INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

EFFECTIVE APRIL 1973

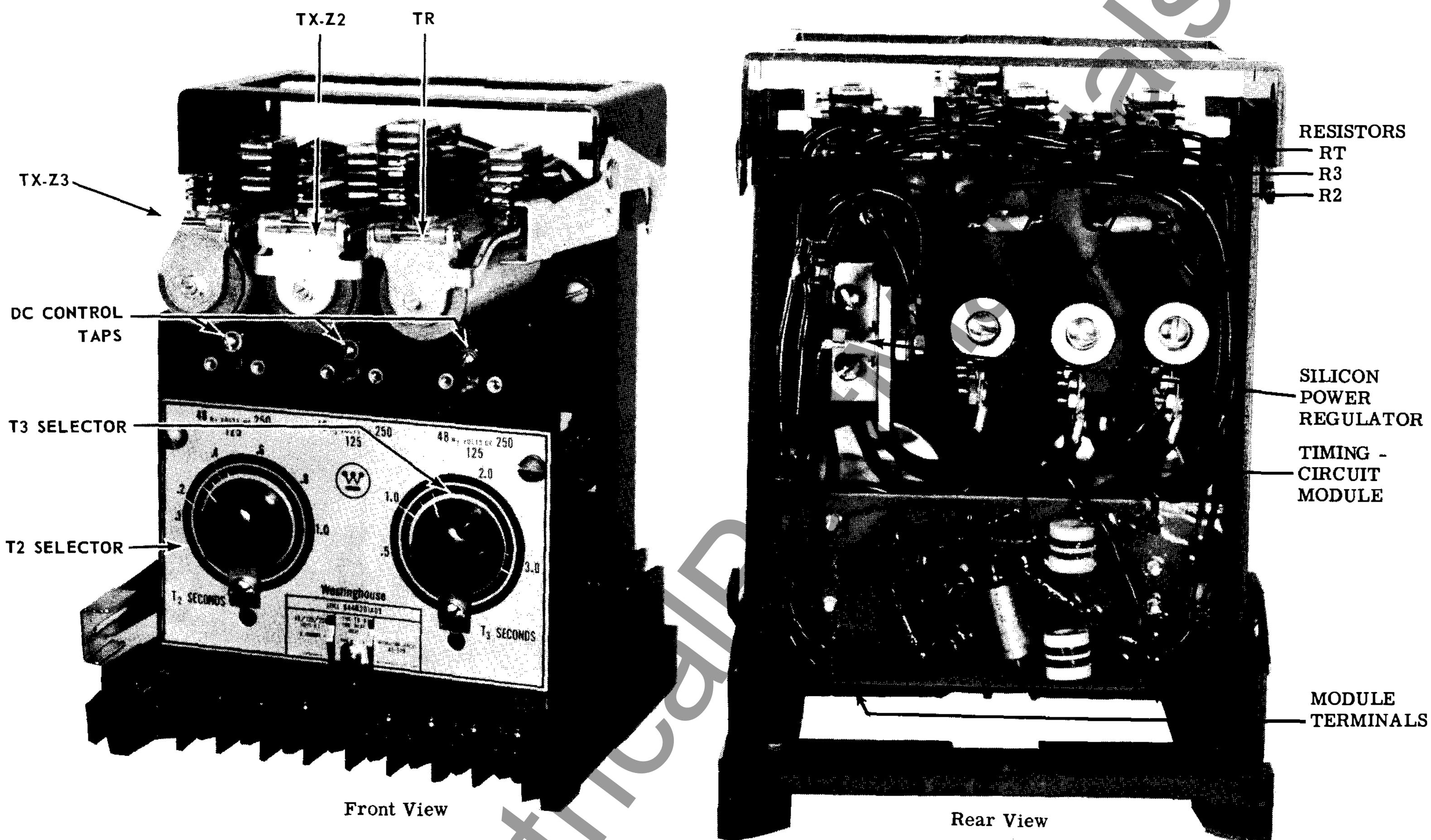


Fig. 1. Type TD-4 Relay without case.

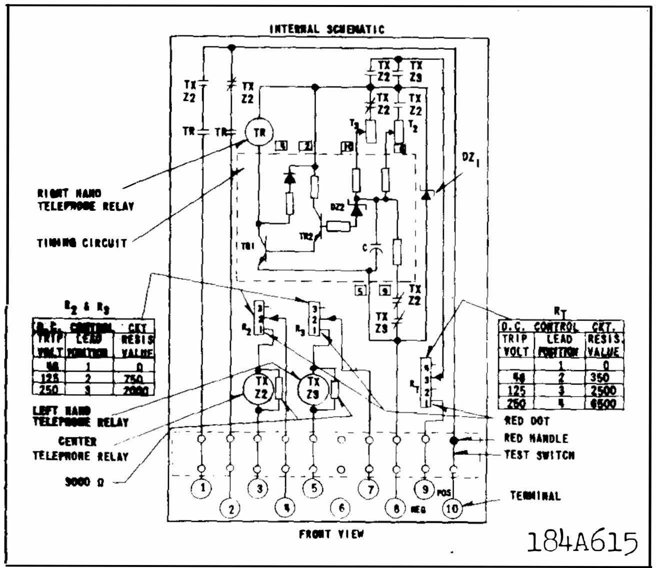


Fig. 2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)

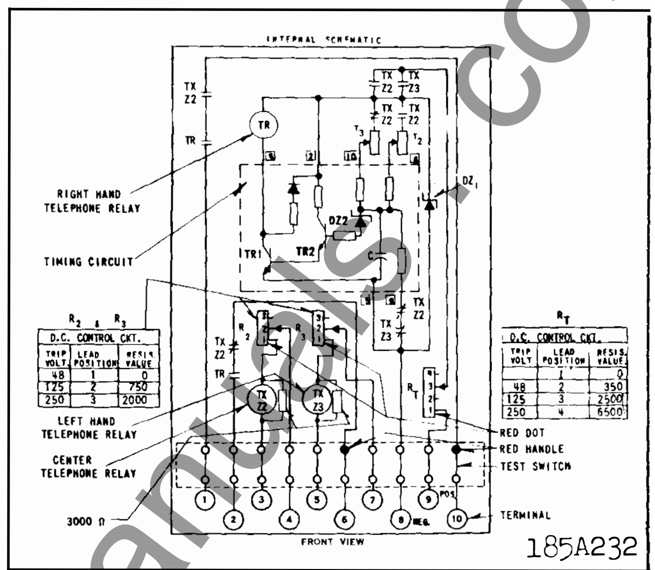


Fig. 3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)

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

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

* When this fault occurs and the "forward" connection is used for the zone 3 relay, it energizes TX-Z3 and starts the timing function at the zone 3 rate, as described in paragraph 3. As soon as the infeed is removed, the zone 2 distance relay operates to energize TX-Z2. The timing function now continues at the zone 2 rate. The total time delay depends on the T_2 setting, the T_3 setting, and the time at which the breaker clears the infeed. In any event the trip time following zone 2 KD-4 operation will be less than the T_3 setting.

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. – 1.0 sec.; 0.1 – 1.0 sec.

Zone 3: 0.5 sec. – 3.0 sec.; 0.3 – 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less

TX-Z2 and TX-Z3 – Drop Out Time: 0.06 sec. or less

Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

For the relay with slow dropout the reset time is:

TX – Z2 dropout time = .045 – .075 sec.

TX – Z3 dropout time = .090 – 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

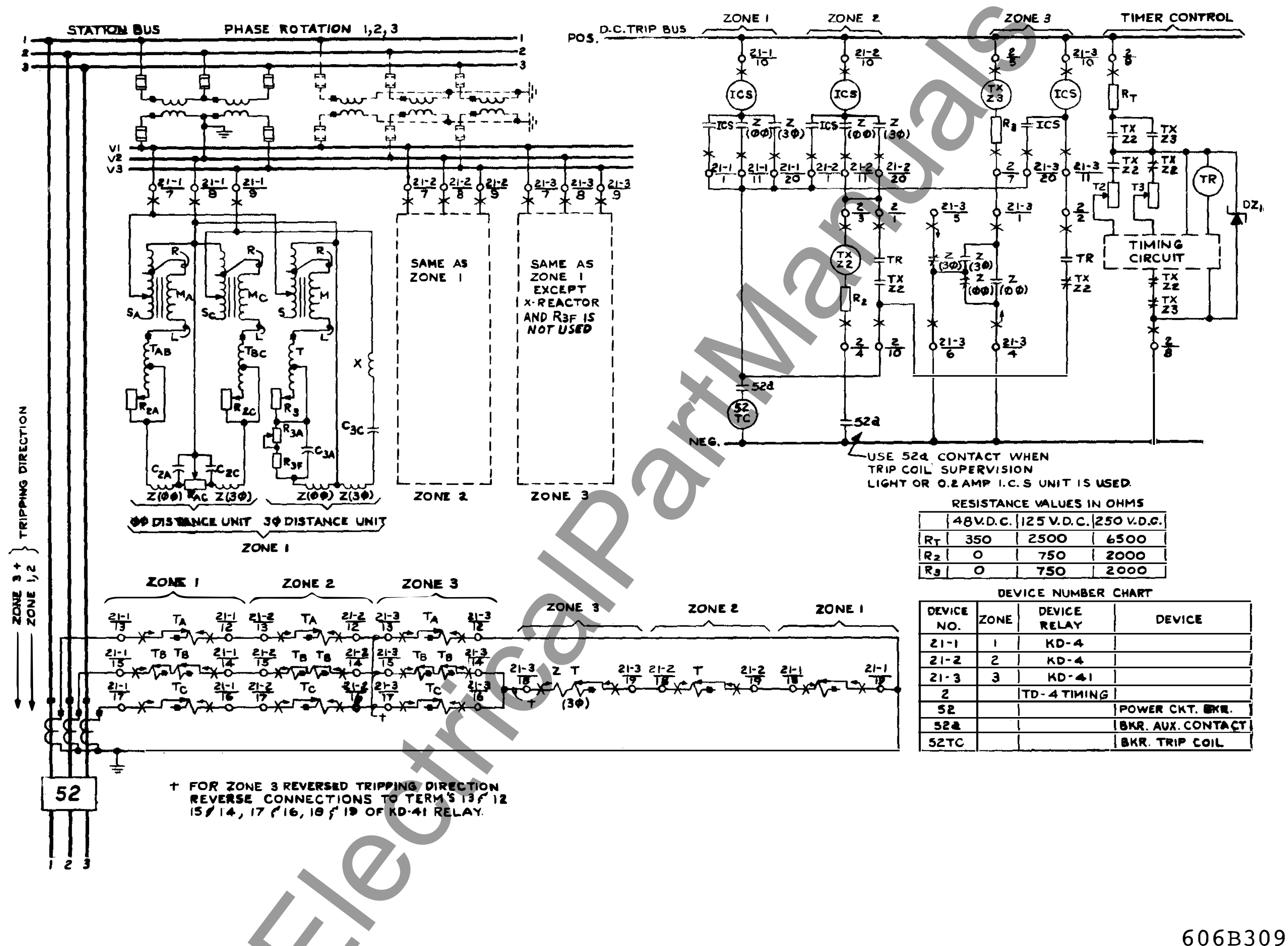
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX-Z_2$:	117 MA	106MA	103MA
$TX-Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD-4	
21-2	2	KD-4	
21-3	3	KD-41	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

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

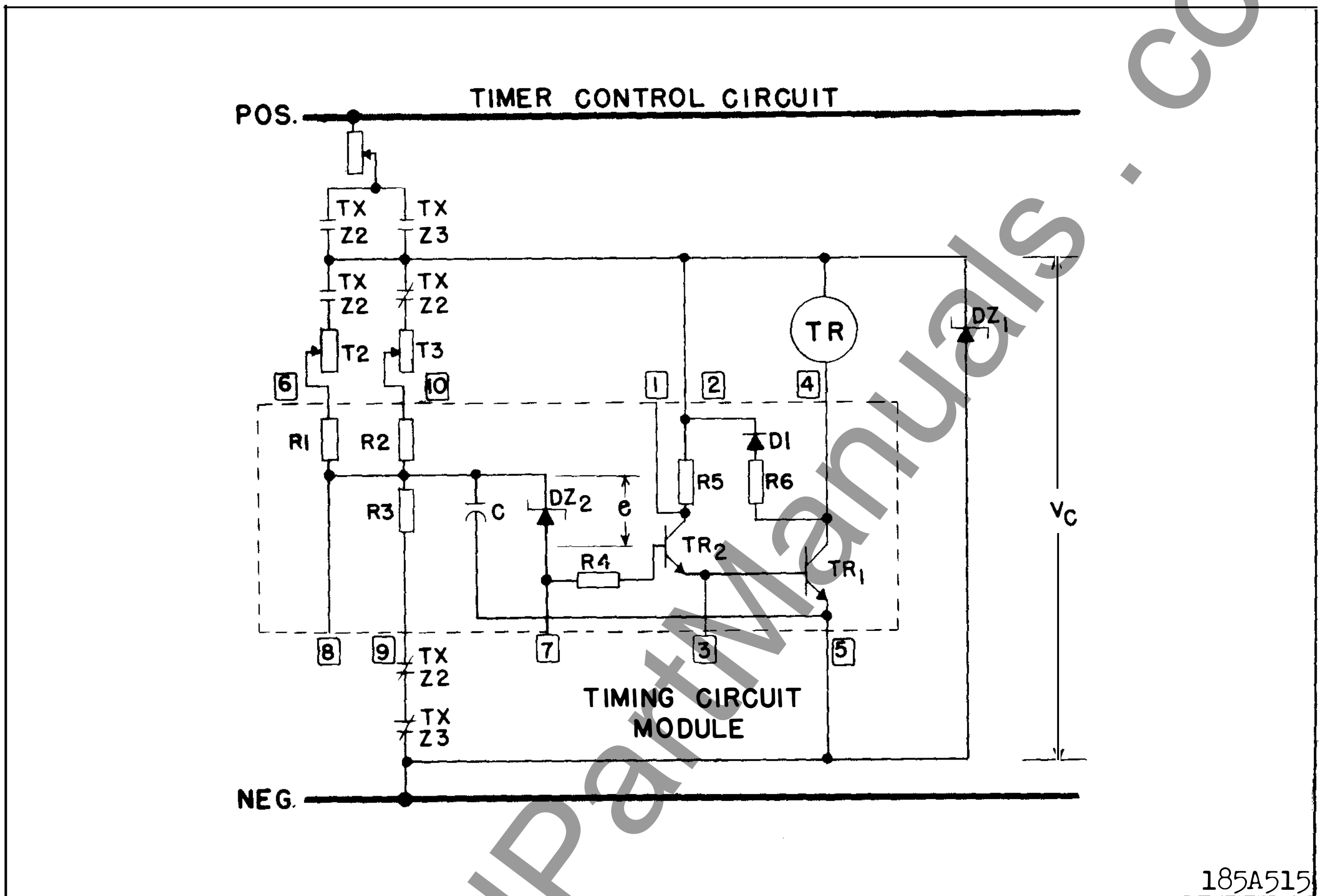


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

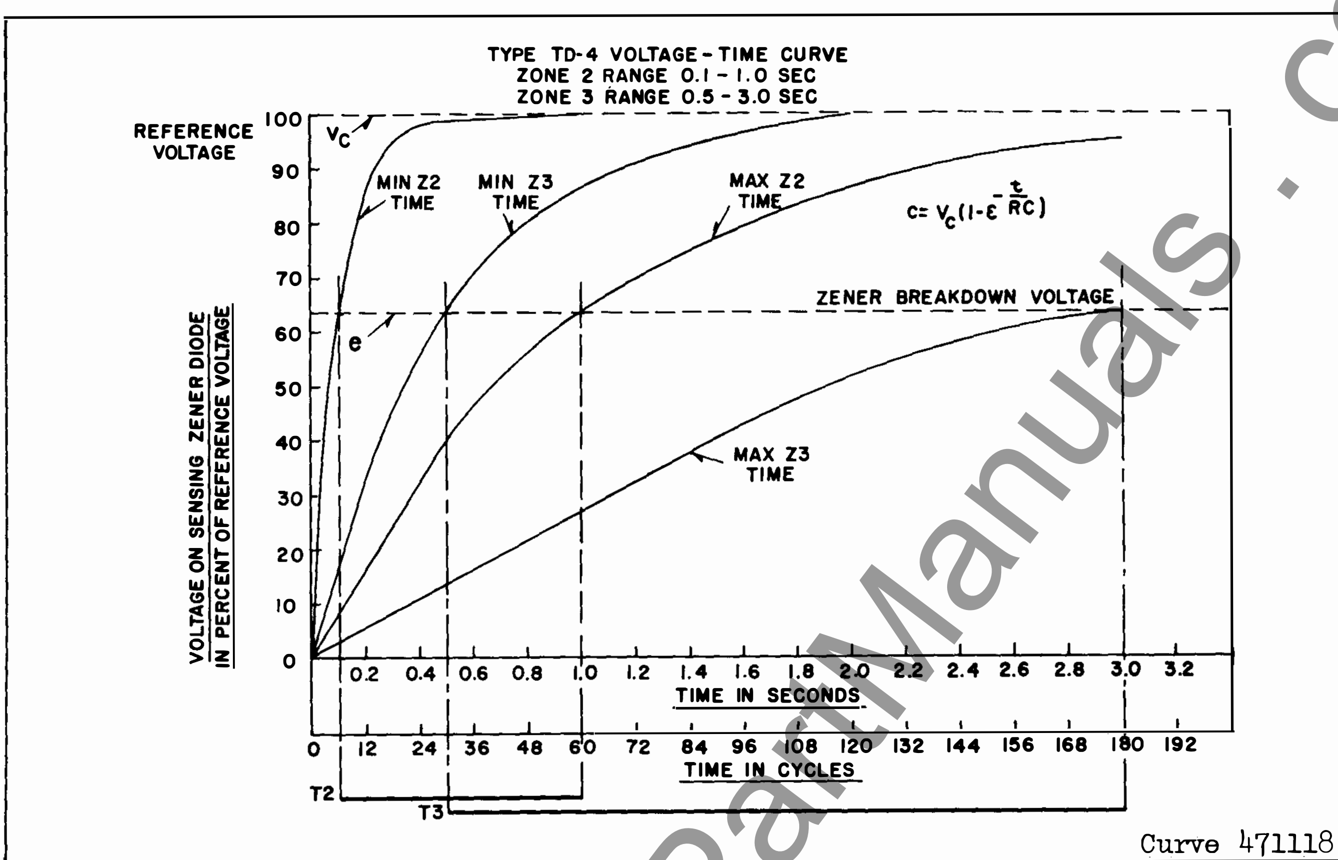


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

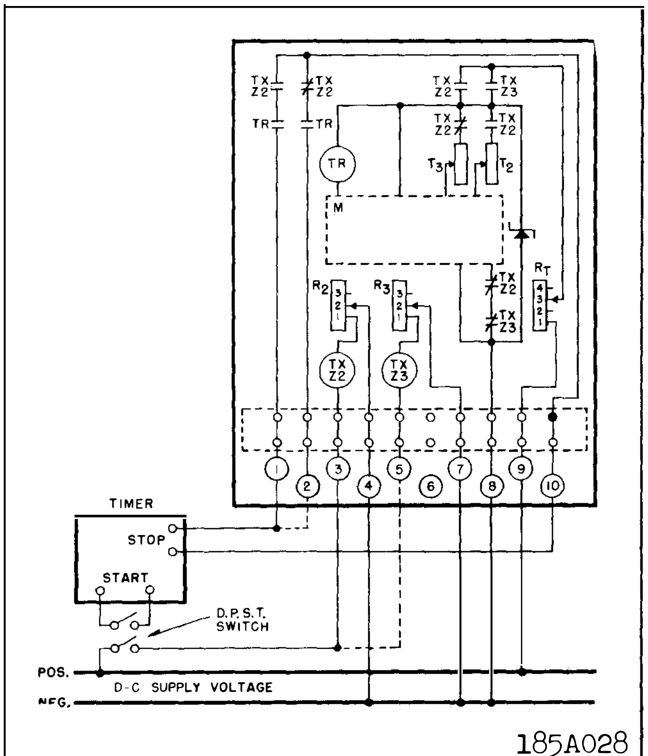


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms (.5-3.0 Sec.)
		0-50,000 ohms (.3-1.5 Sec.)
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

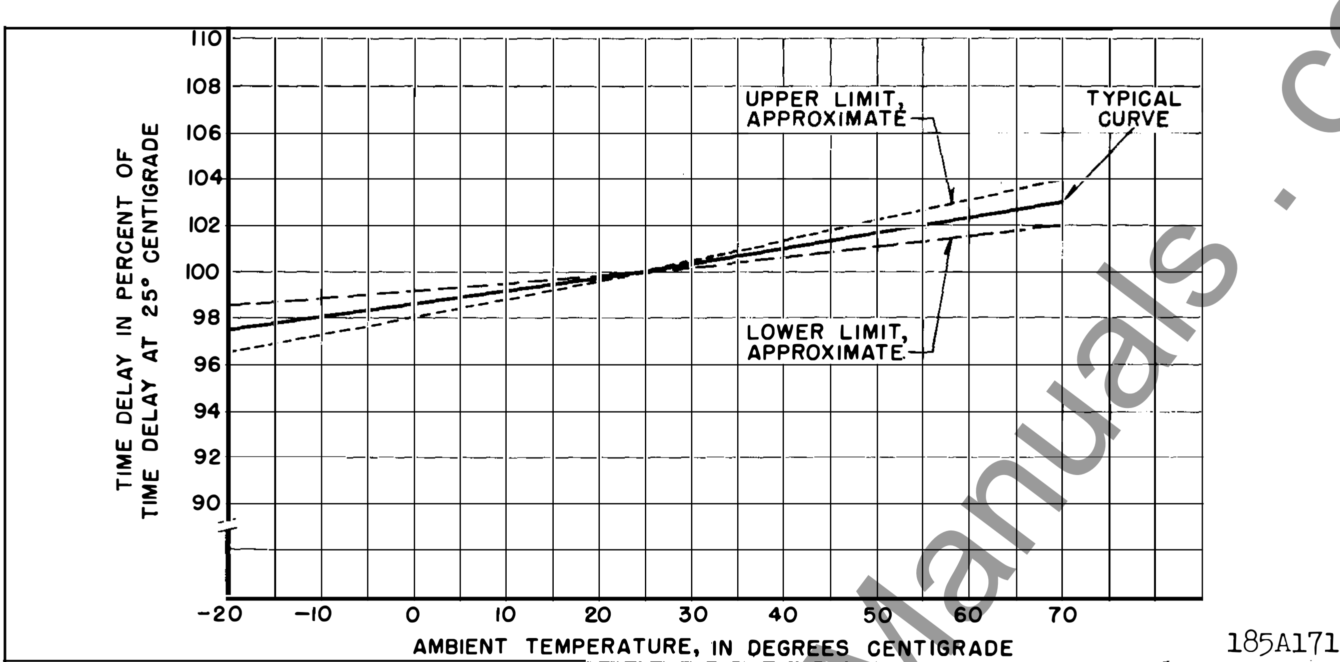


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

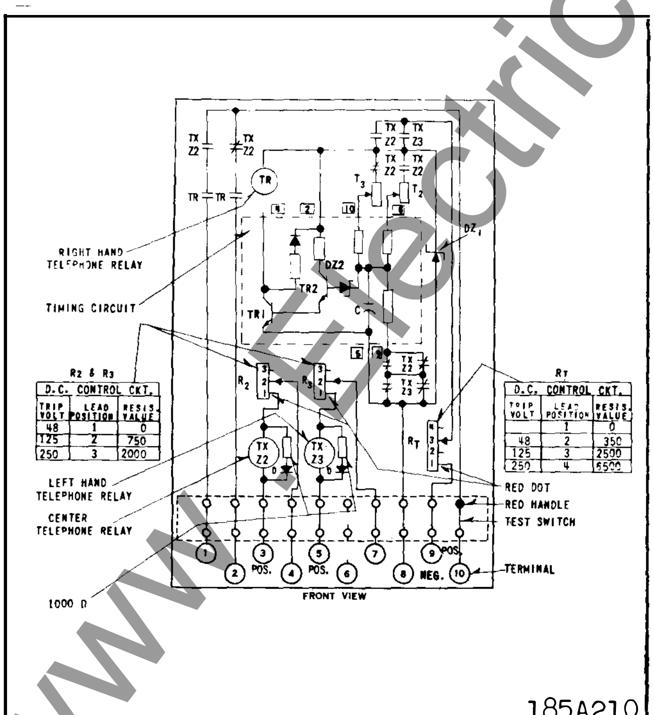


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).

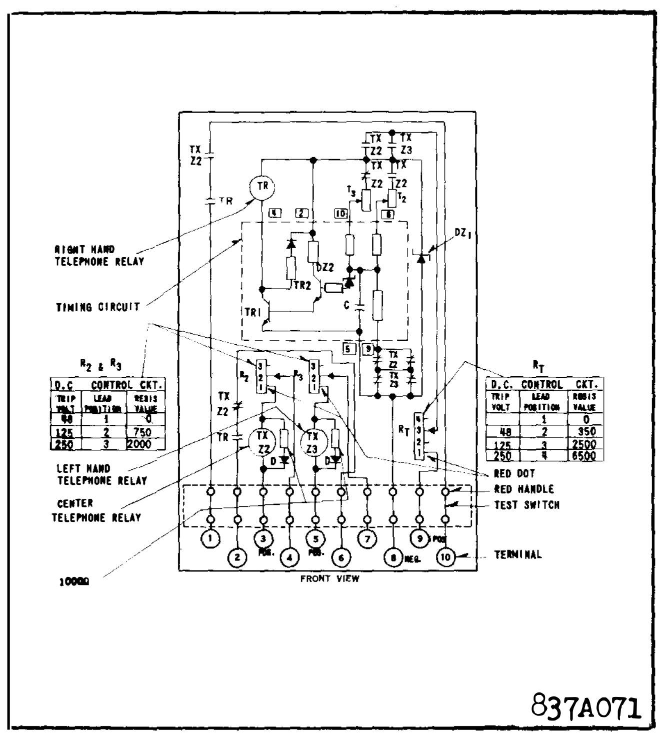


Fig. 10 Internal schematic of the type TD-4 relay with slow dropout relay (independent trip circuits).

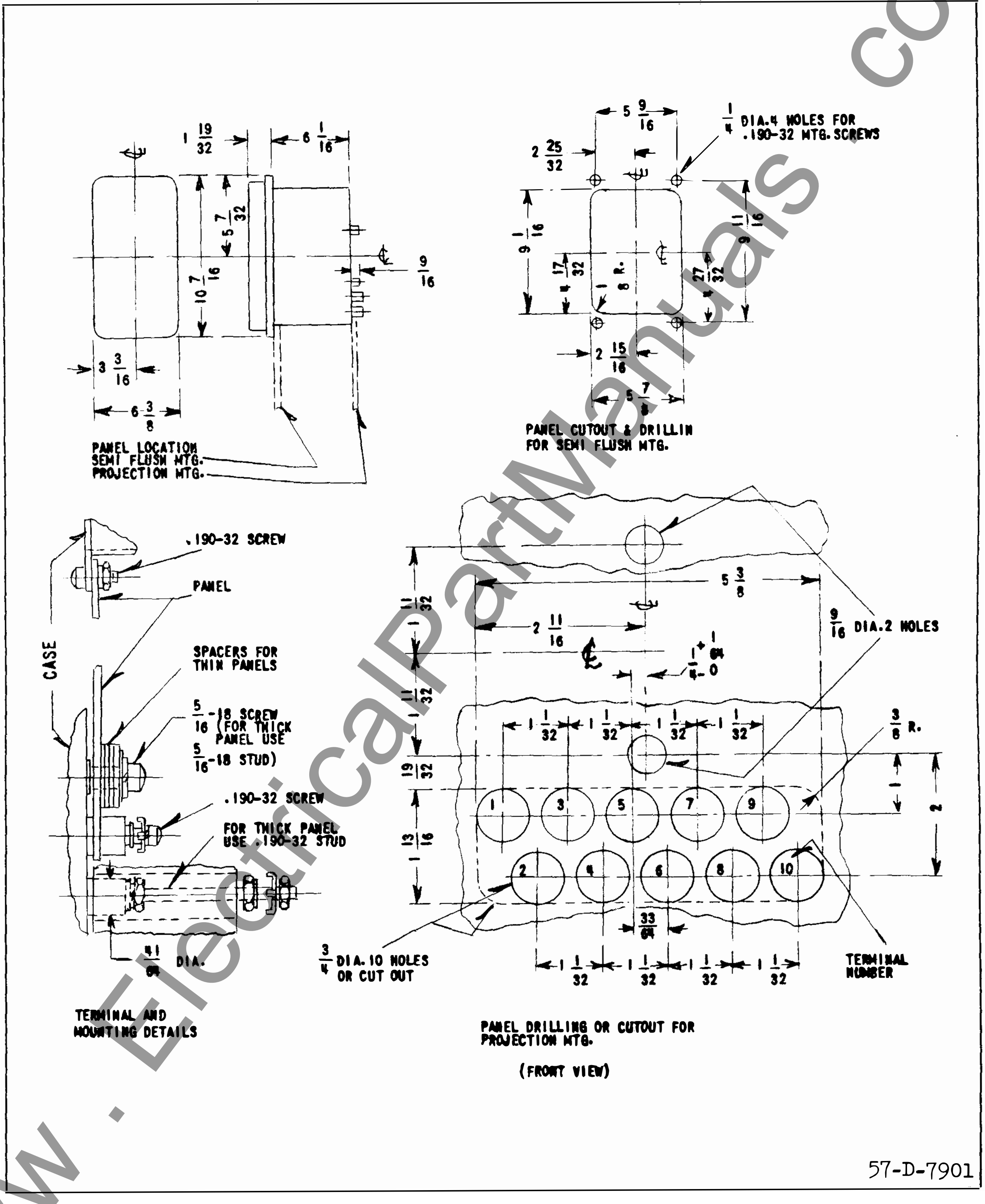


Fig.11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL (See Int. Schem. and also Fig. 5)	TIME RANGE	DESCRIPTION	STYLE NO.
TX22	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TX23	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TR	All	Telephone Relay, 2000 ohm coil	407C280H09
R_T	All	Resistor, 25 watts, 6500 ohms, with tap at 350 and 2500 ohms	184A651H01
R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_1	All	Zener Diode 10W, 1N2989B, 30V ±5%	629A798H01
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000 ohms	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000 ohms	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

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INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

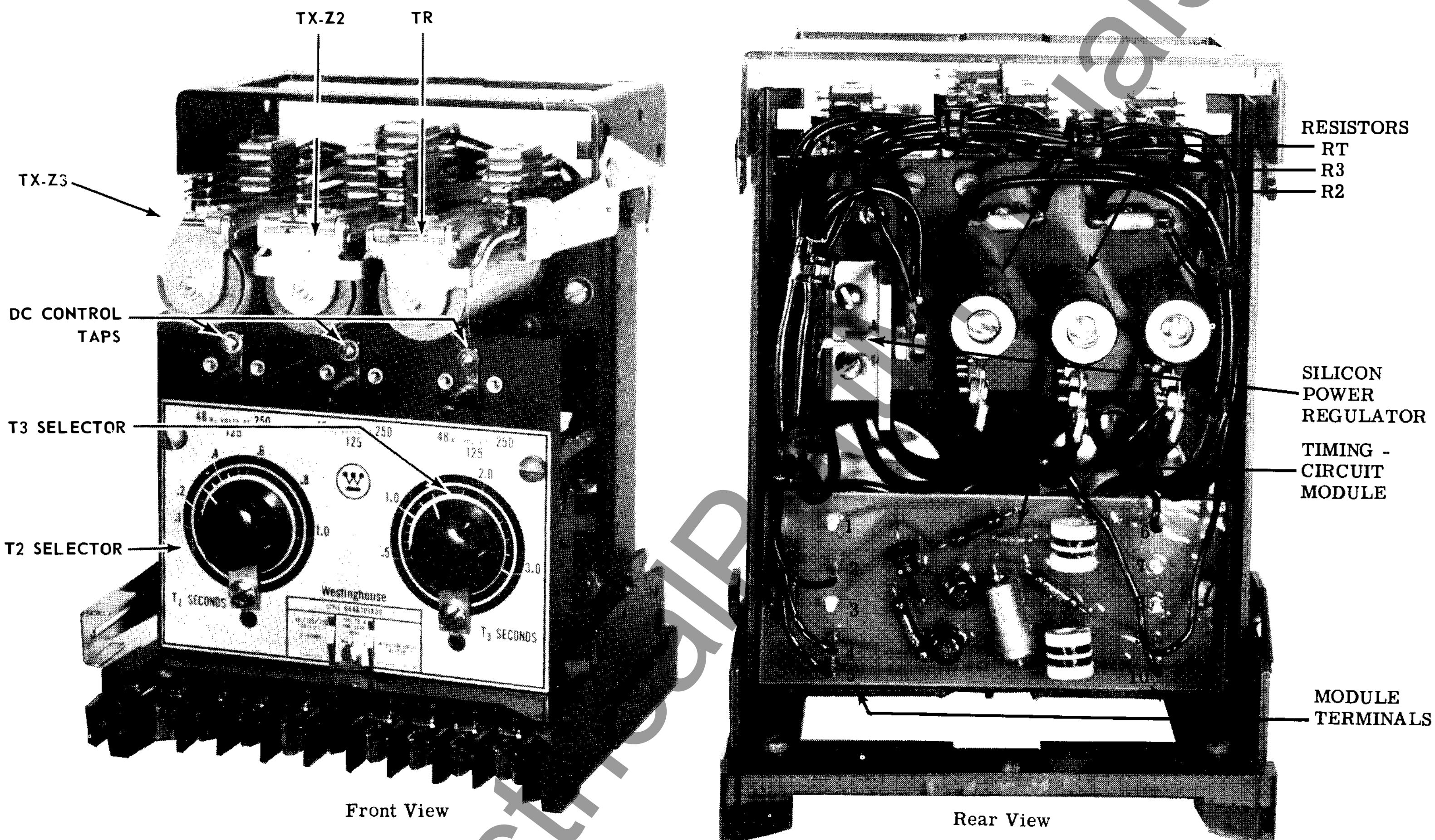
This case is similar to paragraph 1, except that the zone 2 KD contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

EFFECTIVE JUNE 1971



Front View

Rear View

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

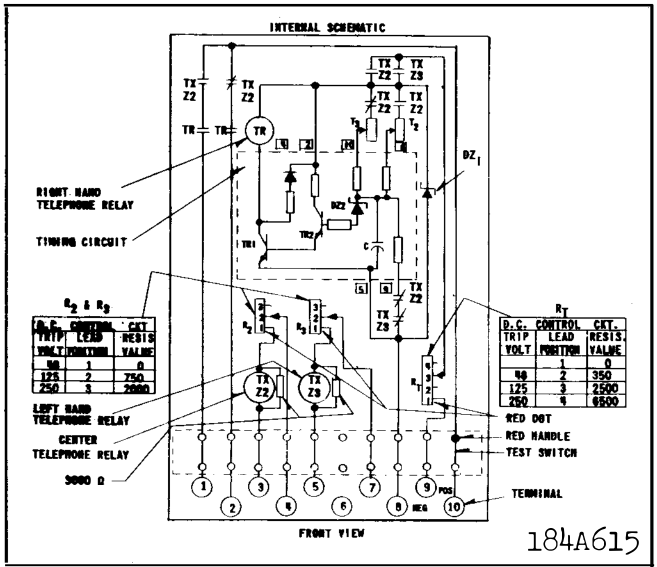


Fig.2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)

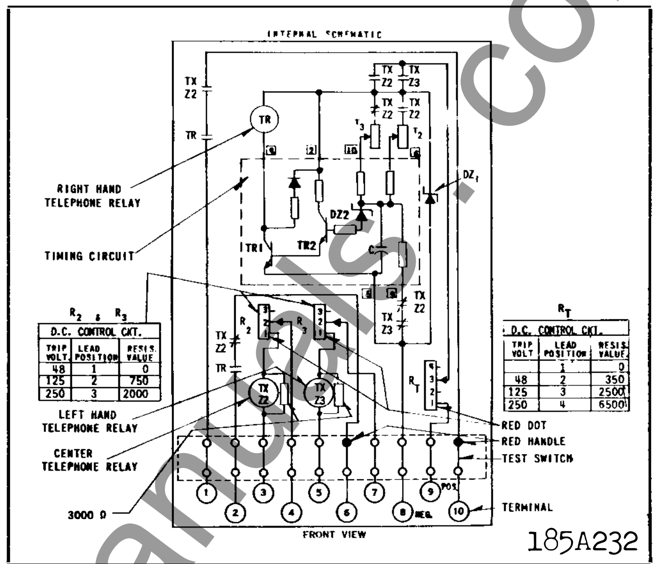


Fig.3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. – 1.0 sec.; 0.1 – 1.0 sec.

Zone 3: 0.5 sec. – 3.0 sec.; 0.3 – 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less

TX-Z2 and TX-Z3 – Drop Out Time: 0.06 sec. or less

Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

For the relay with slow dropout the reset time is:

TX – Z2 dropout time = .045 – .075 sec.

