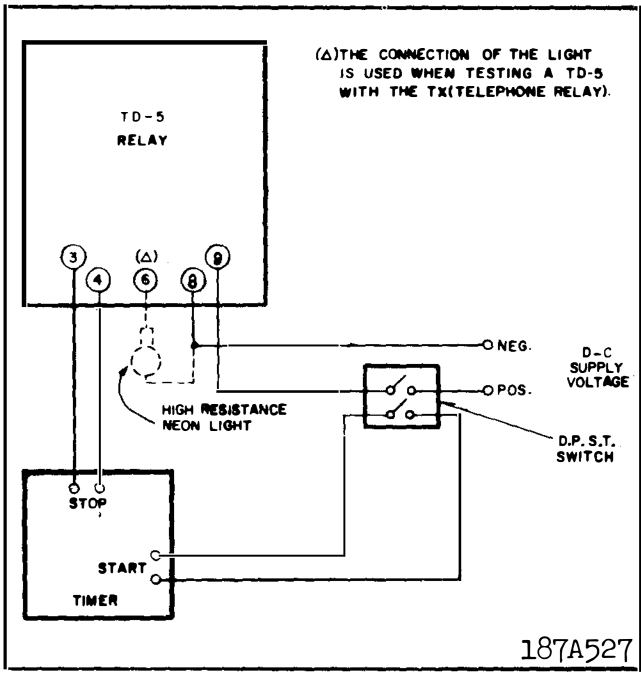


Fig. 4 Test Circuits for Type TD-5 Relay.

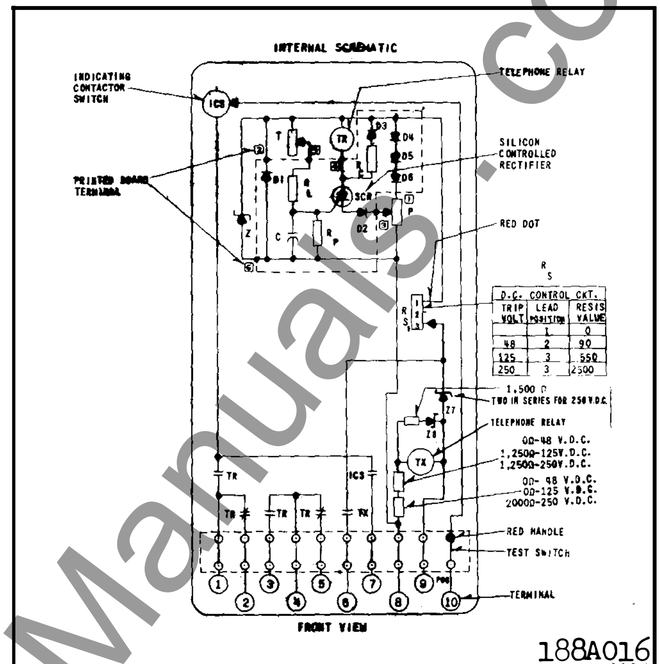


Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

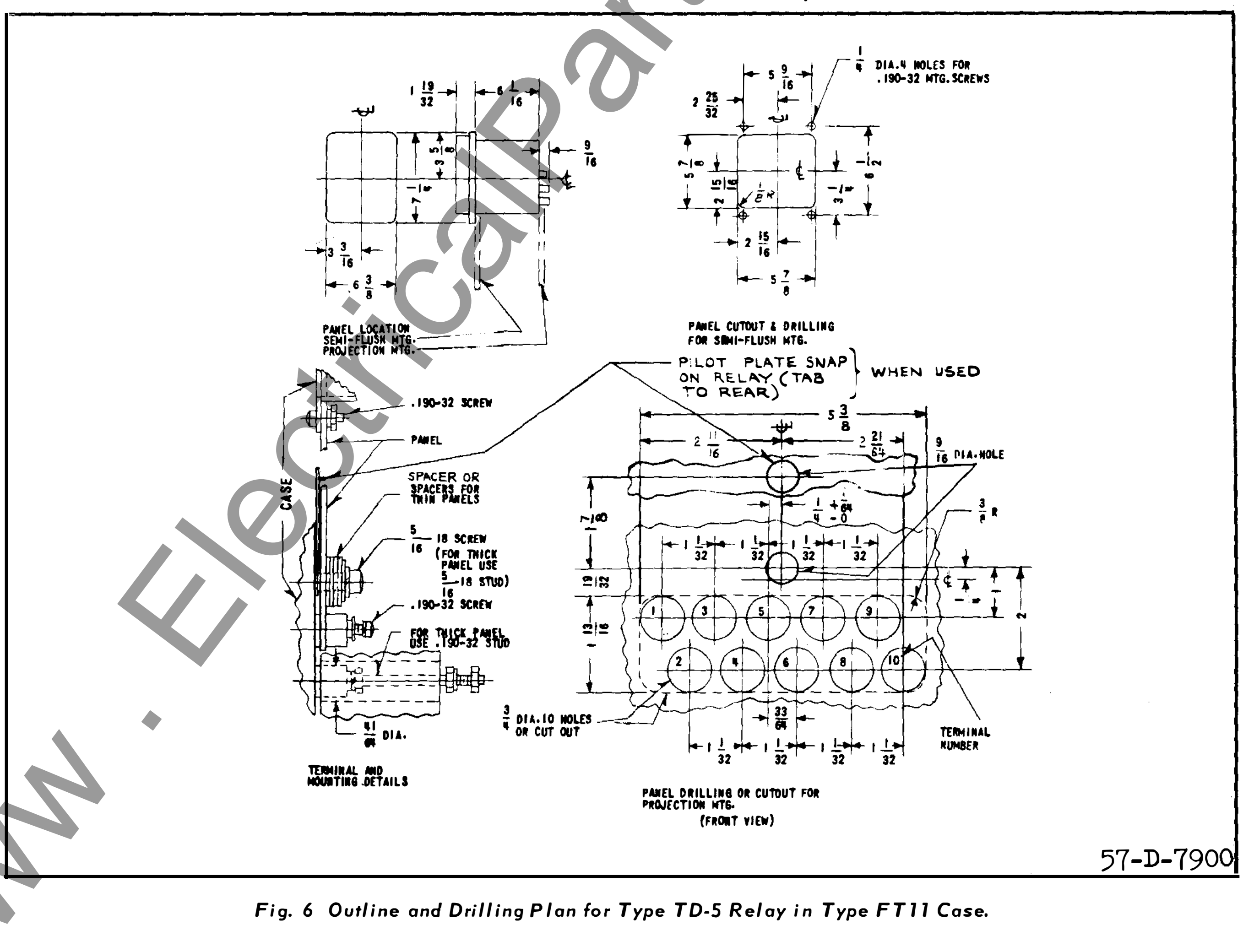


Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts
	250	All	Zener Diode, IN2999B, 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, 1200 ± 5% ohms *
SCR	24/32	All	Silicon Controlled Rectifier, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885
	250	All	Silicon Controlled Rectifier, 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

