INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO OVERCURRENT RELAY

CAUTION

Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

CONTENTS

This instruction leaflet applies to the following types of relays:

Type CO-2 Short Time Relay
CO-5 Long Time Relay
CO-6 Definite Minimum Time Relay
CO-7 Moderately Inverse Time Relay
CO-8 Inverse Time Relay
CO-9 Very Inverse Time Relay
CO-11 Extremely Inverse Time Relay

CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required. The principal component parts of the relay and their location are shown in Figs. 1-5.

Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap cause a contact closing torque.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

Indicating Contactor Switch Unit (ICS)

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

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

Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also, during the operation, two fingers on the armature deflect a spring located on the front of the switch which allows the operation indicator target to drop.

A core screw accessible from the top of the switch provides the adjustable pickup range. The minimum and maximum pick-up points are indicated on the scale which is located to the rear of the core screw.

CHARACTERISTICS

The relays are generally available in the following current ranges:

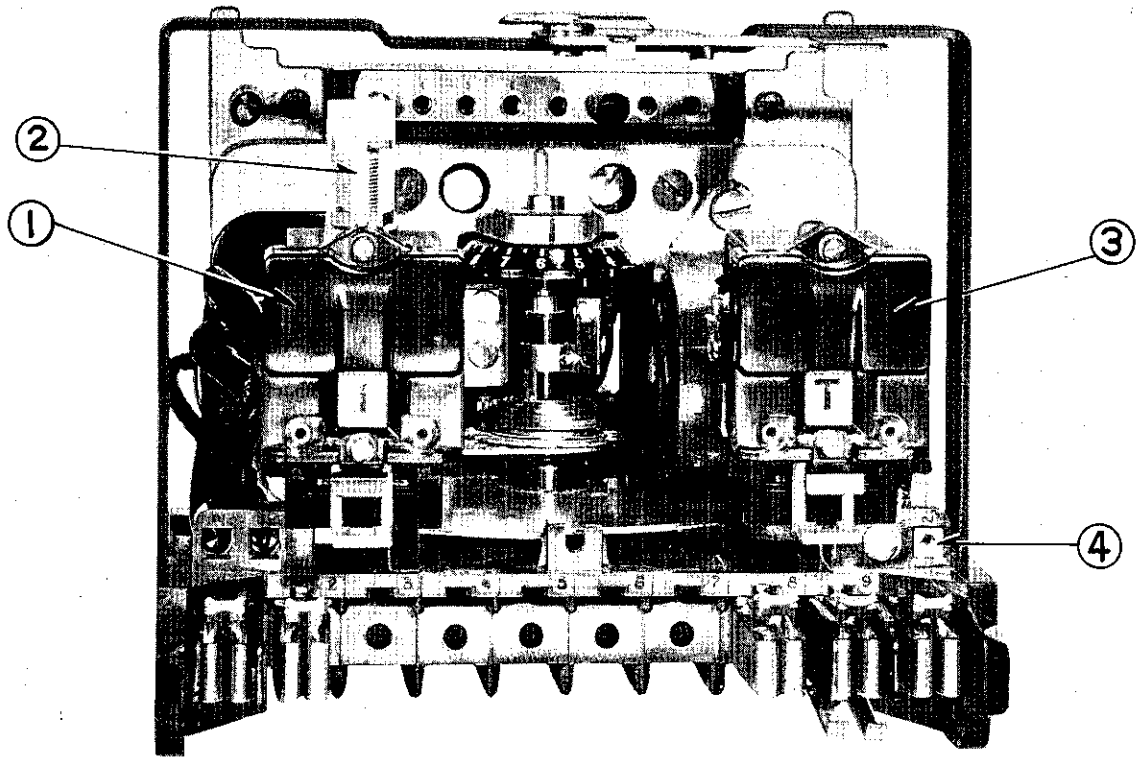

Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

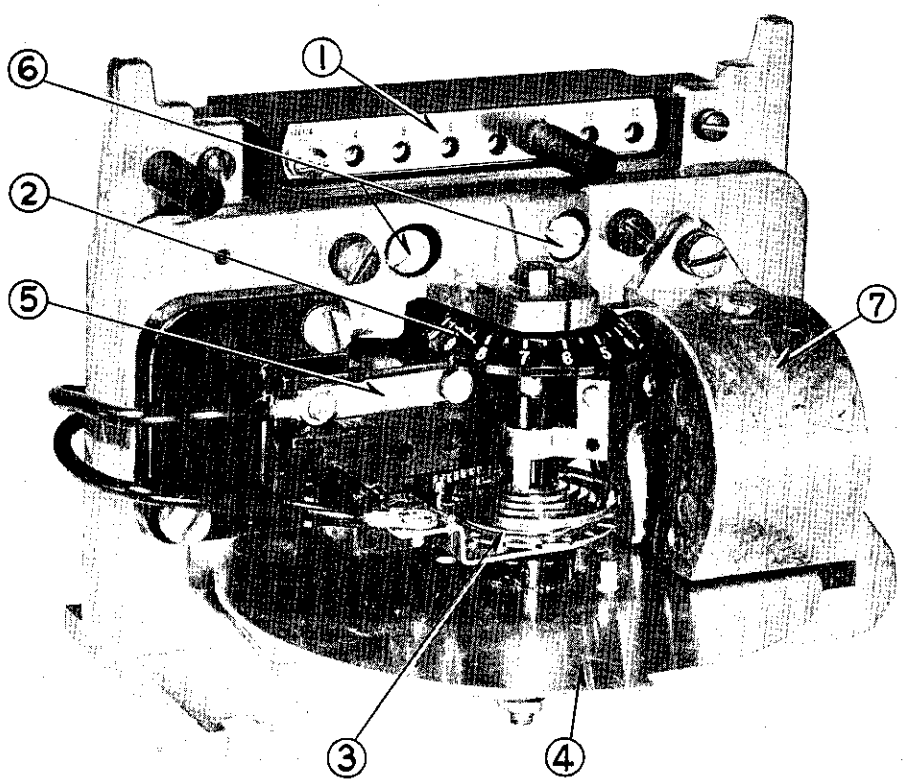

Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

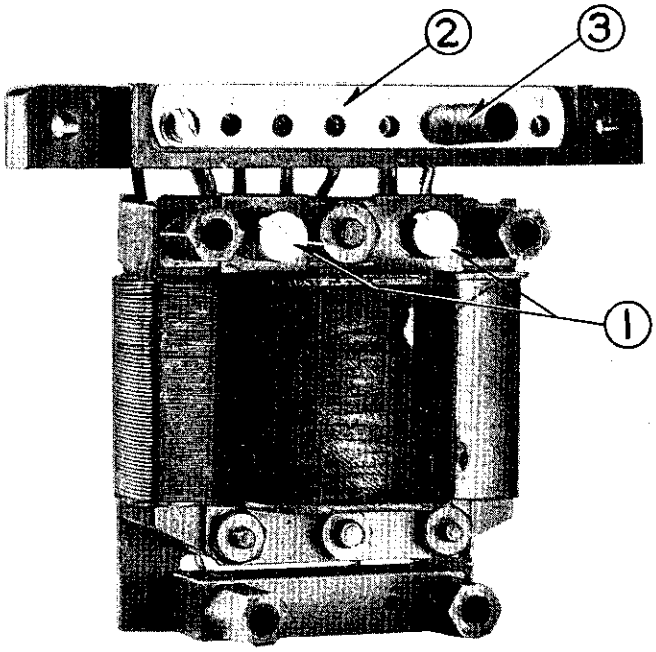

Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

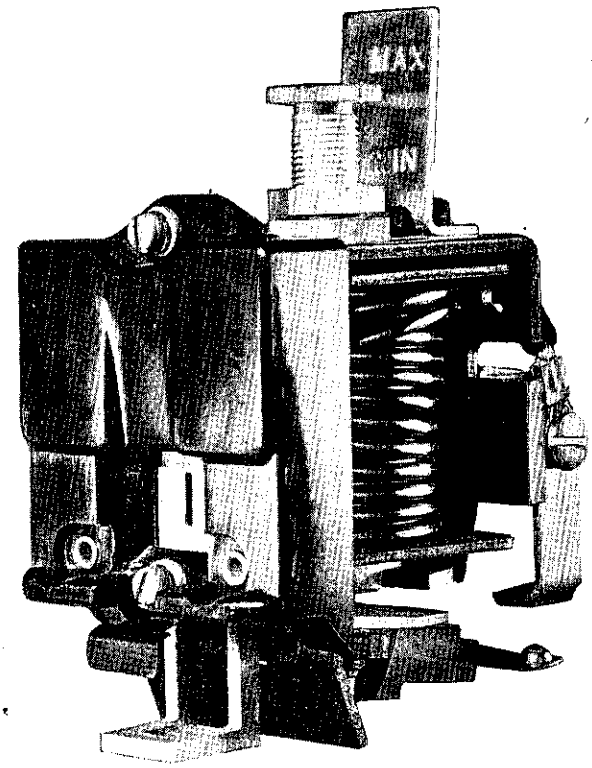

Fig. 4. Indicating Instantaneous Trip Unit (IIT).

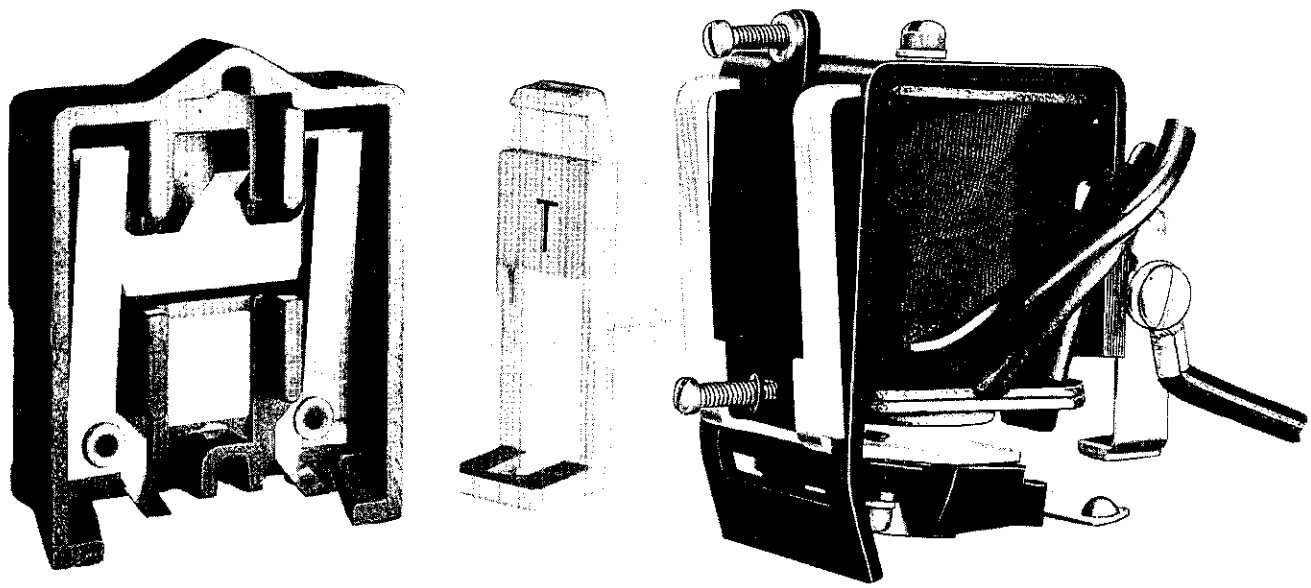

Fig. 5. Indicating Contactor Switch (ICS).

Range	Taps						
.5 - 2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2 - 6	2	2.5	3	3.5	4	5	6
4 - 12	4	5	6	7	8	10	12

The tap value is the minimum current required to just close the relay contacts.

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 7 to 13. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Contactor Switch -