TX – Z3 dropout time = .090 – 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

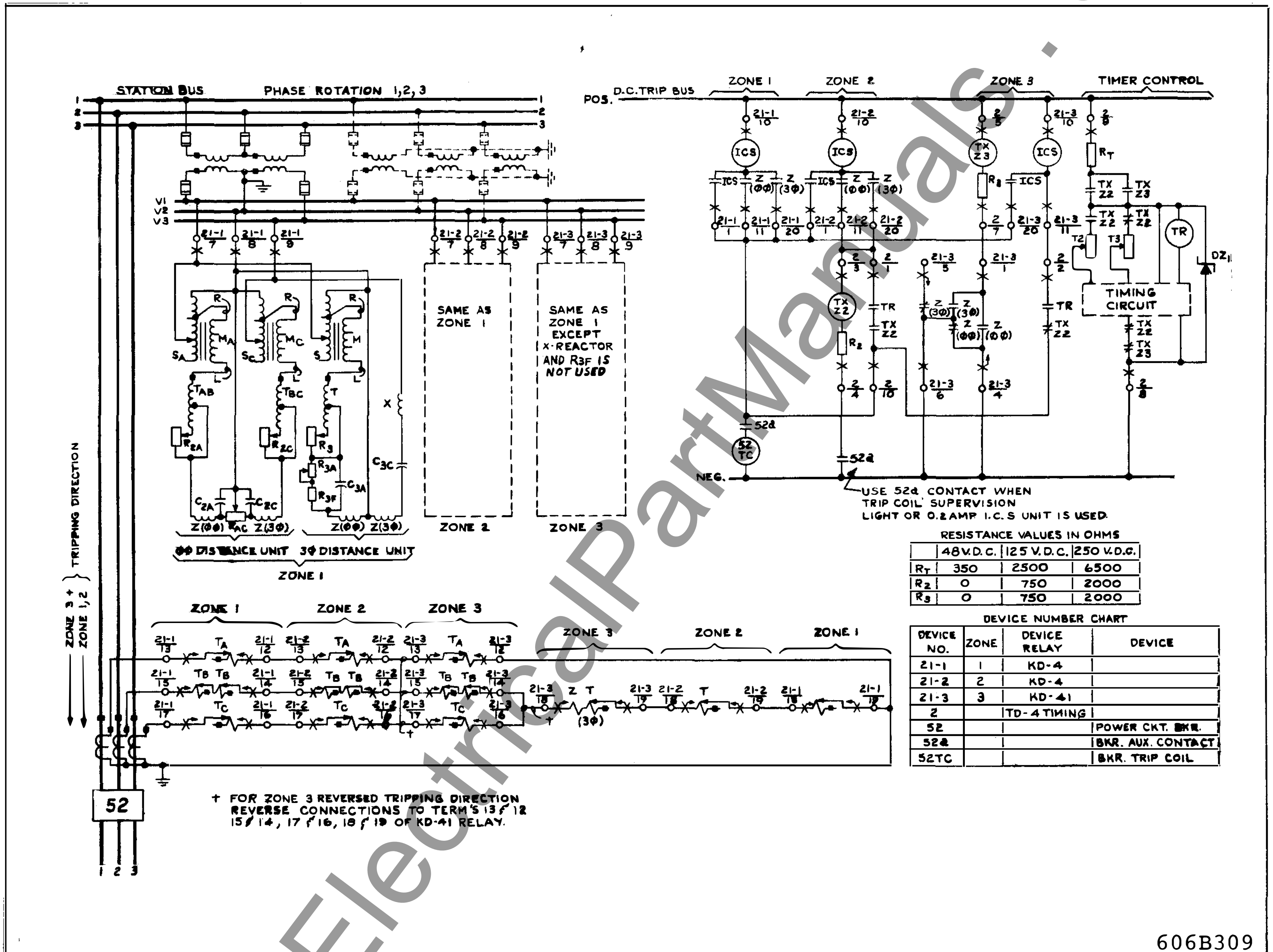
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD-4	
21-2	2	KD-4	
21-3	3	KD-41	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

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

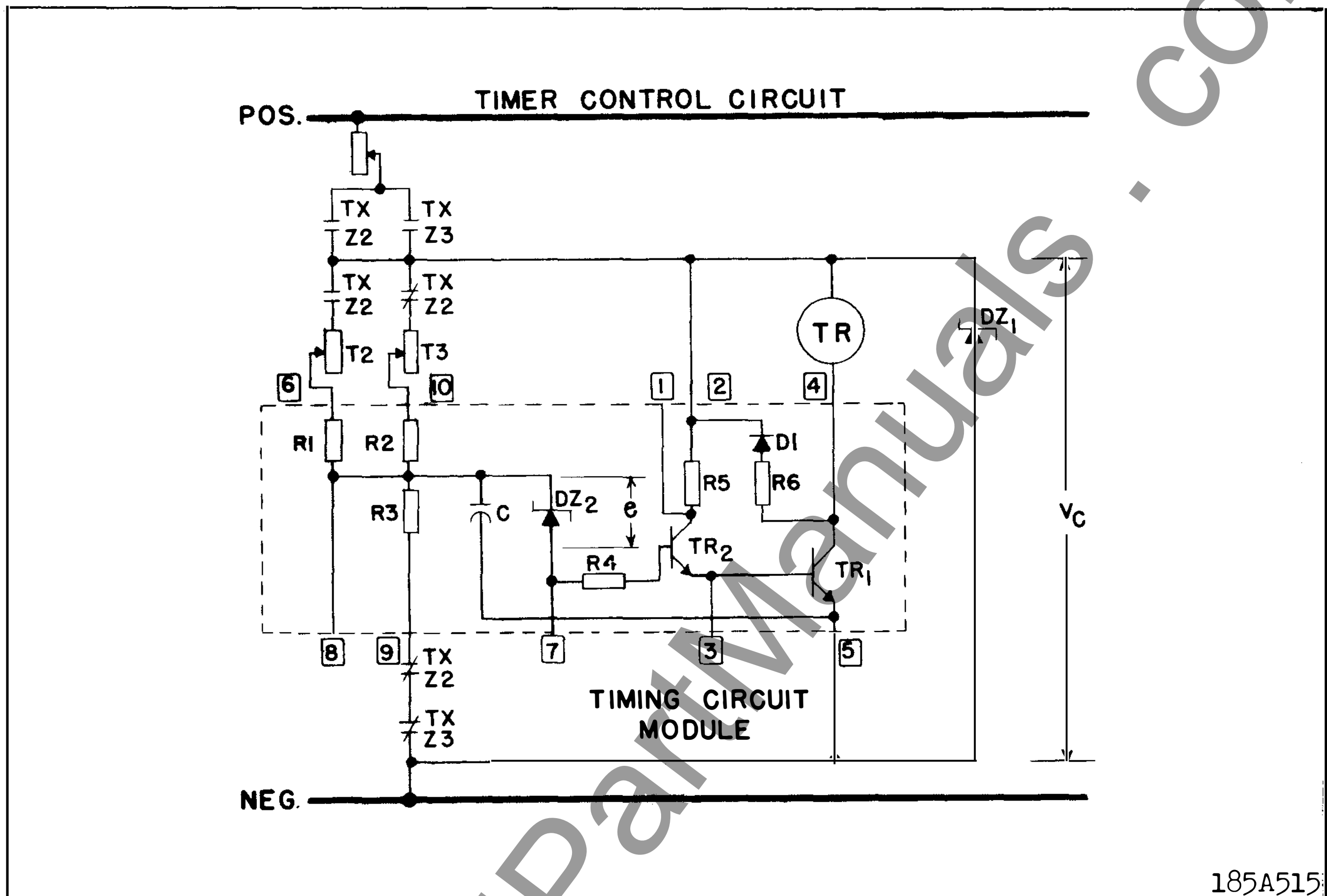


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

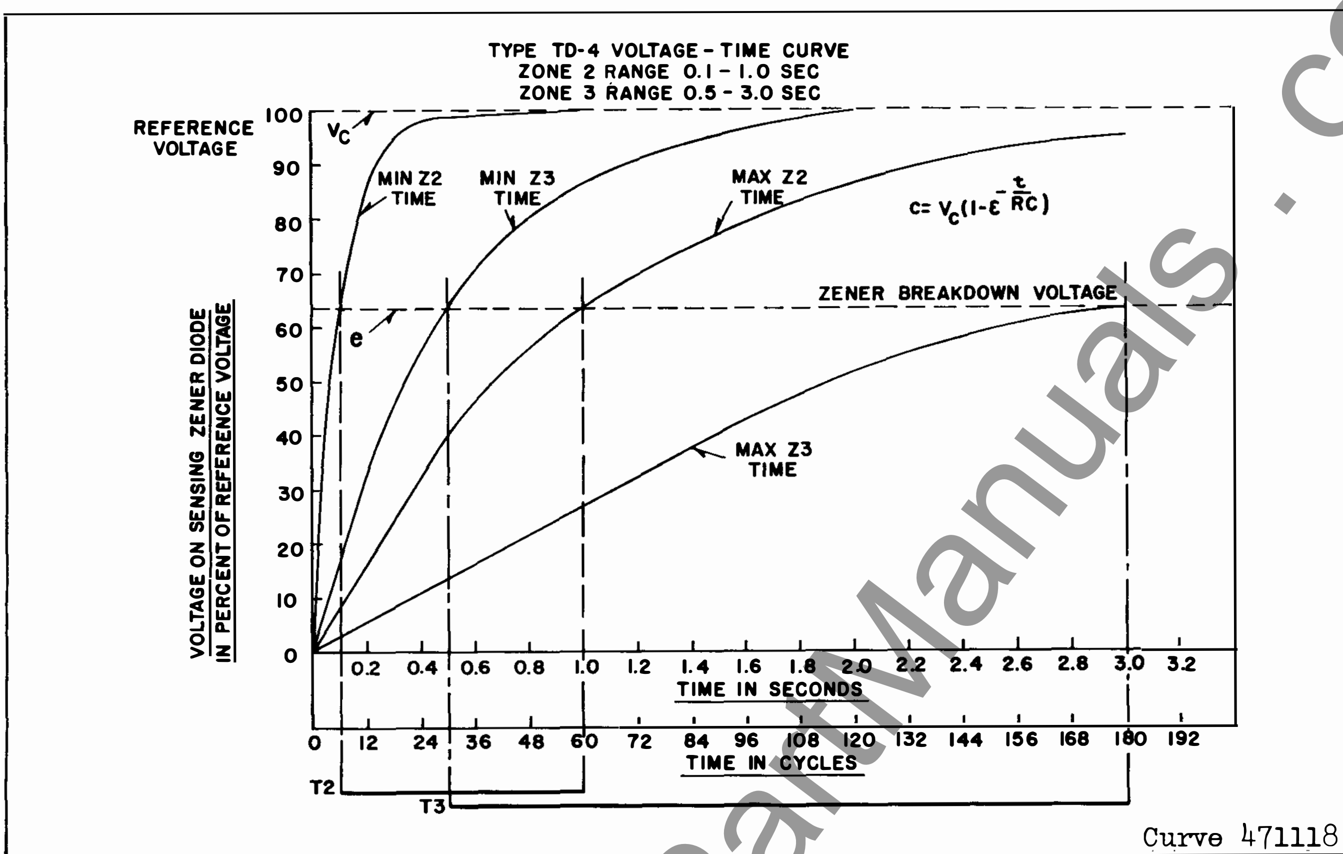


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

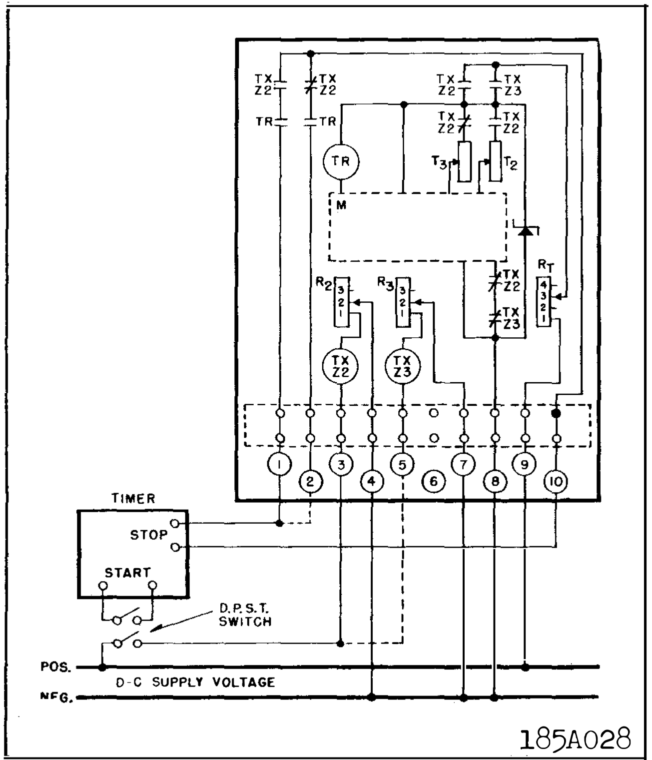


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms (.5-3.0 Sec.)
		0-50,000 ohms (.3-1.5 Sec.)
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

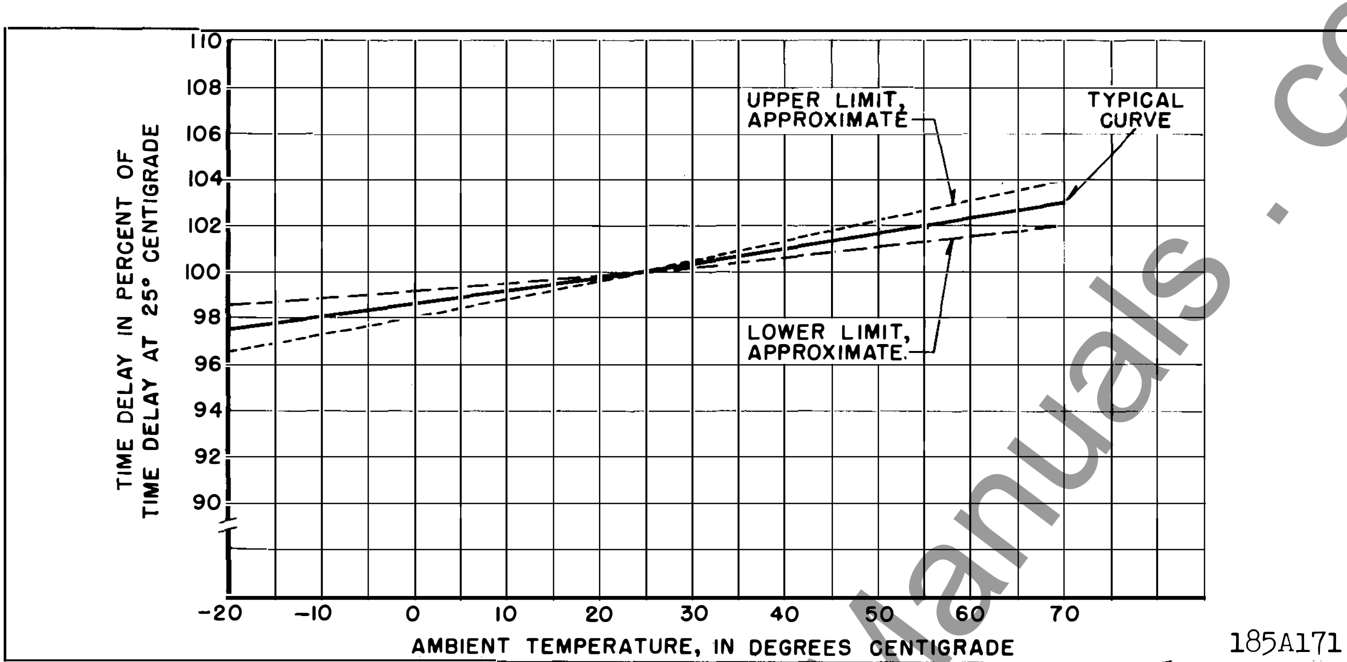


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

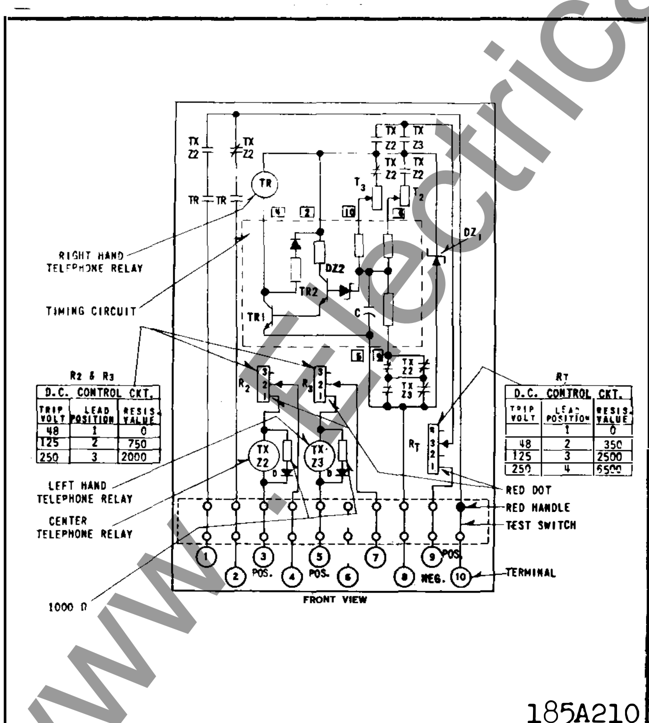


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).

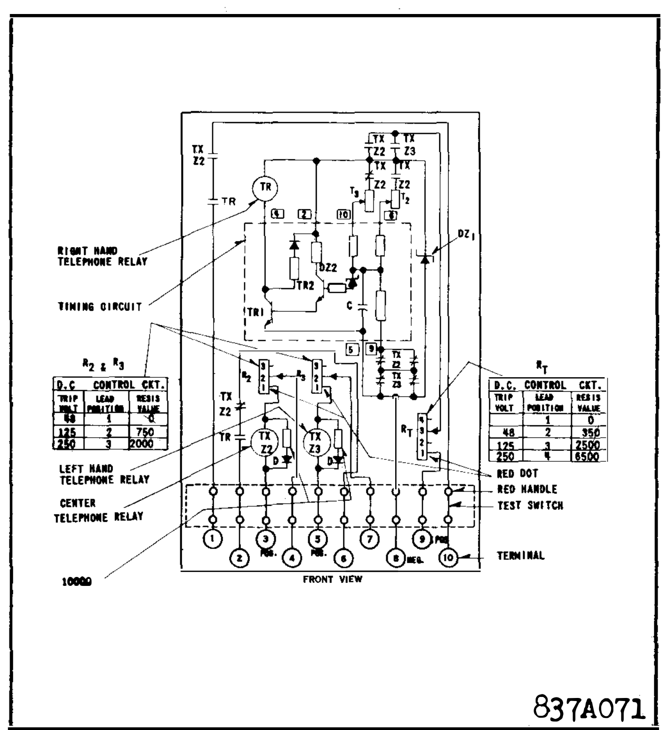


Fig. 10 Internal schematic of the type TD-4 relay with slow dropout relay (independent trip circuits).

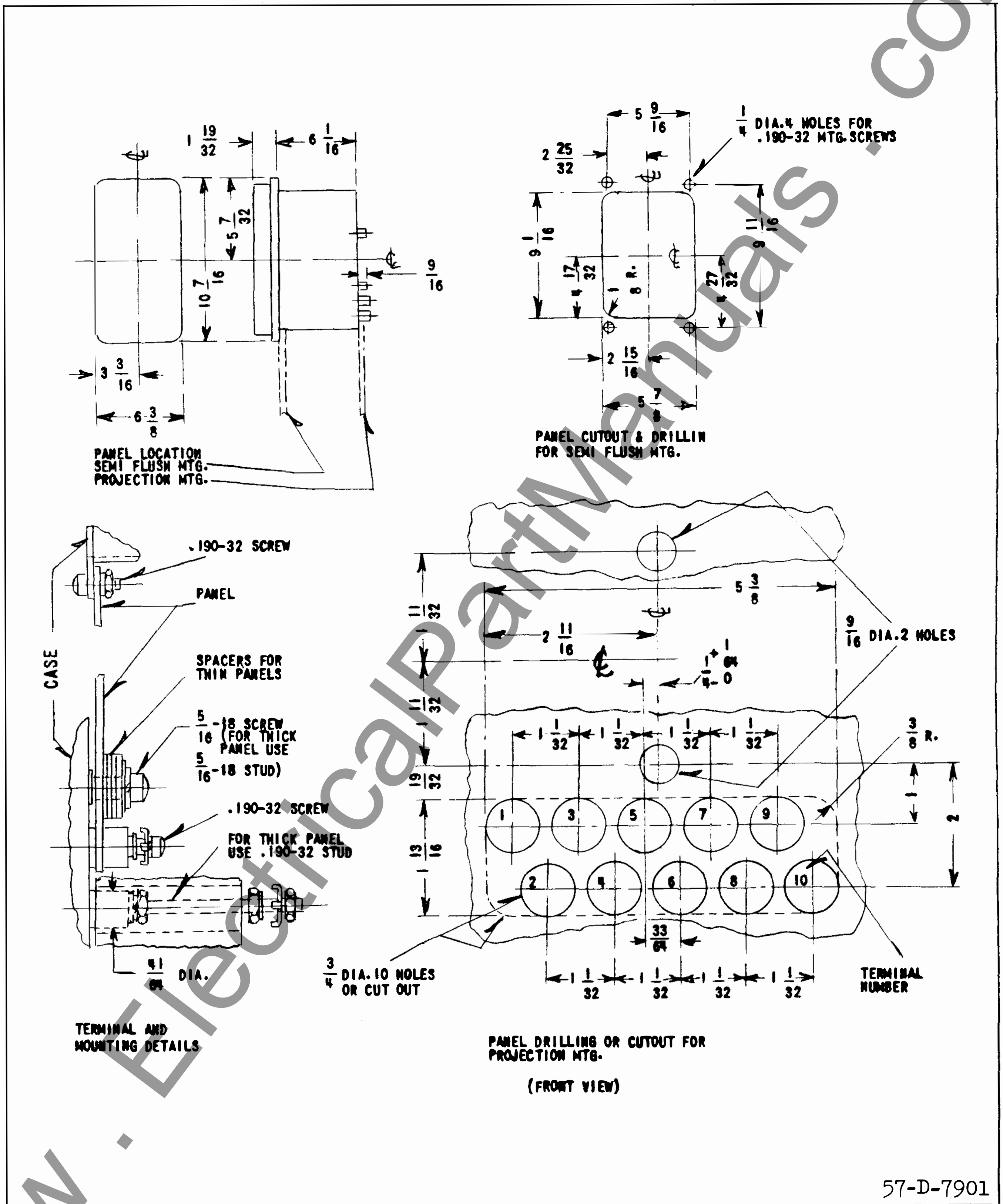


Fig.11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

* TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL (See Int. Schem. and also Fig. 5)	TIME RANGE	DESCRIPTION	STYLE NO.
TX22	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TX23	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TR	All	Telephone Relay, 2000 ohm coil	407C280H09
R_T	All	Resistor, 25 watts, 6500 ohms, with tap at 350 and 2500 ohms	184A651H01
R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_1	All	Zener Diode 10W, 1N2989B, 30V ±5%	629A798H01
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40 K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50 K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100 K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000 ohms	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000 ohms	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

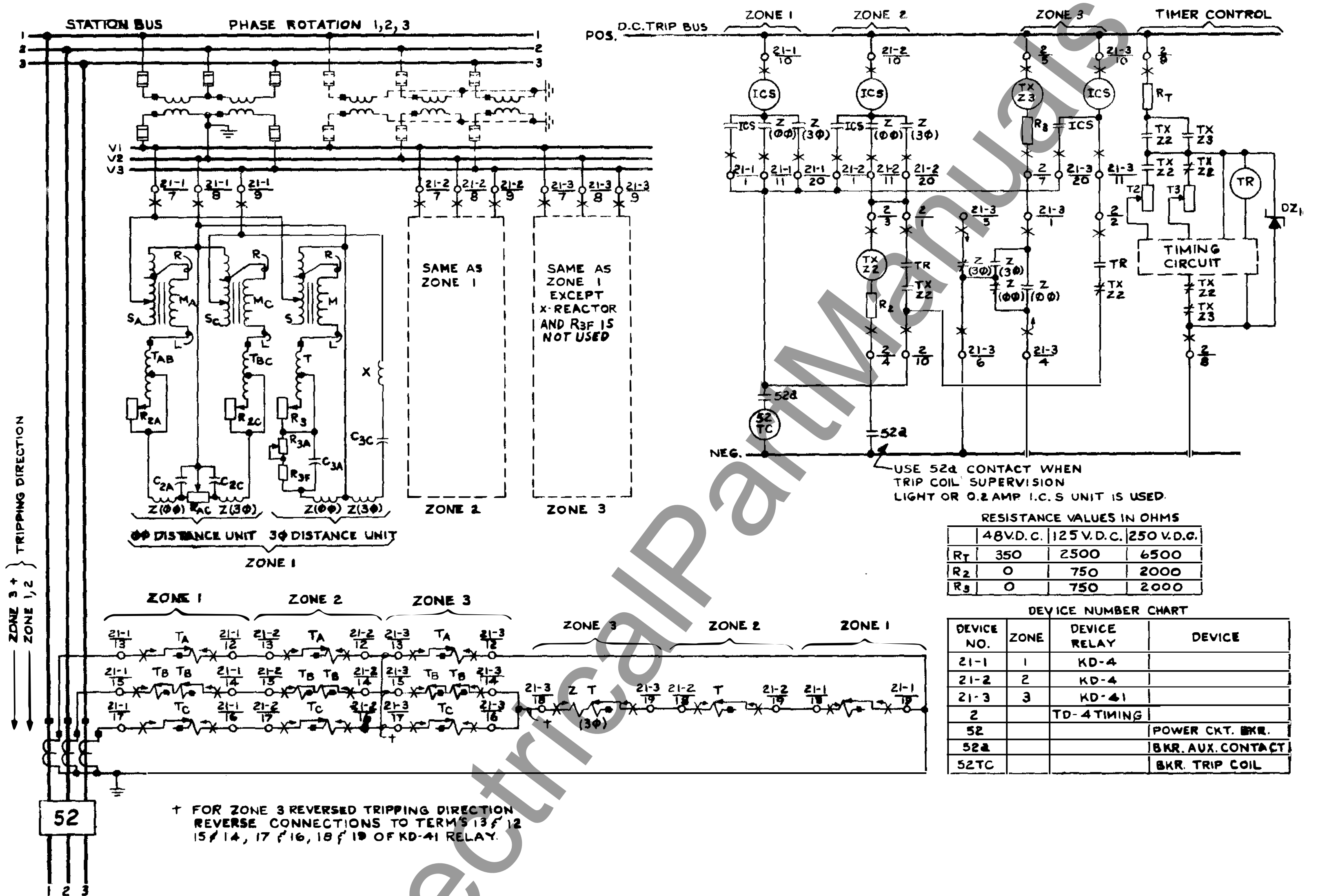
This case is similar to paragraph 1, except that the zone 2 KD contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

EFFECTIVE NOVEMBER 1969



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD-4	
21-2	2	KD-4	
21-3	3	KD-41	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

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

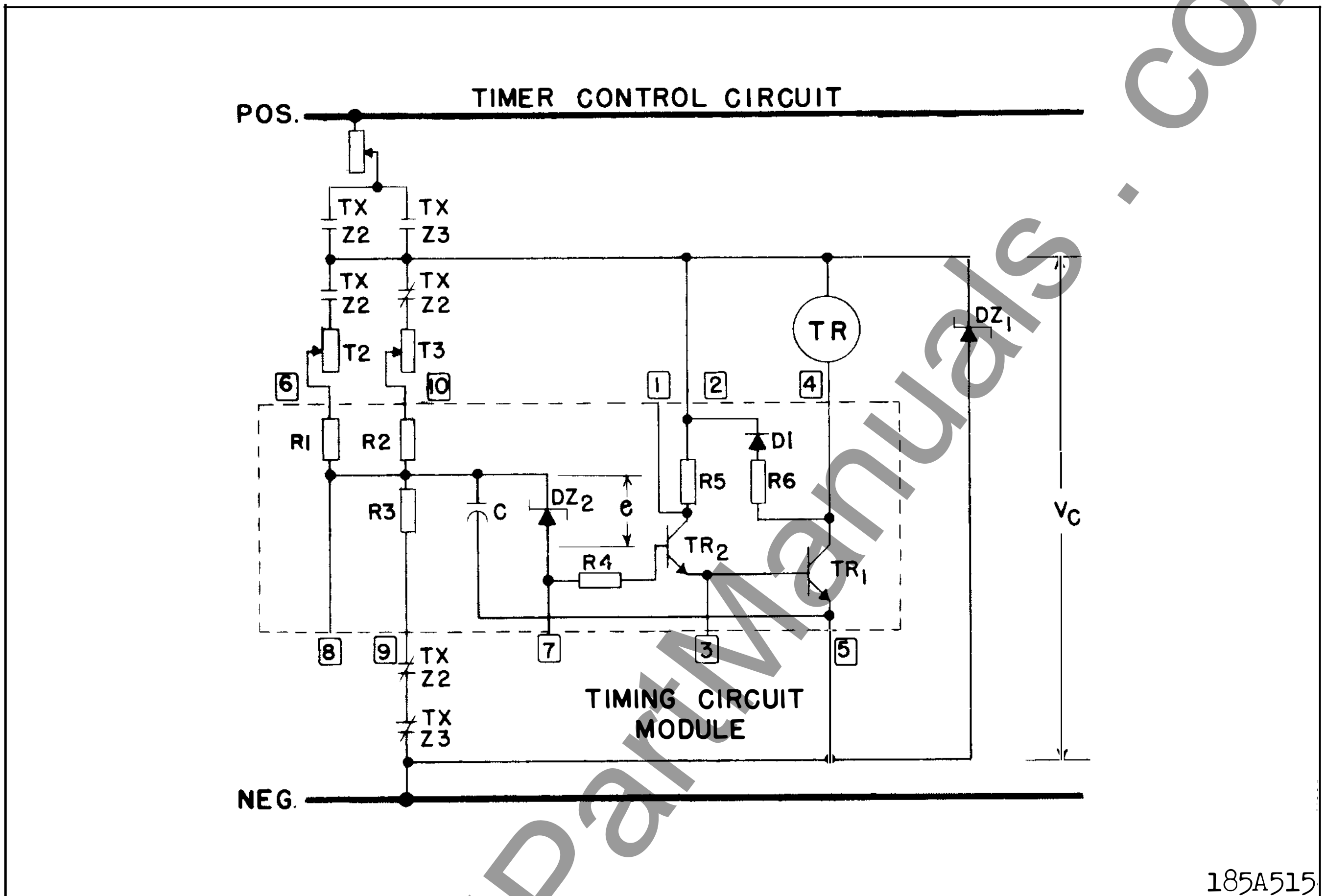


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

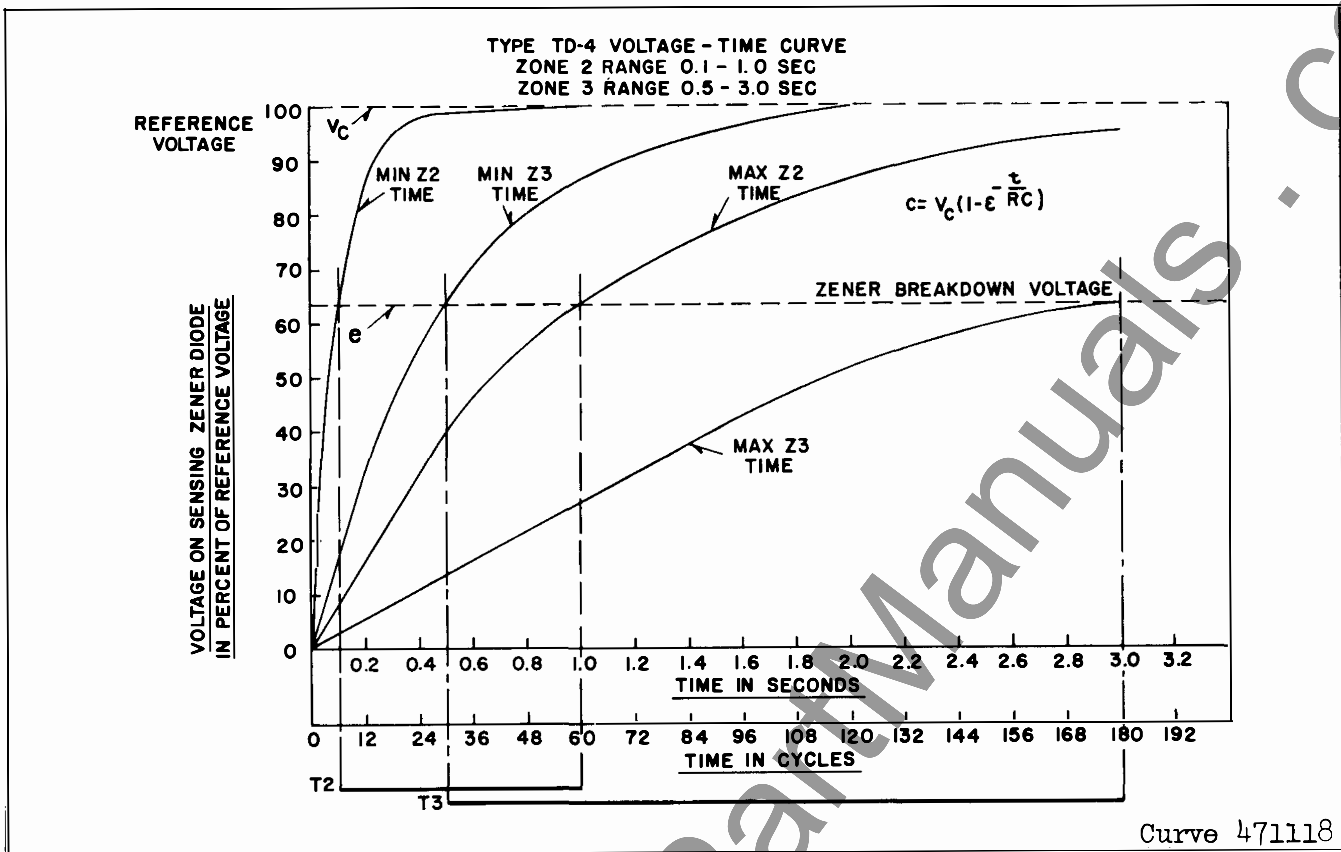


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

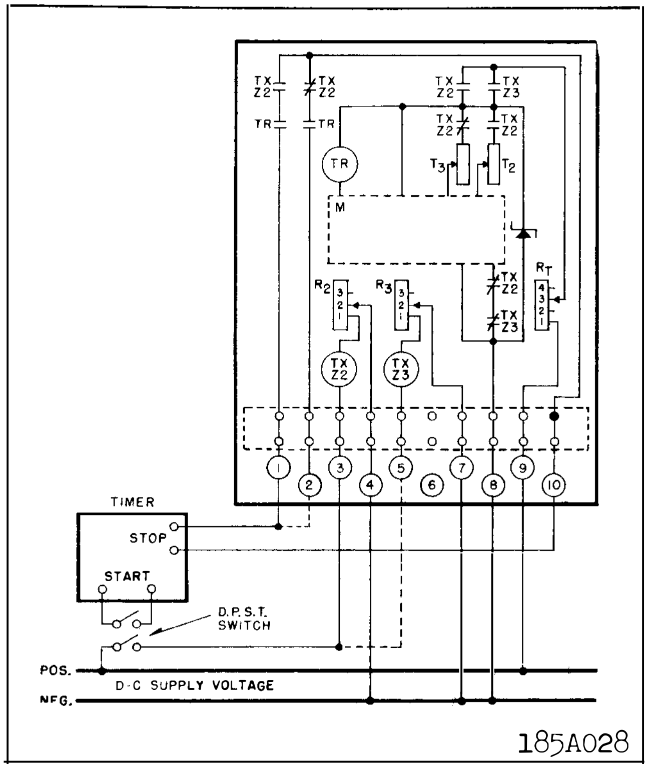


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms (.5-3.0 Sec.) 0-50,000 ohms (.3-1.5 Sec.)
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

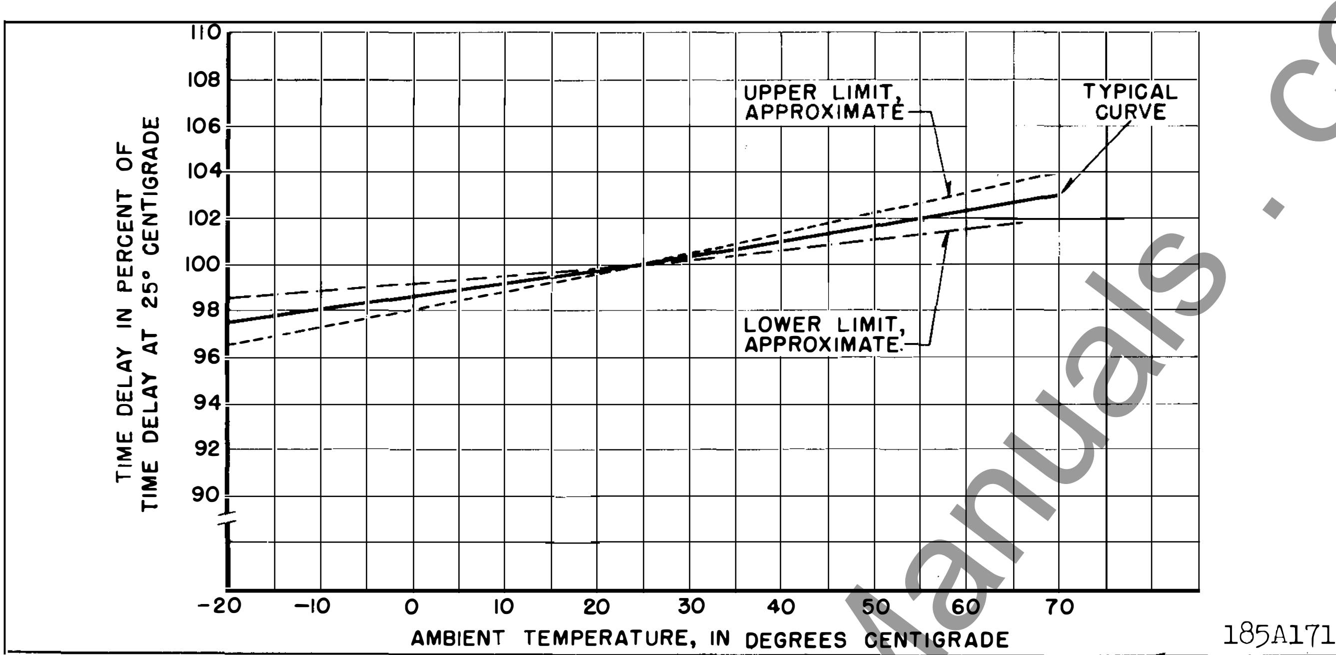


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

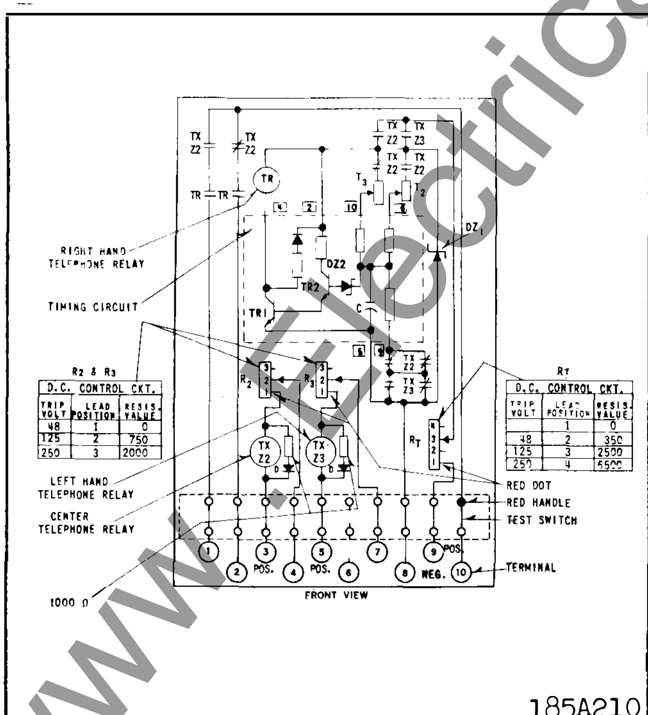


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).

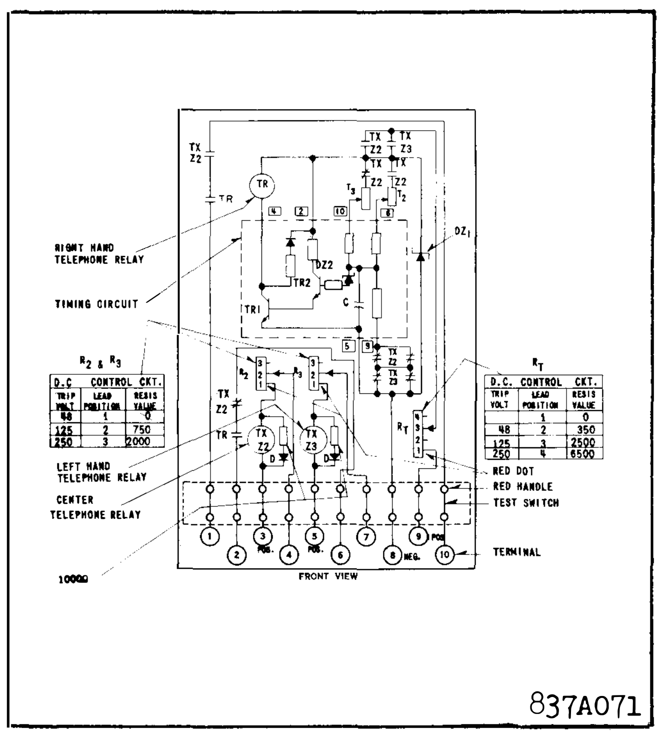


Fig. 10 Internal schematic of the type TD-4 relay with slow dropout relay (independent trip circuits).