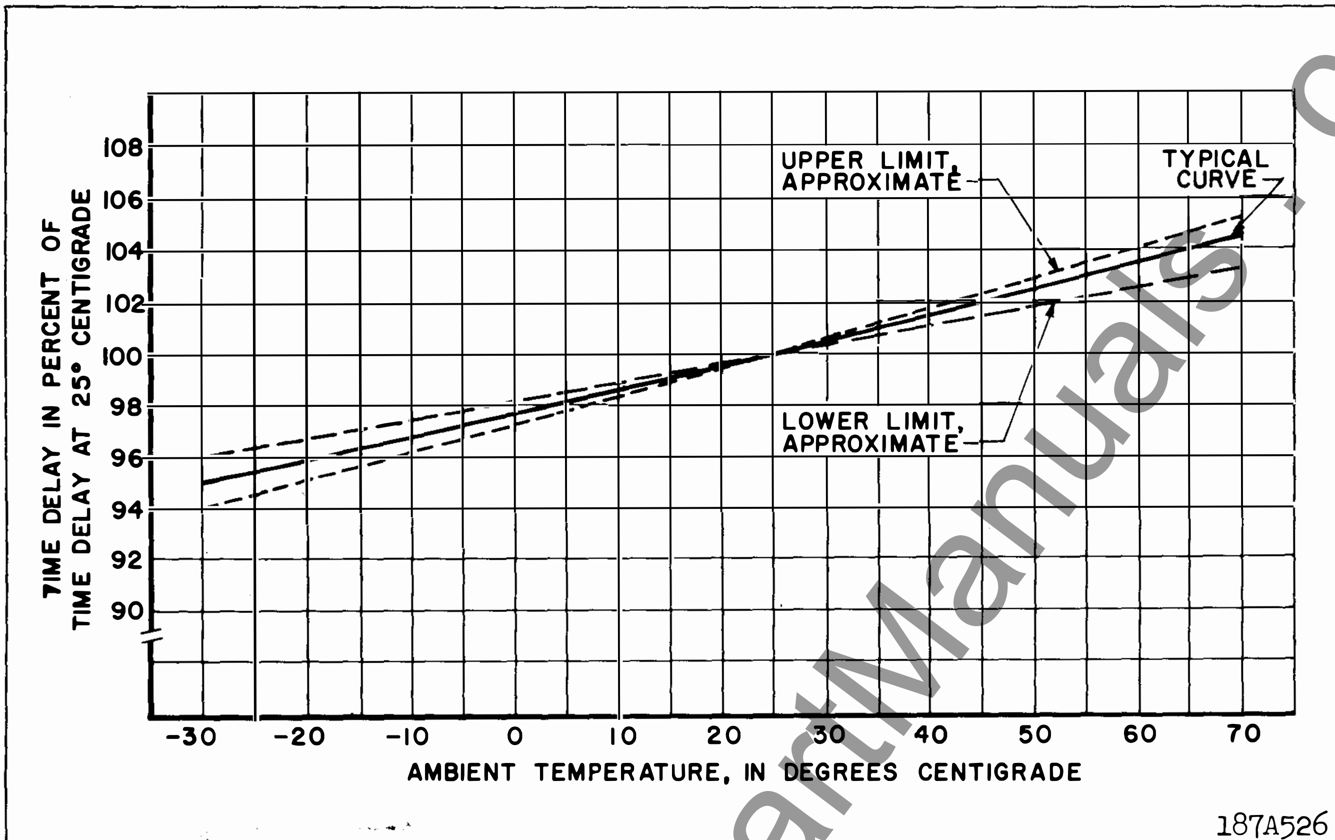


Fig. 3. Timing Variation with Temperature Changes.

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 Cis 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

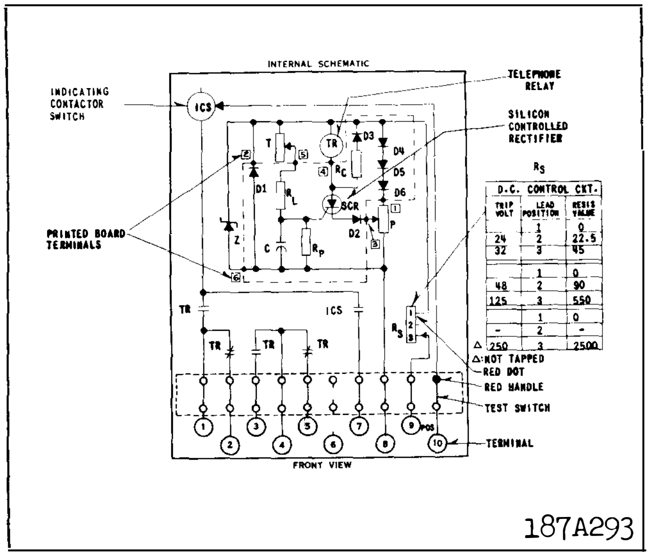


Fig. 2. Internal Schematic of Type TD-5 Relay.

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.