0.2 ampere tap - 6.5 ohms d-c resistance

2.0 ampere tap - 0.15 ohms d-c resistance

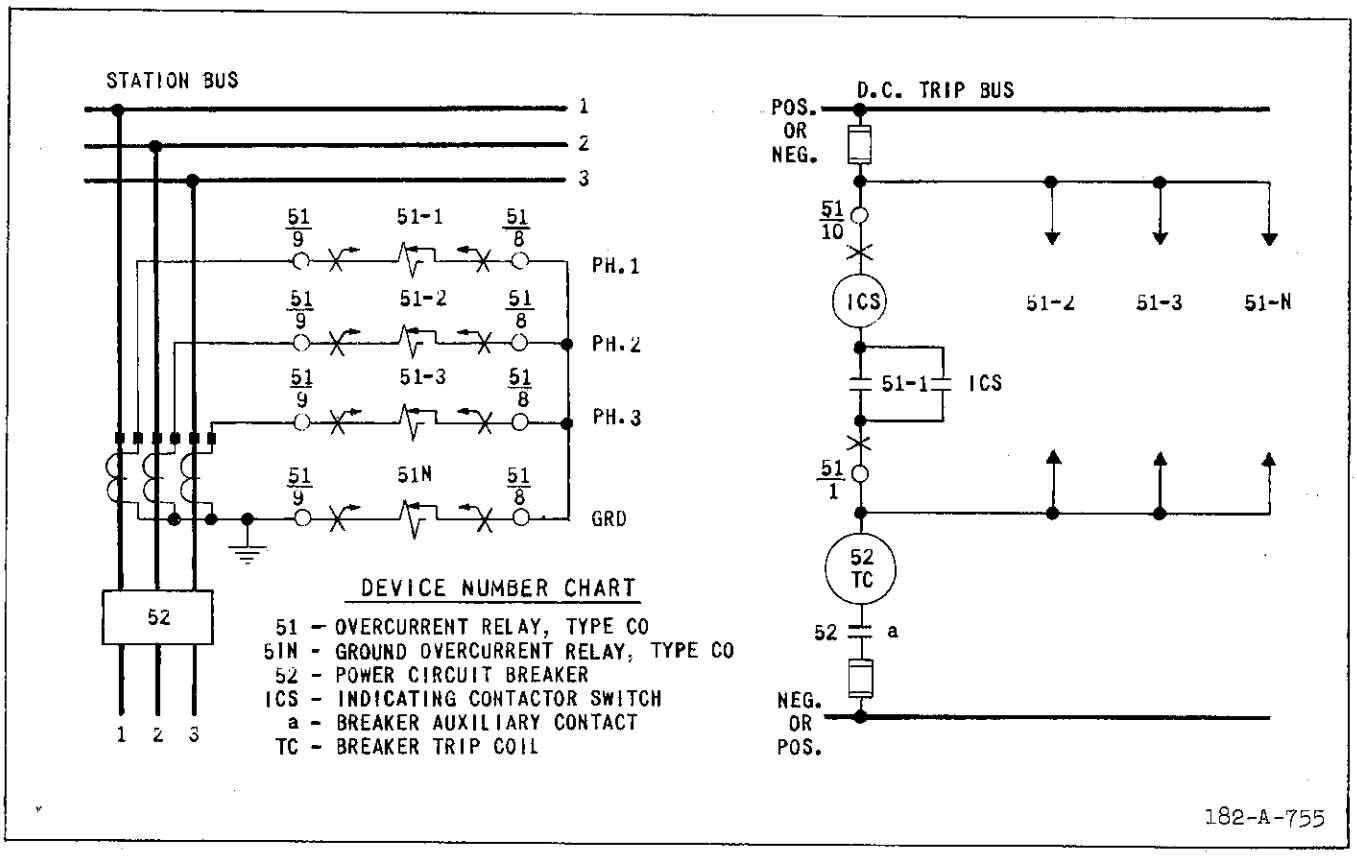

Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

TYPE CO-2 RELAY

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES** AT TAP VALUE CURRENT	VOLT AMPERES** AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 20 TIMES TAP VALUE CURRENT
	0.5	0.91	28	58	4.8	39.6	256	790
	0.6	0.96	28	57	4.9	39.8	270	851
	0.8	1.18	28	53	5.0	42.7	308	1024
0.5/2.5	1.0	1.37	28	50	5.3	45.4	348	1220
	1.5	1.95	28	40	6.2	54.4	435	1740
	2.0	2.24	28	36	7.2	65.4	580	2280
	2.5	2.50	28	29	7.9	73.6	700	2850
	2.0	3.1	110	59	5.04	38.7	262	800
	2.5	4.0	110	55	5.13	39.8	280	920
	3.0	4.4	110	51	5.37	42.8	312	1008
2/6	3.5	4.8	110	47	5.53	42.8	329	1120
	4.0	5.2	110	45	5.72	46.0	360	1216
	5.0	5.6	110	41	5.90	50.3	420	1500
	6.0	6.0	110	37	6.54	54.9	474	1800
	4.0	7.3	230	65	4.92	39.1	268	848
	5.0	8.0	230	50	5.20	42.0	305	1020
	6.0	8.8	230	47	5.34	44.1	330	1128
4/12	7.0	9.6	230	46	5.35	45.8	364	1260
	8.0	10.4	230	43	5.86	49.9	400	1408
	10.0	11.2	230	37	6.6	55.5	470	1720
	12.0	12.0	230	34	7.00	62.3	528	2064

* *Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.*

ϕ *Degrees current lags voltage at tap value current.*

** *Voltages taken with Rectox type voltmeter.*

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES** AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	(0.5	2	56	69	3.92	20.6	103	270
	(0.6	2.2	56	68	3.96	20.7	106	288
	(0.8	2.5	56	67	3.96	21	114	325
0.5/2.5	(1.0	2.8	56	66	4.07	21.4	122	360
	(1.5	3.4	56	62	4.19	23.2	147	462
	(2.0	4.0	56	60	4.30	24.9	168	548
	(2.5	4.4	56	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.87	21.6	118	342
	(3	9.7	230	64	3.93	22.1	126	381
2/6	(3.5	10.4	230	63	4.09	23.1	136	417
	(4	11.2	230	62	4.08	23.5	144	448
	(5	12.5	230	59	4.20	24.8	162	540
	(6	13.7	230	57	4.38	26.5	183	624
	(4	16	460	65	4.00	22.4	126	376
	(5	18.8	460	63	4.15	23.7	143	450
	(6	19.3	460	61	4.32	25.3	162	531
4/12	(7	20.8	460	59	4.27	26.4	183	611
	(8	22.5	460	56	4.40	27.8	204	699
	(10	25	460	53	4.60	30.1	247	880
	(12	28	460	47	4.92	35.6	288	1056

CO-7 MODERATELY INVERSE TIME RELAY

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES** AT TAP VALUE CURRENT	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	(0.5	2	56	68	3.88	20.7	103	278
	(0.6	2.2	56	67	3.93	20.9	107	288
	(0.8	2.5	56	66	3.93	21.1	114	320
0.5/2.5	(1.0	2.8	56	64	4.00	21.6	122	356
	(1.5	3.4	56	61	4.08	22.9	148	459
	(2.0	4.0	56	58	4.24	24.8	174	552
	(2.5	4.4	56	56	4.38	25.9	185	640
	(2	8	230	66	4.06	21.3	111	306
	(2.5	8.8	230	63	4.07	21.8	120	342
	(3	9.7	230	63	4.14	22.5	129	366
2/6	(3.5	10.4	230	62	4.34	23.4	141	413
	(4	11.2	230	61	4.34	23.8	149	448
	(5	12.5	230	59	4.40	25.2	163	530
	(6	13.7	230	58	4.62	27	183	624
	(4	16	460	64	4.24	22.8	129	392
	(5	18.8	460	61	4.30	24.2	149	460
4/12	(6	19.3	460	60	4.62	25.9	168	540
	(7	20.8	460	58	4.69	27.3	187	626
	(8	22.5	460	55	4.80	29.8	211	688
	(10	25	460	51	5.20	33	260	860
	(12	28	460	46	5.40	37.5	308	1032

* *Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.*

ϕ *Degrees current lags voltage at tap value current.*

** *Voltages taken with Rectox type voltmeter.*

CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES** AT TAP VALUE CURRENT	VOLT AMPERES** AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 20 TIMES TAP VALUE CURRENT
	(0.5	2	56	72	2.38	21	132	350
	(0.6	2.2	56	71	2.38	21	134	365
	(0.8	2.5	56	69	2.40	21.1	142	400
0.5/2.5	(1.0	2.8	56	67	2.42	21.2	150	440
	(1.5	3.4	56	62	2.51	22	170	530
	(2.0	4.0	56	57	2.65	23.5	200	675
	(2.5	4.4	56	53	2.74	24.8	228	800
	(2	8	230	70	2.38	21	136	360
	(2.5	8.8	230	66	2.40	21.1	142	395
	(3	9.7	230	64	2.42	21.5	149	430
2/6	(3.5	10.4	230	62	2.48	22	157	470
	(4	11.2	230	60	2.53	22.7	164	500
	(5	12.5	230	58	2.64	24	180	580
	(6	13.7	230	56	2.75	25.2	198	660
	(4	16	460	68	2.38	21.3	146	420
	(5	18.8	460	63	2.46	21.8	158	480
	(6	19.3	460	60	2.54	22.6	172	550
4/12	(7	20.8	460	57	2.62	23.6	190	620
	(8	22.5	460	54	2.73	24.8	207	700
	(10	25	460	48	3.00	27.8	248	850
	(12	28	460	45	3.46	31.4	292	1020