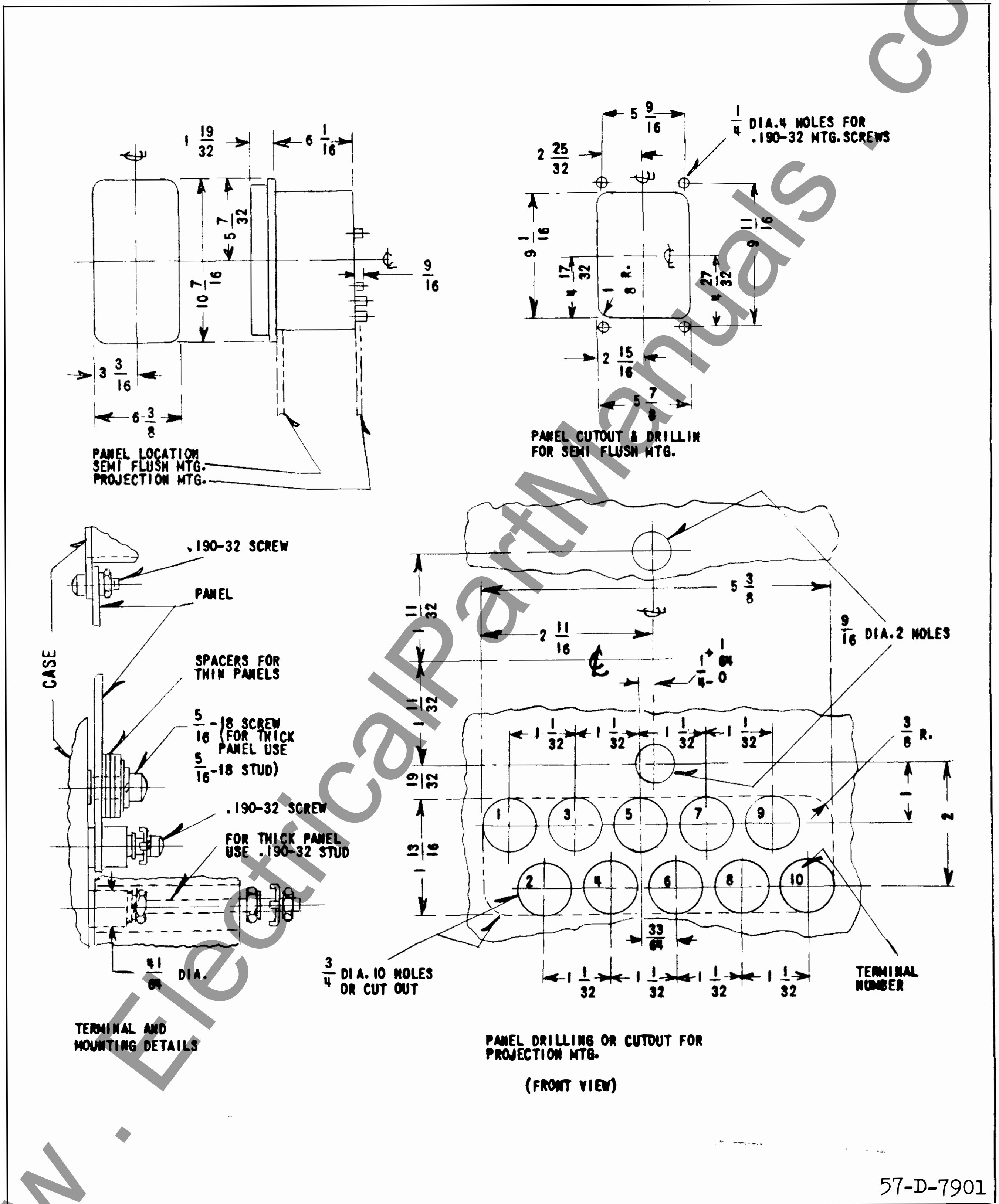


Fig. 11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL (See Int. Schem. and also Fig. 5)	TIME RANGE	DESCRIPTION	STYLE NO.
TX22	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TX23	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TR	All	Telephone Relay, 500 ohm coil	407C280H09
R_T	All	Resistor, 25 watts, 6500 ohms, with tap at 350 and 2500 ohms	184A651H01
R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40 K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50 K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100 K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000r	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000r	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

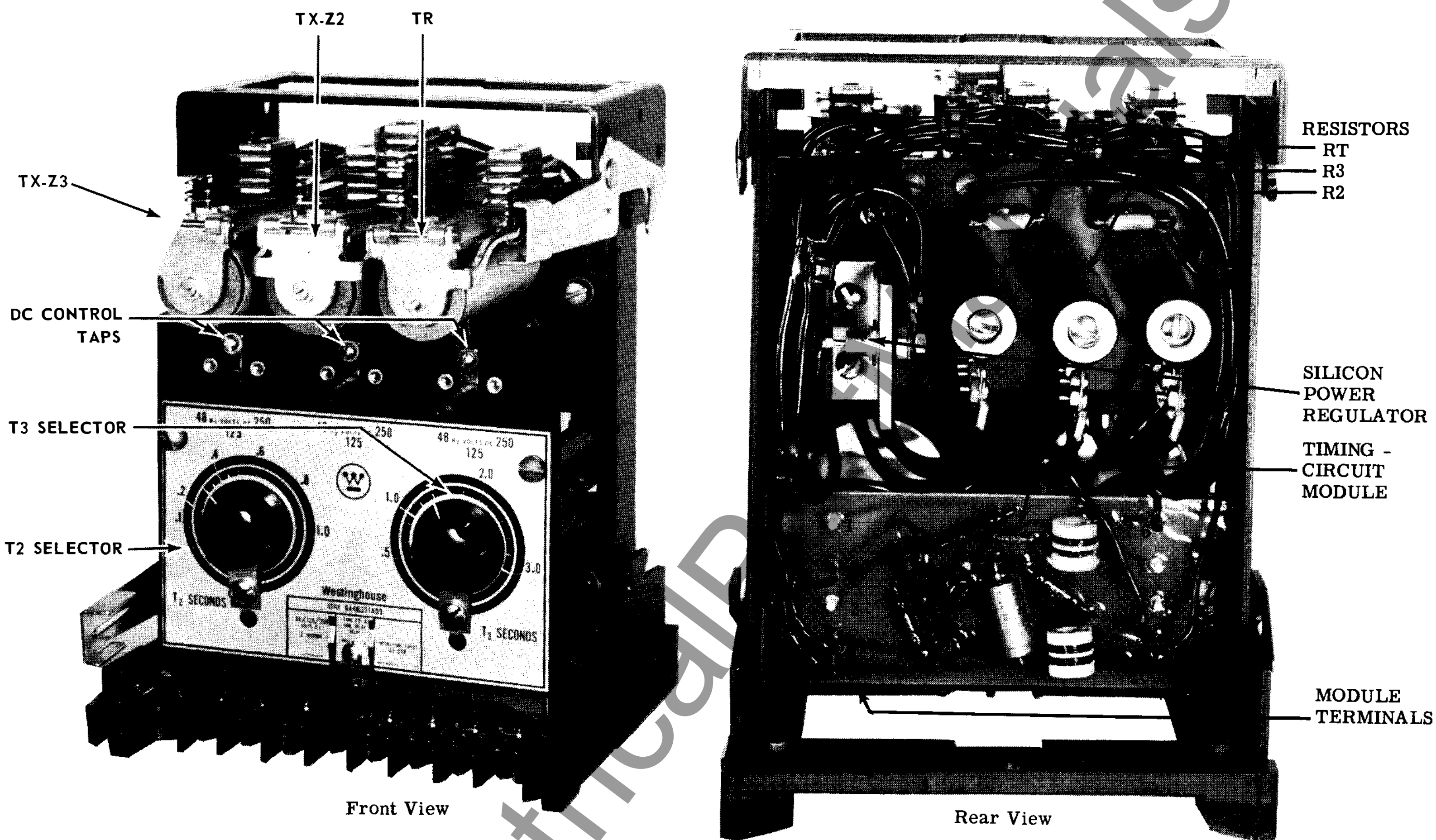
For a zone 2 fault, both zone 2 and zone 3 KD contacts close, energizing both TX-Z2 and TX-Z3. This completes the D. C. reference voltage circuit through DZ_1. The time delay circuit is energized through rheostat T_2. When the time delay is completed, telephone relay, TR, is energized and completes the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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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



Front View

Rear View

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

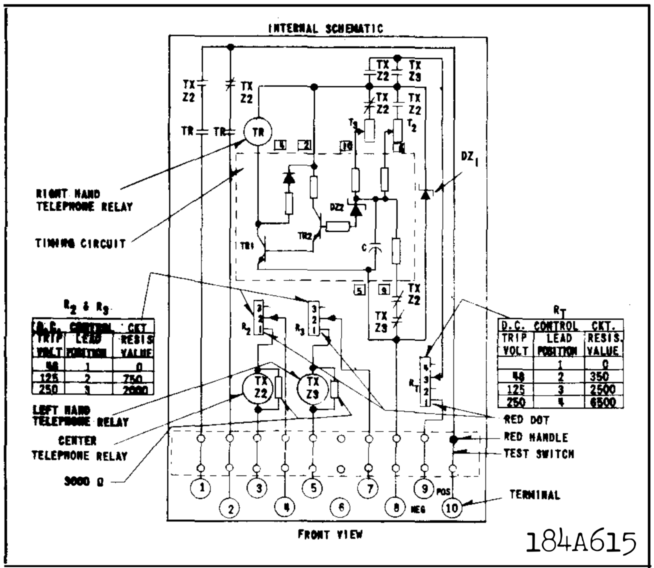


Fig.2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)

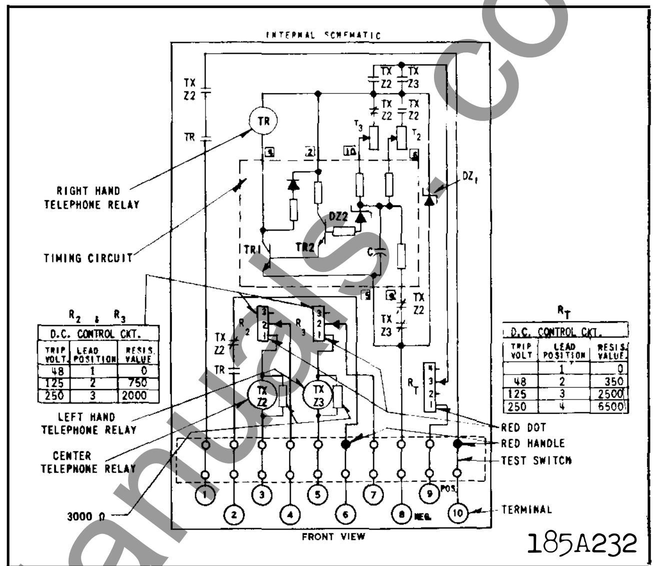


Fig.3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. — 1.0 sec.; 0.1 — 1.0 sec.

Zone 3: 0.5 sec. — 3.0 sec.; 0.3 — 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less

TX-Z2 and TX-Z3 — Drop Out Time: 0.06 sec. or less

Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

For the relay with slow dropout the reset time is:

TX — Z2 dropout time = 0.45 — .075 sec.

TX — Z3 dropout time = .090 — 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

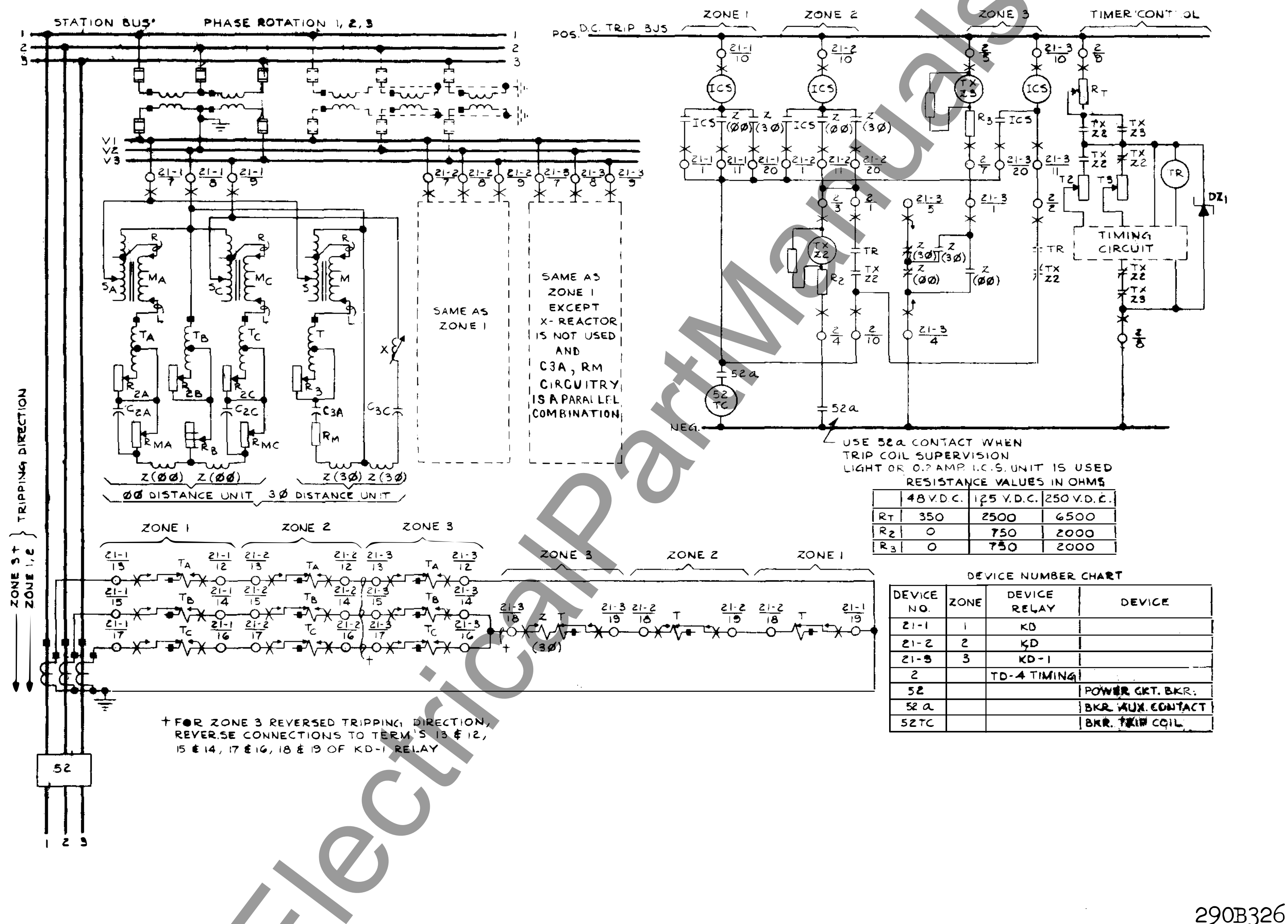
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



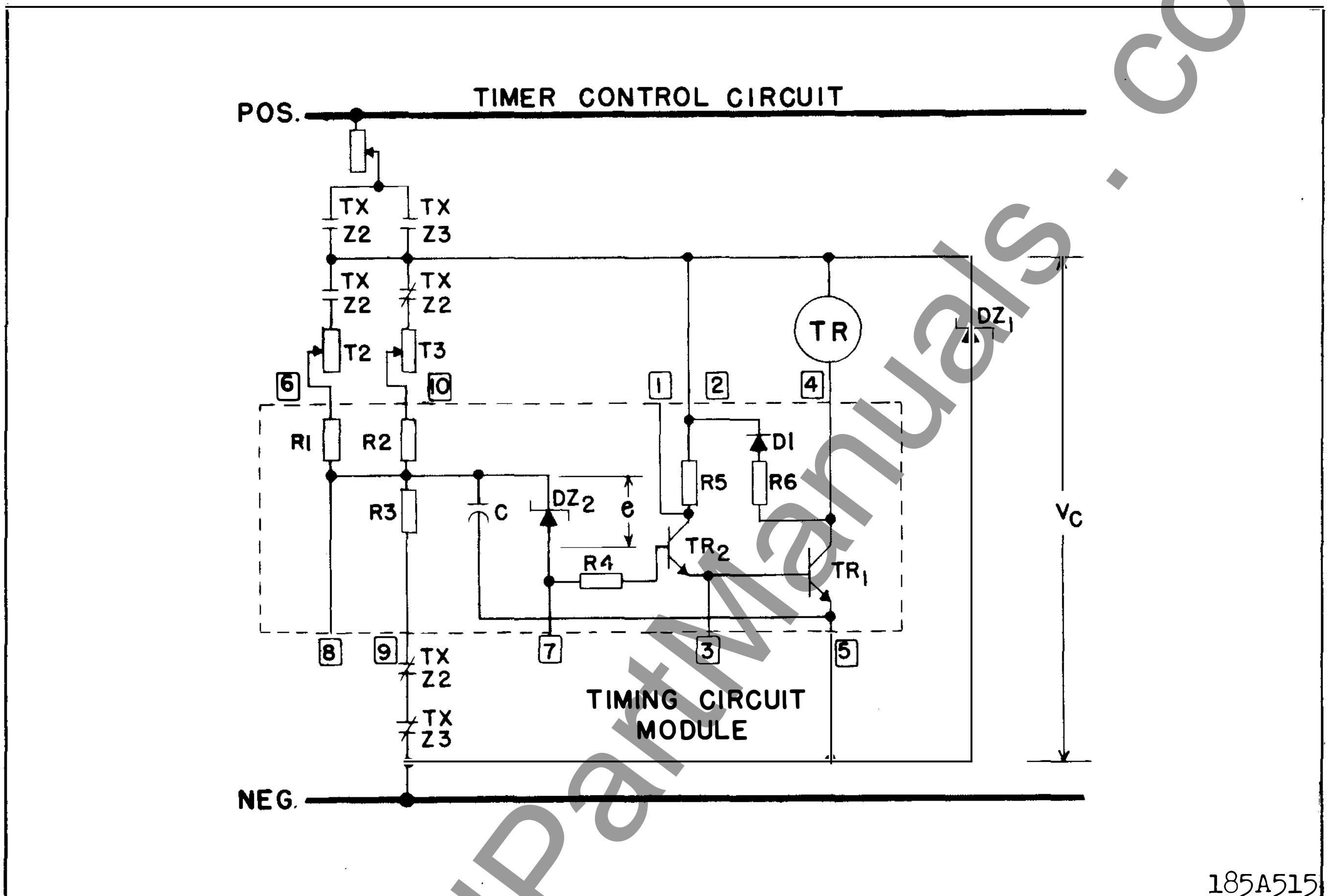
RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

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

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



* *Fig. 5. Timer Control Circuit*

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat *	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

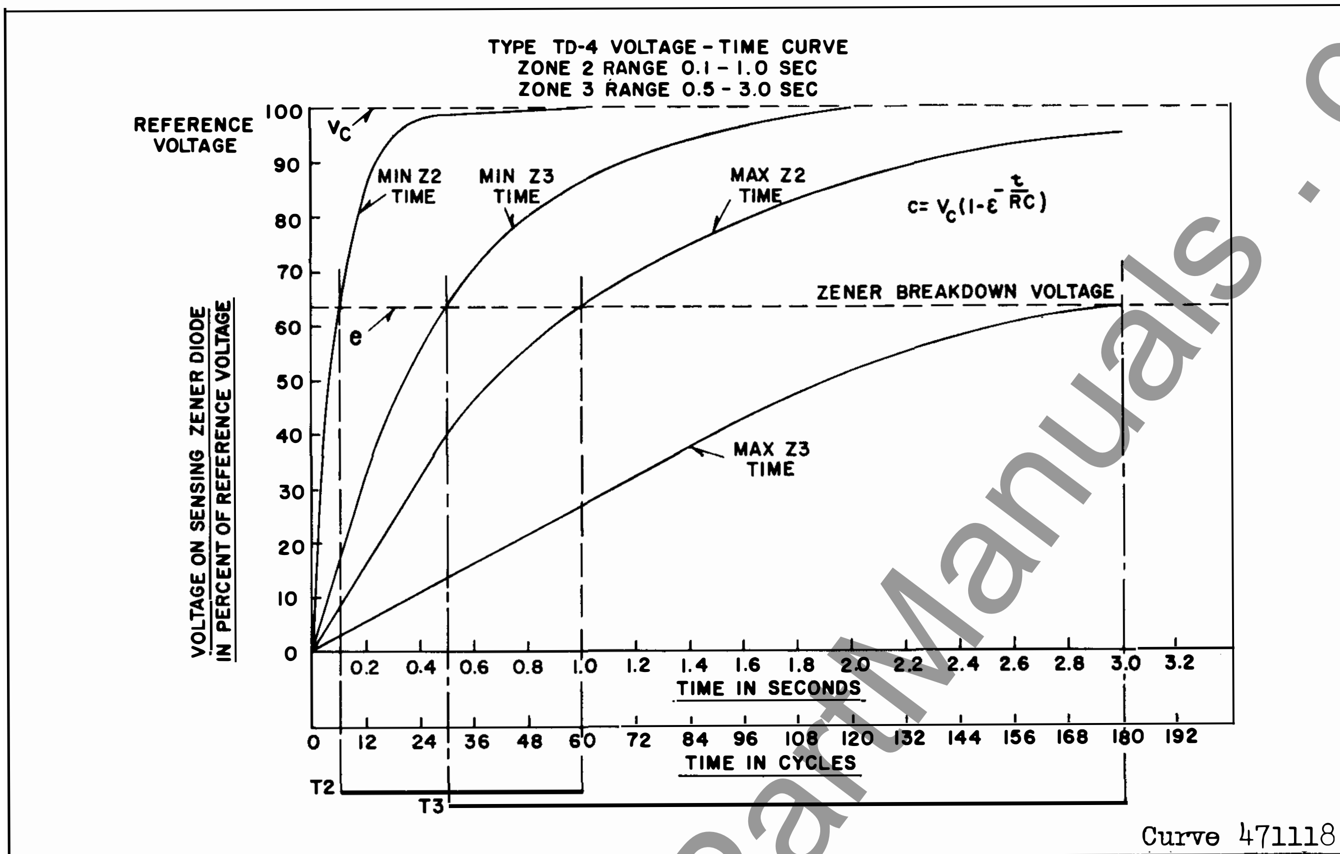


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

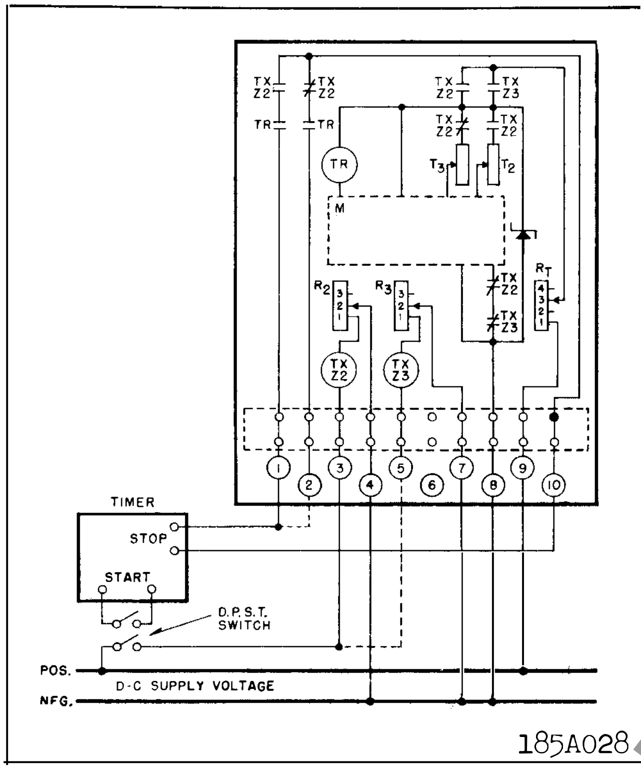


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms (.5-3.0 Sec.) * 0-50,000 ohms (.3-1.5 Sec.)
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

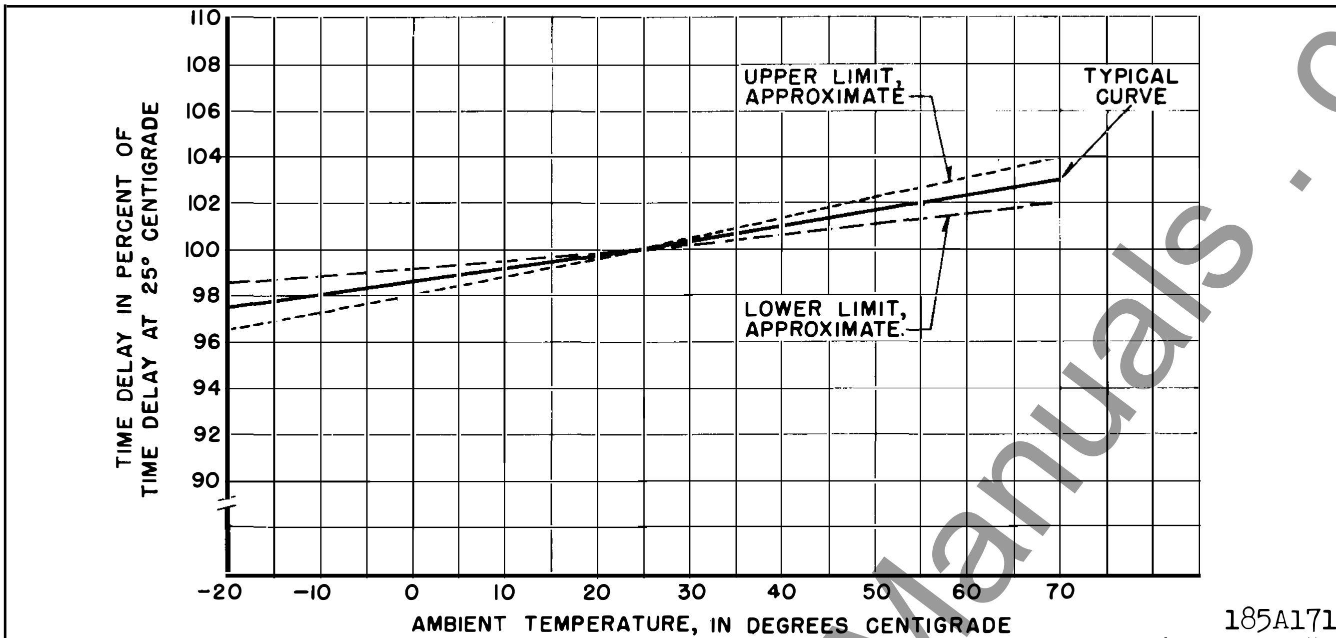


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

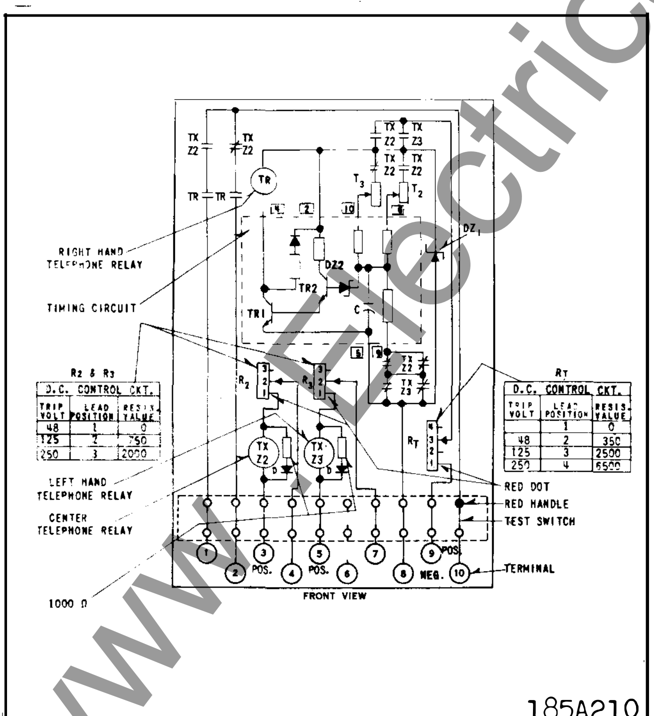
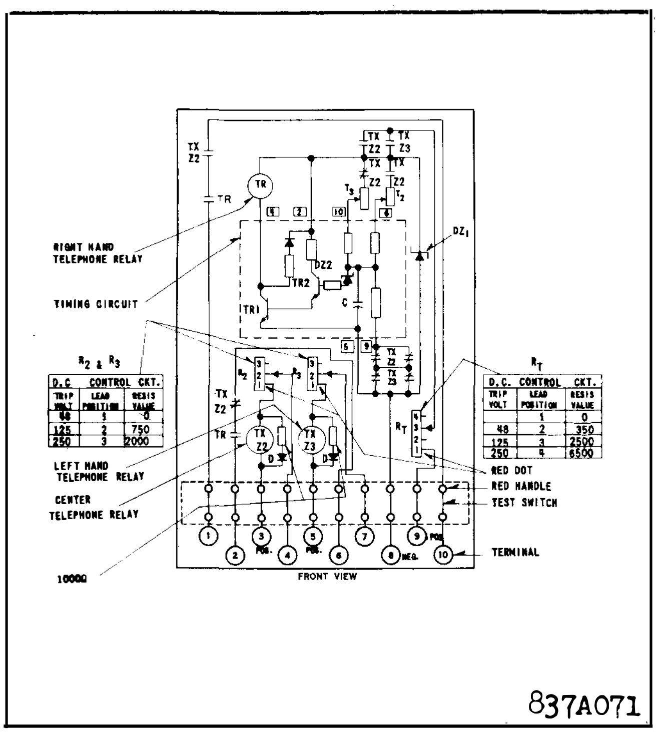


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).



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

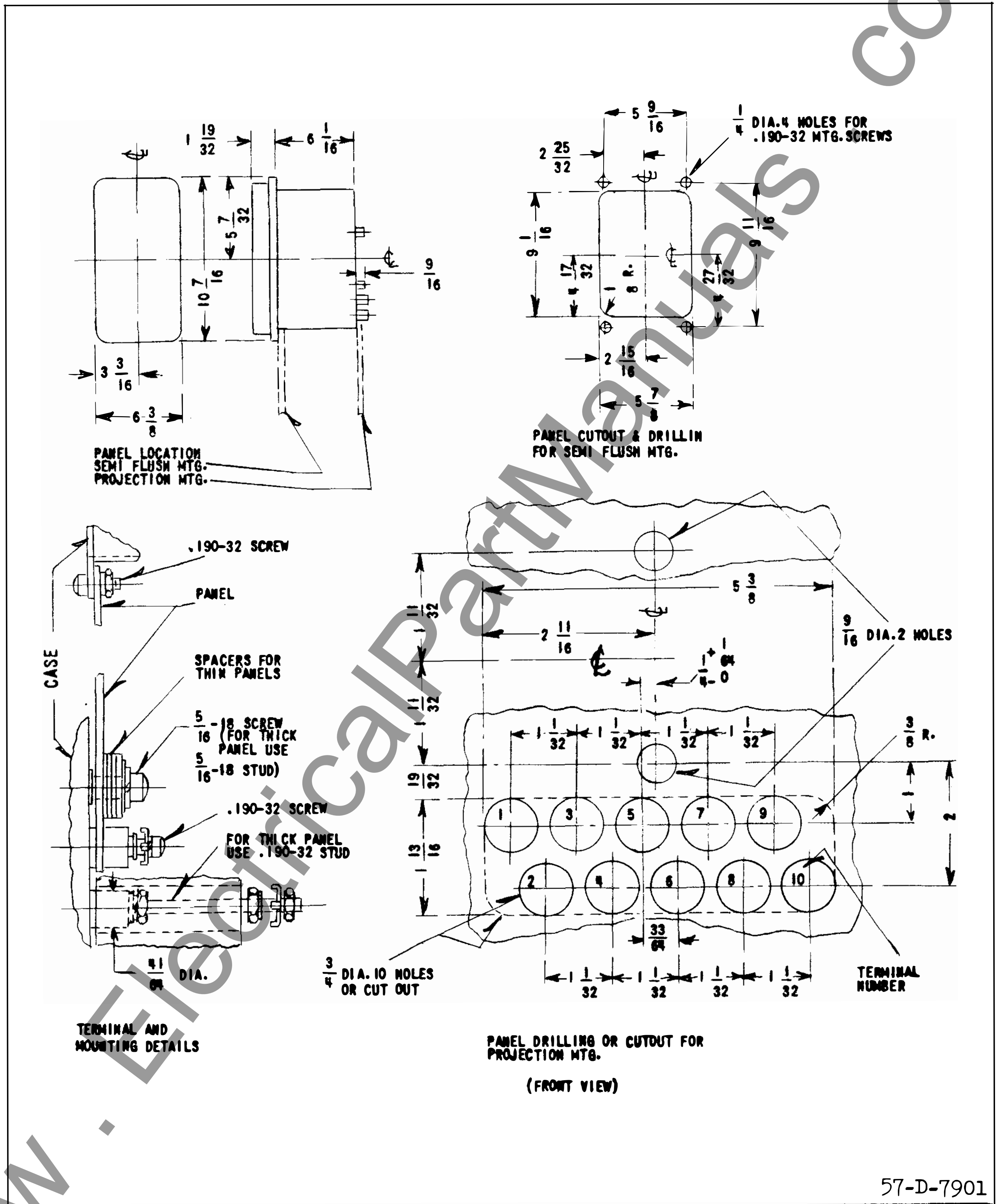


Fig.11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

* TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL (See Int. Schem. and also Fig. 5)	TIME RANGE	DESCRIPTION	STYLE NO.
TX22	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TX23	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TR	All	Telephone Relay, 500 ohm coil	407C280H09
R_T	All	Resistor, 25 watts, 6500 ohms, with tap at 350 and 2500 ohms	184A651H01
R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40 K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50 K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100 K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000r	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000r	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

The type TD-4 relay consists of an auxiliary circuit for initiating the time delay, a reference voltage circuit, and a time delay circuit.

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

When capacitor C changes to the voltage value e, DZ_2 breaks down to provide base drive for transistor TR_4 causing it to conduct. Emitter current of TR_2 provides base drive for transistor TR_1. Transistor TR_1 conducts, energizing output relay TR to the trip the breaker.

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

SUPERSEDES I.L. 41-579B
Complete Revision

EFFECTIVE SEPTEMBER 1961

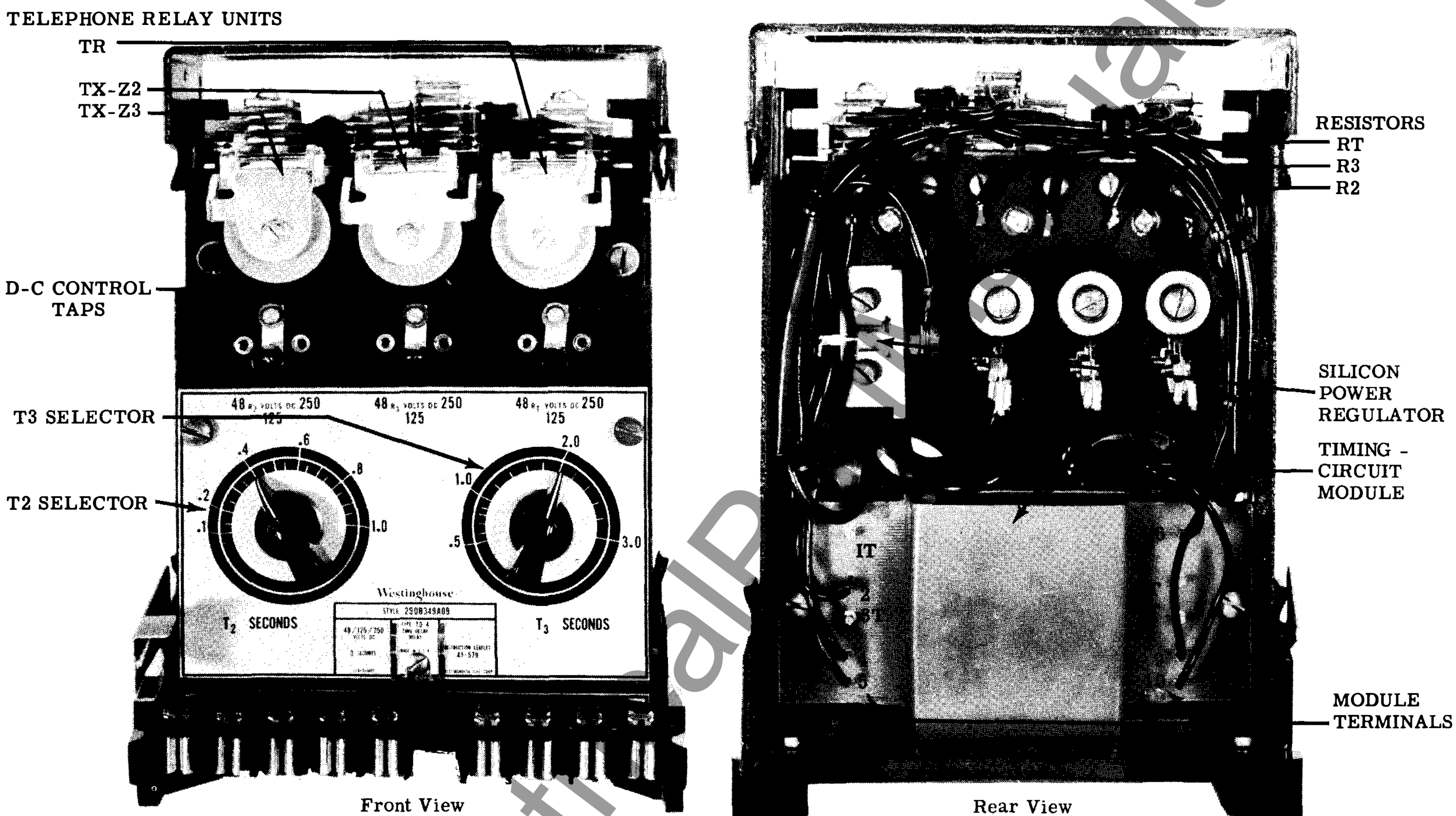


Fig. 1. Type TD-4 Relay without case.

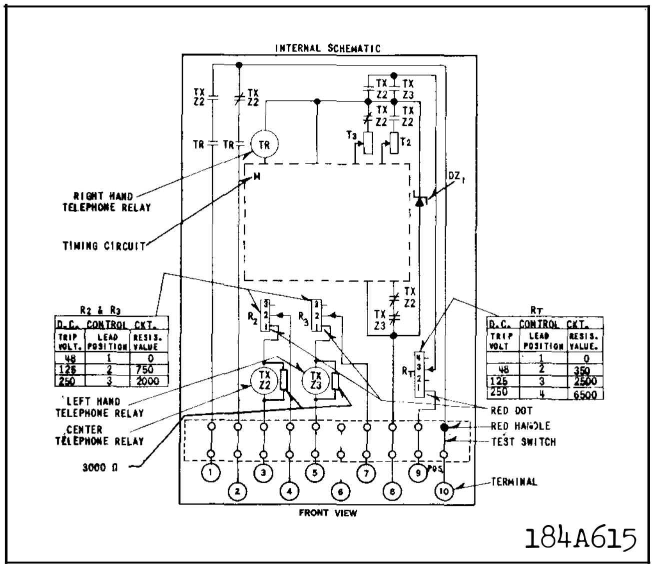


Fig. 2. Internal Schematic of S#290B349A09 TD-4 Relay in FT21 case. (Common trip circuits)

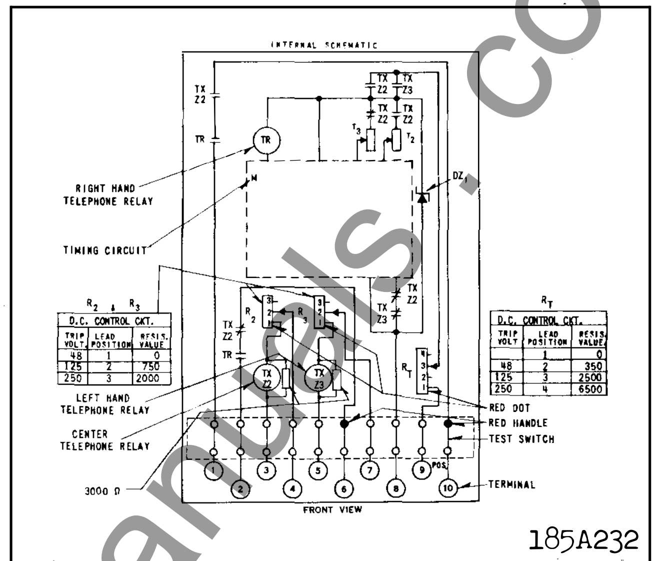


Fig. 3. Internal Schematic S#290B349A10 TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. – 1.0 sec.
Zone 3: 0.5 sec. – 3.0 sec.