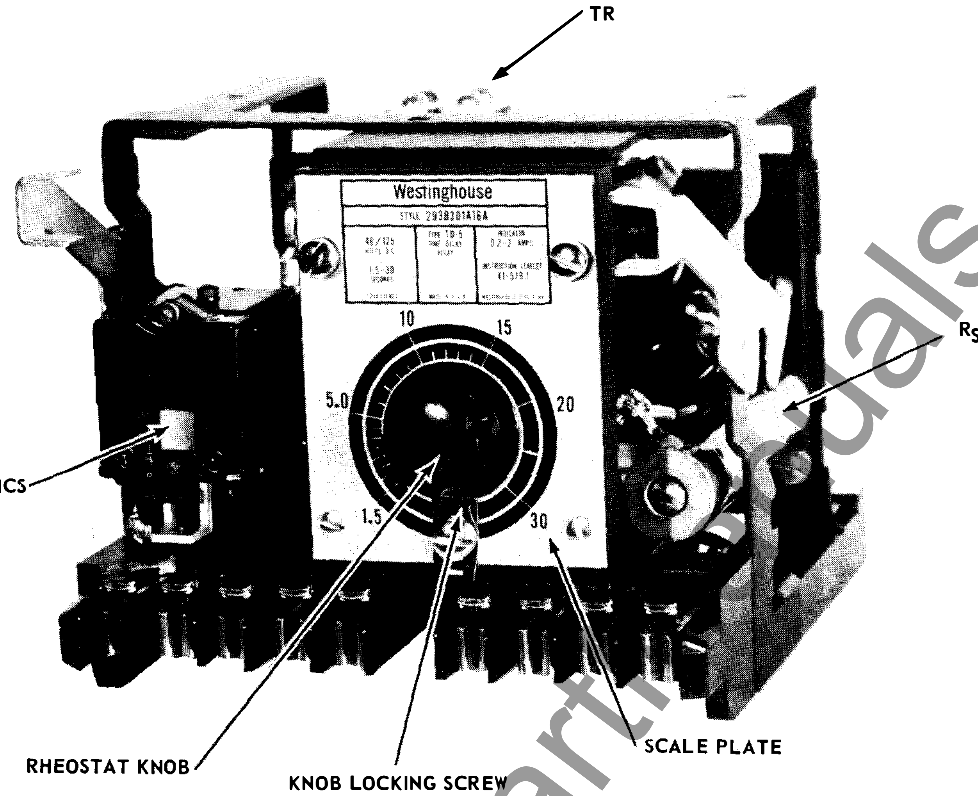
The SCR latches on when it switches and can be reset only by removing voltage from terminals 8 and 9. If a trip coil supervisory indicator lamp is used, when the timer is used with a fault detector to trip a breaker, a breaker "a" contact must be connected between terminal 8 of the relay and negative.

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



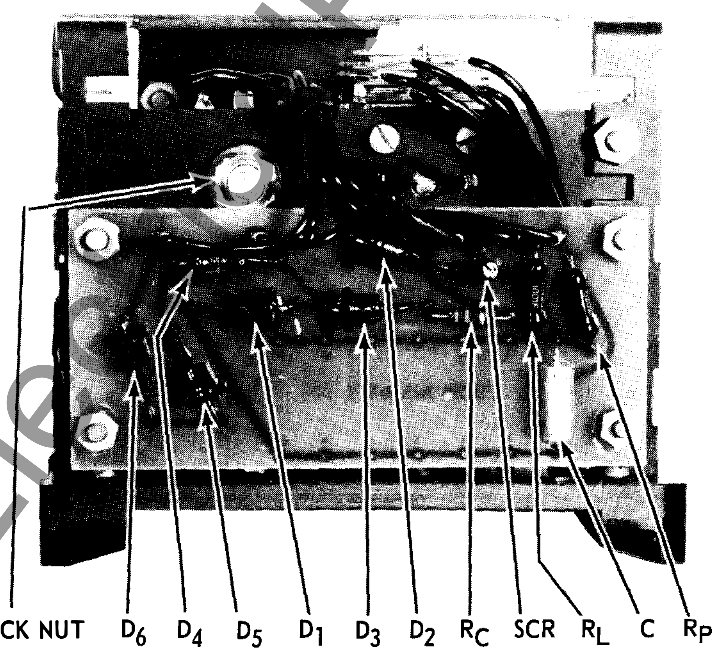


Fig. 1. Type TD-5 Relay Without Case.

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 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. Refer to Fig. 5.

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

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

EFFECTIVE AUGUST 1968

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 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.

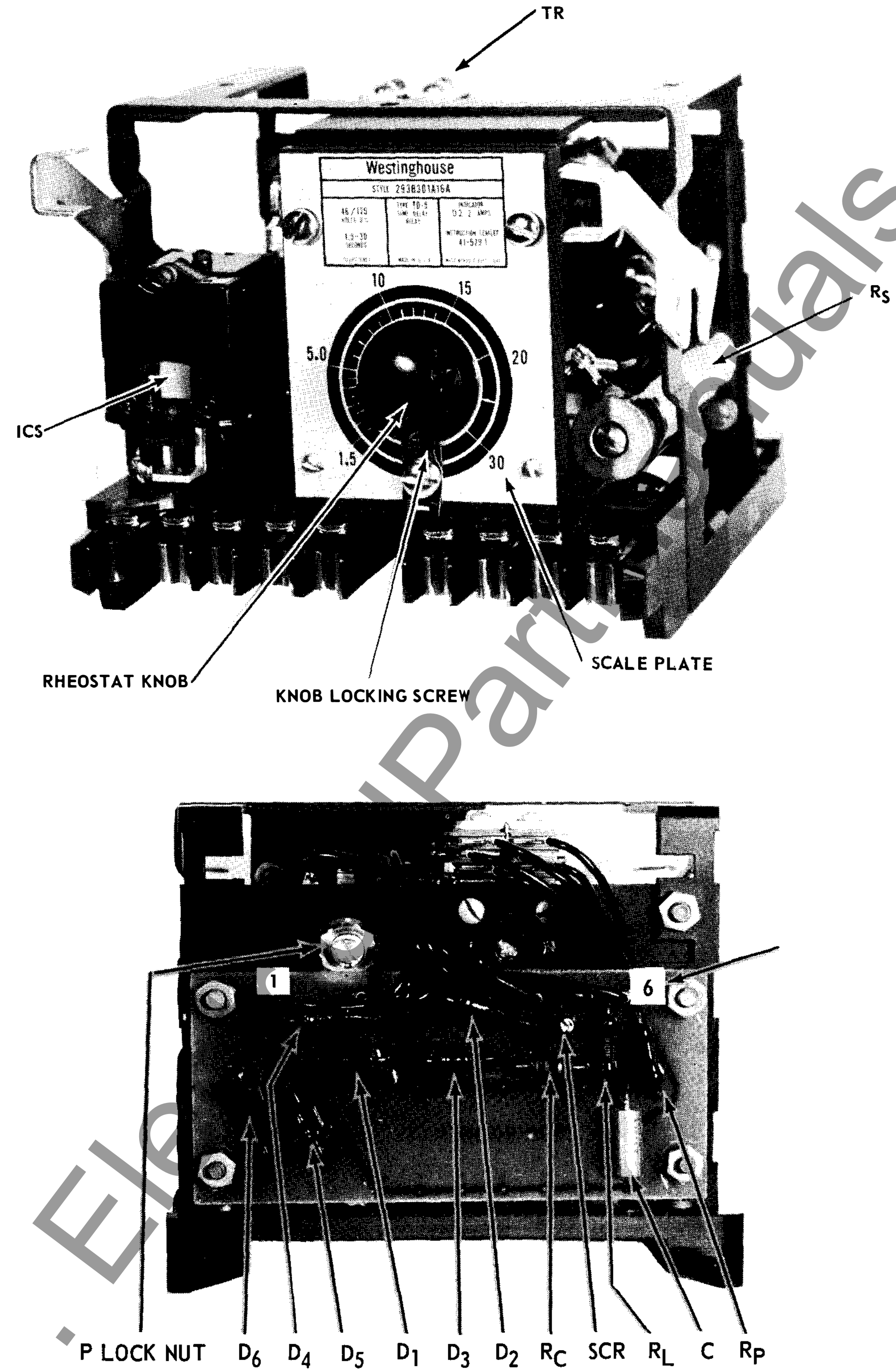
Telephone Relay (TX)