TYPE CO-11 RELAY

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES** AT TAP VALUE CURRENT	VOLT AMPERES** AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES** AT 20 TIMES TAP VALUE CURRENT
	0.5	1.7	56	36	0.72	6.54	71.8	250
	0.6	1.9	56	34	0.75	6.80	75.0	267
	0.8	2.2	56	30	0.81	7.46	84.0	298
0.5/2.5	1.0	3.5	56	27	0.89	8.30	93.1	330
	1.5	3.0	56	22	1.13	10.04	115.5	411
	2.0	3.5	56	17	1.30	11.95	136.3	502
	2.5	3.8	56	16	1.48	13.95	160.0	610
	2.0	7.0	230	32	0.73	6.30	74.0	264
	2.5	7.8	230	30	0.78	7.00	78.5	285
	3.0	8.3	230	27	0.83	7.74	84.0	309
2/6	3.5	9.0	230	24	0.88	8.20	89.0	340
	4.0	10.0	230	23	0.96	9.12	102.0	372
	5.0	11.0	230	20	1.07	9.80	109.0	430
	6.0	12.0	230	20	1.23	11.34	129.0	504
	4.0	14	460	29	0.79	7.08	78.4	296
	5.0	16	460	25	0.89	8.00	90.0	340
	6.0	17	460	22	1.02	9.18	101.4	378
4/12	7.0	18	460	20	1.10	10.00	110.0	454
	8.0	20	460	18	1.23	11.1	124.8	480
	10.0	22	460	17	1.32	14.9	131.6	600
	12.0	26	460	16	1.8	16.3	180.0	720

* *Thermal capacities for short times other than one second may be calaculated on the basis of time being inversely proportional to the square of the current.*

ϕ *Degrees current lags voltage at tap value current.*

** *Voltages taken with Rectox type voltmeter.*

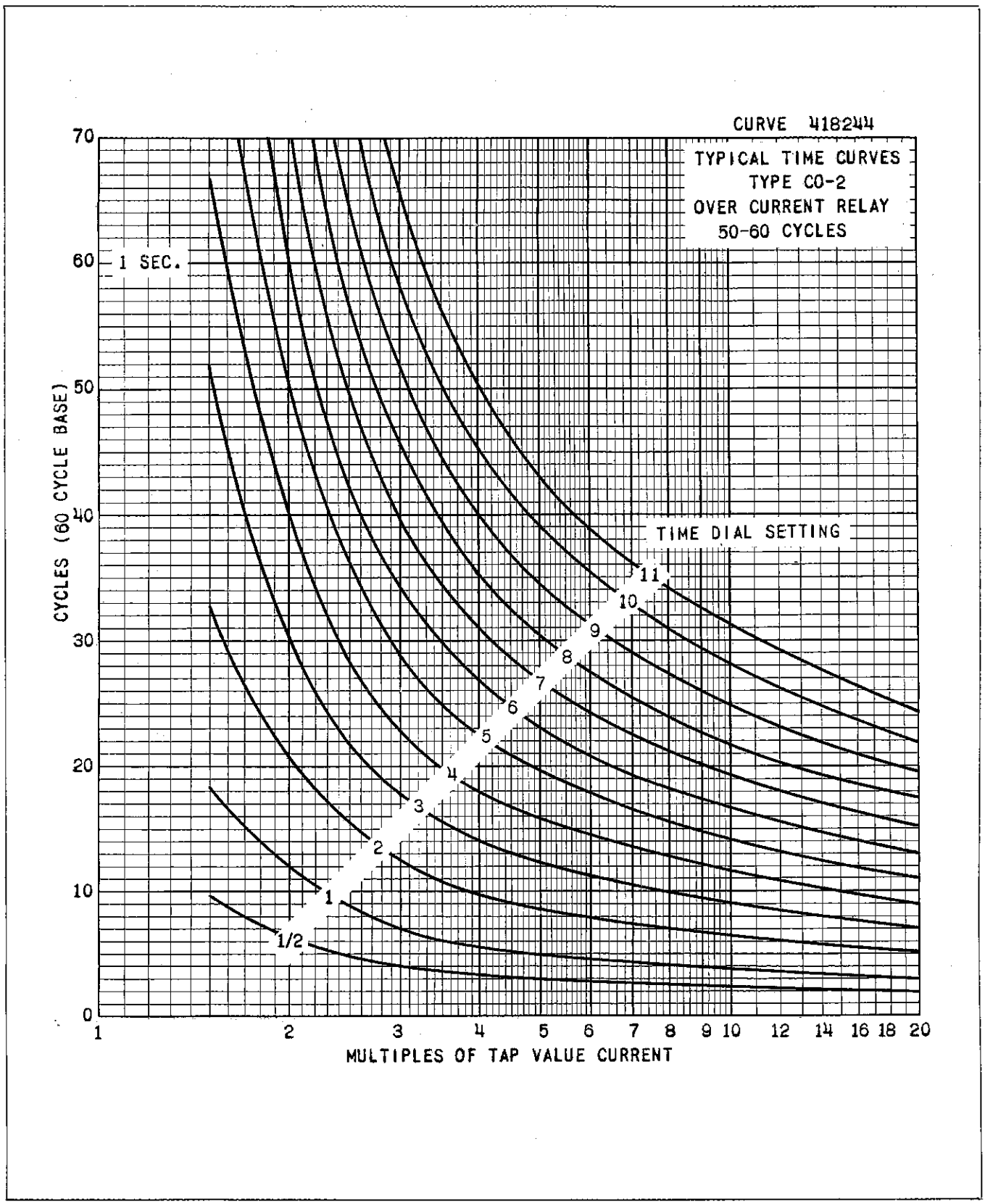

Fig. 7. Typical Time Curves of the Type CO-2 Relay.