Reset Time

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

Voltage Rating

48, 125 or 250 volts d-c. The relay can stand 110% voltage continuously, up to 100°C.

Battery Drain

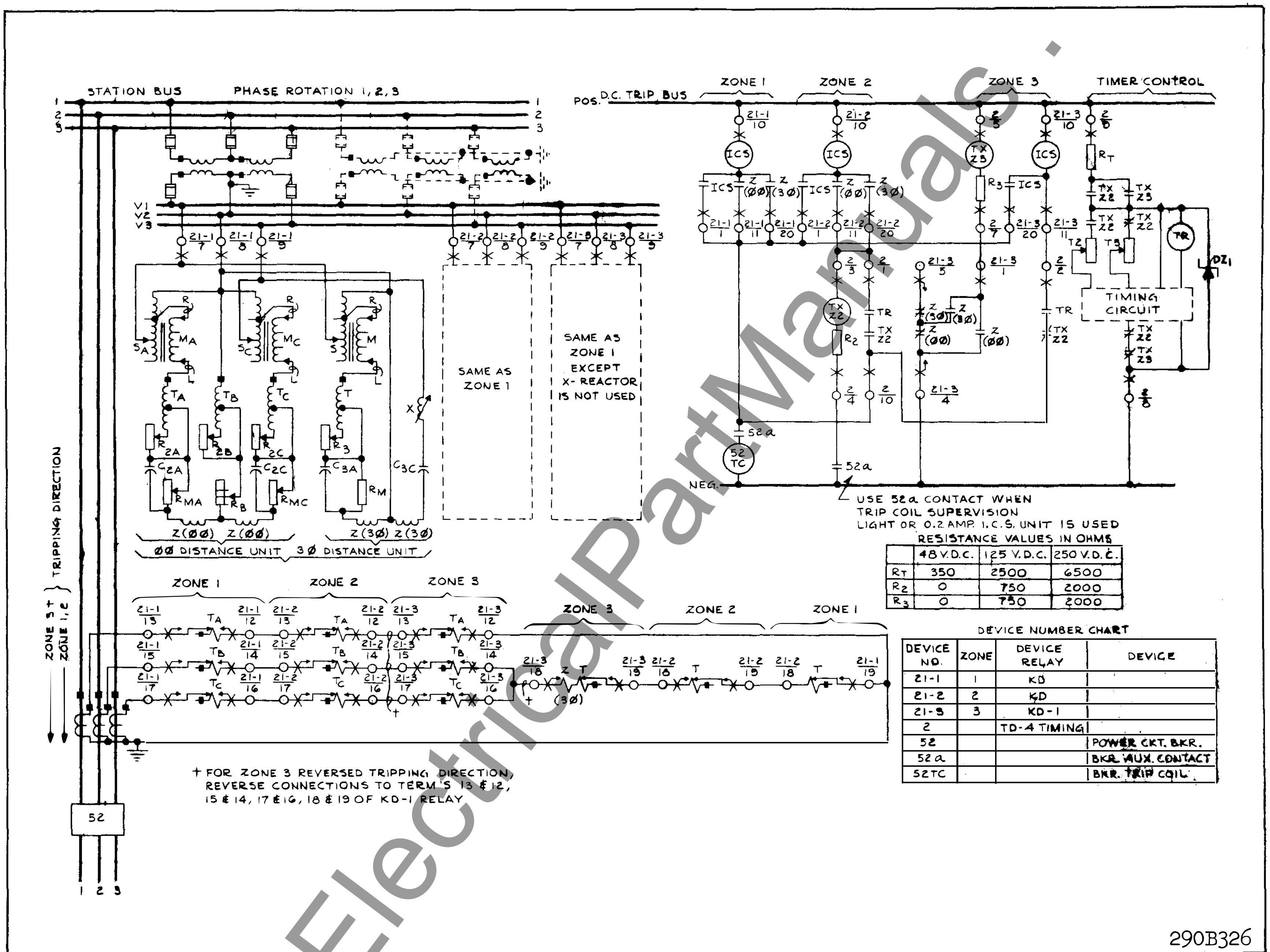
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

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

Fig. 4. External Schematic of S#290B349A09 Type TD-4 Relay

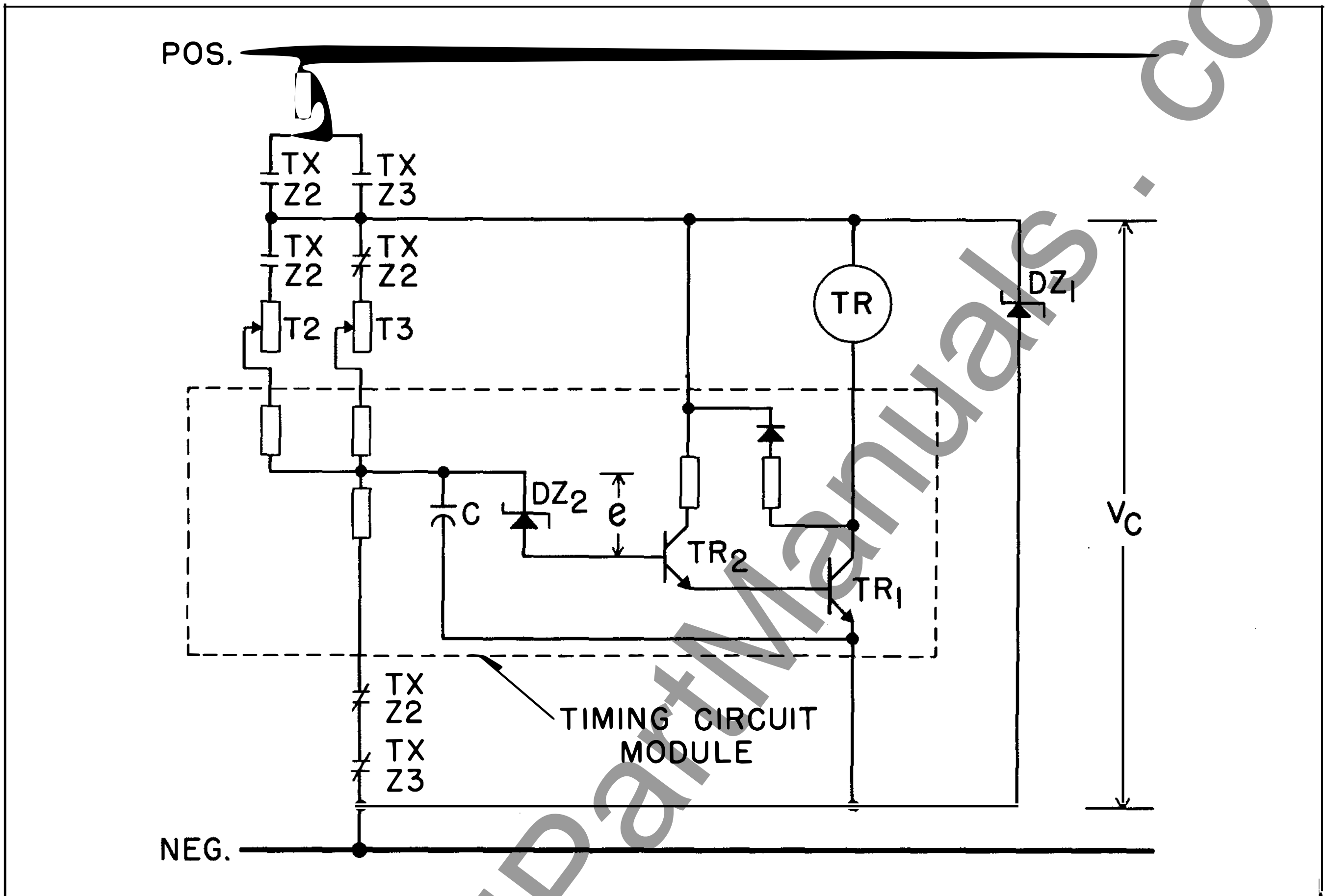


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

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

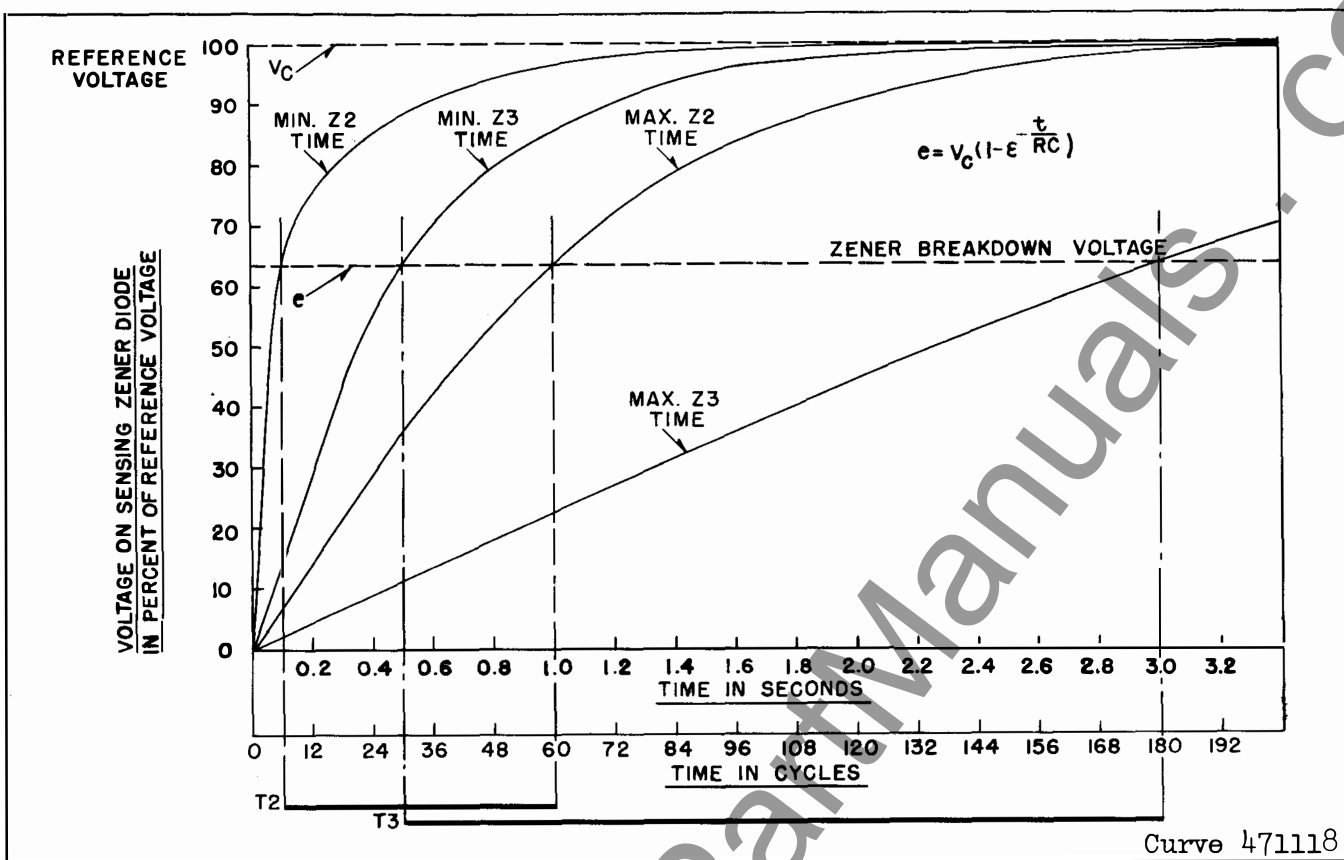


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

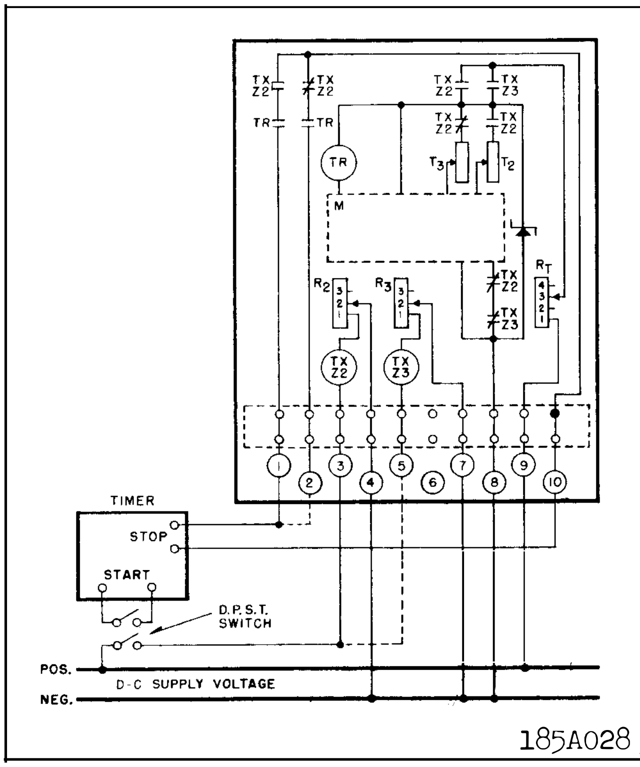


Fig. 7. Test Circuit for S#290B349A09 Type TD-4 Relay. (Jumper terminals 6 and 10 when testing S#290B349 A10)

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0 - 400,000 ohms (TX-Z2 operated)
T_3	2 and 10	0 - 100,000 ohms
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

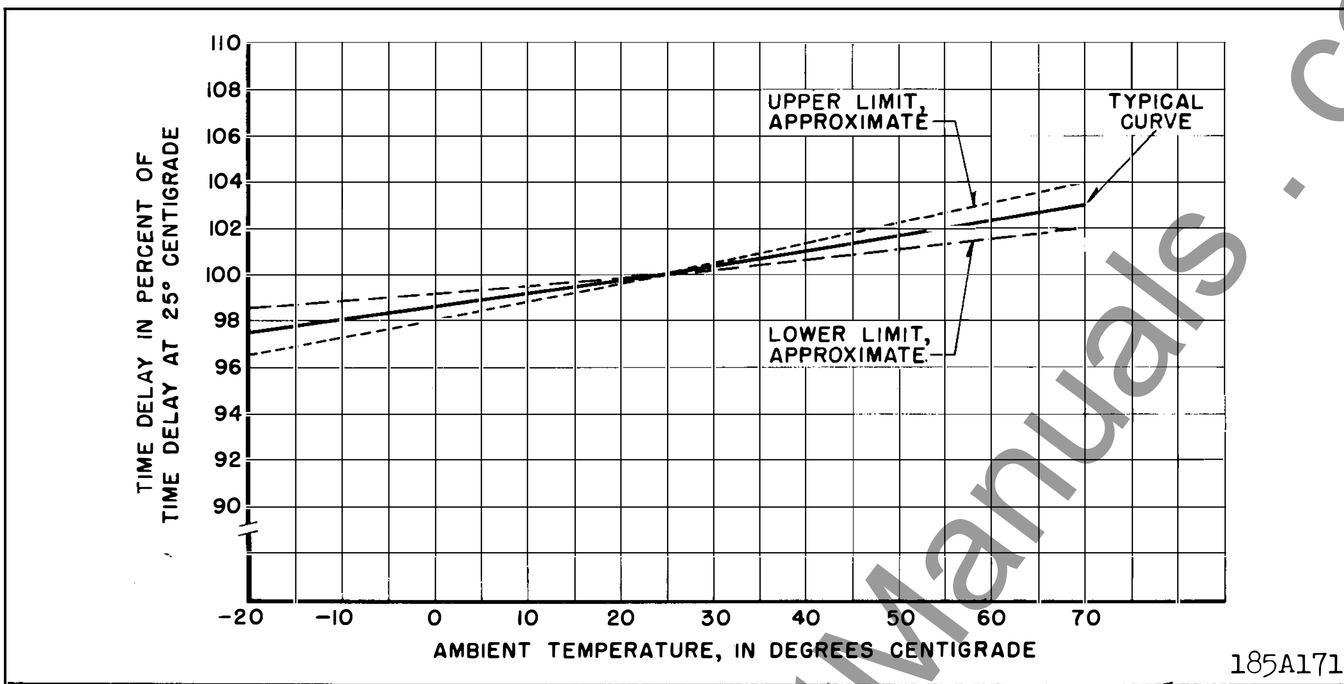


Fig. 8. Timing Variations with Temperature Changes

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

See section under Accuracy for discussion of this.

RENEWAL PARTS

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

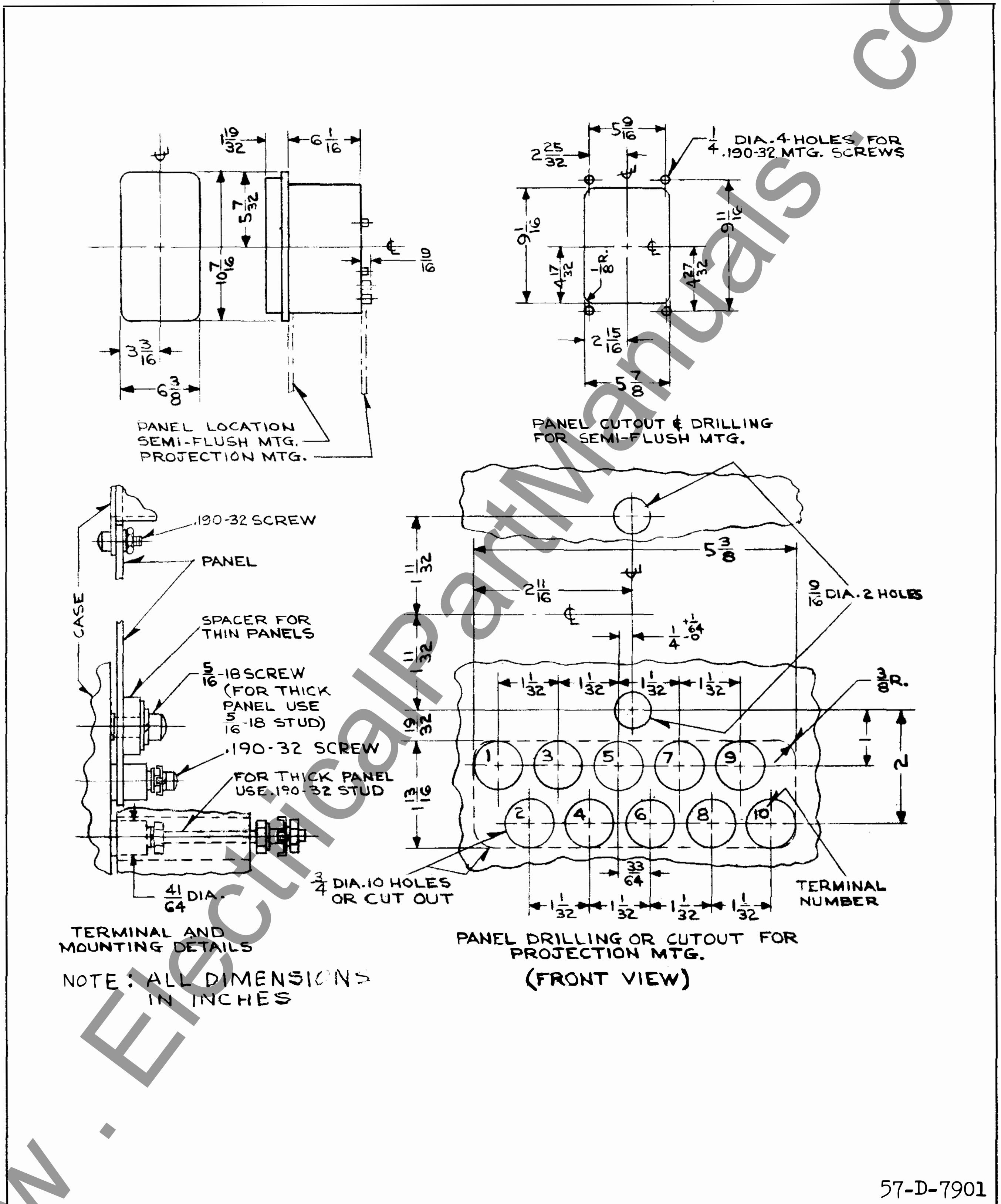


Fig. 9. Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

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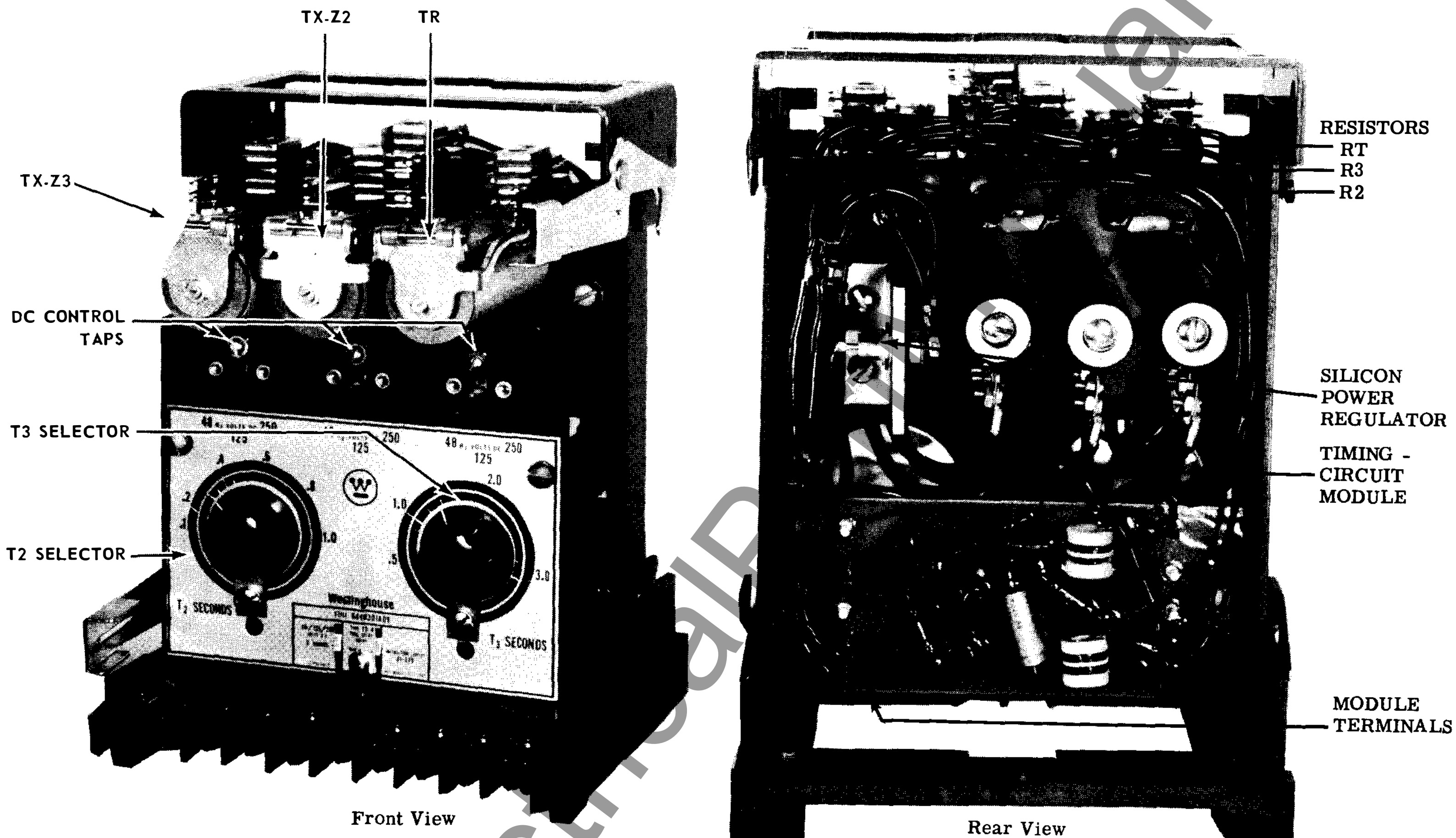
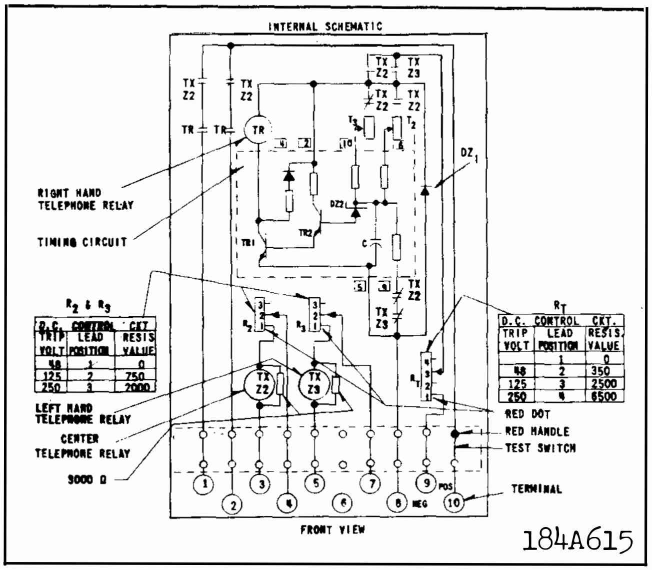
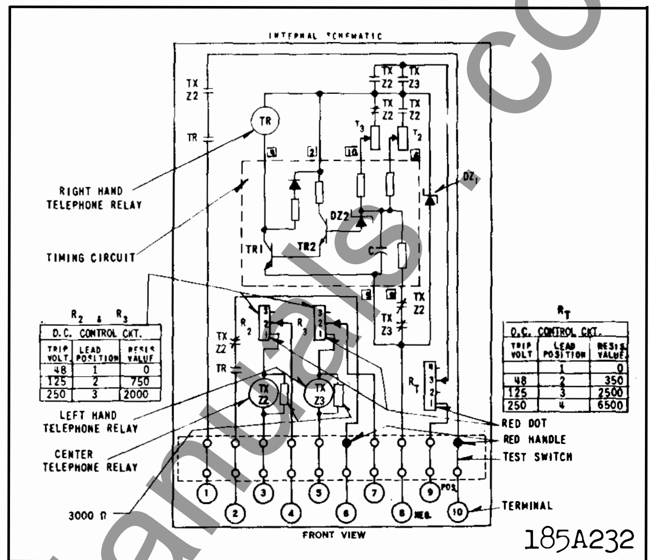


∗ *Fig. 1. Type TD-4 Relay without case.*



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



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

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

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

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

CHARACTERISTICS

* **Time Delay Range**

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

Reset Time

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

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

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

Voltage Rating Over The Temperature Range

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

Battery Drain

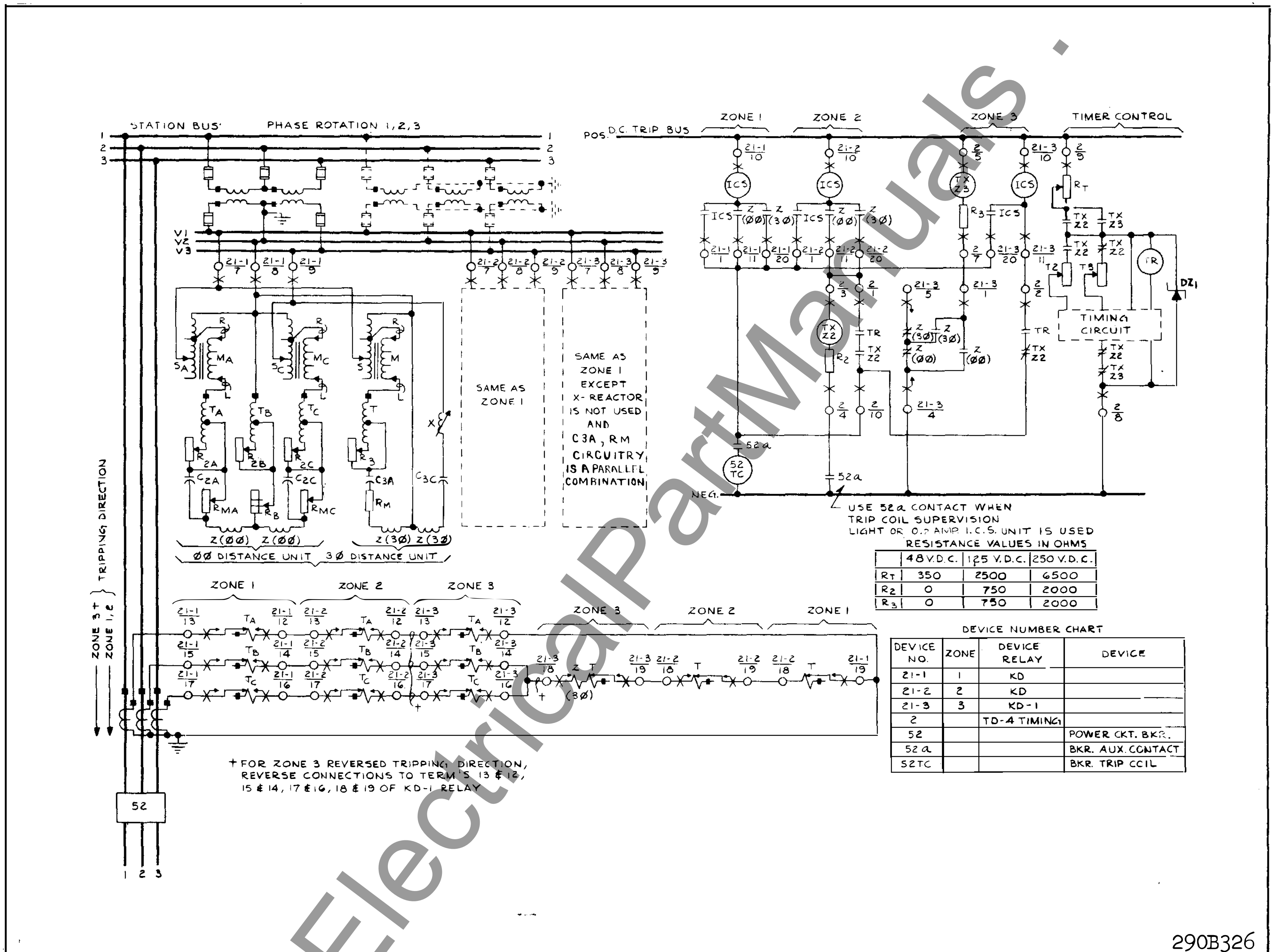
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

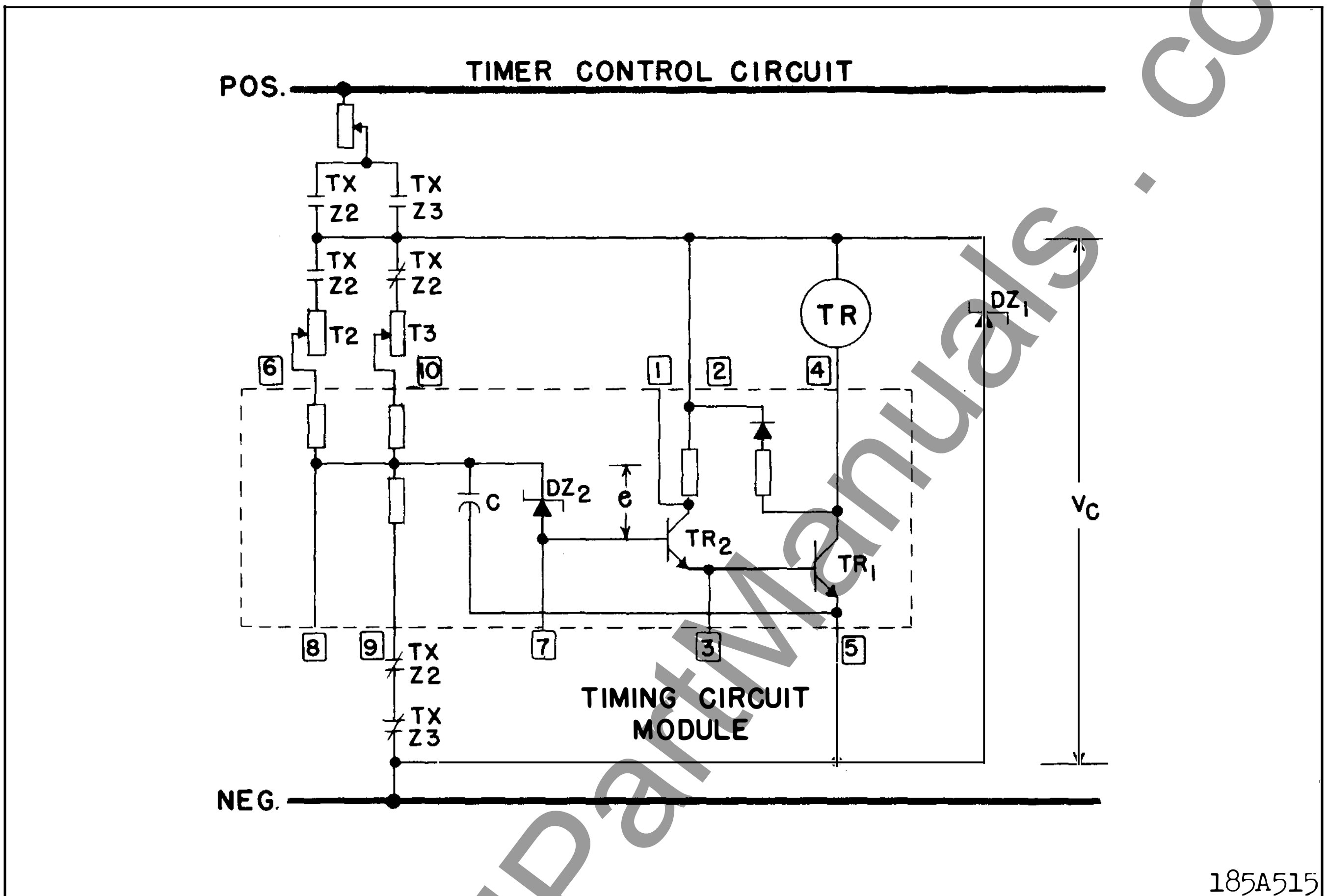
The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, and the ambient temperature. Self-heating has a negligible effect on the timing accuracy.

(1) Nominal Setting

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



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



* *Fig. 5. Timer Control Circuit*

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

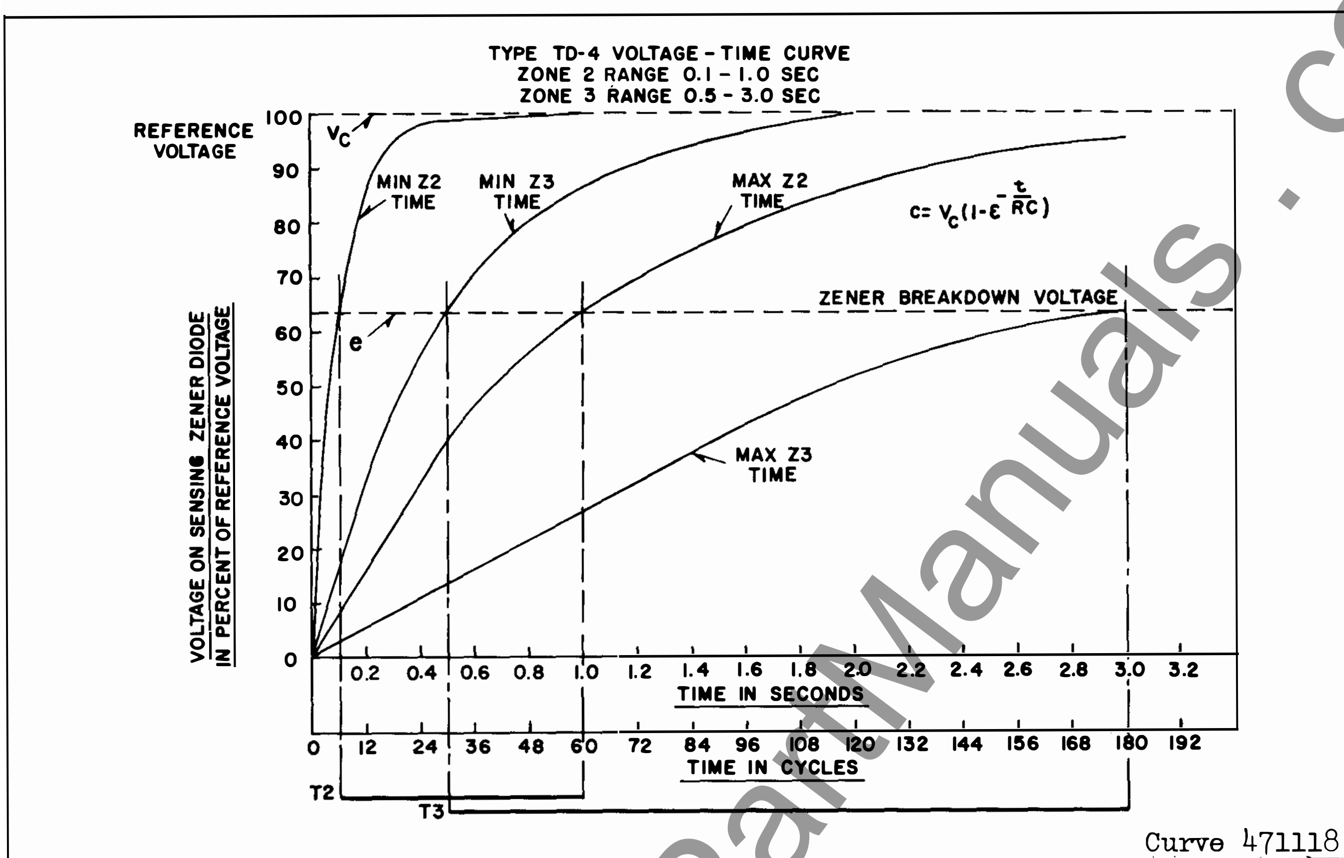
Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ±5 milliseconds for settings of .5 seconds or less, and no more than ±1% for settings above .5 seconds.

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

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



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

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

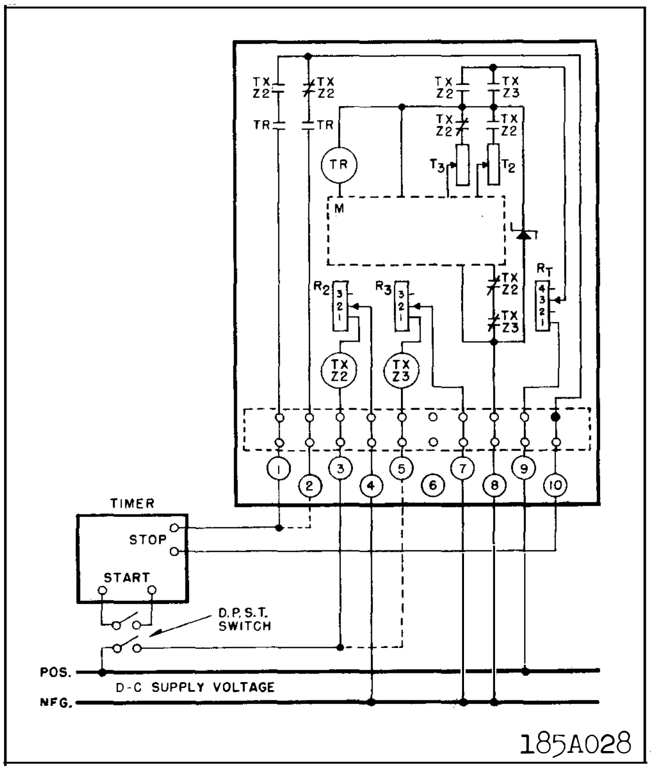
The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. Do not remove the knobs on the T_2 and T_3 rheostats unless the rheostats are to be replaced as this will upset the relay calibration.