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. Refer to Fig. 5.

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

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

EFFECTIVE JUNE 1969



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

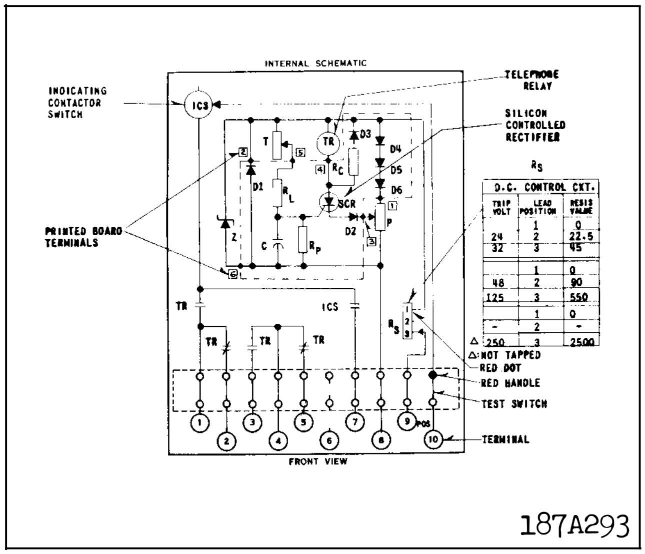


Fig. 2. Internal Schematic of Type TD-5 Relay.

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

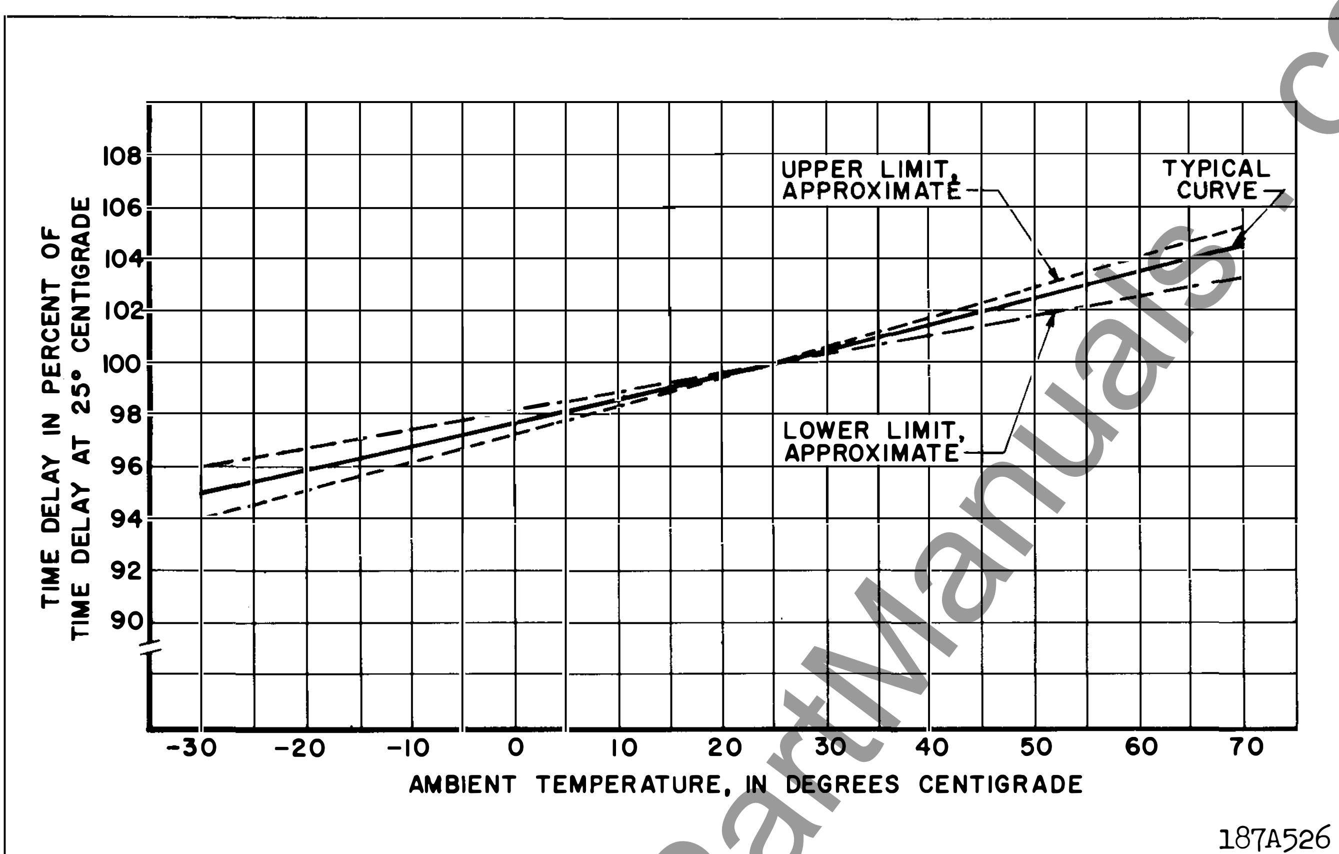


Fig. 3. Timing Variation with Temperature Changes.