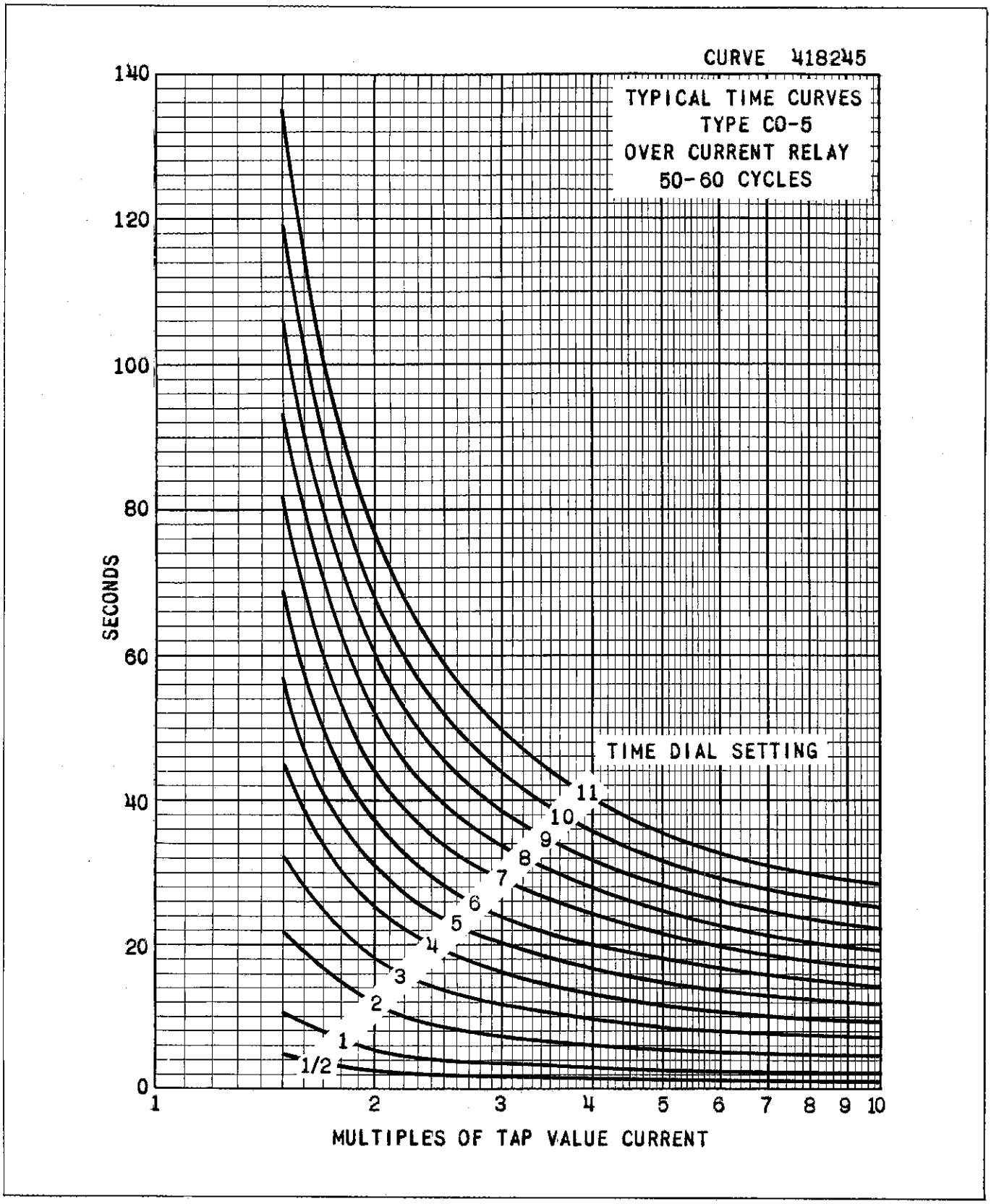

Fig. 8. Typical Time Curves of the Type CO-5 Relay.

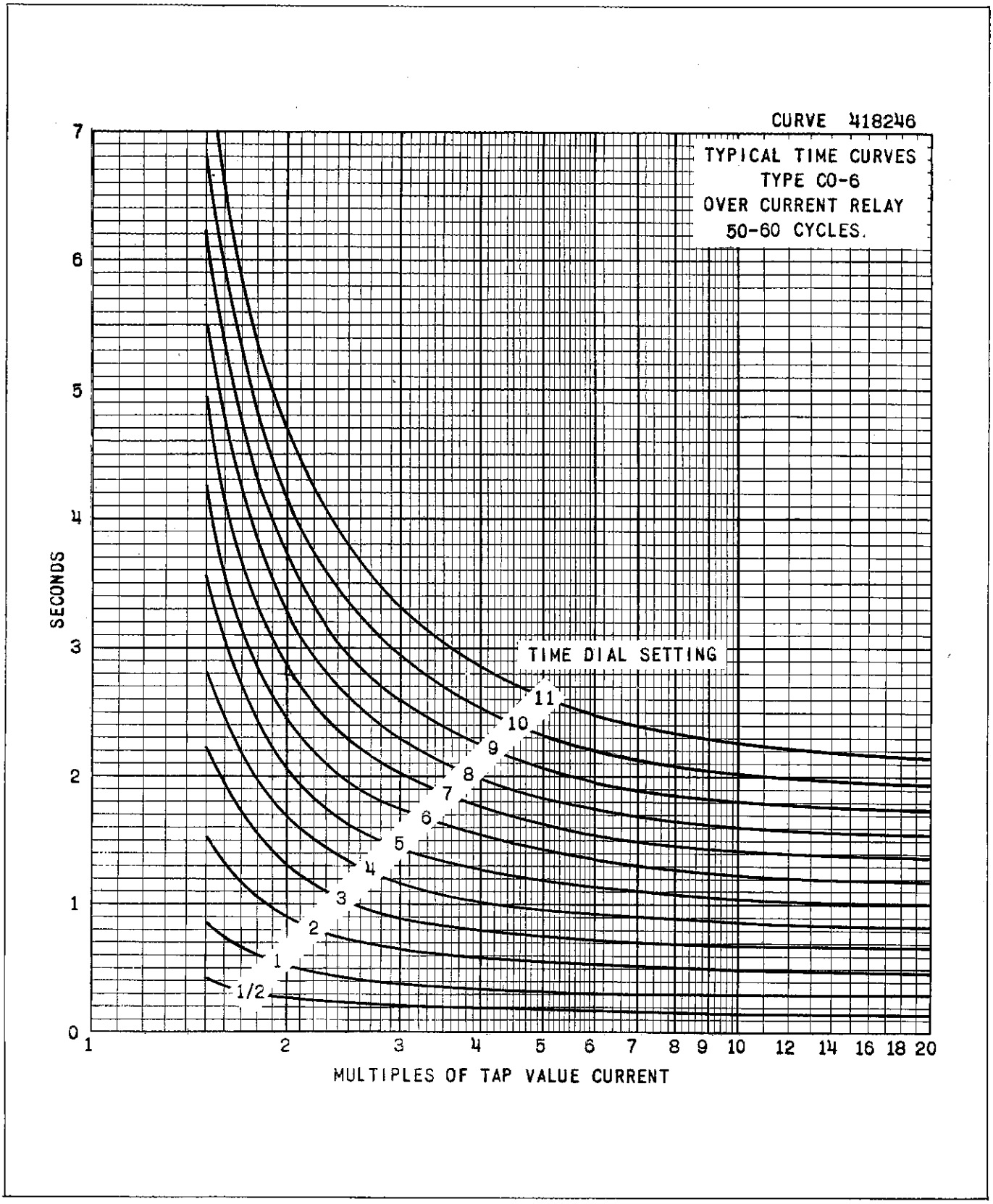

Fig. 9. Typical Time Curves of the Type CO-6 Relay.