Acceptance Tests

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

Routine Maintenance

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



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

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

Trouble Shooting Procedure

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

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

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

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

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

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

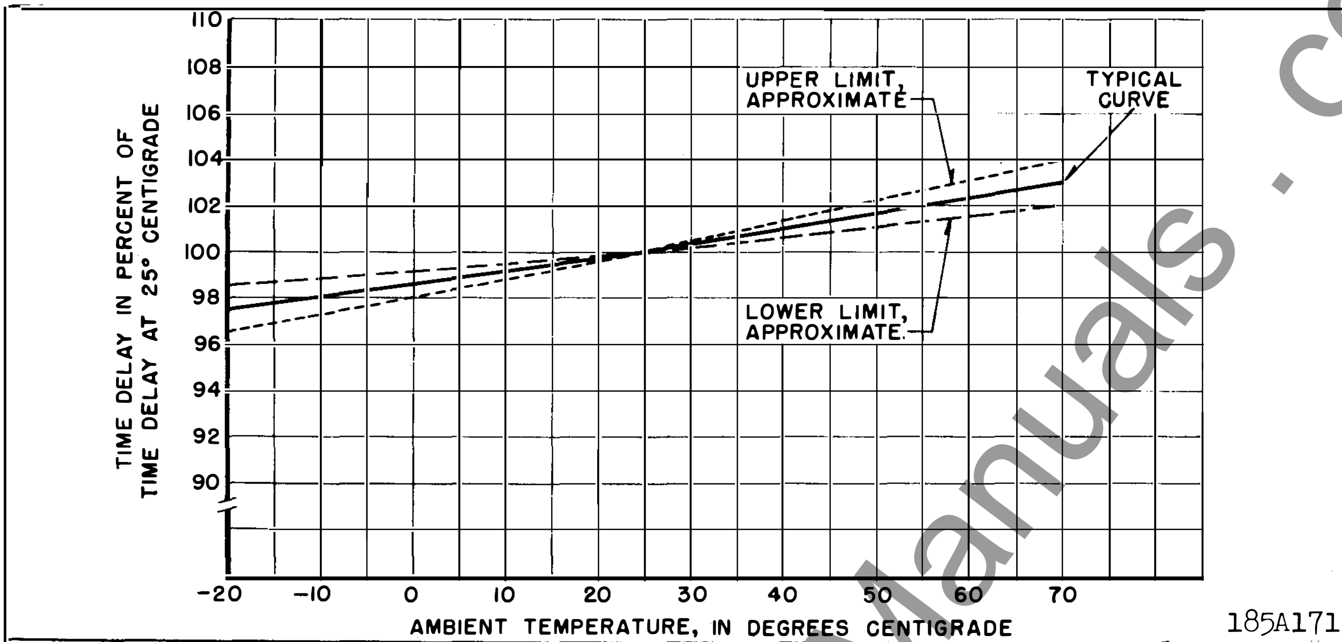
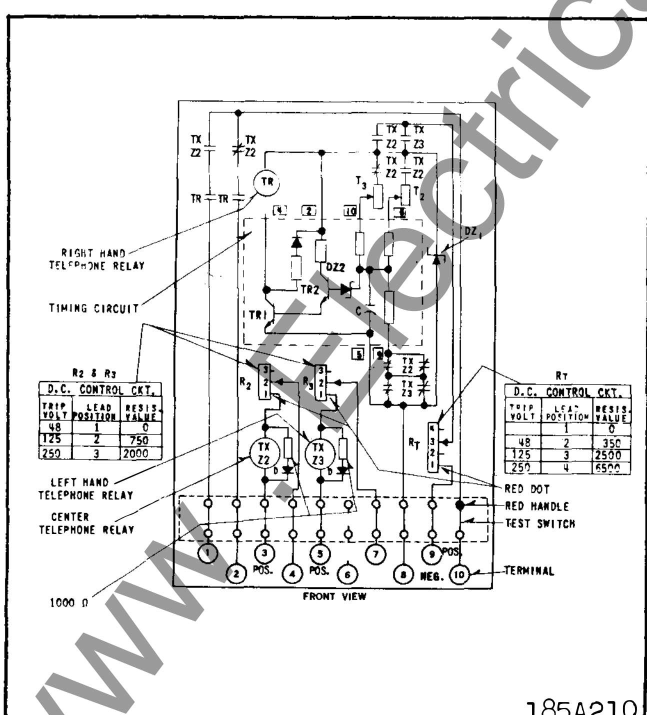


Fig. 8. Timing Variations with Temperature Changes

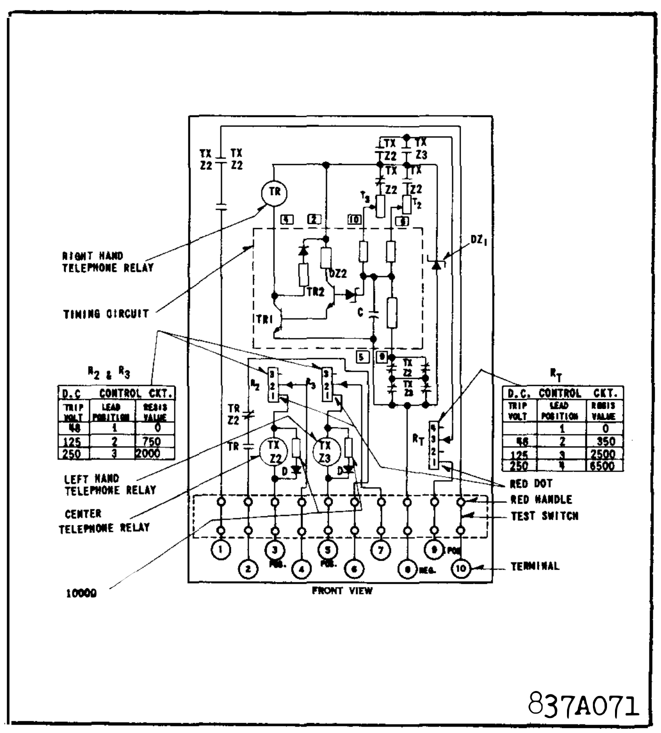
The first step should be to insure that the knob is approximately vertical for the mid-scale time time delay (.550 sec. for T_2 and 1.75 sec. for T_3 This will locate the calibration lines symmetrically around the scale plate. After centering and securely locking the knob on the rheostat shaft, new calibration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

RENEWAL PARTS

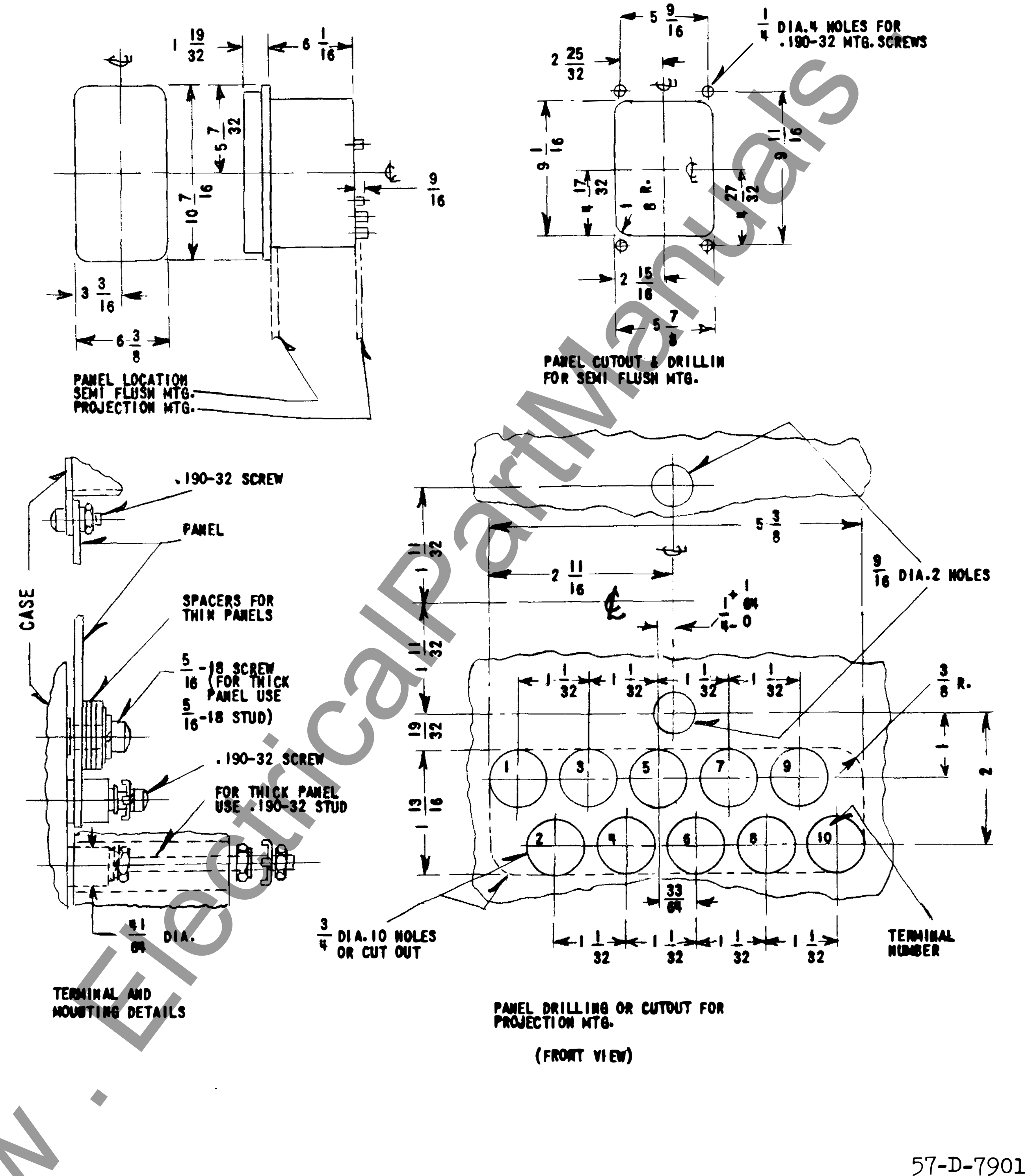
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



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



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



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

WESTINGHOUSE ELECTRIC CORPORATION

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

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

• OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

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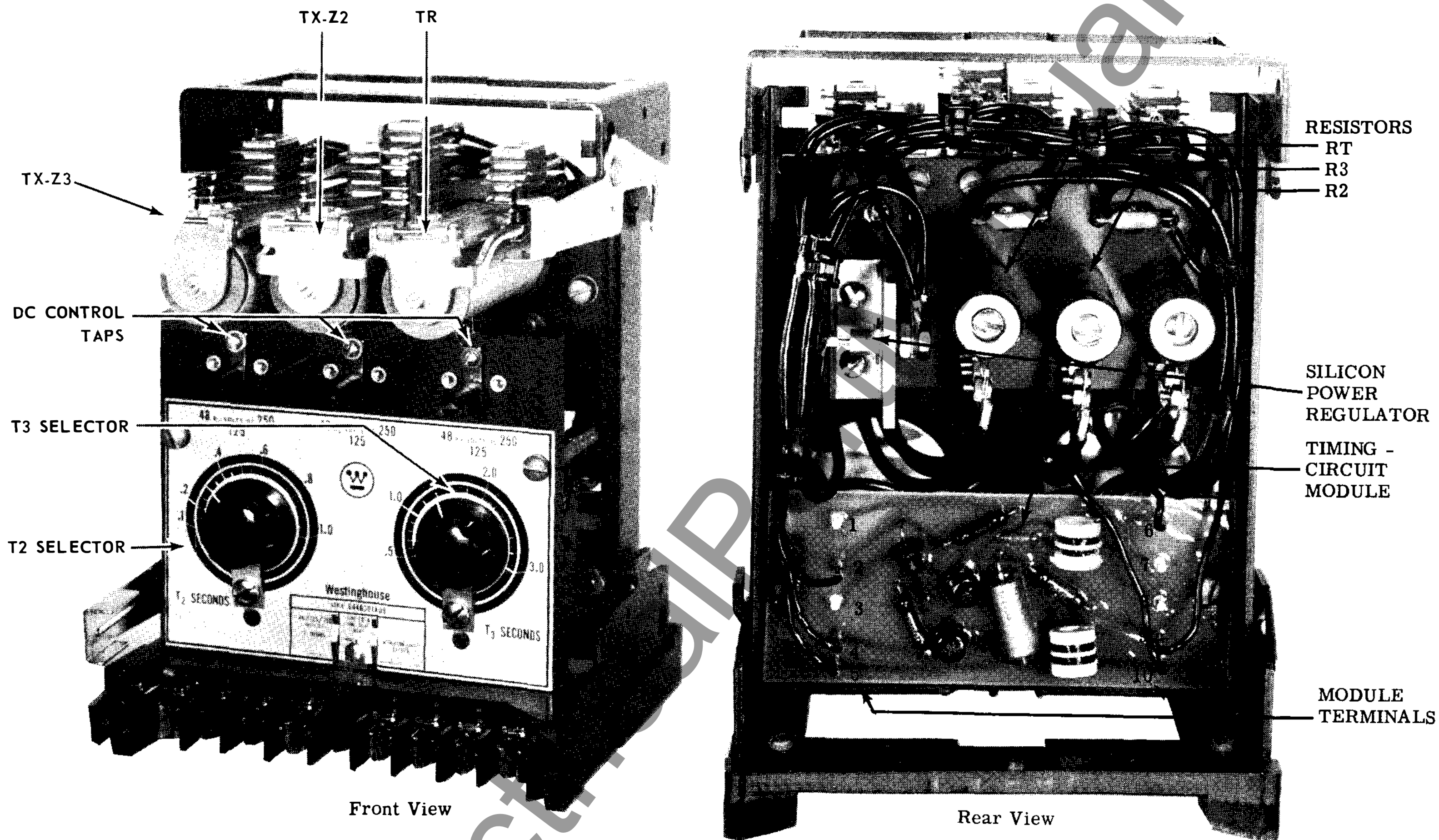


Fig. 1. Type TD-4 Relay without case.

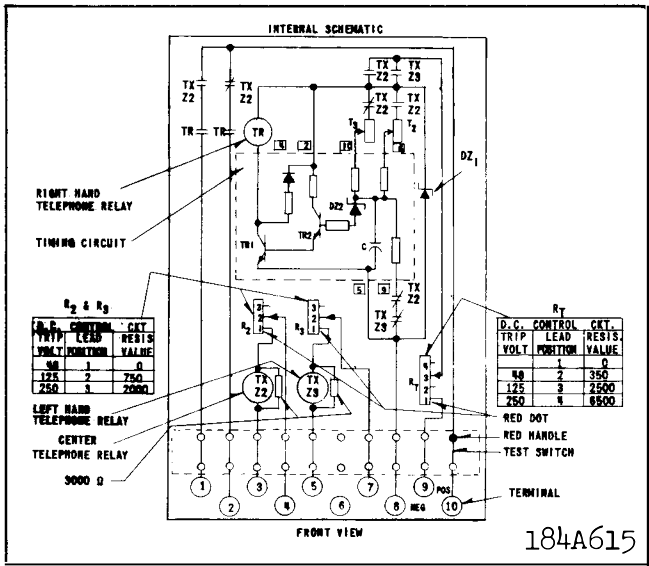


Fig.2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)

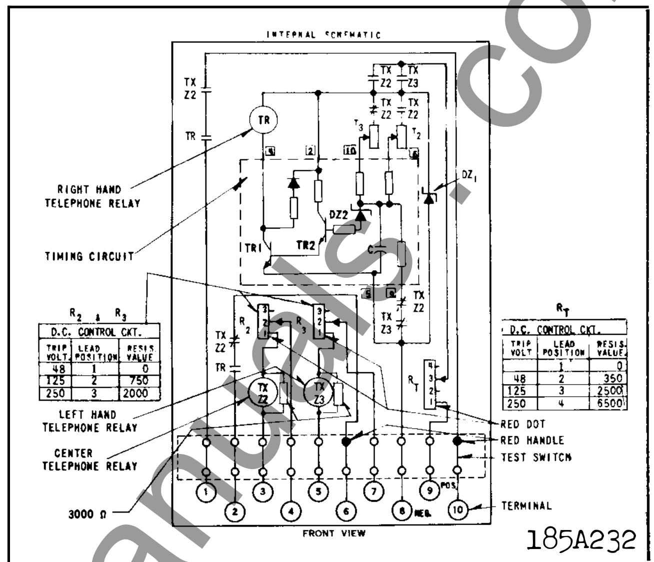


Fig.3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

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

Reset Time

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

For the relay with slow dropout the reset time is:

* TX – Z2 dropout time = .045 – .075 sec.
TX – Z3 dropout time = .090 – 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

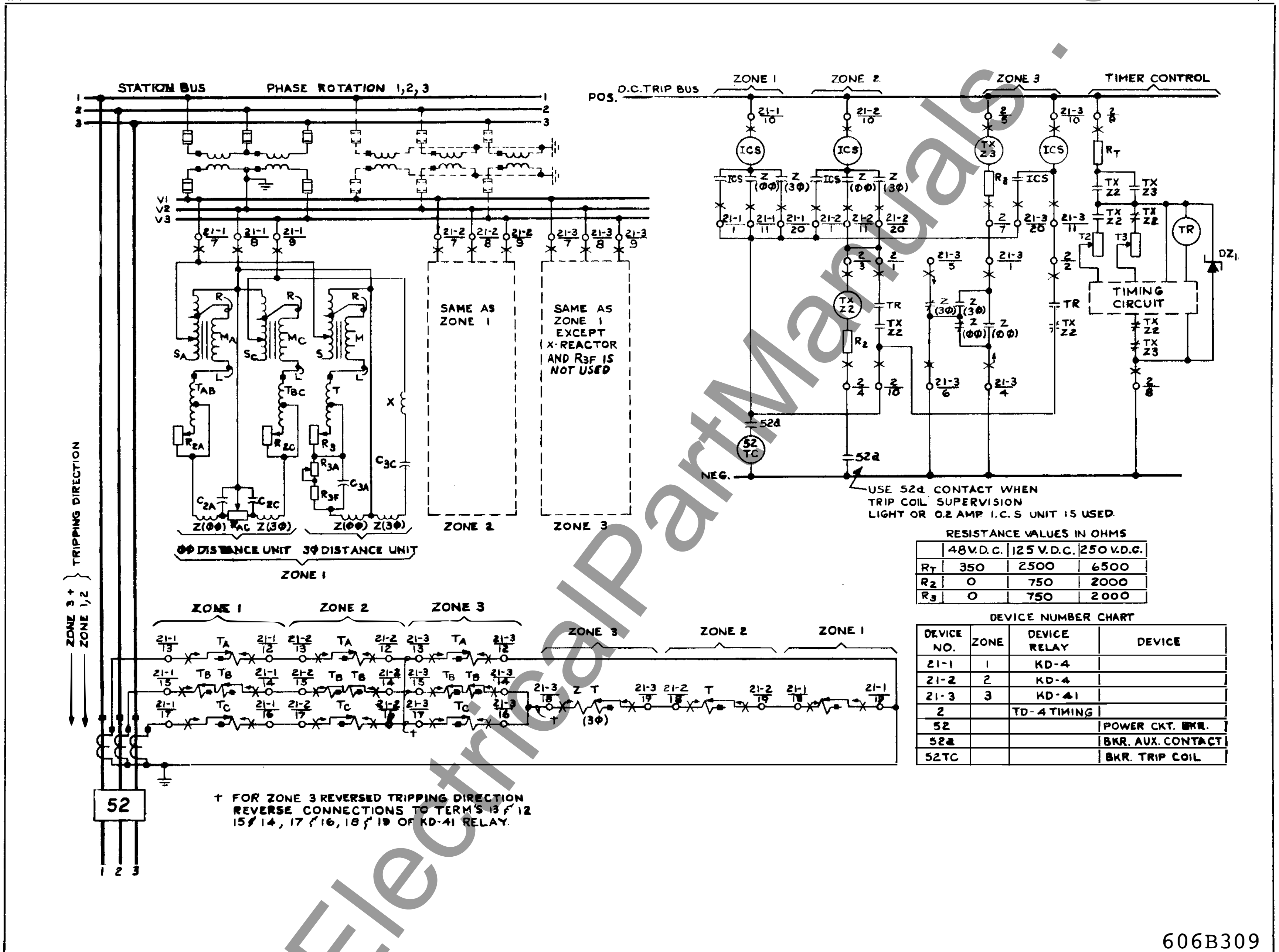
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD-4	
21-2	2	KD-4	
21-3	3	KD-41	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

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

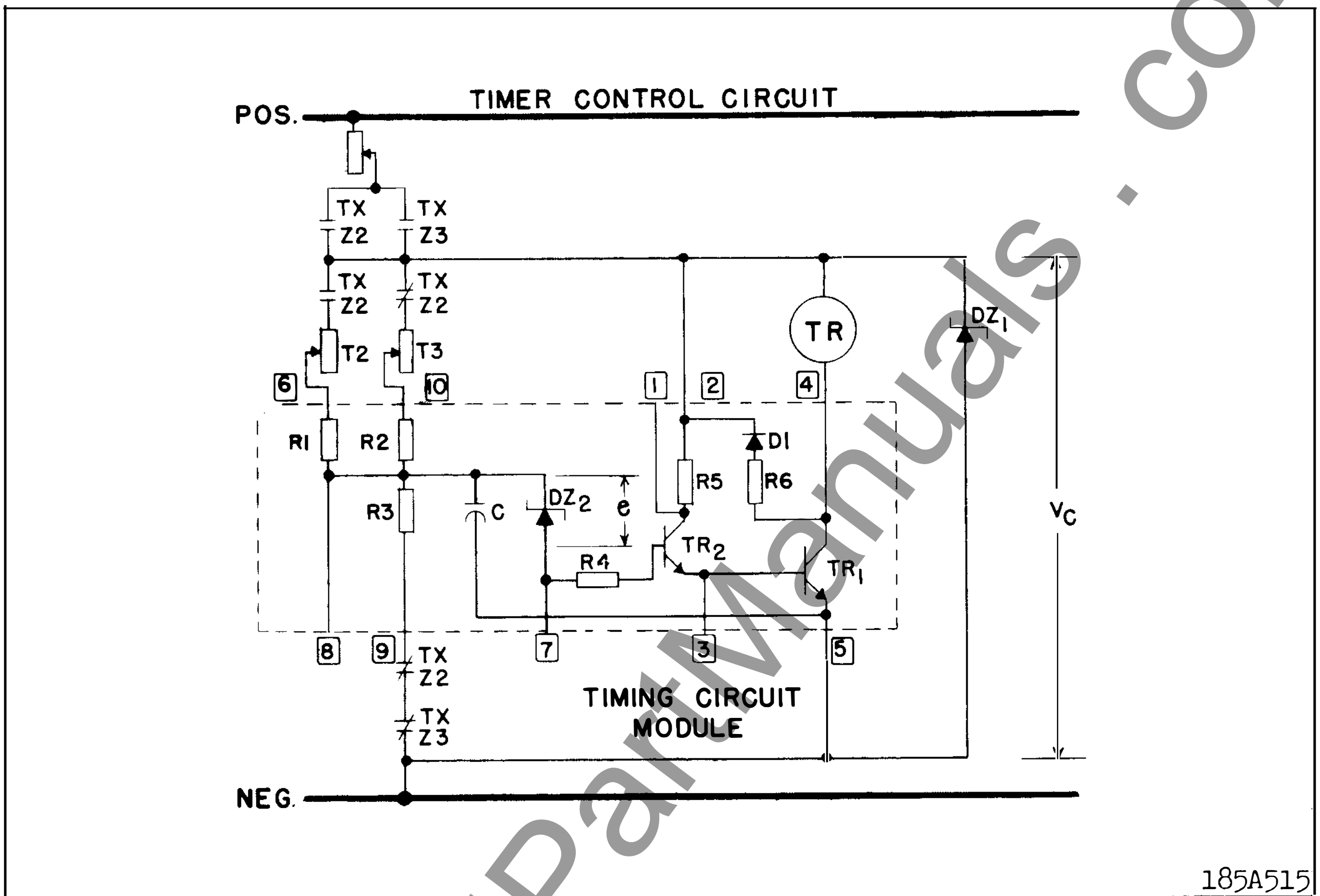


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– "
R_T Tapped Resistor	– "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

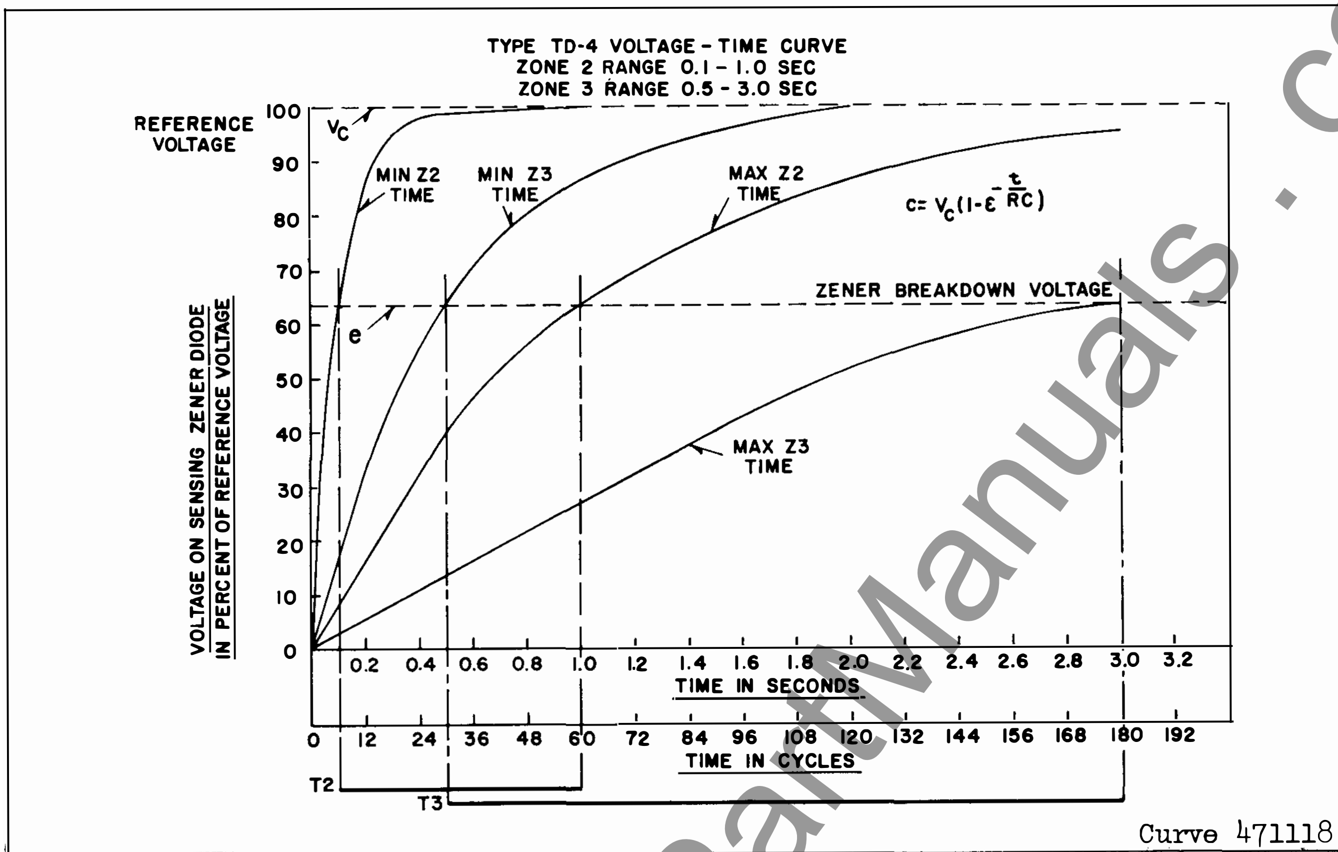


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

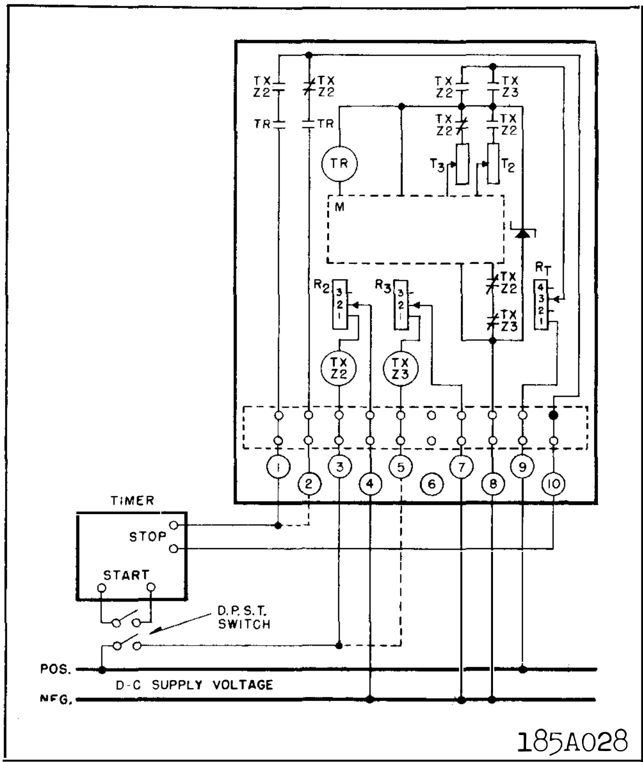


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-40,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms (.5-3.0 Sec.)
		0-50,000 ohms (.3-1.5 Sec.)
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

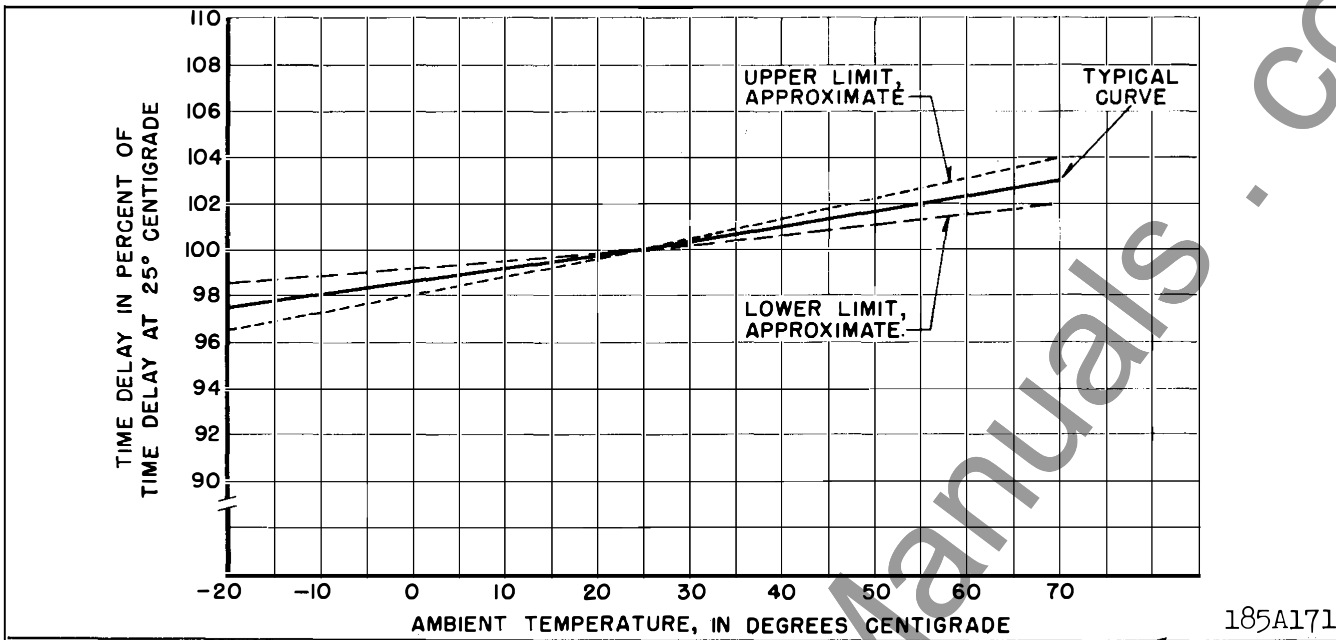


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

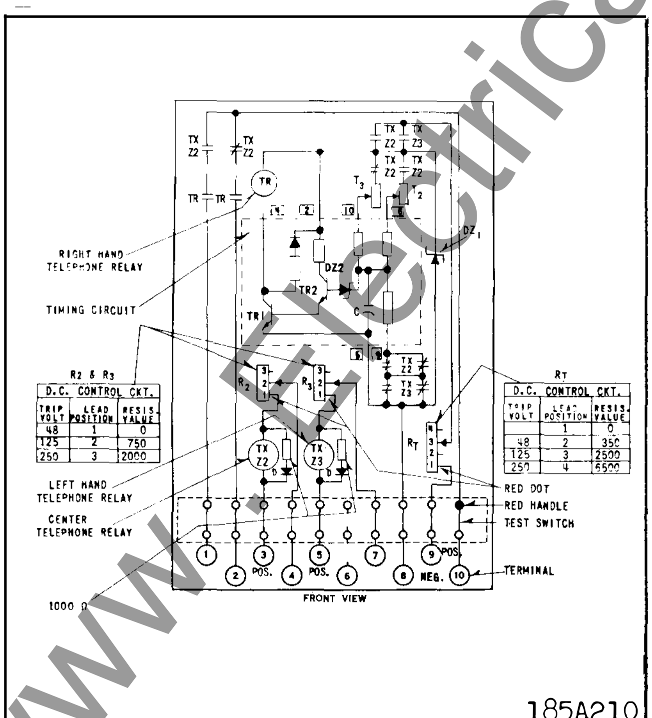


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).

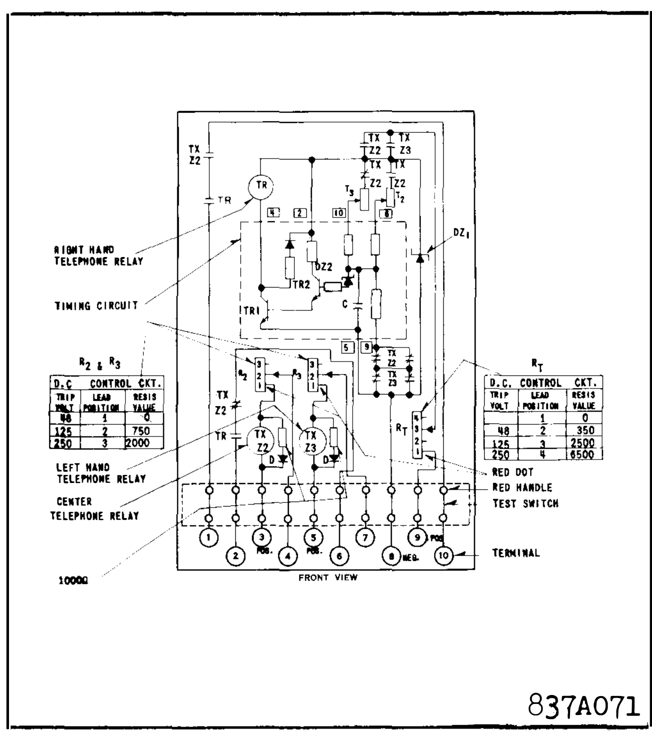


Fig. 10 Internal schematic of the type TD-4 relay with slow dropout relay (independent trip circuits).

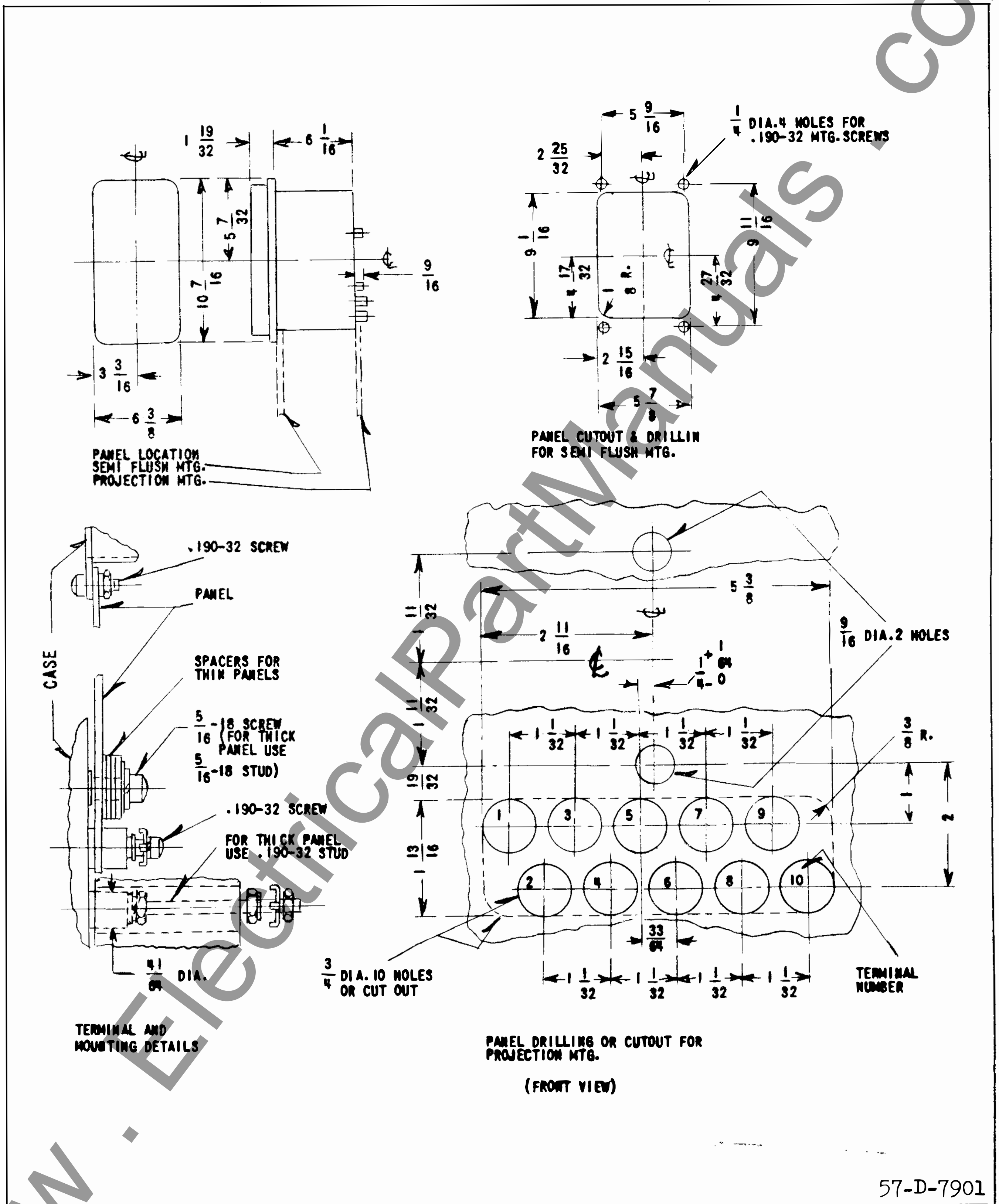


Fig. 11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL (See Int. Schem. and also Fig. 5)	TIME RANGE	DESCRIPTION	STYLE NO.
TX22	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TX23	All	Telephone relay, 500 ohm coil	Refer-Relay Style
TR	All	Telephone Relay, 500 ohm coil	407C280H09
R_T	All	Resistor, 25 watts, 6500 ohms, with tap at 350 and 2500 ohms	184A651H01
R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40 K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100 K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000r	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000r	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

EFFECTIVE JUNE 1971

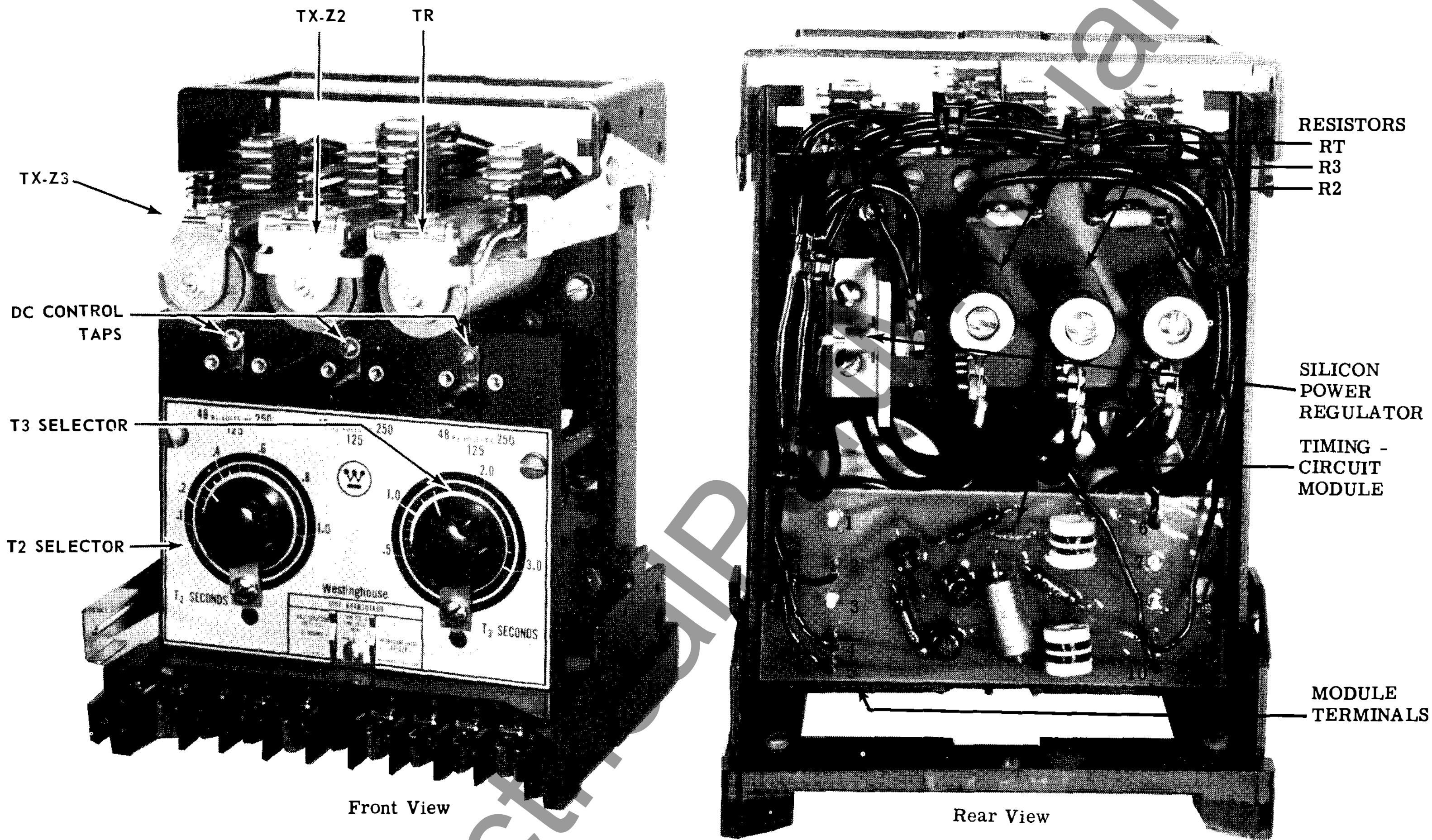


Fig. 1. Type TD-4 Relay without case.