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

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, IN2977B, 10 Watts, 13 Volts
	48/125	All	Zener Diode, IN2986B, 10 Watts, 24 Volts
	250	All	Zener Diode, IN2999B, 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, 1200 ± 5% ohms
SCR	24/32	All	Silicon Controlled Rectifier, 2N885
	48/125	All	Silicon Controlled Rectifier, 2N885
	250	All	Silicon Controlled Rectifier, 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.

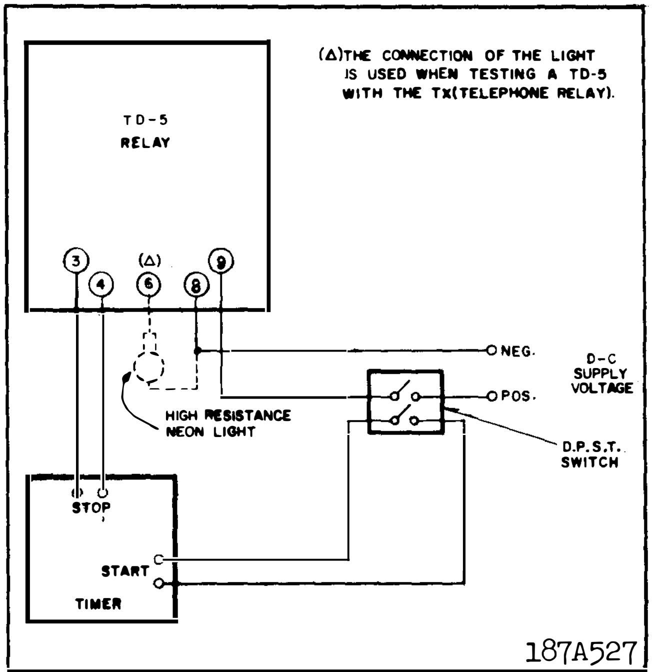


Fig. 4 Test Circuits for Type TD-5 Relay.

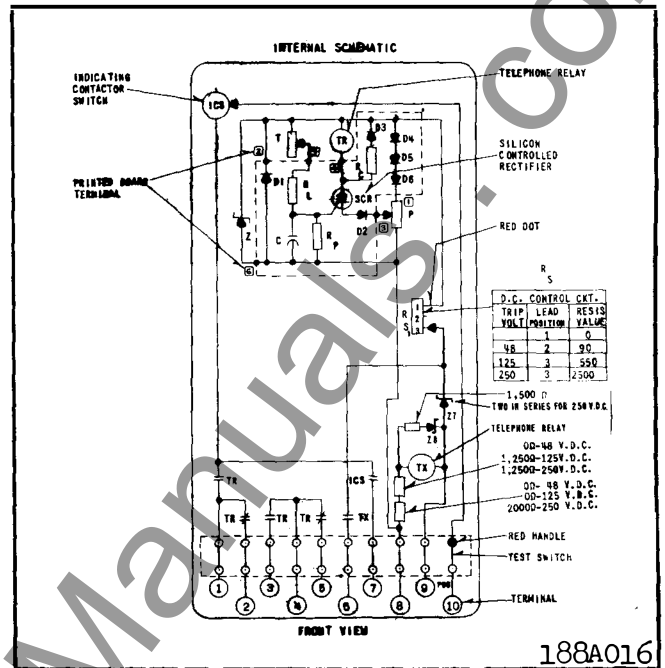


Fig. 5 Internal Schematic of TD-5 with Telephone Relay (TX).