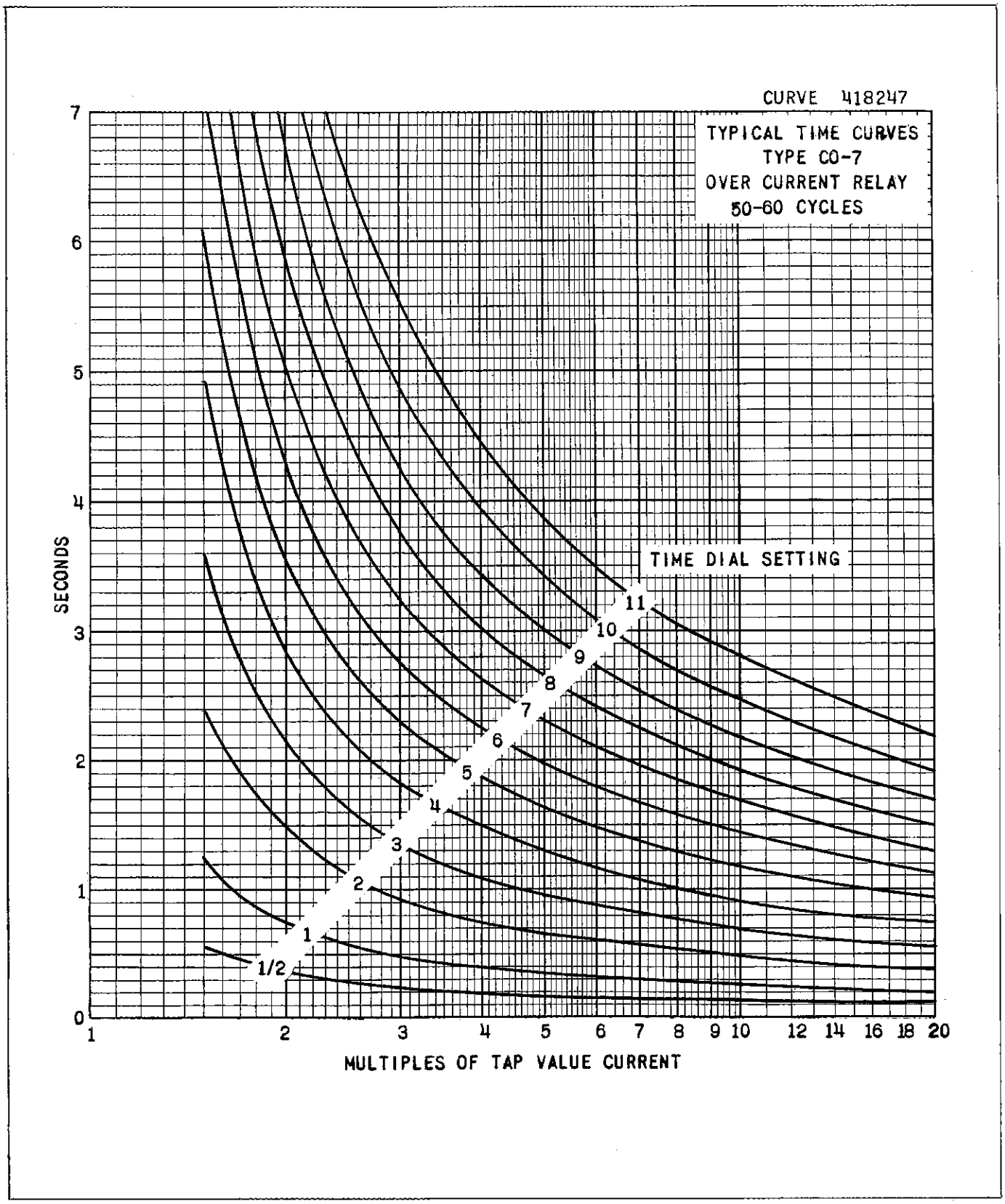

Fig. 10. Typical Time Curves of the Type CO-7 Relay.

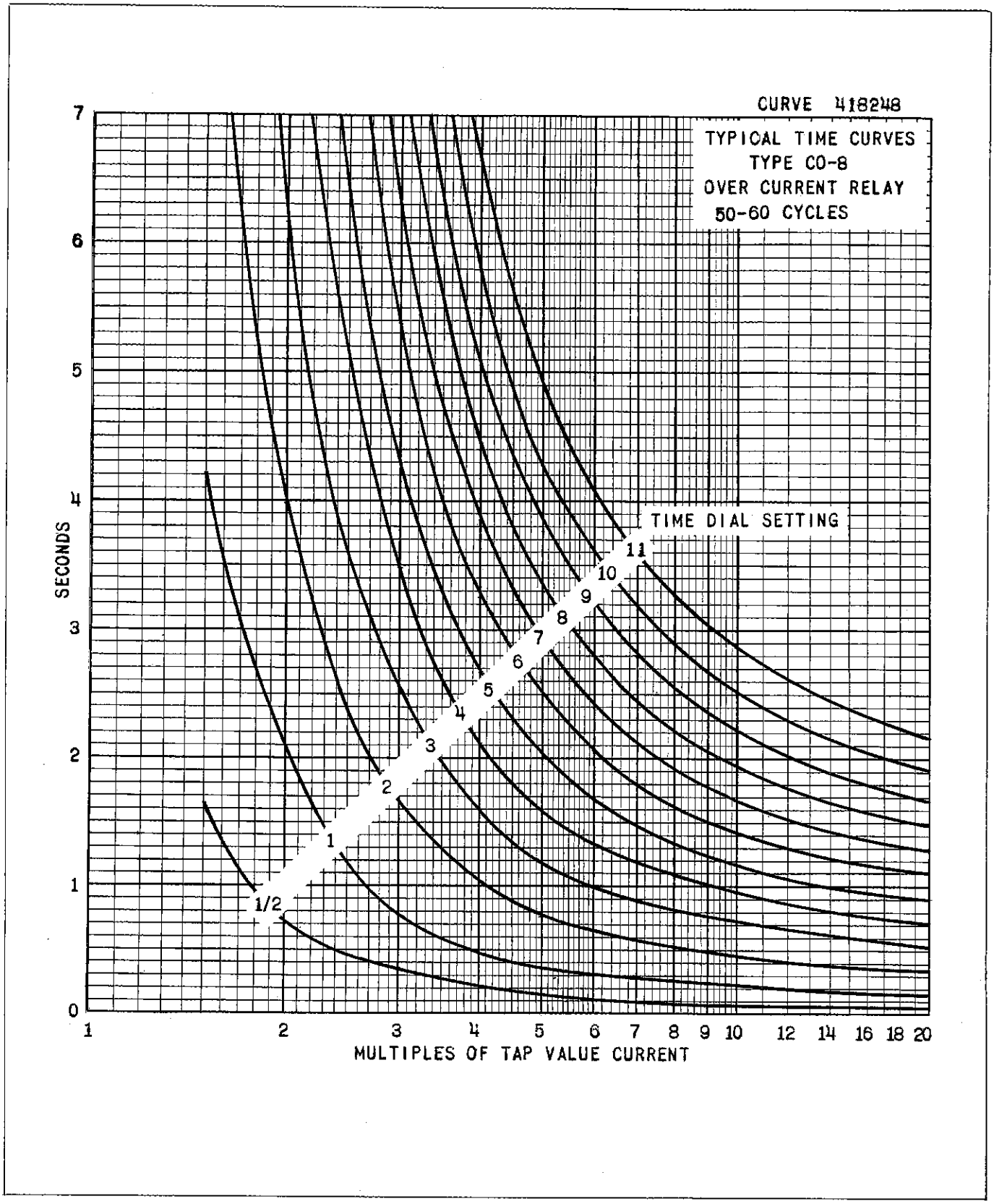

Fig. 11. Typical Time Curves of the Type CO-8 Relay.