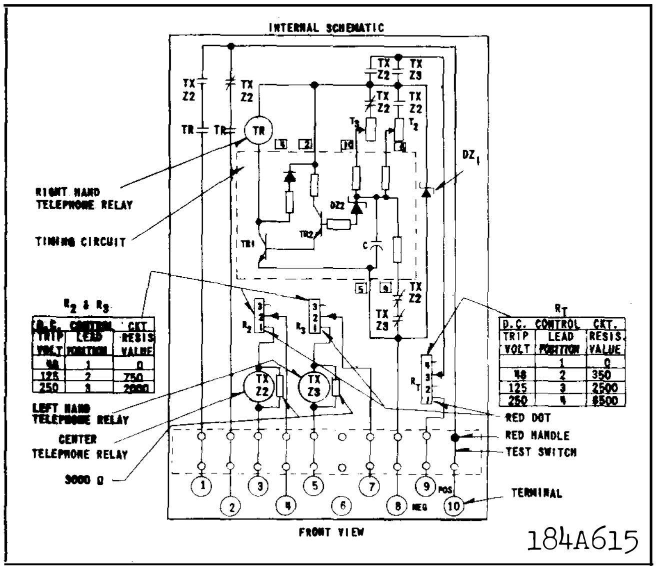


Fig. 2. Internal Schematic of the type TD-4 Relay in FT21 case. (Common trip circuits)

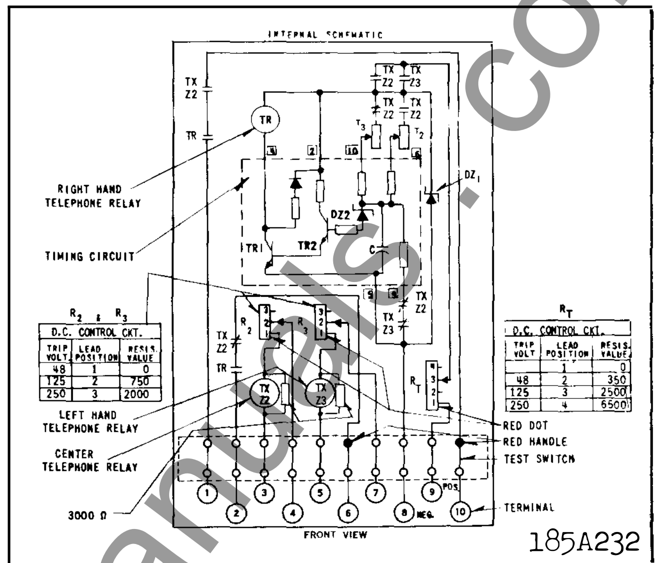


Fig. 3. Internal Schematic of the type TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

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

Reset Time

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

For the relay with slow dropout the reset time is:

TX – Z2 dropout time = .045 – .075 sec.
TX – Z3 dropout time = .090 – 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

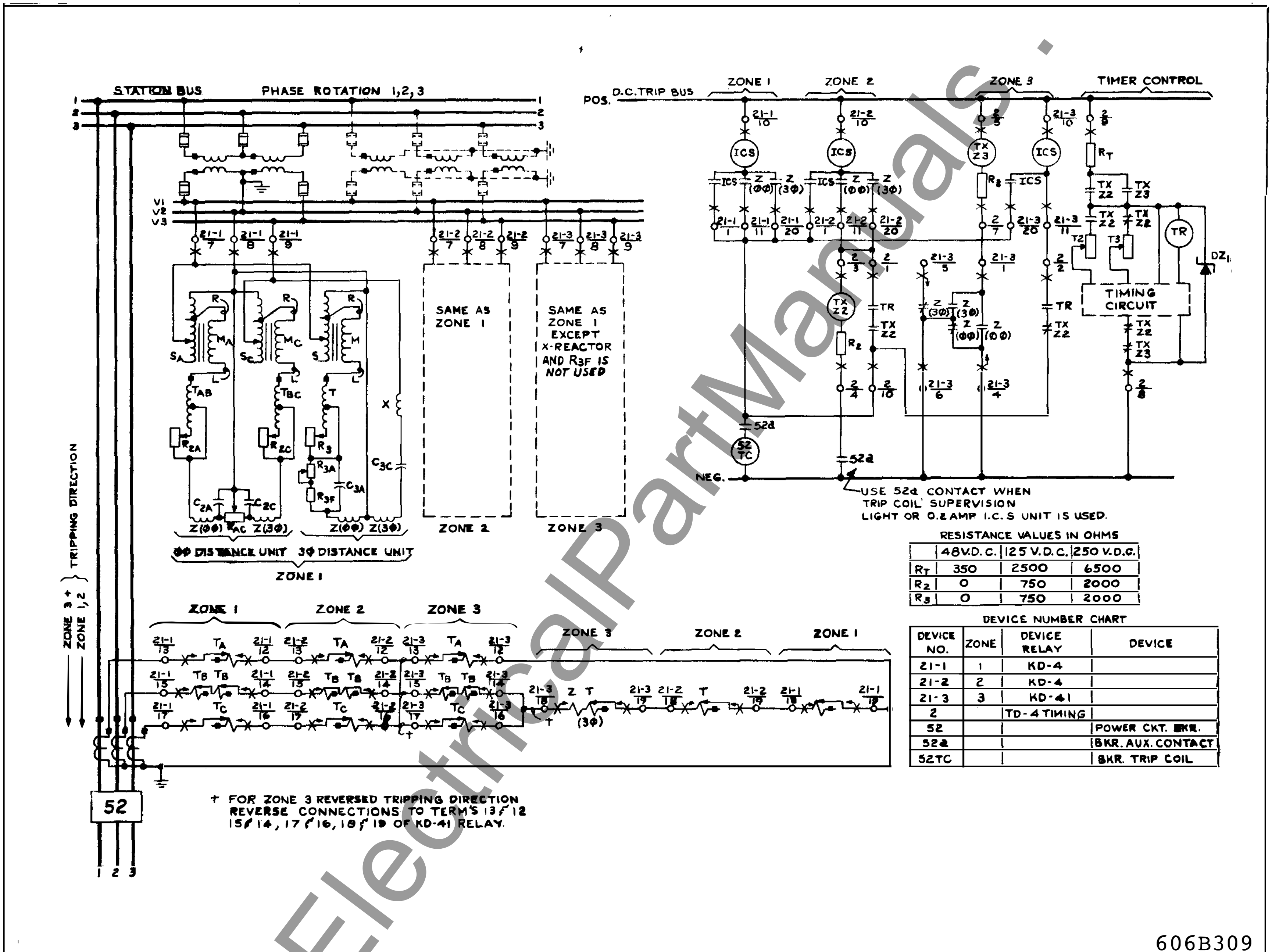
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

DEVICE NO.	ZONE	DEVICE RELAY	DEVICE
21-1	1	KD-4	
21-2	2	KD-4	
21-3	3	KD-41	
2		TD-4 TIMING	
52			POWER CKT. BKR.
52a			BKR. AUX. CONTACT
52TC			BKR. TRIP COIL

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

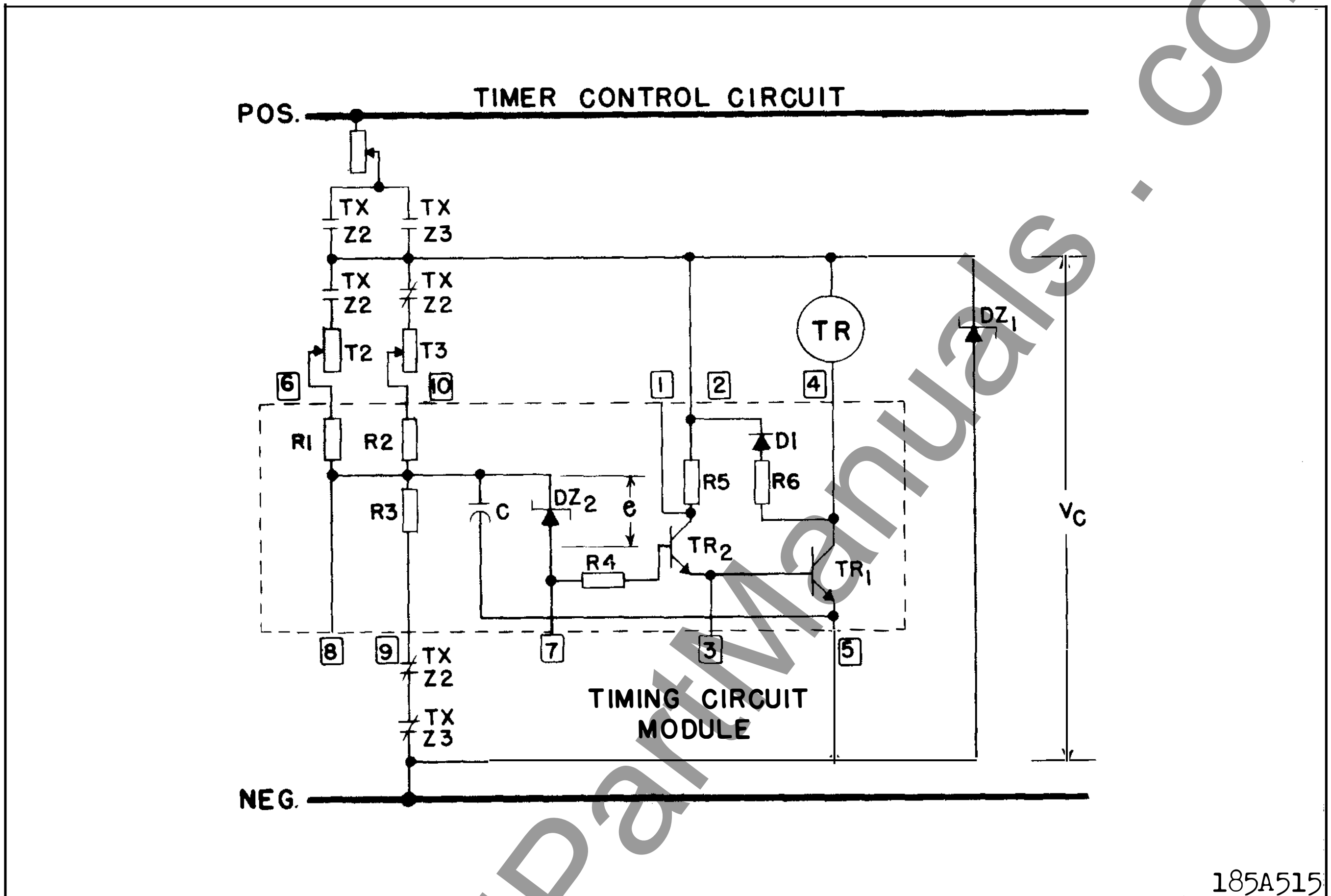


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

TR Relay Unit	– Nominal resistance 2,000 ohms
TX-Z2 Relay Unit	– " " 500 ohms
TX-Z3 Relay Unit	– " " 500 ohms
R_2 Tapped Resistor	– See Internal Schematic
R_3 Tapped Resistor	– " " "
R_T Tapped Resistor	– " " "
DZ_1 Zener Diode	– 30 volt breakdown - 10 watt
T_2 Rheostat	– Adjustable 0-40,000 ohms
T_3 Rheostat	– Adjustable 0-100,000 ohms 0-50,000 ohms (.3-1.5 Sec. Range)
M Module	– Timing Circuit

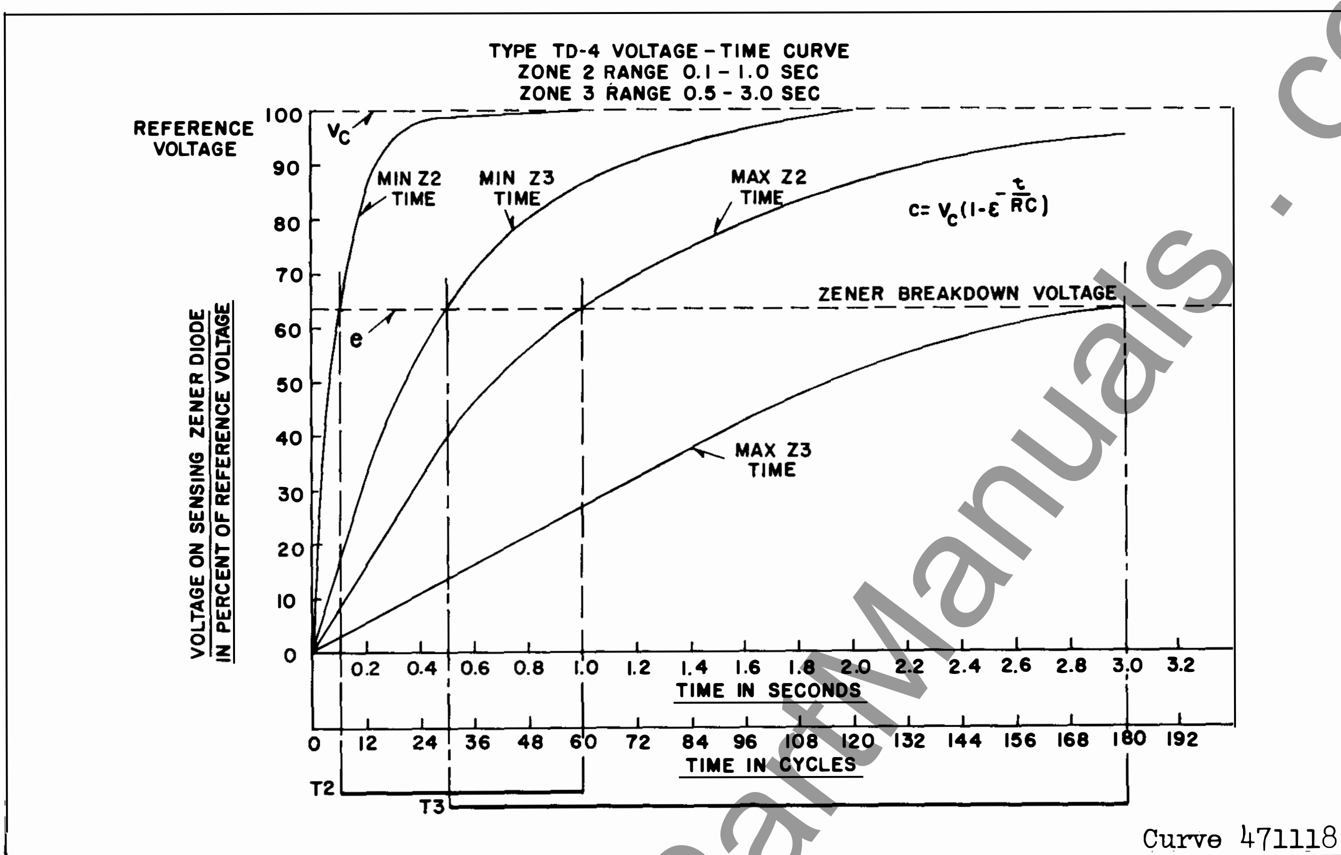


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

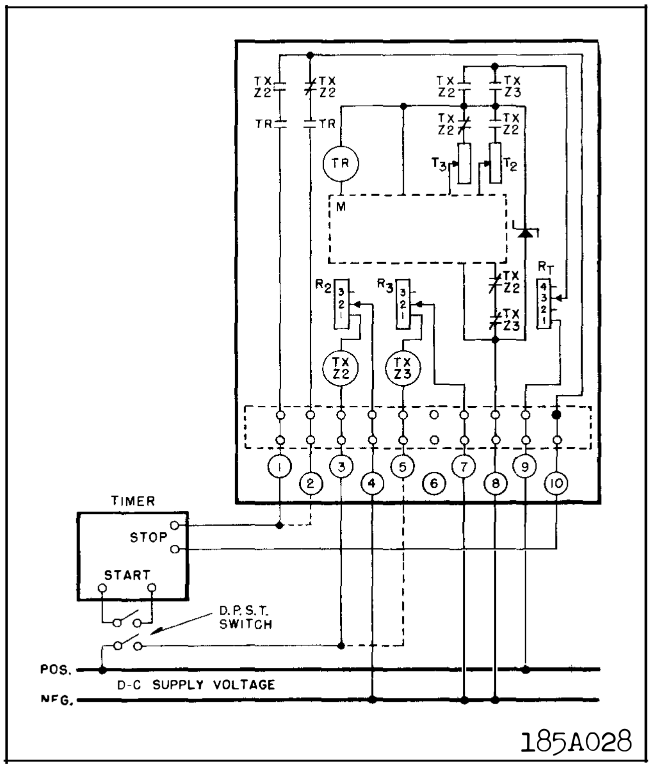
The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. Do not remove the knobs on the T_2 and T_3 rheostats unless the rheostats are to be replaced as this will upset the relay calibration.

Acceptance Tests

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

Routine Maintenance

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



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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.

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

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

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

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Component	Ohmmeter Between Module Terminals	Resistance
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T_R	2 and 4	2,000 ohms

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Calibration

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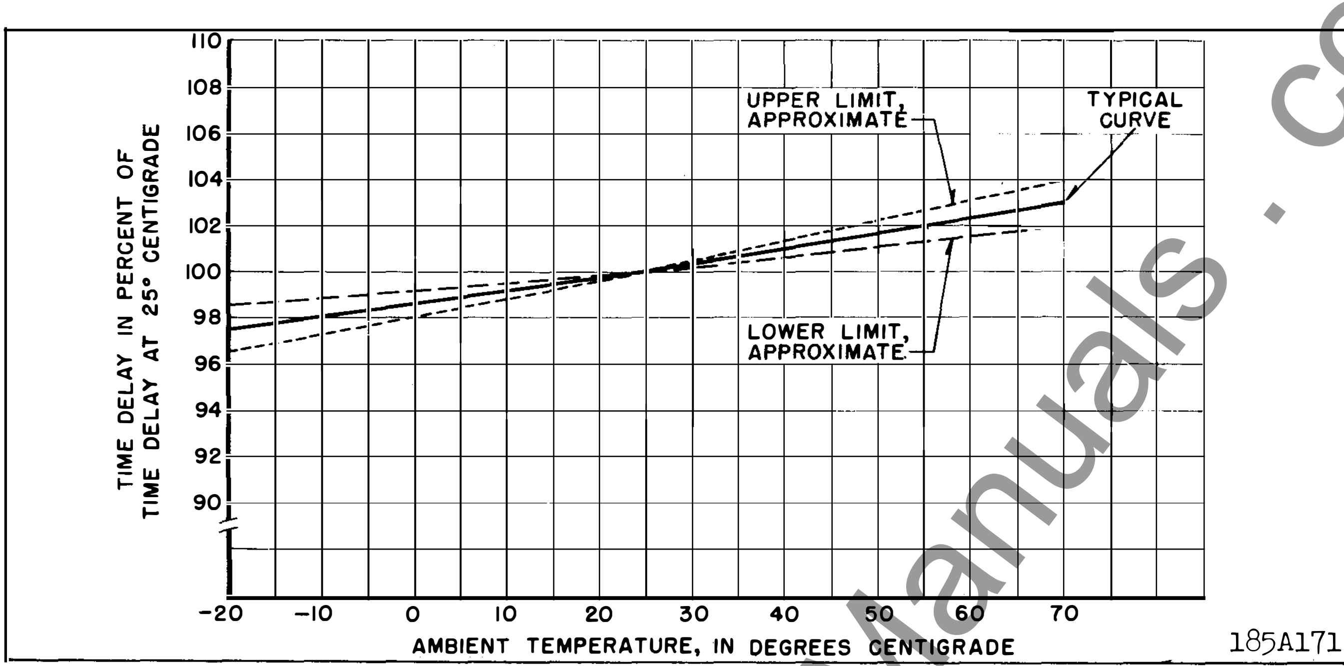
Adjust the armature gap on the three telephone type relays to be approximately .004" with the armature closed. This is done with the armature set-screw and lock-nut. Also, adjust contact leaf springs to obtain at least .015" gap on all contacts and at least .010" follow on all normally open contacts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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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



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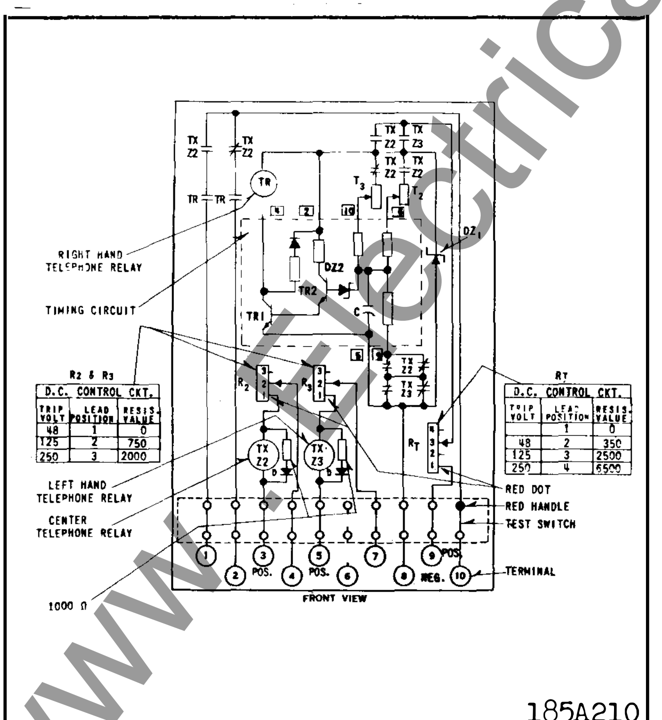
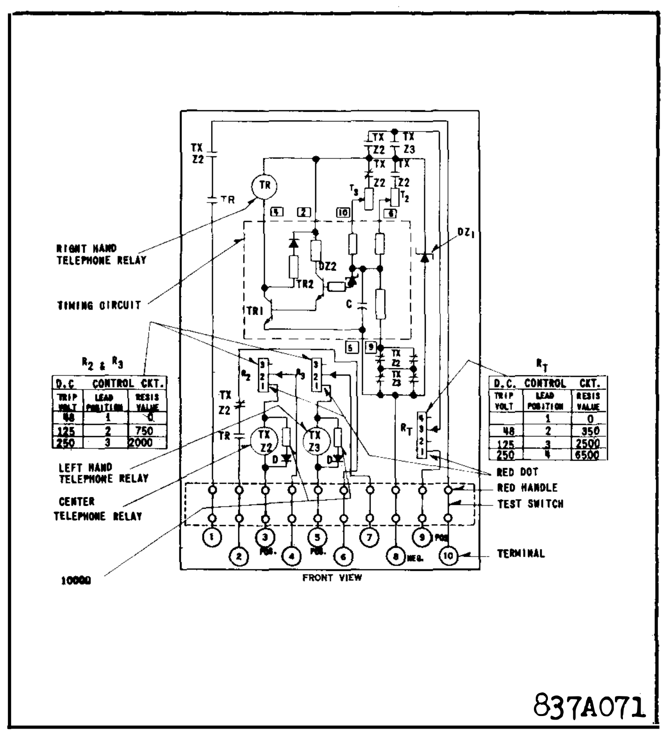


Fig. 9. Internal Schematic of the type TD-4 Relay with slow dropout relay (common trip circuit).



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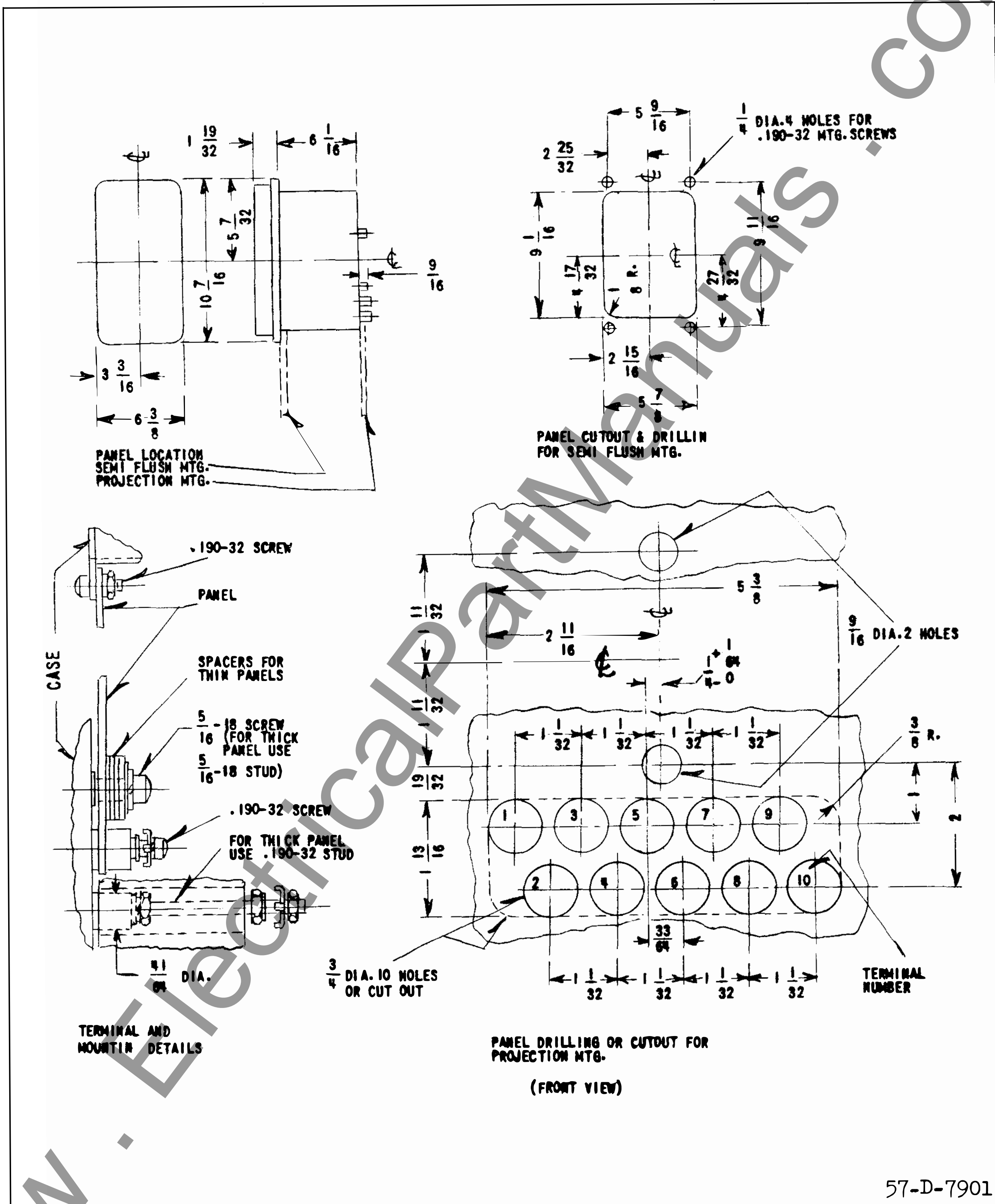

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R_2	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_3	All	Resistor, 25 watts, 2000 ohms, with tap at 750 ohms	11D9511H04
R_1	All	Resistor, 1050 ohms	184A868G01
R_3	All	Resistor, 120 ohms, ½ watt	184A764H05
R_4	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_5	All	Resistor, 10K ohms, 1%, ½ watt	184A764H51
R_6	All	Resistor, 3,920 ohms, ½ watt	184A764H41
D_1	All	Diode 1N538	407C703H03
TR_1, TR_2	All	Transistor 2N697	184A638H18
DZ_1	All	Zener Diode 10W, 1N2989B, 30V ±5%	629A798H01
DZ_2	All	Zener Diode, ½ watt, 18-20 volts	185A033H01
C	All	Capacitor, 27 ufd., 35 V.D.C.	187A508H15
T2	All	Potentiometer, 40K ohms	184A756H01
T_3	.3 - 1.5 Sec.	Potentiometer, 50K ohms	184A756H03
T_3	.5 - 3.0 Sec.	Potentiometer, 100K ohms	184A756H02
R_2	.3 - 1.5 Sec.	Resistor 5000 ohms	184A868G03
R_2	.5 - 3.0 Sec.	Resistor, 8000 ohms	184A868G02
Resistor Across TX Coil	All	Resistor, 3000 ohms, 3 watt	184A636H05
Resistor Across TX Coil (Slow Dropout)	◆ All	Resistor, 1000 ohms, ½ watt	184A764H27
Diode Across TX Coil (Slow Dropout)	All	Diode 1N1224	508C320H12

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

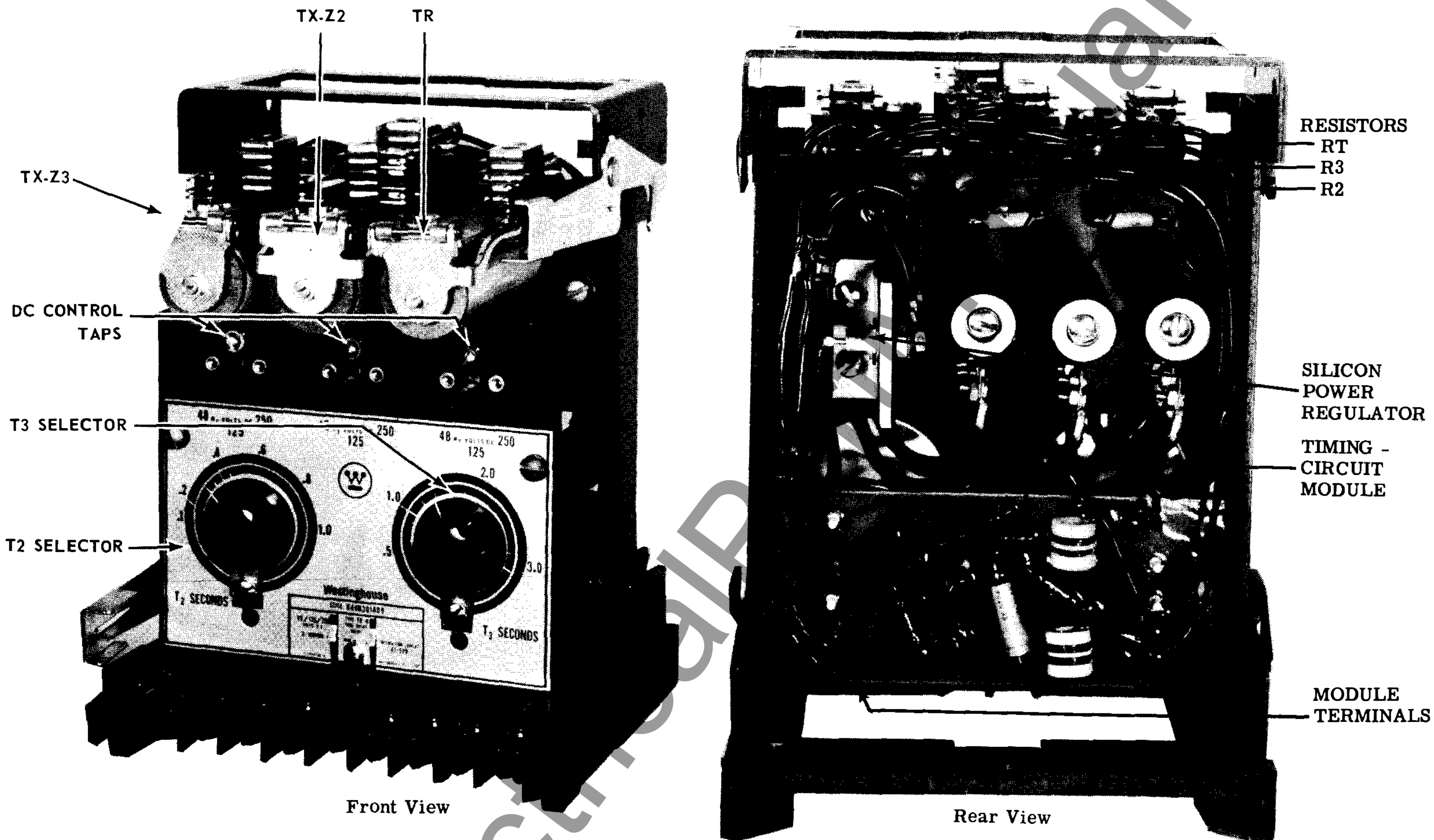
This case is similar to paragraph 1, except that the zone 2 KD contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

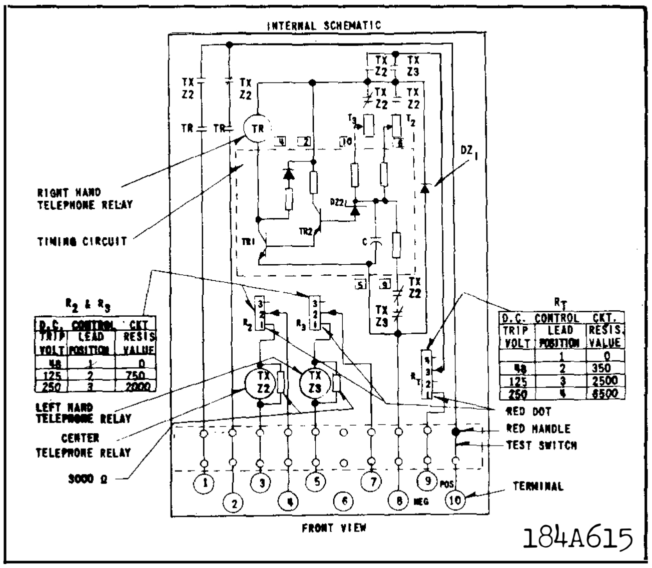
EFFECTIVE NOVEMBER 1965



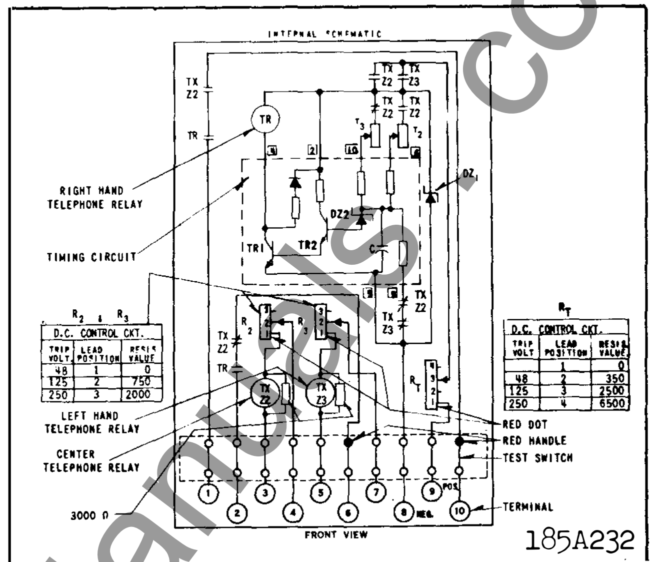
Front View

Rear View

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



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



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

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

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

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

CHARACTERISTICS

* **Time Delay Range**

Zone 2: 0.1 sec. — 1.0 sec.; 0.1 — 1.0 sec.

Zone 3: 0.5 sec. — 3.0 sec.; 0.3 — 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less

TX-Z2 and TX-Z3 — Drop Out Time: 0.06 sec. or less

Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

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

TX — Z2 dropout time = 0.45 — .075 sec.