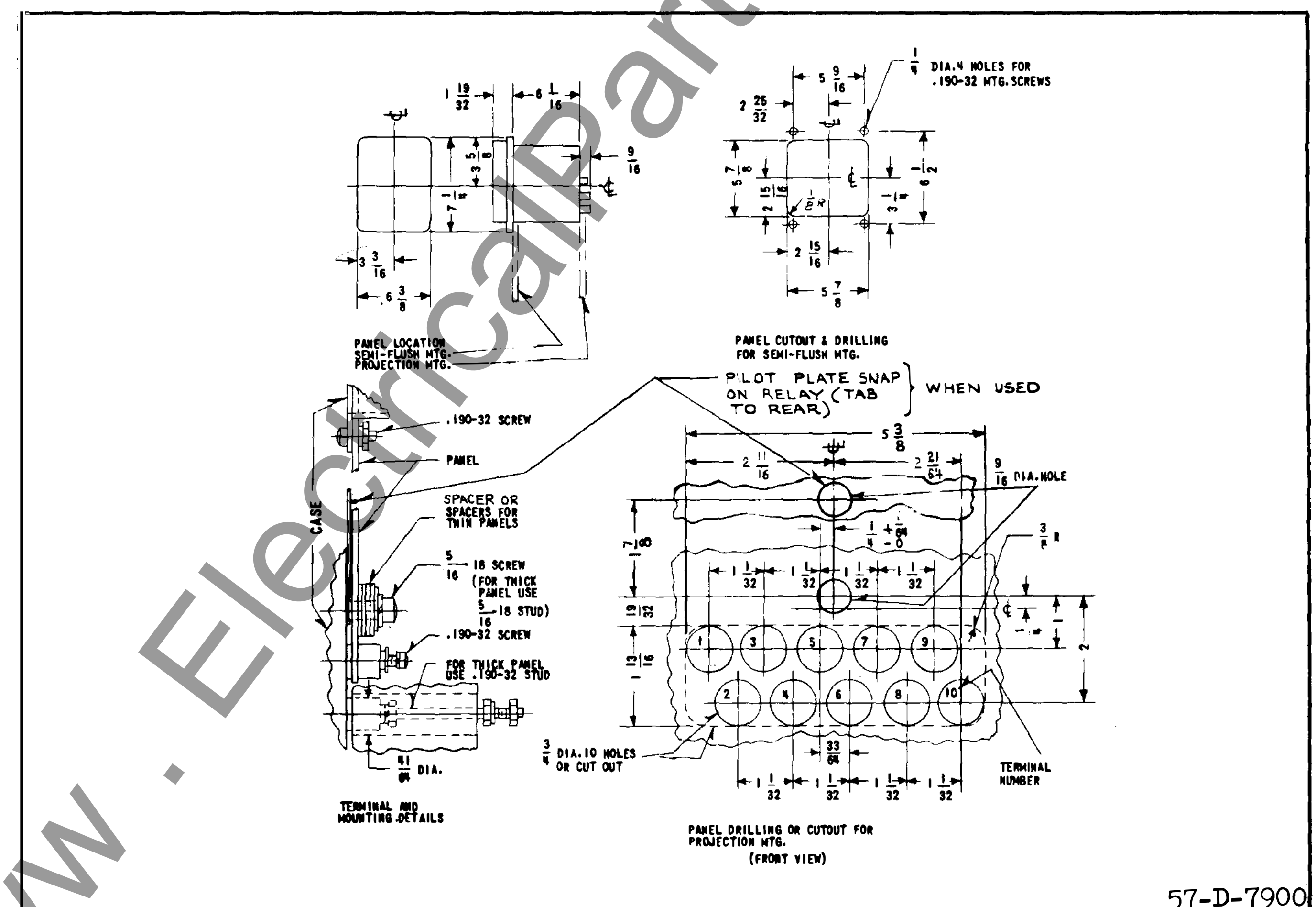


Fig. 6 Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

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.

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.

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 used in timing applications where accuracy, repeatability and fast reset are required. Its principal use is in time delayed distance relaying and in breaker failure timing applications.

It is a dc relay capable of direct application to station batteries. It covers 0.05 to 30 seconds in 4 different ranges. For dual independent timing refer to TD-52 relay, I.L. 41-579.3.

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 dc and 48/125 volt dc 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

SUPERSEDES I.L. 41-579.1M, dated March 1980
✪ Denotes changed since previous issue.
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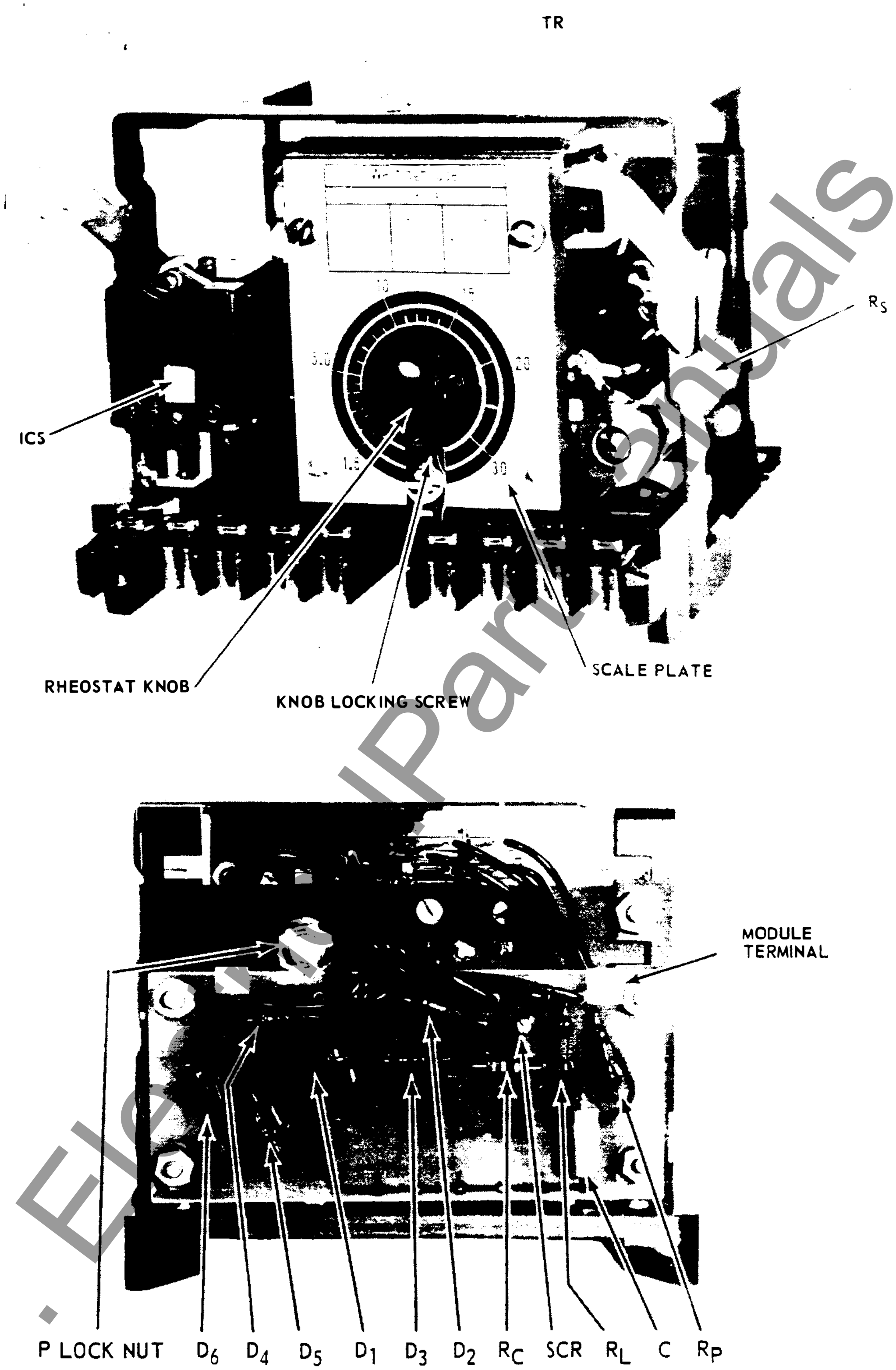

Fig. 1. Type TD-5 Relay Without Case.

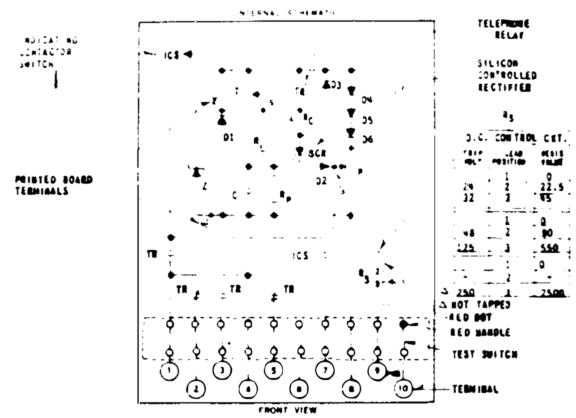

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Fig. 2. Internal Schematic of Type TD-5 Relay.