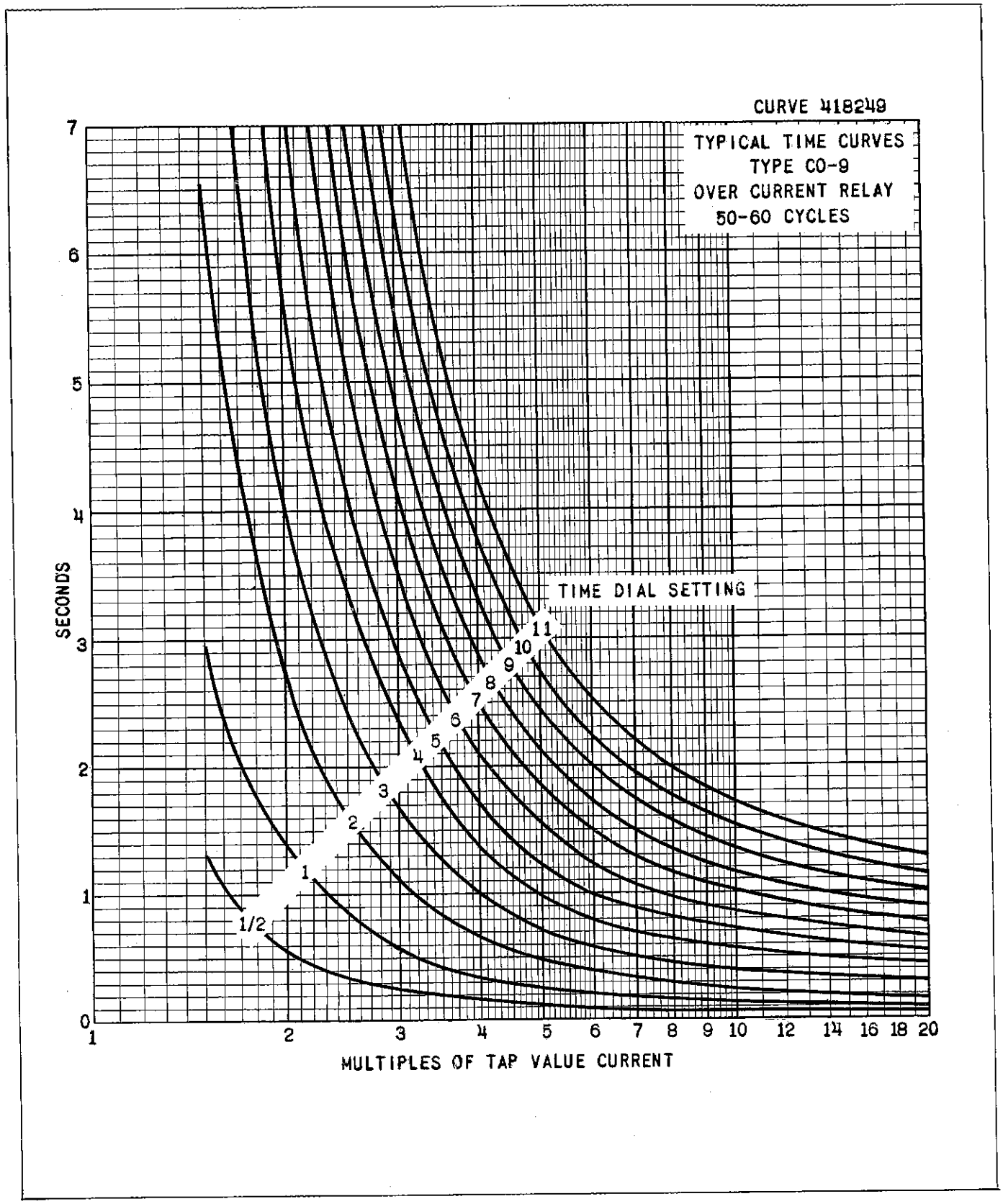

Fig. 12. Typical Time Curves of the Type CO-9 Relay.