TX — Z3 dropout time = .090 — 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

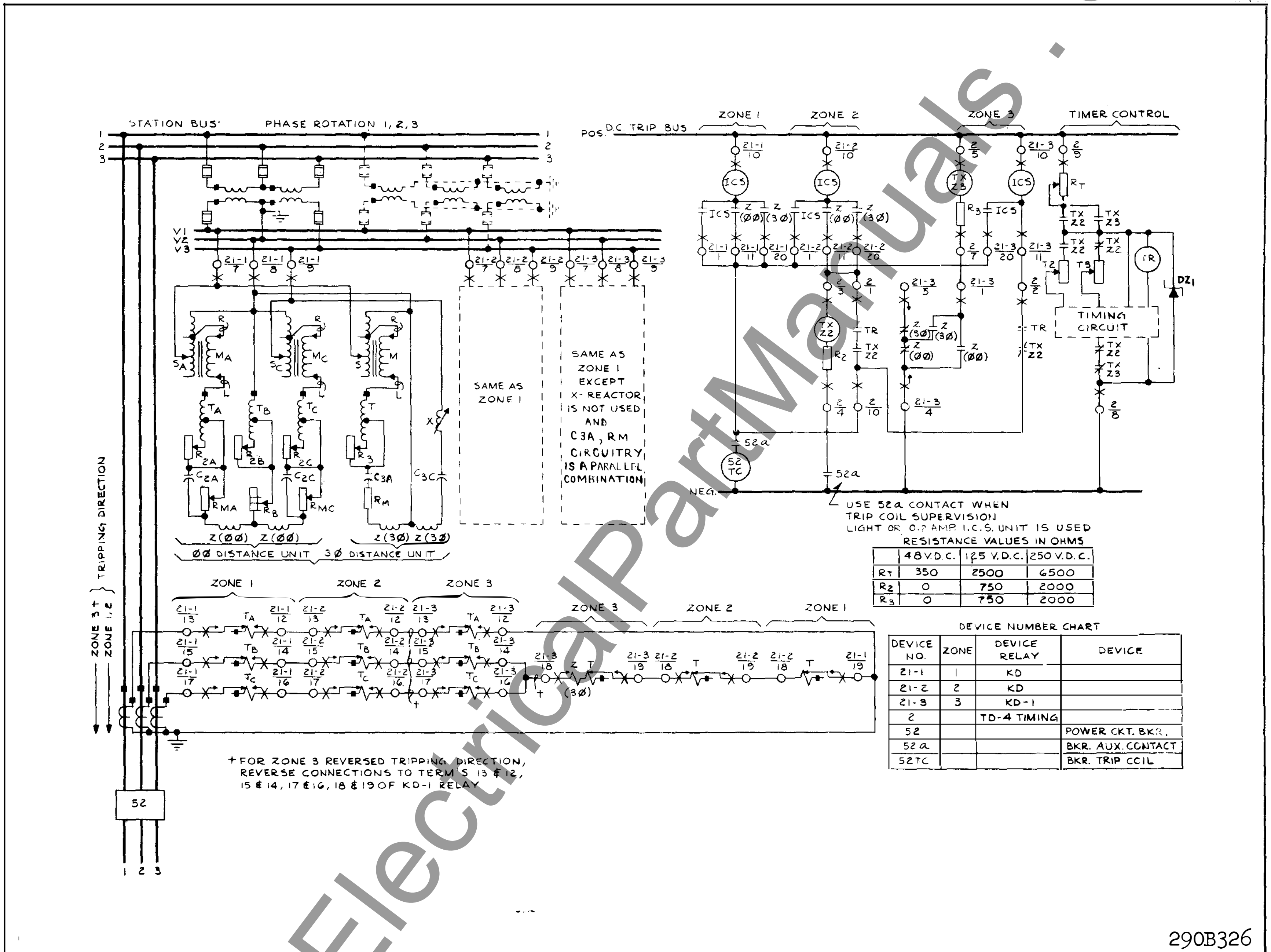
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



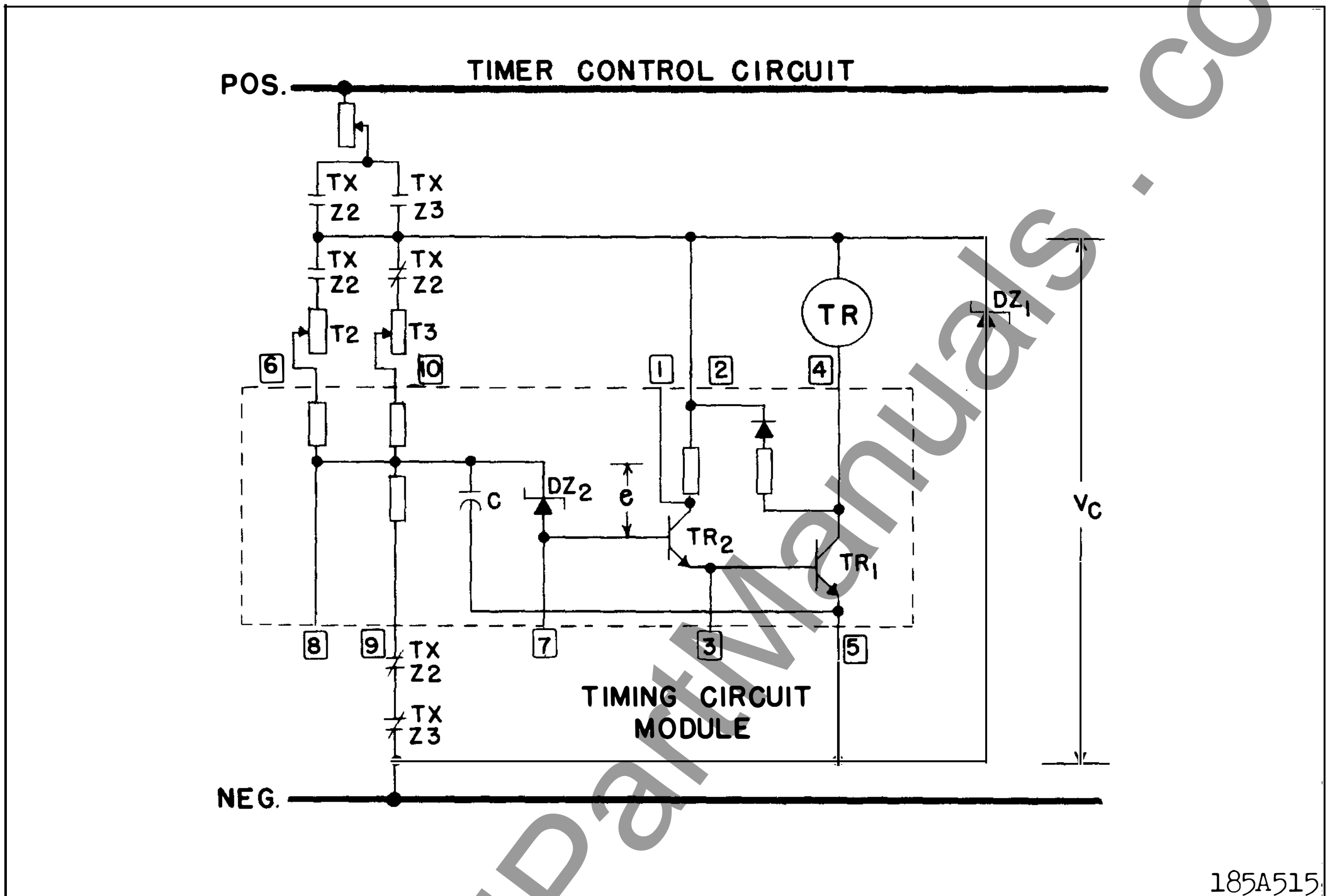
RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

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

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



*** *Fig. 5. Timer Control Circuit***

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

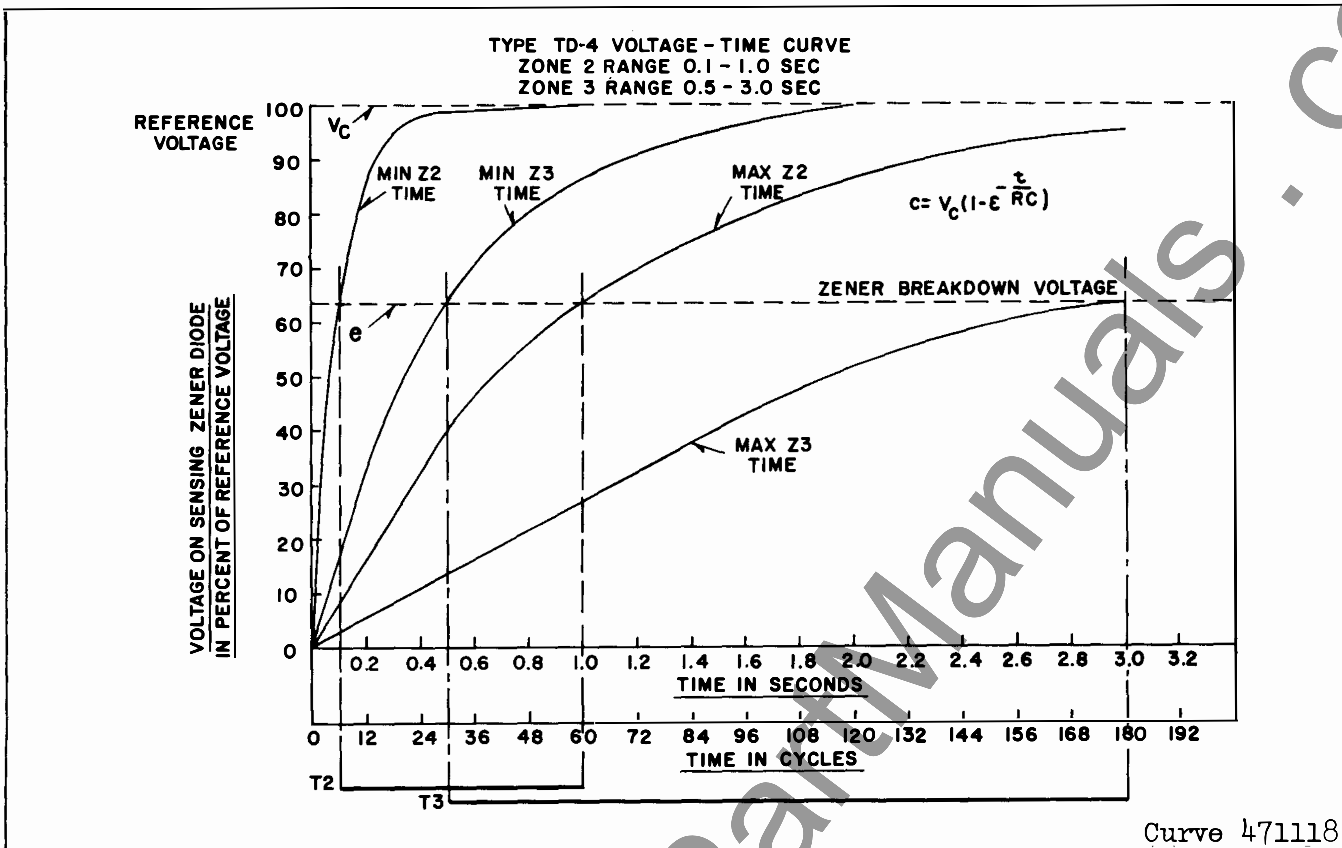
Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ±5 milliseconds for settings of .5 seconds or less, and no more than ±1% for settings above .5 seconds.

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

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



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

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

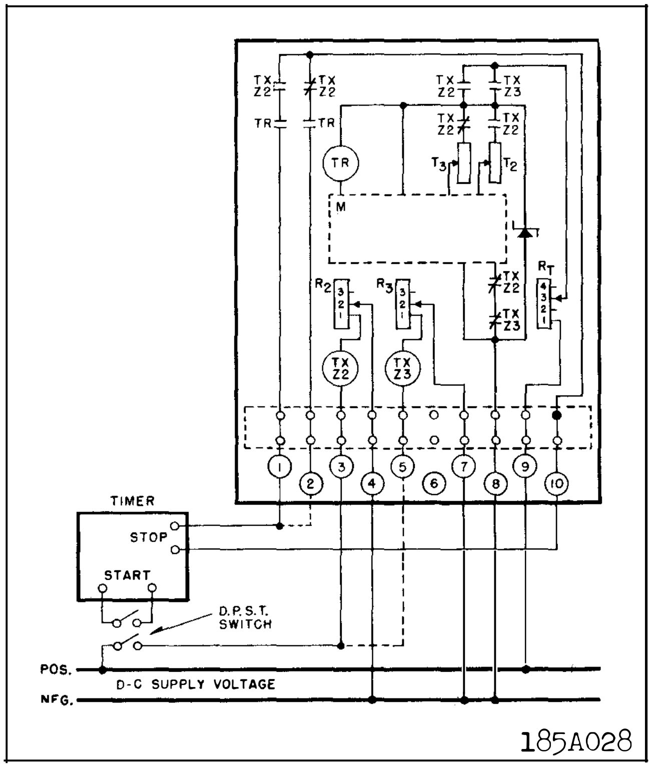
The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. Do not remove the knobs on the T_2 and T_3 rheostats unless the rheostats are to be replaced as this will upset the relay calibration.

Acceptance Tests

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

Routine Maintenance

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



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

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

Trouble Shooting Procedure

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

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

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

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

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

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

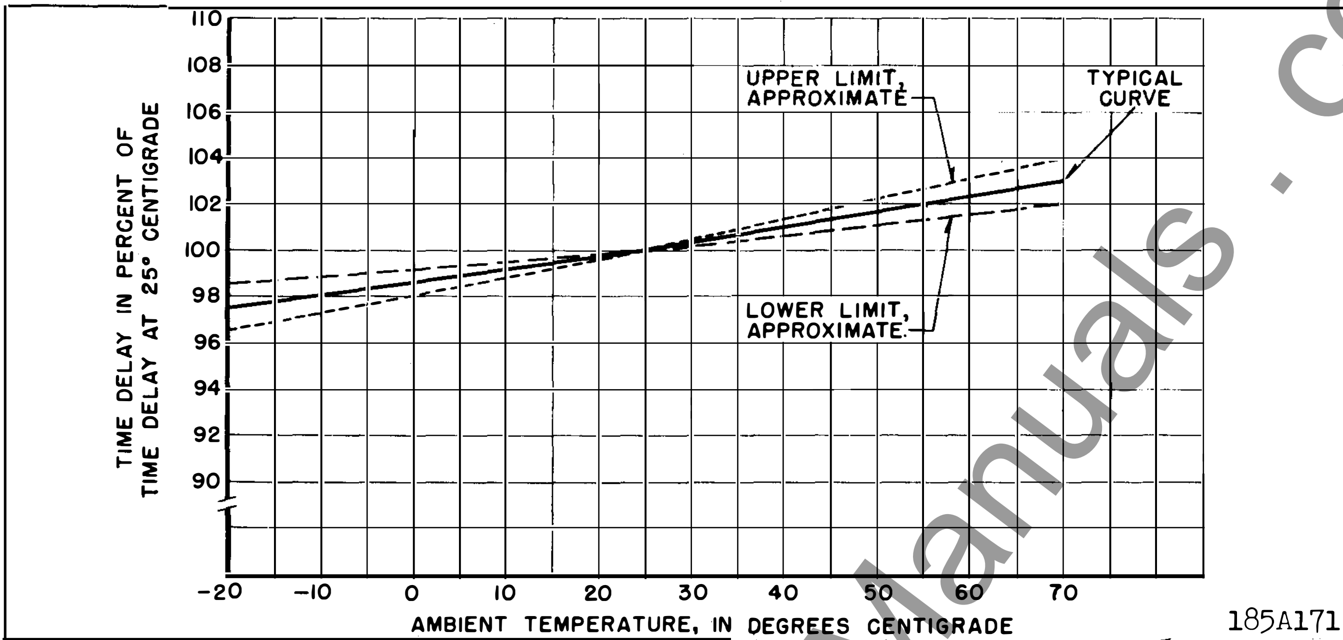
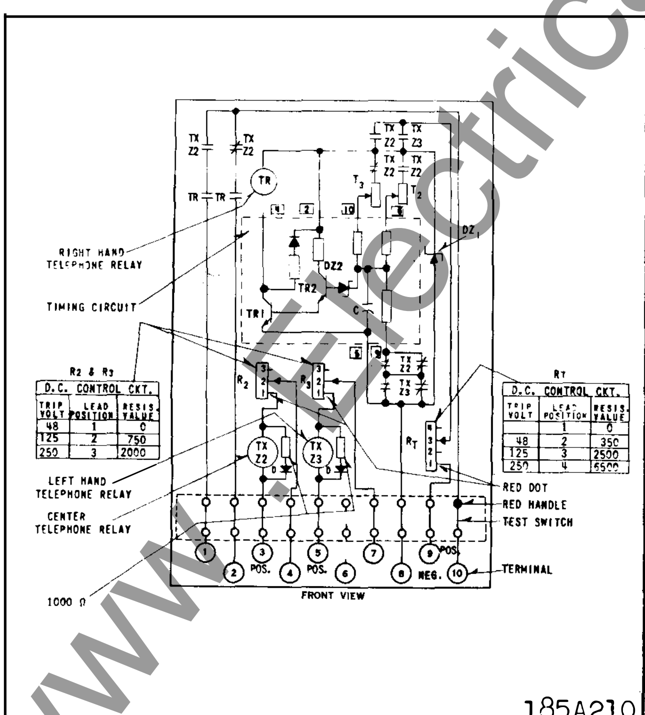


Fig. 8. Timing Variations with Temperature Changes

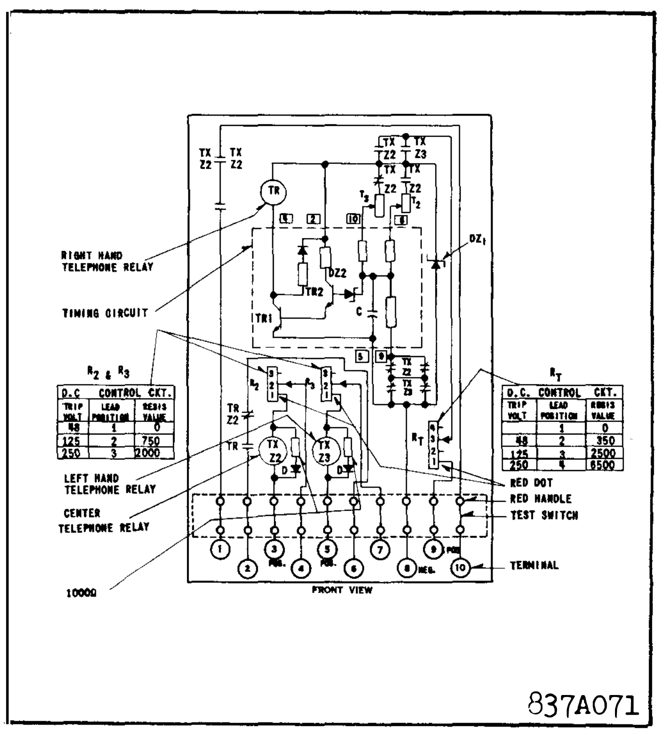
The first step should be to insure that the knob is approximately vertical for the mid-scale time time delay (.550 sec. for T_2 and 1.75 sec. for T_3 This will locate the calibration lines symmetrically around the scale plate. After centering and securely locking the knob on the rheostat shaft, new calibration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

RENEWAL PARTS

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



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



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

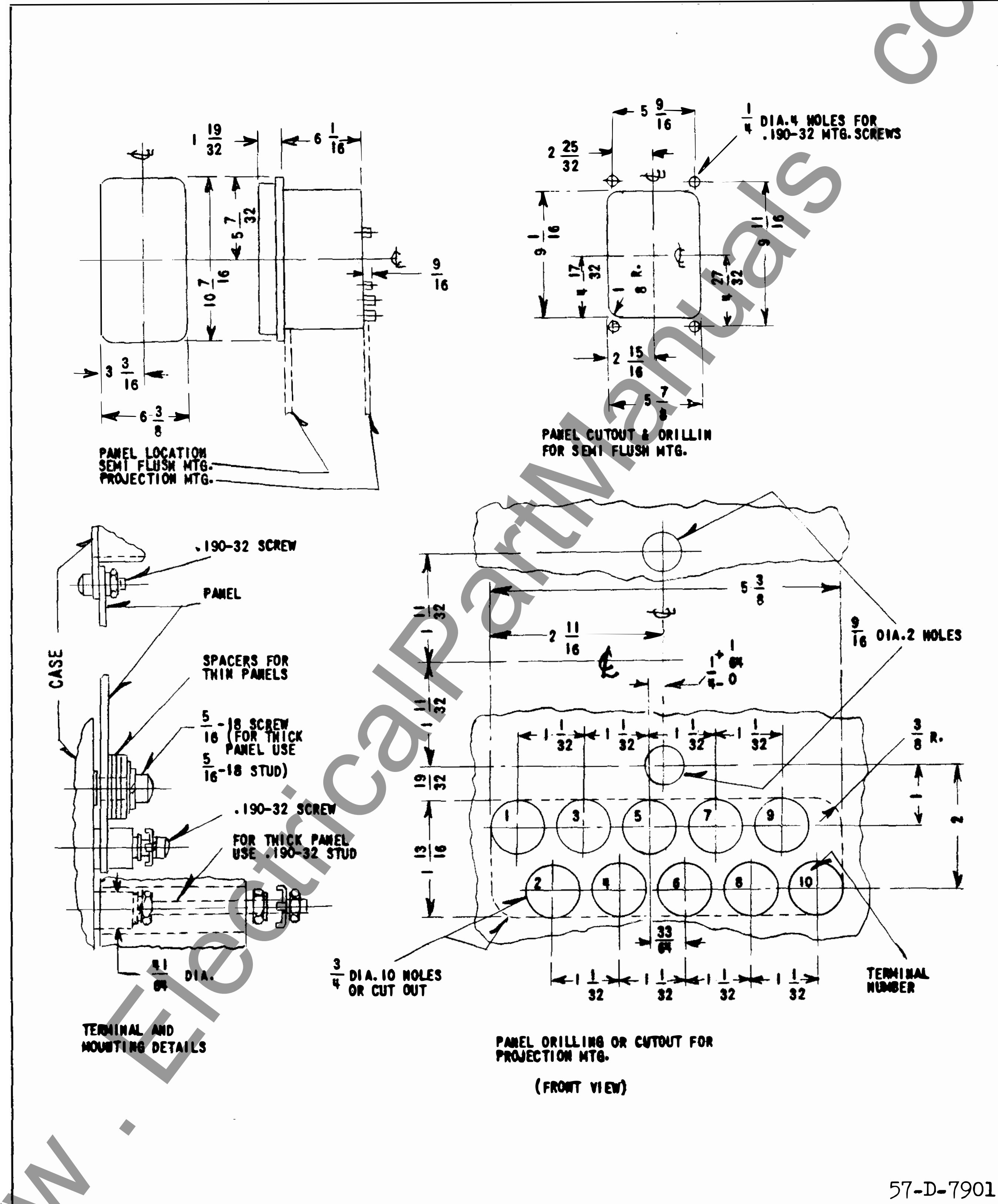


Fig. 11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

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Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

The type TD-4 relay consists of an auxiliary circuit for initiating the time delay, a reference voltage circuit, and a time delay circuit.

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

When capacitor C changes to the voltage value e, DZ_2 breaks down to provide base drive for transistor TR_4 causing it to conduct. Emitter current of TR_2 provides base drive for transistor TR_1. Transistor TR_1 conducts, energizing output relay TR to the trip the breaker.

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

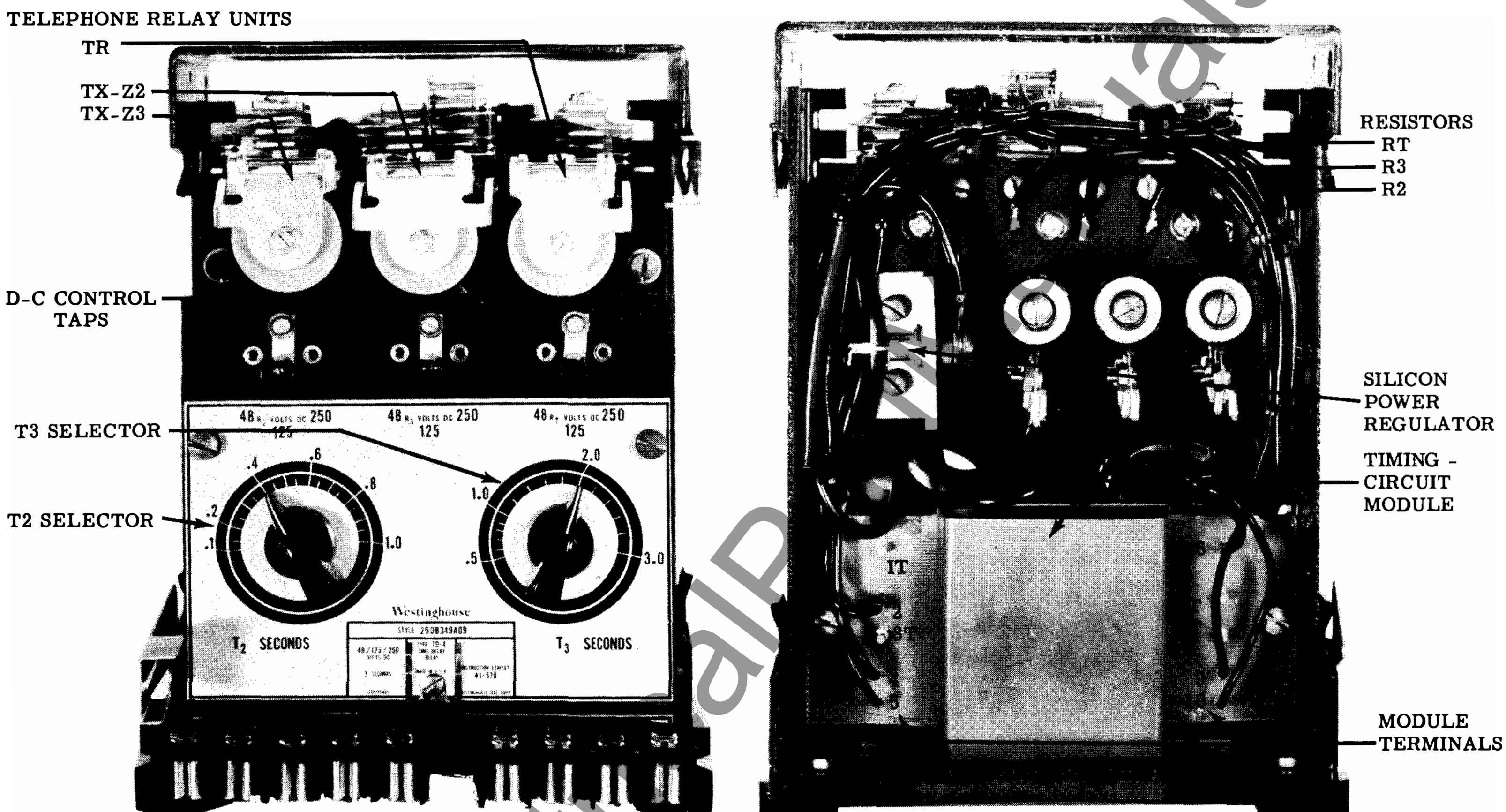
This case is similar to paragraph 1, except that the zone 2 KD contact only is closed. Therefore, only TX-Z2 is energized since zone 3 reach is reversed. The operation of the timing circuit and trip circuit is identical to that described in paragraph 1.

3. Zone 3 Operation, Non-Carrier or Carrier

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

SUPERSEDES I.L. 41-579B
Complete Revision

EFFECTIVE SEPTEMBER 1961



Front View

Rear View

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

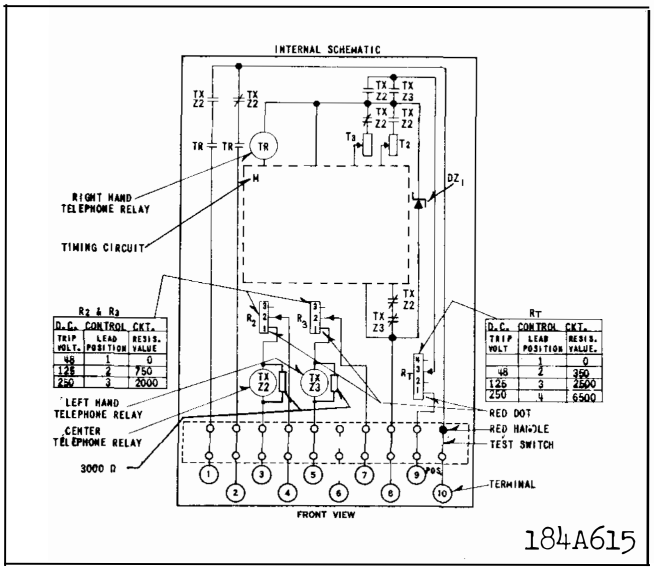


Fig. 2. Internal Schematic of S#290B349A09 TD-4 Relay in FT21 case. (Common trip circuits)

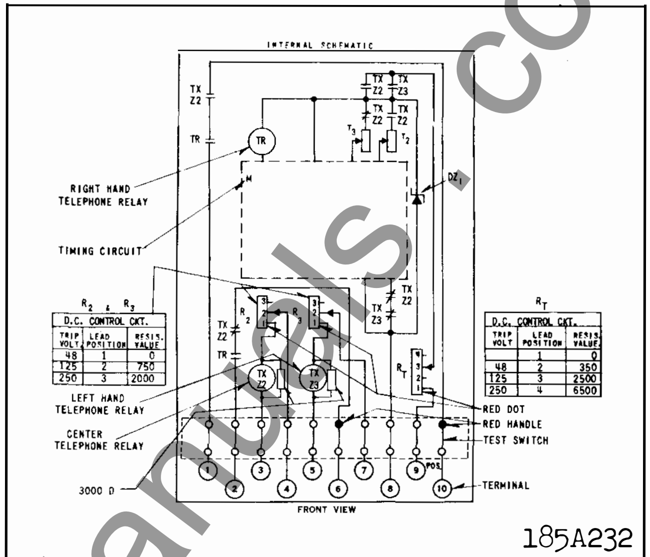


Fig. 3. Internal Schematic S#290B349A10 TD-4 relay in FT21 case. (Independent trip circuits)

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

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

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

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. — 1.0 sec.
Zone 3: 0.5 sec. — 3.0 sec.

Reset Time

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

Voltage Rating

48, 125 or 250 volts d-c. The relay can stand 110% voltage continuously, up to 100°C.

Battery Drain

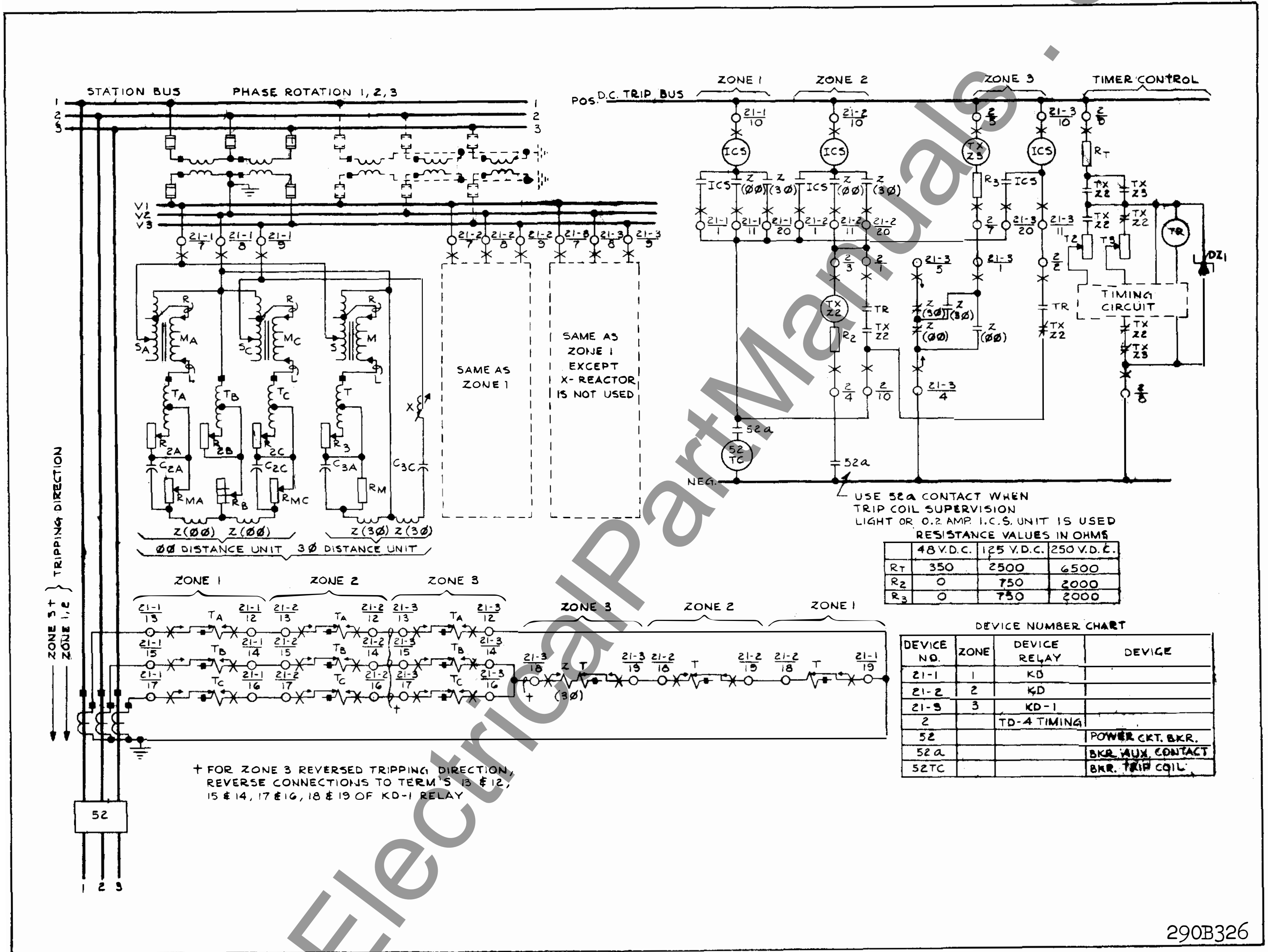
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX-Z_2$:	117 MA	106MA	103MA
$TX-Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

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

Fig. 4. External Schematic of S#290B349A09 Type TD-4 Relay

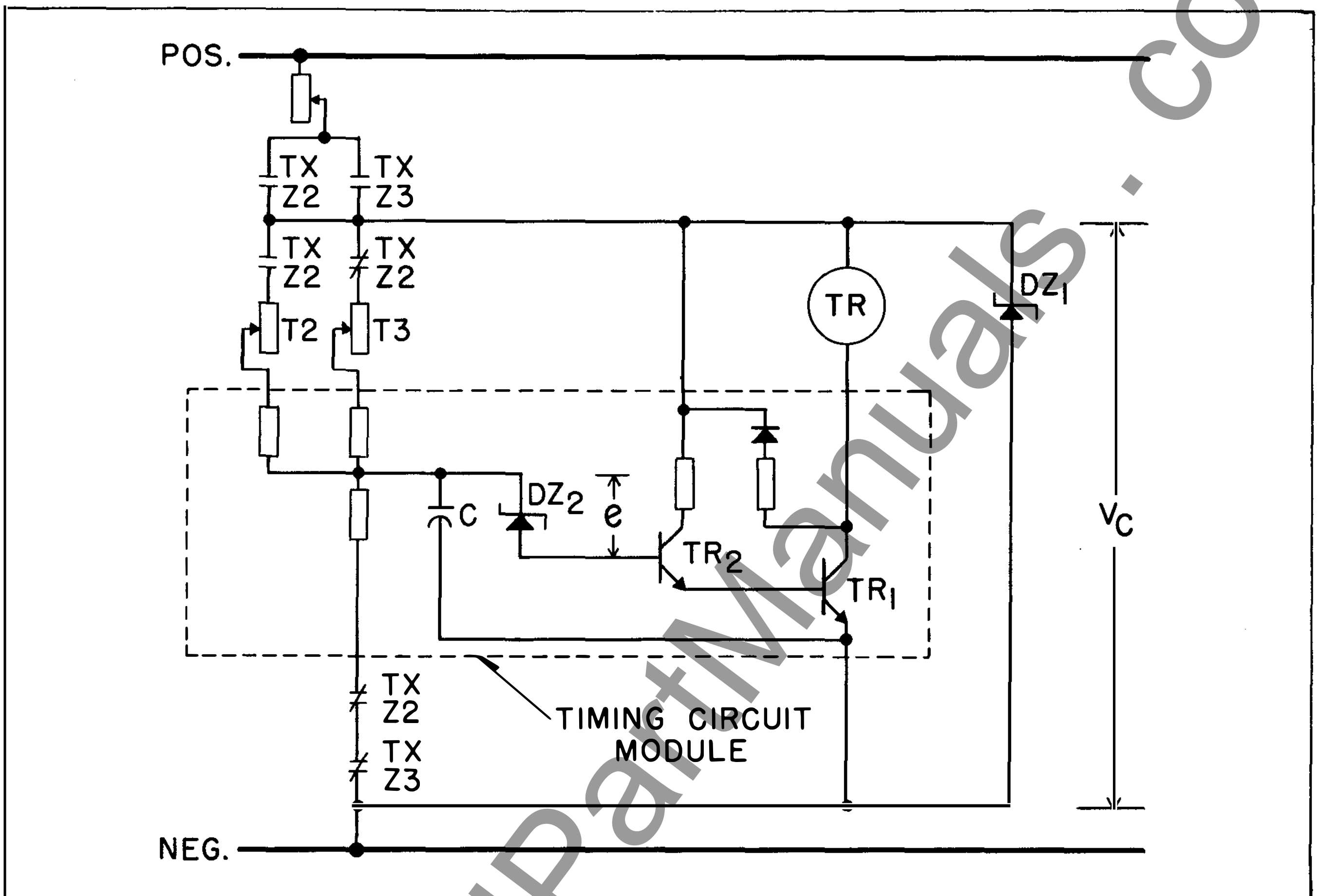


Fig. 5. Timer Control Circuit

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

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

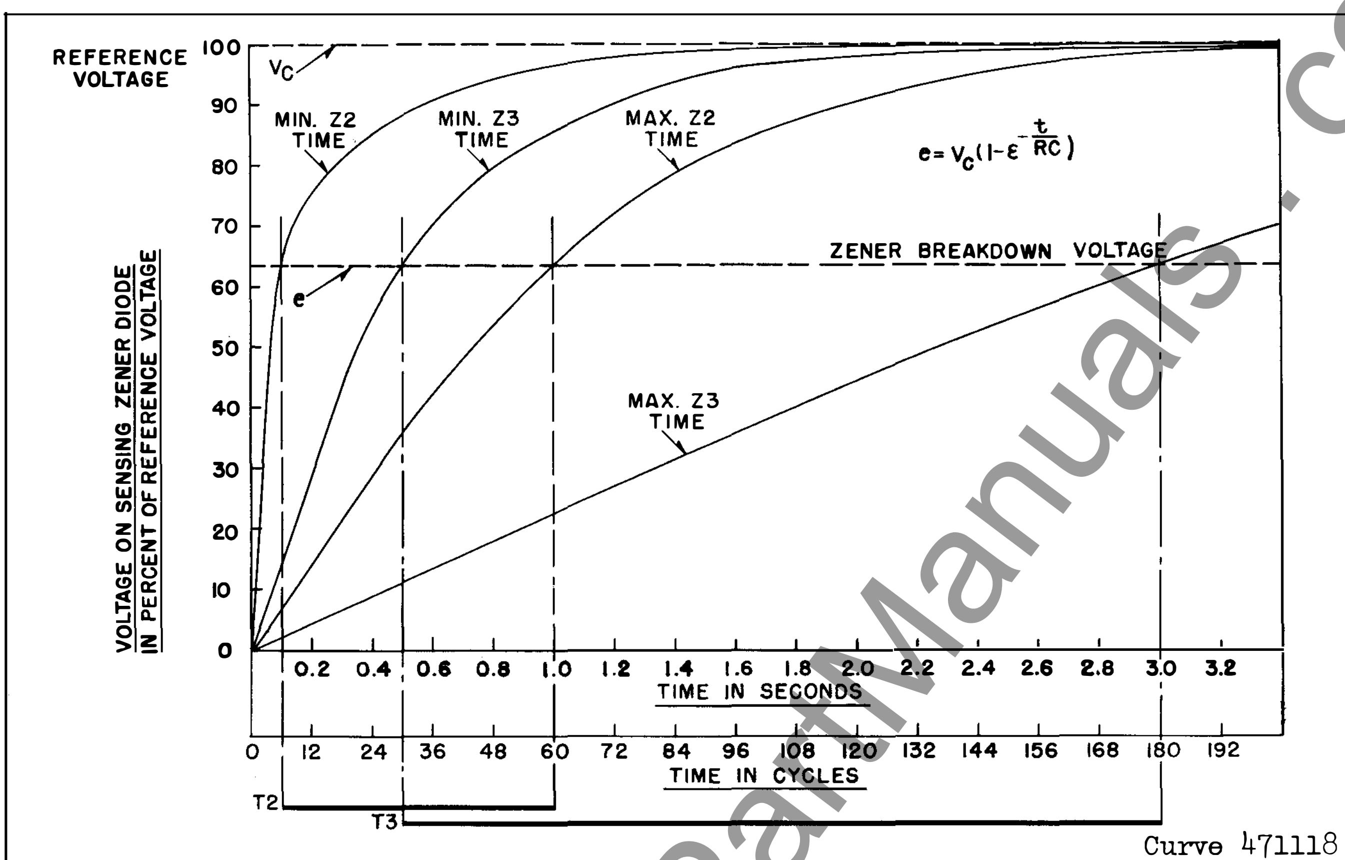


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

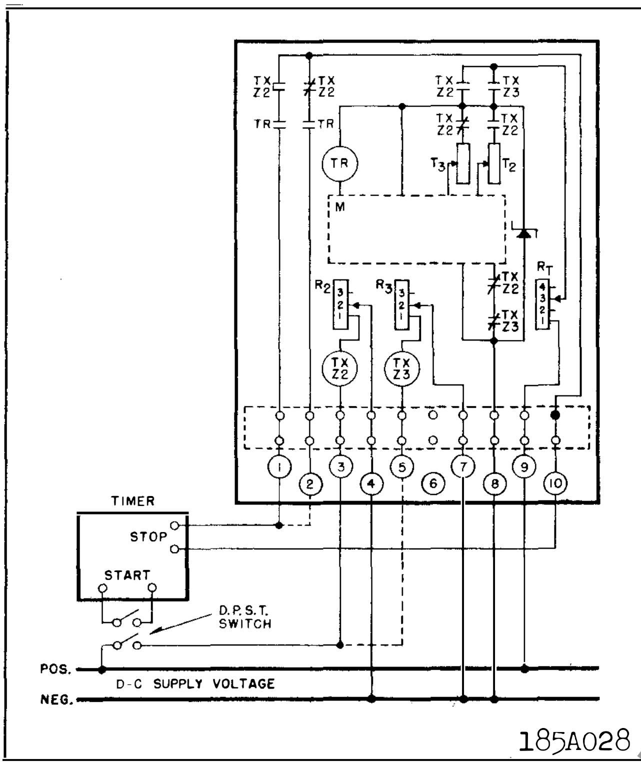


Fig. 7. Test Circuit for S#290B349A09 Type TD-4 Relay. (Jumper terminals 6 and 10 when testing S#290B349 A10)