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 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 dc 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 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 dc 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 cover.

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 dc 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 dc voltage is first applied to the relay,

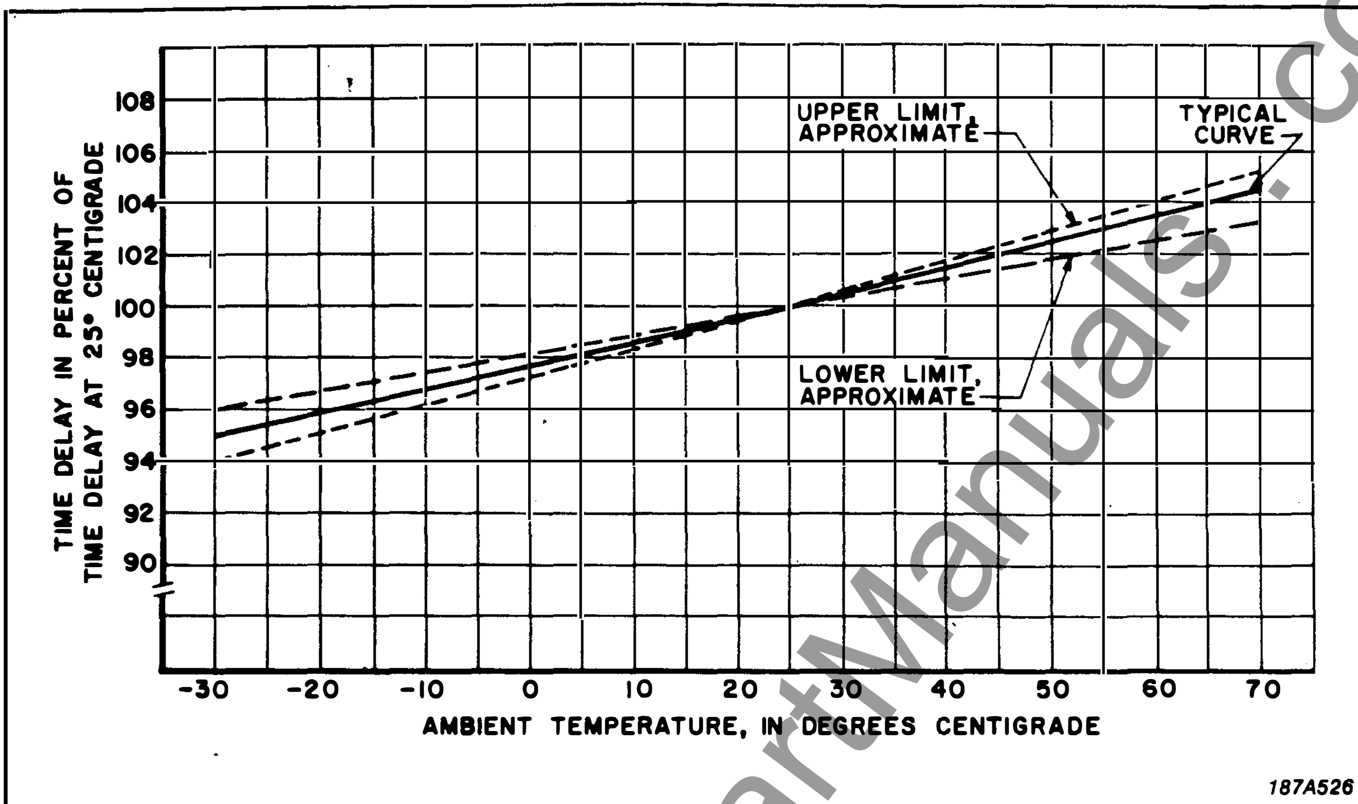

Fig. 3. Timing Variation with Temperature Changes.

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 dc)
.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

Battery Drain

	24 Volts dc	32 Volts dc	48 Volts dc	125 Volts dc	250 Volts dc
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 dc, 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, totaling 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

Time delay is selected by adjusting rheostat, T.

✪ For zone 2 distance applications, the timer setting should be sufficient to allow relays and breakers beyond the next bus to clear the fault. Also, it should be set to allow successful breaker-failure clearing without it operating. This usually requires a setting of approximately 0.25 seconds.

✪ Zone 3 timing must coordinate with remote zone 2 timing. A typical setting is 0.5 seconds.

✪ Breaker failure timing is set to assure normal fault clearing and fault detector reset plus 2 to 3 cycles margin. 0.1 to 0.2 second settings are typical.

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 of 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 dc voltage across the silicon power regulator, Z. Connect the dc 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 14.0 volts for 24/32 volt relays, between 21.5 and 25.5 volts for 48/125 volt relays, and between 50 and 59 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 dc 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 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 seconds, 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 dc 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 wipe should be 1/64" to 3/64" 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.

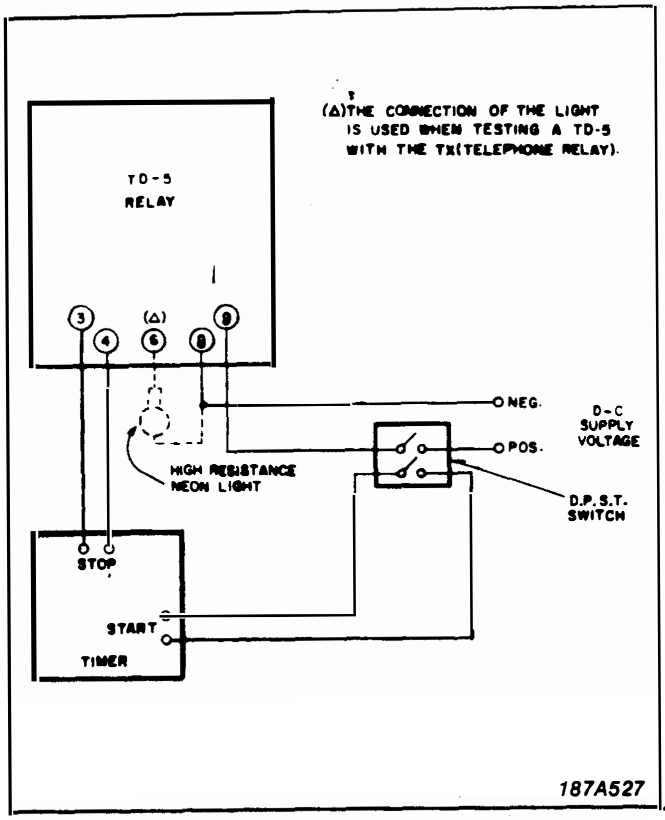

Fig. 4. Test Circuits for Type TD-5 Relay.

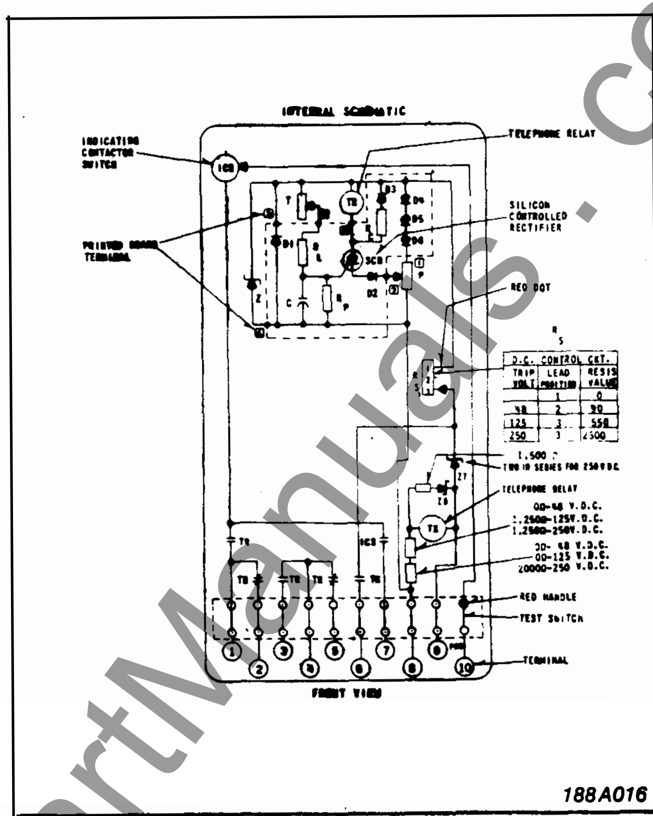

Fig. 5. Internal Schematic of TD-5 with Telephone Relay (TX).

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC DC VOLTS	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

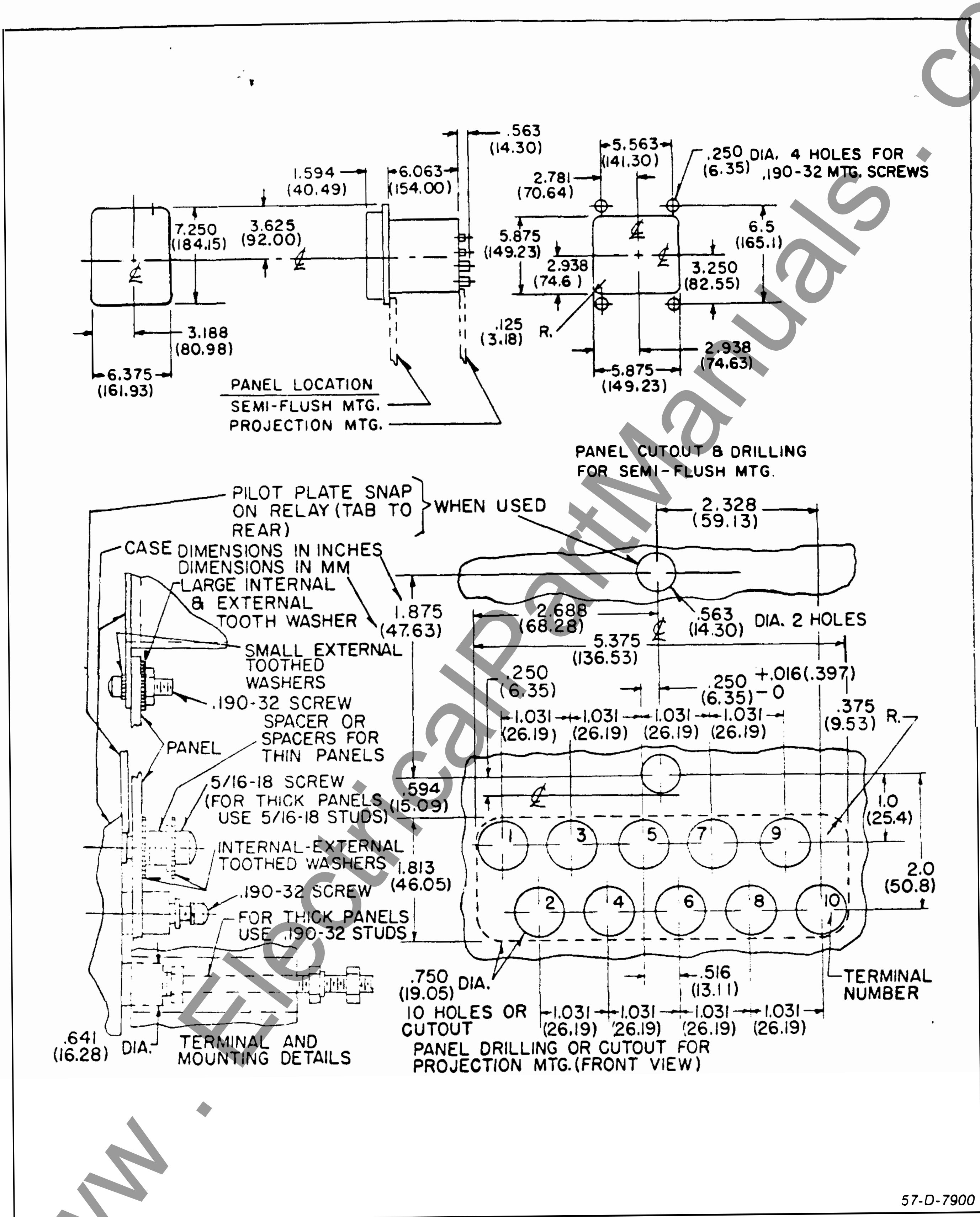

Fig. 6. Outline and Drilling Plan for Type TD-5 Relay in Type FT11 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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