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

Trouble Shooting Procedure

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

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

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

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

Component	Ohmmeter Between Module Terminals	Resistance
T_2	2 and 6	0-400,000 ohms (TX-Z2 operated)
T_3	2 and 10	0-100,000 ohms
T_R	2 and 4	2,000 ohms

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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

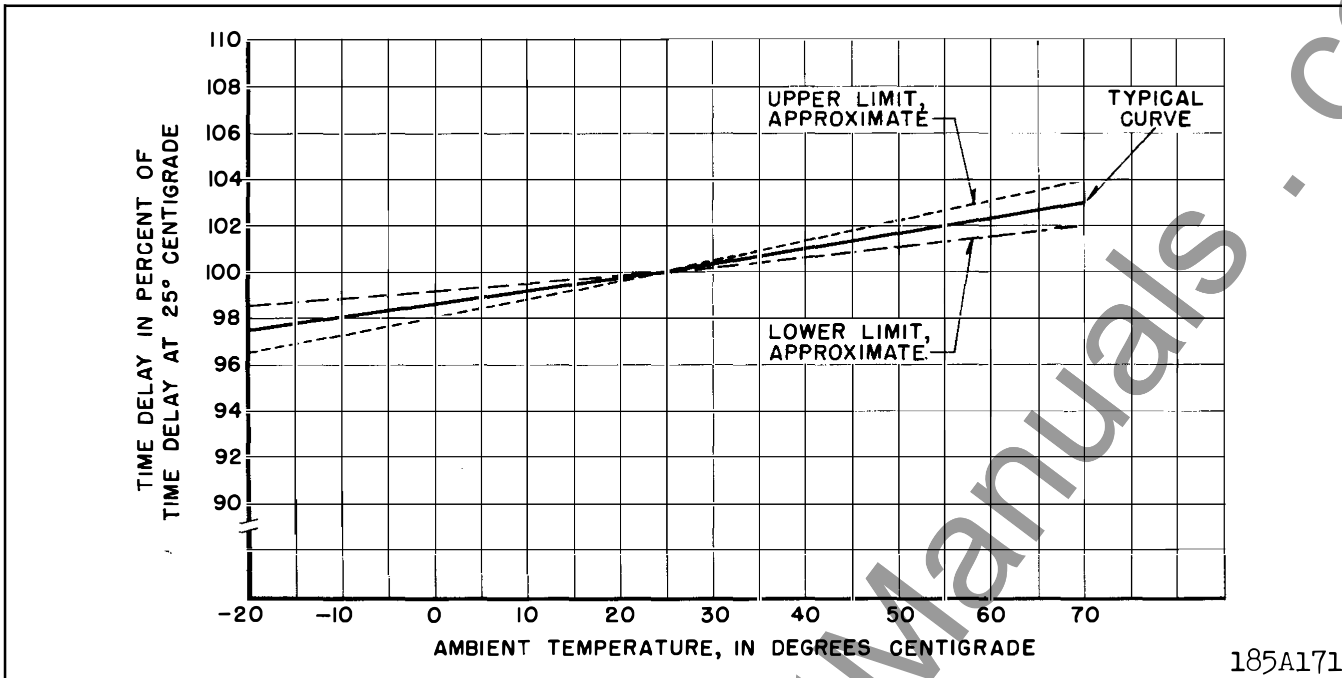


Fig. 8. Timing Variations with Temperature Changes

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

RENEWAL PARTS

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

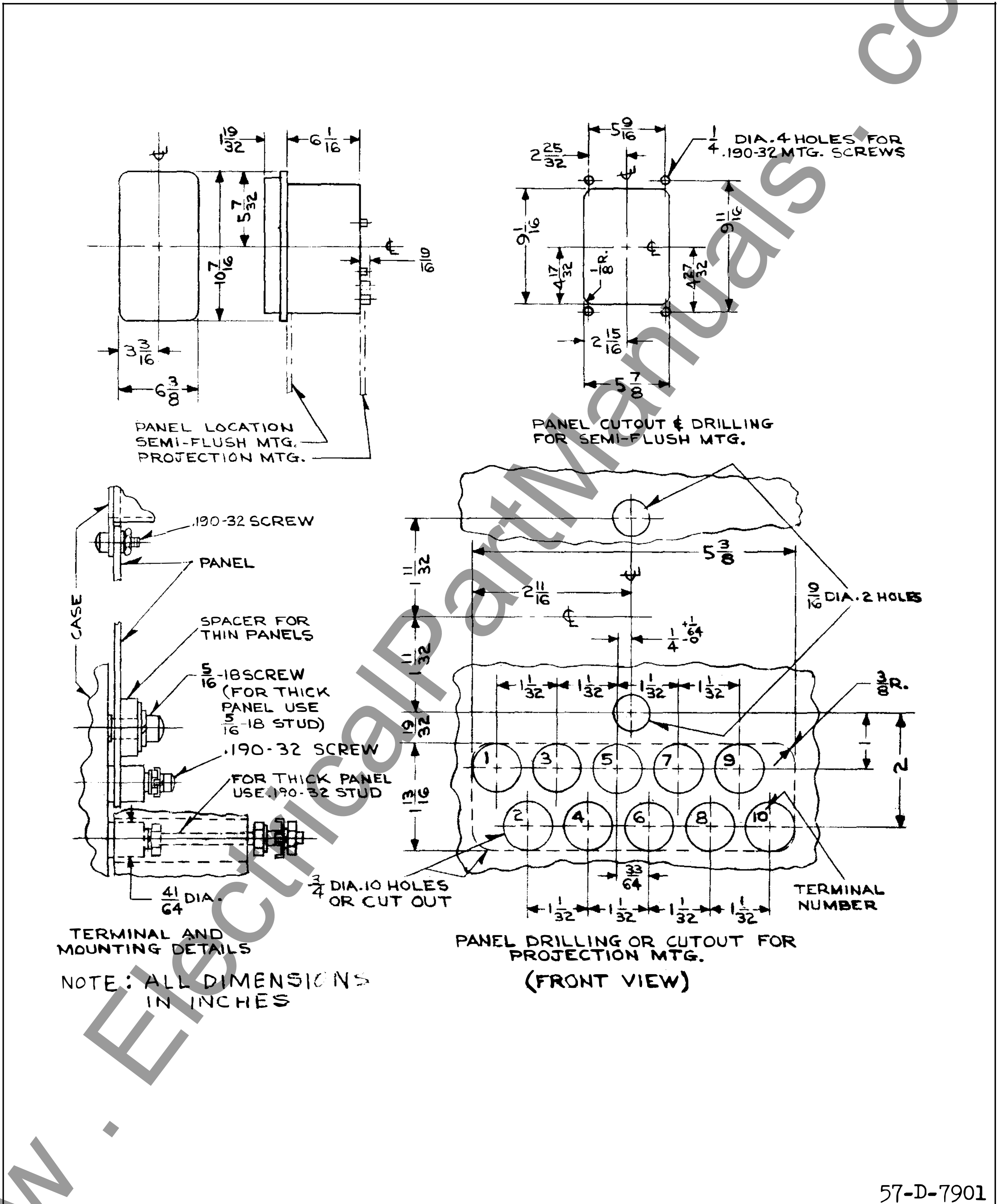


Fig. 9. Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TD-4 TIME DELAY RELAY

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

APPLICATION

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

CONSTRUCTION

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

Auxiliary Circuit for Initiating Time Delay

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

Reference Voltage Circuit

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

Time Delay Circuit

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

OPERATION

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

Timing Circuit Operation

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

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

1. Zone 2 Operation, Non-Carrier

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

2. Zone 2 Operation, Carrier

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

3. Zone 3 Operation, Non-Carrier or Carrier

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

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

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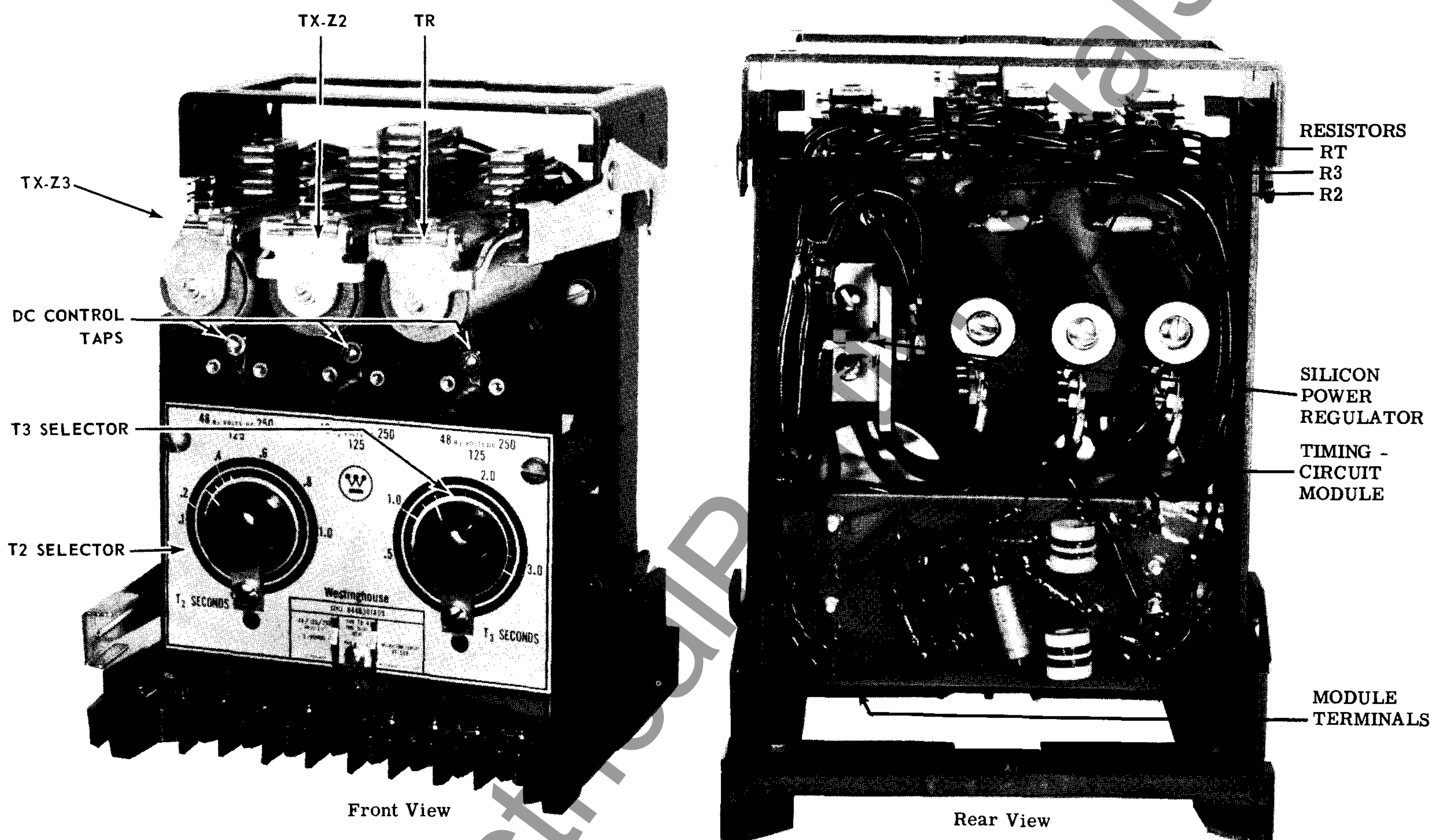
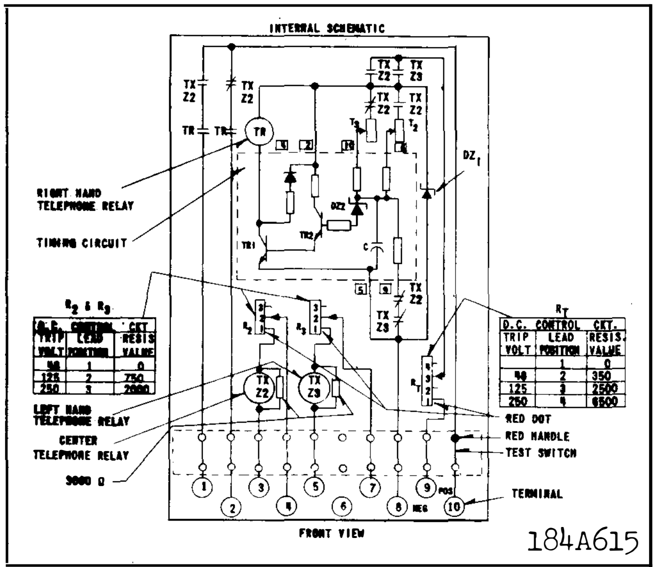
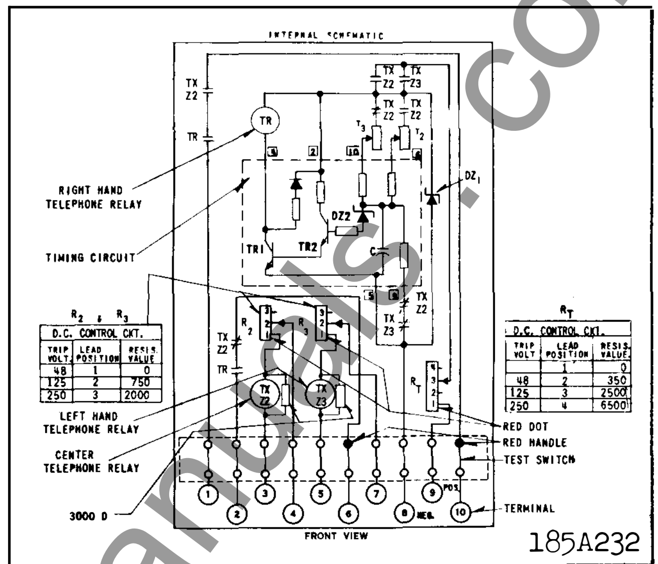


Fig. 1. Type TD-4 Relay without case.



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



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

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

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

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

CHARACTERISTICS

Time Delay Range

Zone 2: 0.1 sec. — 1.0 sec.; 0.1 — 1.0 sec.

Zone 3: 0.5 sec. — 3.0 sec.; 0.3 — 1.5 sec.

Reset Time

TR Drop Out Time: 0.1 sec. or less

TX-Z2 and TX-Z3 — Drop Out Time: 0.06 sec. or less

Discharge to timing capacitor: Discharges to less than 1% of full voltage in 0.015 sec.

For the relay with slow dropout the reset time is:

TX — Z2 dropout time = 0.45 — .075 sec.

TX — Z3 dropout time = .090 — 0.15 sec.

Voltage Rating Over The Temperature Range

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

Battery Drain

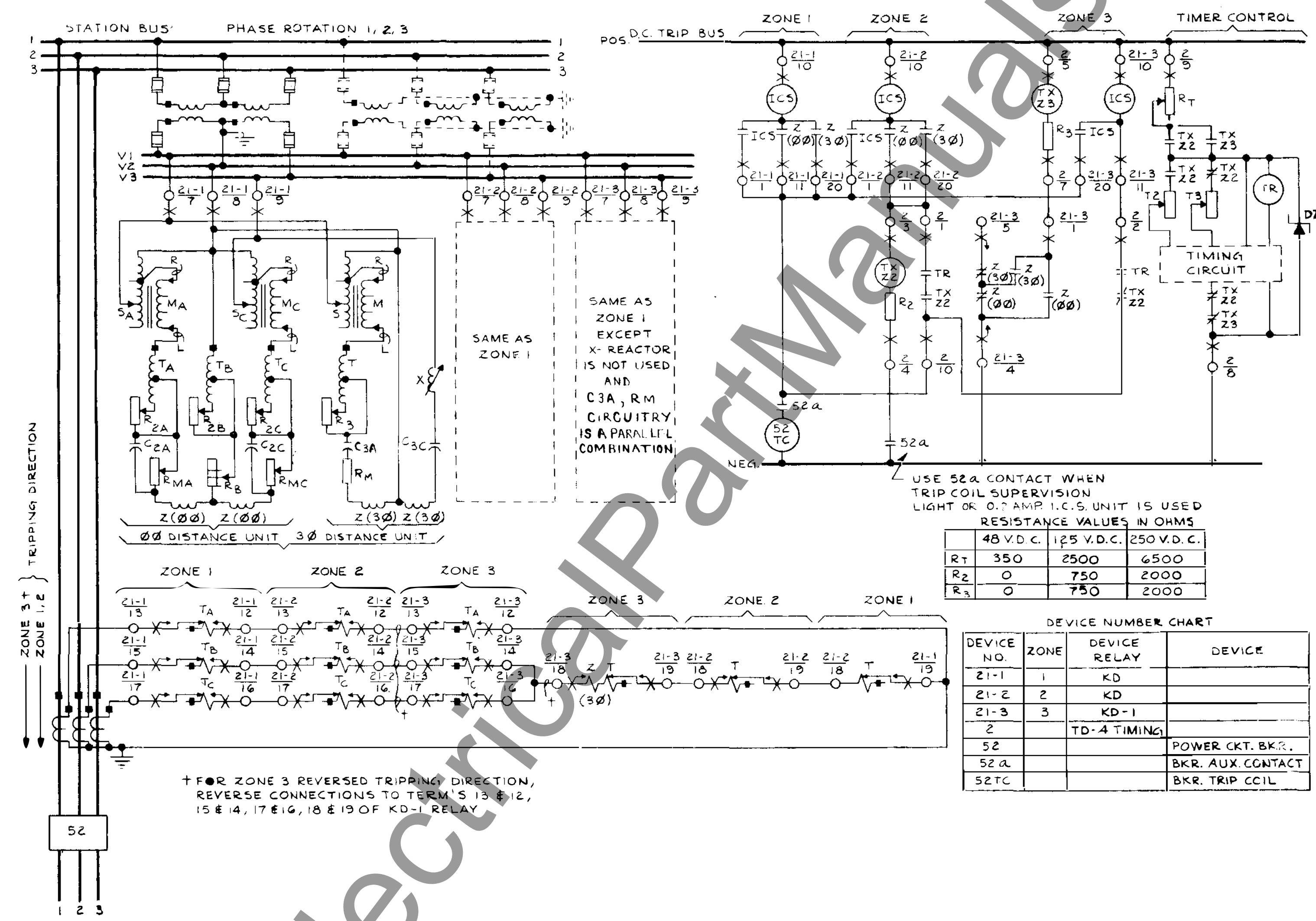
	48 V.D.C.	125 V.D.C.	250 V.D.C.
Non-operating Condition:	0	0	0
Operating Condition			
Timing Circuit and DZ_1:	50-90 MA	30-80MA	25-70MA
$TX\text{-}Z_2$:	117 MA	106MA	103MA
$TX\text{-}Z_3$:	117 MA	106MA	103MA

Accuracy

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

(1) Nominal Setting

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



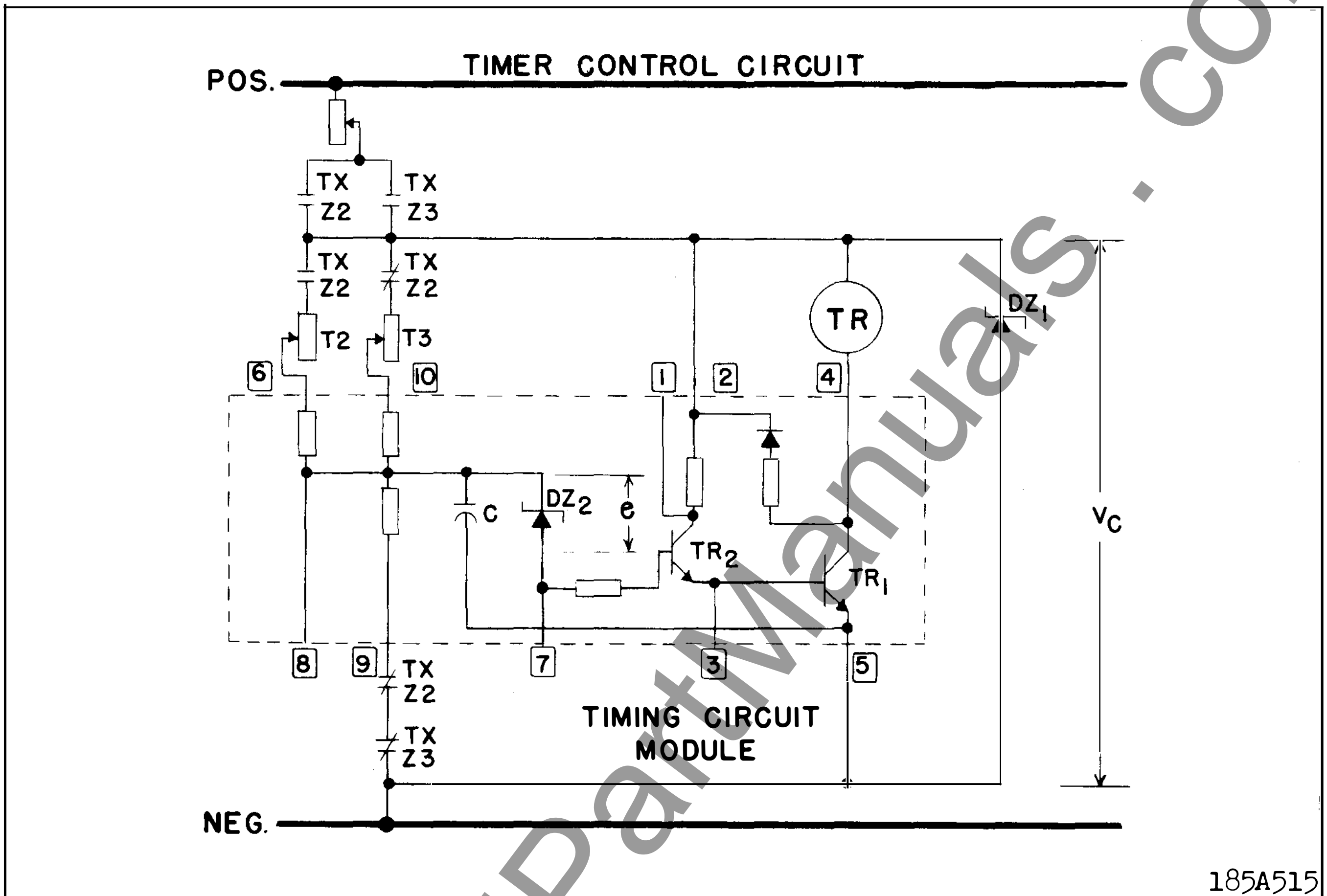
RESISTANCE VALUES IN OHMS

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

DEVICE NUMBER CHART

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

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



* *Fig. 5. Timer Control Circuit*

(2) Consecutive Timings

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

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

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

(3) Supply Voltage

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

(4) Ambient Temperature

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

Nomenclature for Type TD-4 Timing Relay

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

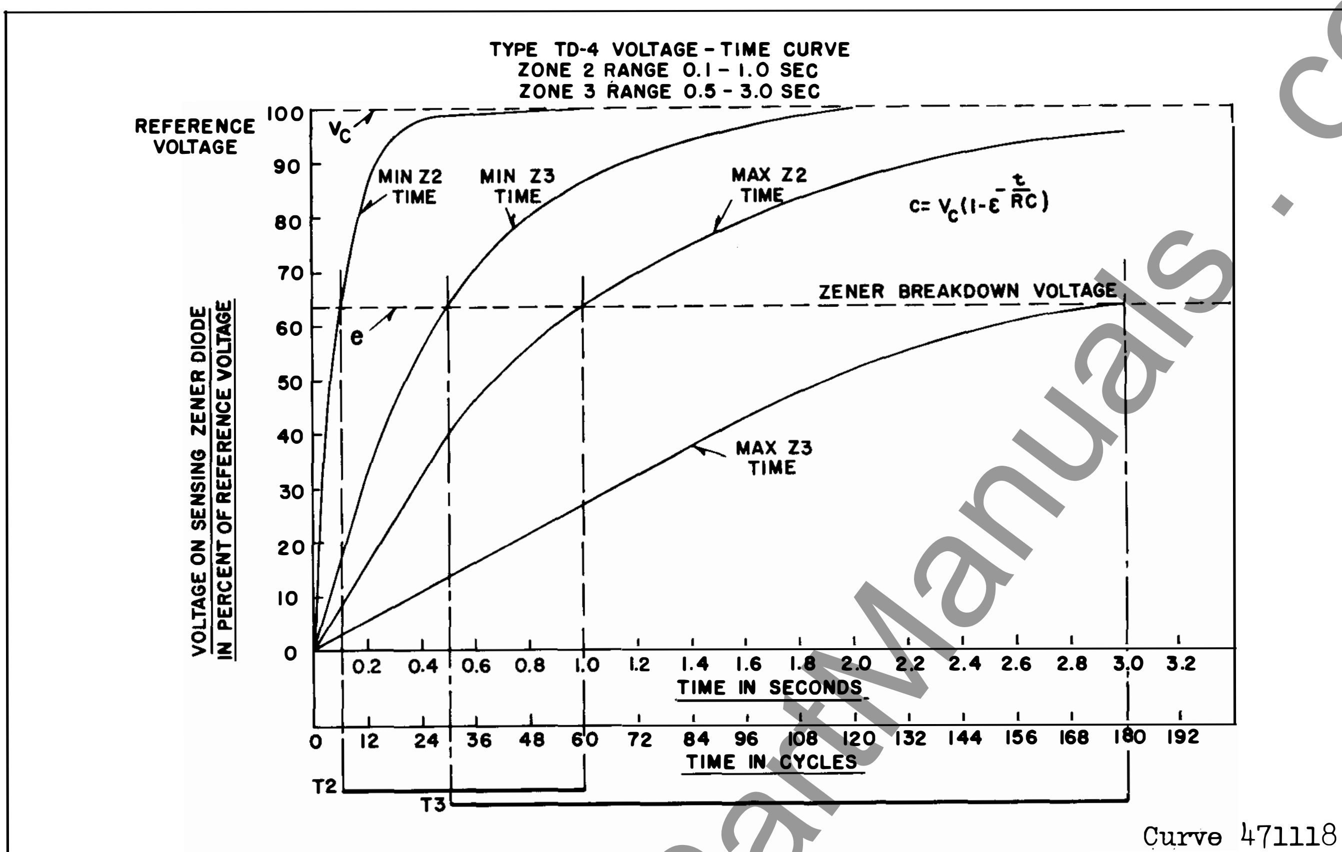


Fig. 6. Voltage-Time Curves for Minimum and Maximum Time Settings

SETTINGS

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

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

INSTALLATION

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

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Tests

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

Routine Maintenance

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

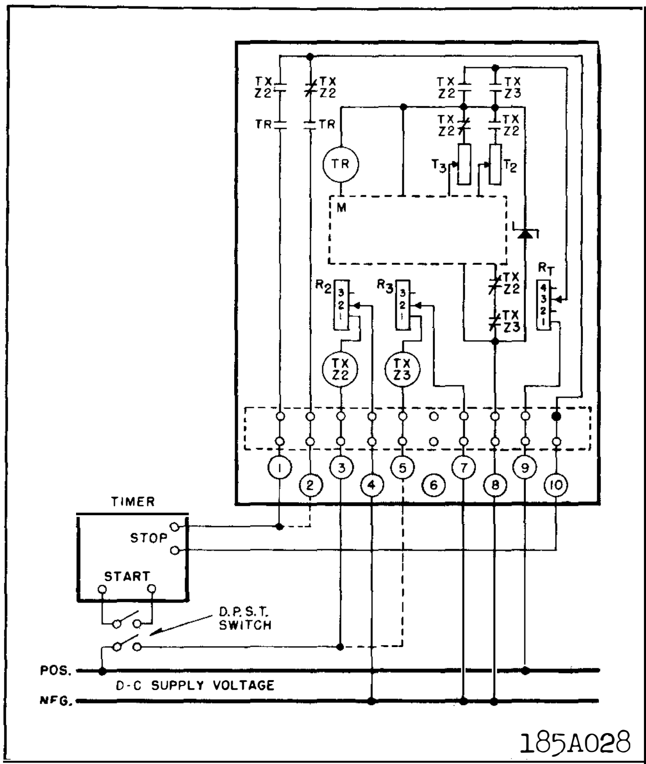


Fig. 7. Test Circuit for the Type TD-4 Relay. (Jumper terminals 6 and 10 when testing relay with independent trip contacts).

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

Trouble Shooting Procedure

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

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

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

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

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

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

Calibration

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

1. Telephone Type Relay Adjustment

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

2. Rheostat Knob Adjustment, Same Scale Plate

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

3. Scale Plate Calibration, New Scale Plate

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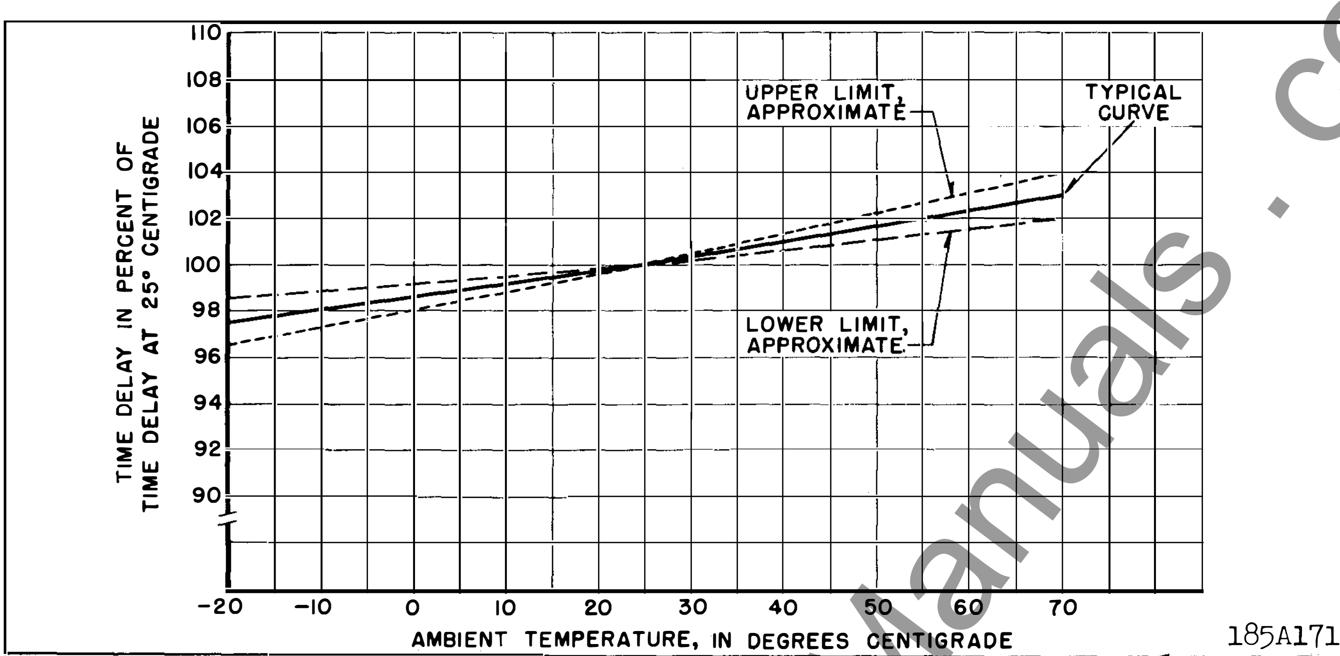

Fig. 8. Timing Variations with Temperature Changes

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

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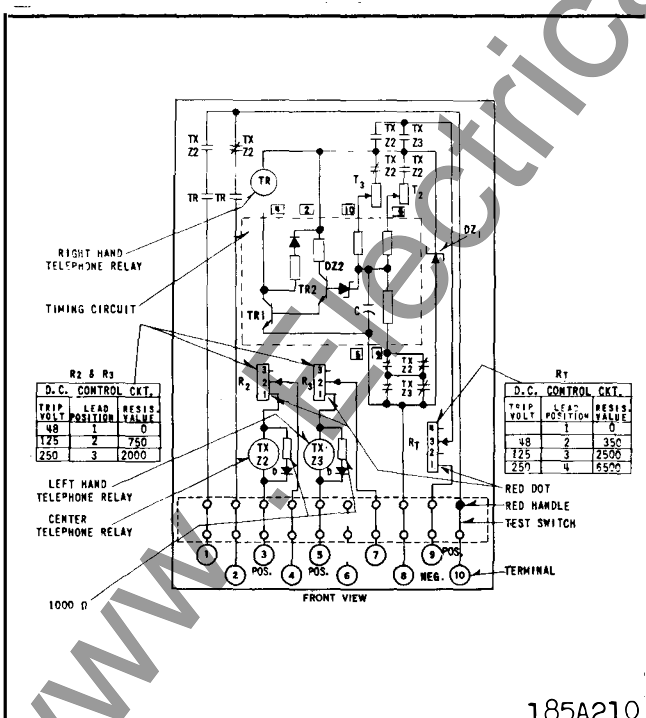
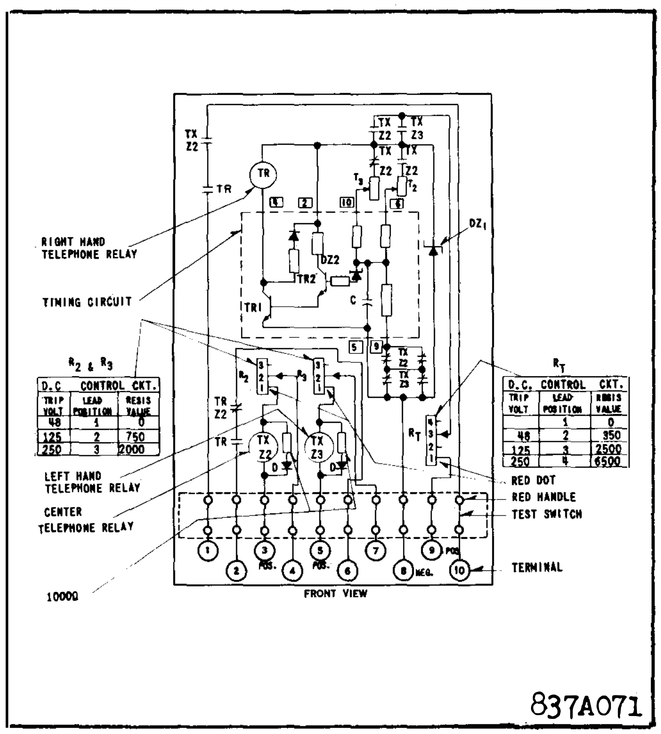
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



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



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

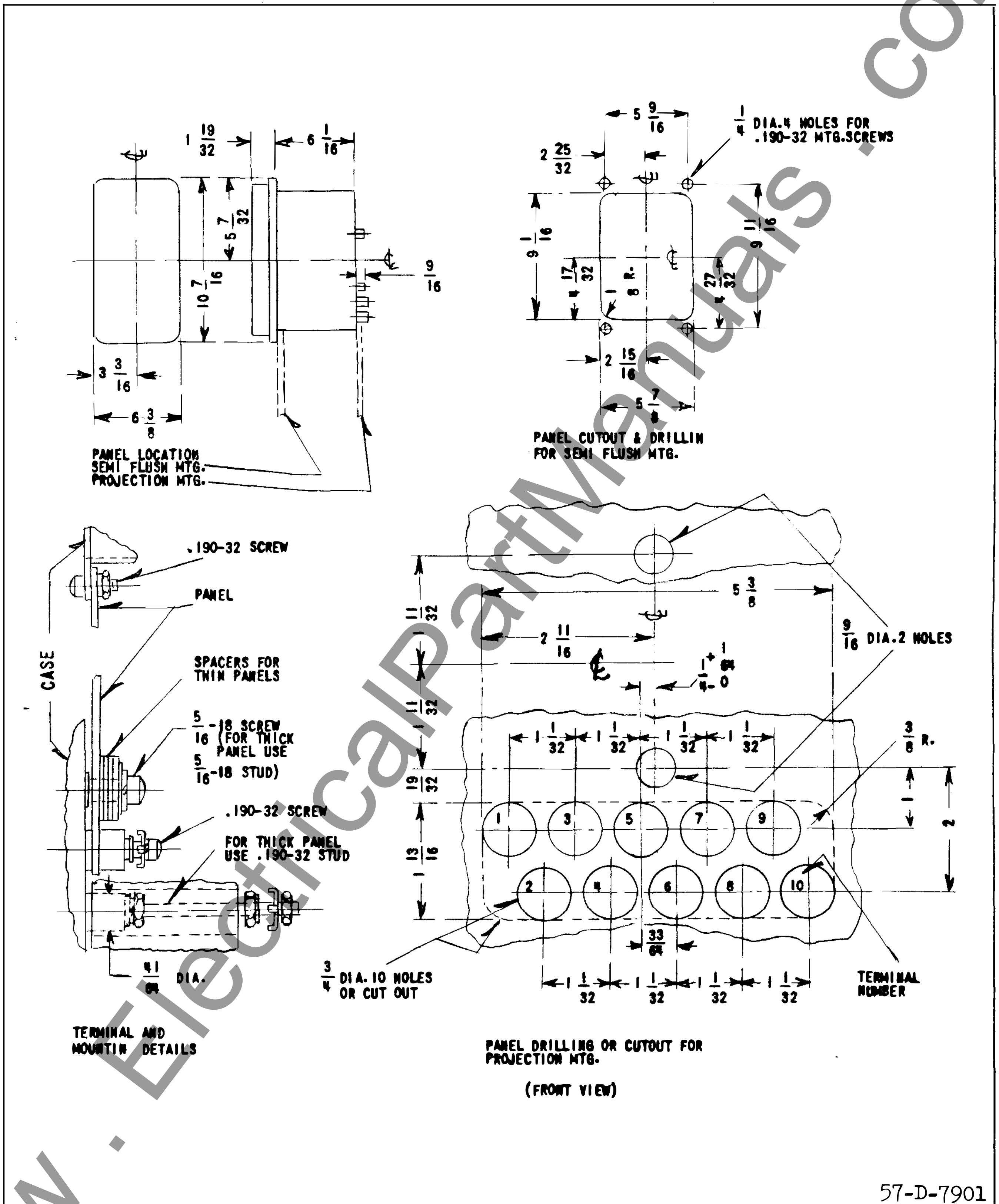


Fig.11 Outline and Drilling Plan for the Type TD-4 Relay in the FT21 Case.

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

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