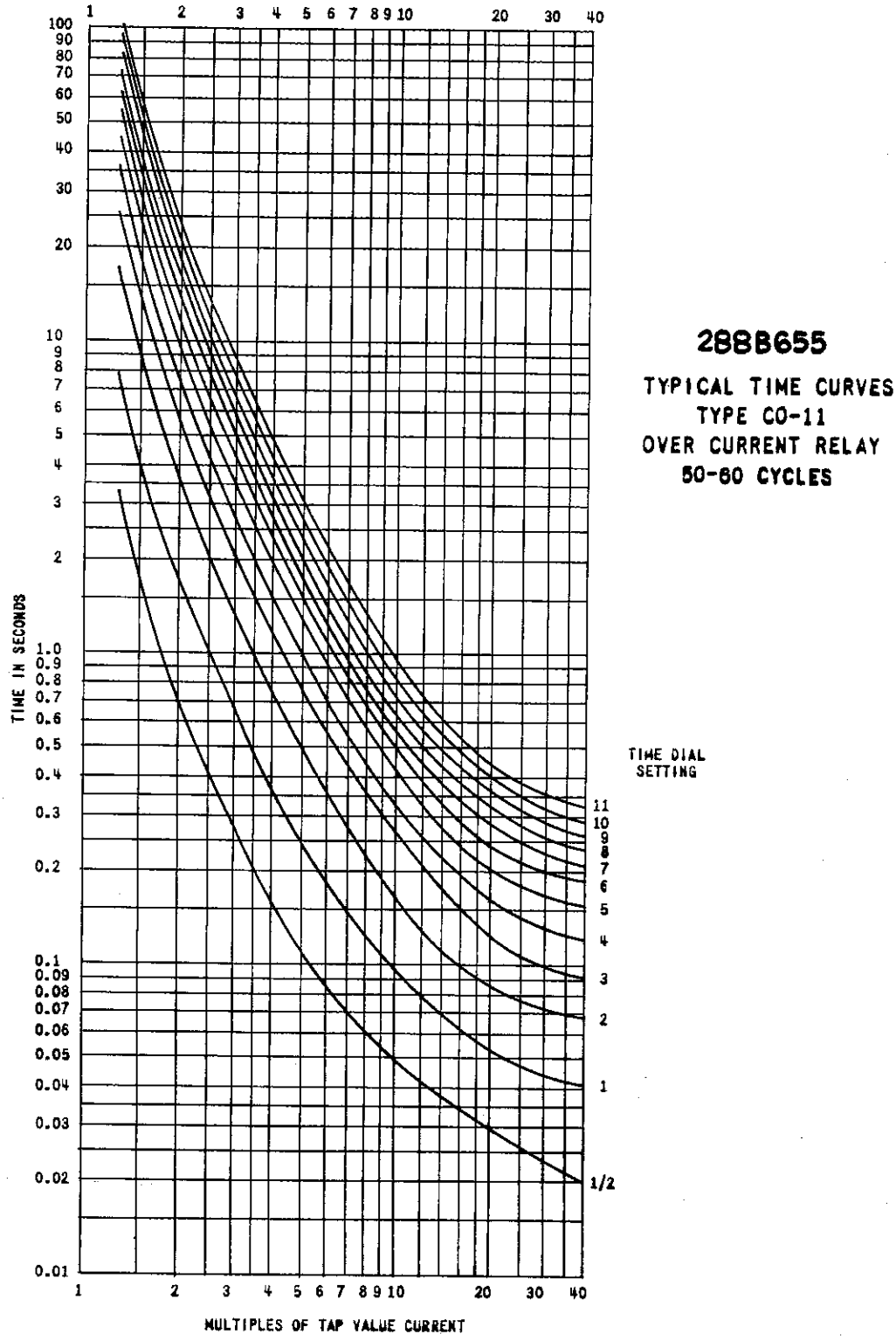

Fig. 13. Typical Time Curves of the Type CO-11 Relay.

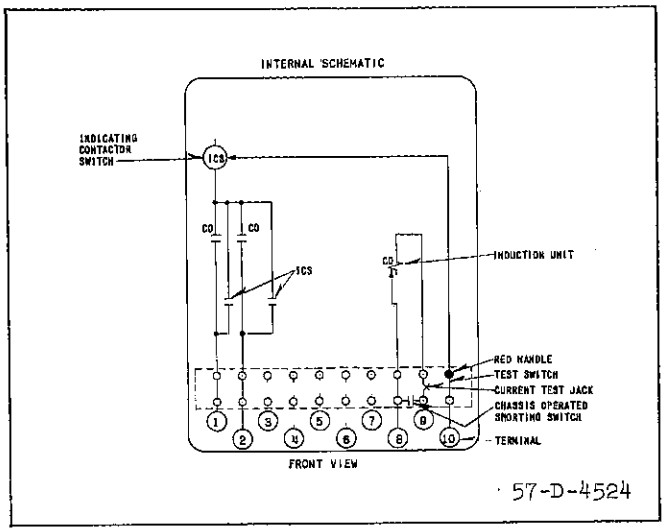

Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted.

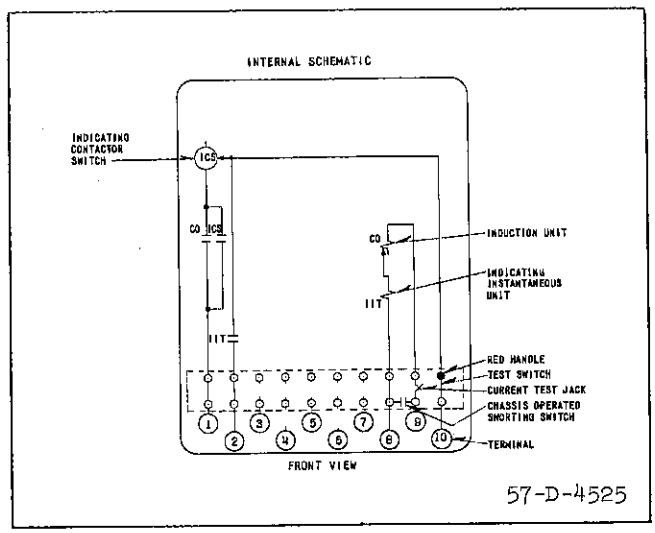

Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

SETTINGS

CO Unit

The overcurrent unit settings can be defined either by tap setting and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will just close its contacts at the corresponding current 4-5-6-7-8-10-12 amperes, or as marked on the terminal plate.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector screw in the desired tap position before removing the other tap screw from the original tap position.

Instantaneous Reclosing

The factory adjustment of the CO unit contact provides a contact follow. Where instantaneous circuit breaker reclosing will be initiated upon the closure of the CO contact, this contact follow must be eliminated by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring. With this change and the contact mounting screw tightened, the stationary contact will rest solidly against its backstop.

Indicating Contactor Switch (ICS)

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

Indicating Instantaneous Trip (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount

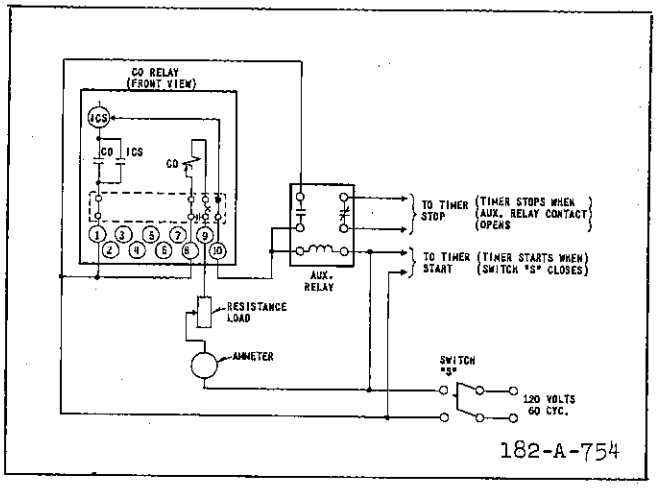

Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

the relay vertically be means of the mounting stud for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to be terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to IL 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under "SETTINGS" should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

1. Contacts - By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is just resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial.

2. Minimum Trip Current - Set the time dial to position 6. Alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.

3. Time Curve - Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table I, (e.g. for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table I plus or minus 5 percent.

4. Indicating Instantaneous Trip Unit (IIT) - The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

Apply sufficient current to operate the IIT. The operation indicator target should drop freely.

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

Routine Maintenance

All relays should be inspected periodically and the time of operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application. Phantom loads should not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

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

CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order. (See "Acceptance Check")

CO Unit

1) Contacts - By turning the time dial move the moving contacts until they deflect the stationary con-

tact to a position where the stationary contact is just resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial.

2) Minimum Trip Current - The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

With the time dial set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. Time Curve Calibration - Install the permanent magnet.

Apply the indicated current per Table I (e.g. CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table I.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (Withdrawing the left hand plug, front view, increases the operating time and withdrawing the right hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

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

5. Indicating Instantaneous Trip Unit (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from the IIT unit.

RENEWAL PARTS

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

TABLE 1

TIME CURVE CALIBRATION DATA – 60 CYCLES

	PERMANENT MAGNET ADJUSTMENT			ELECTROMAGNET PLUGS	
RELAY TYPE	TIME DIAL POSITION	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS	CURRENT (MULTIPLES OF TAP VALUE)	OPERATING TIME SECONDS
CO-2	6	3	0.57	20	0.22
CO-5	6	2	37.80	10	14.30
CO-6	6	2	2.46	20	1.19
CO-7	6	2	4.27	20	1.11
CO-8	6	2	13.35	20	1.11
CO-9	6	2	8.87	20	0.65
CO-11	6	2	11.27	20	0.24

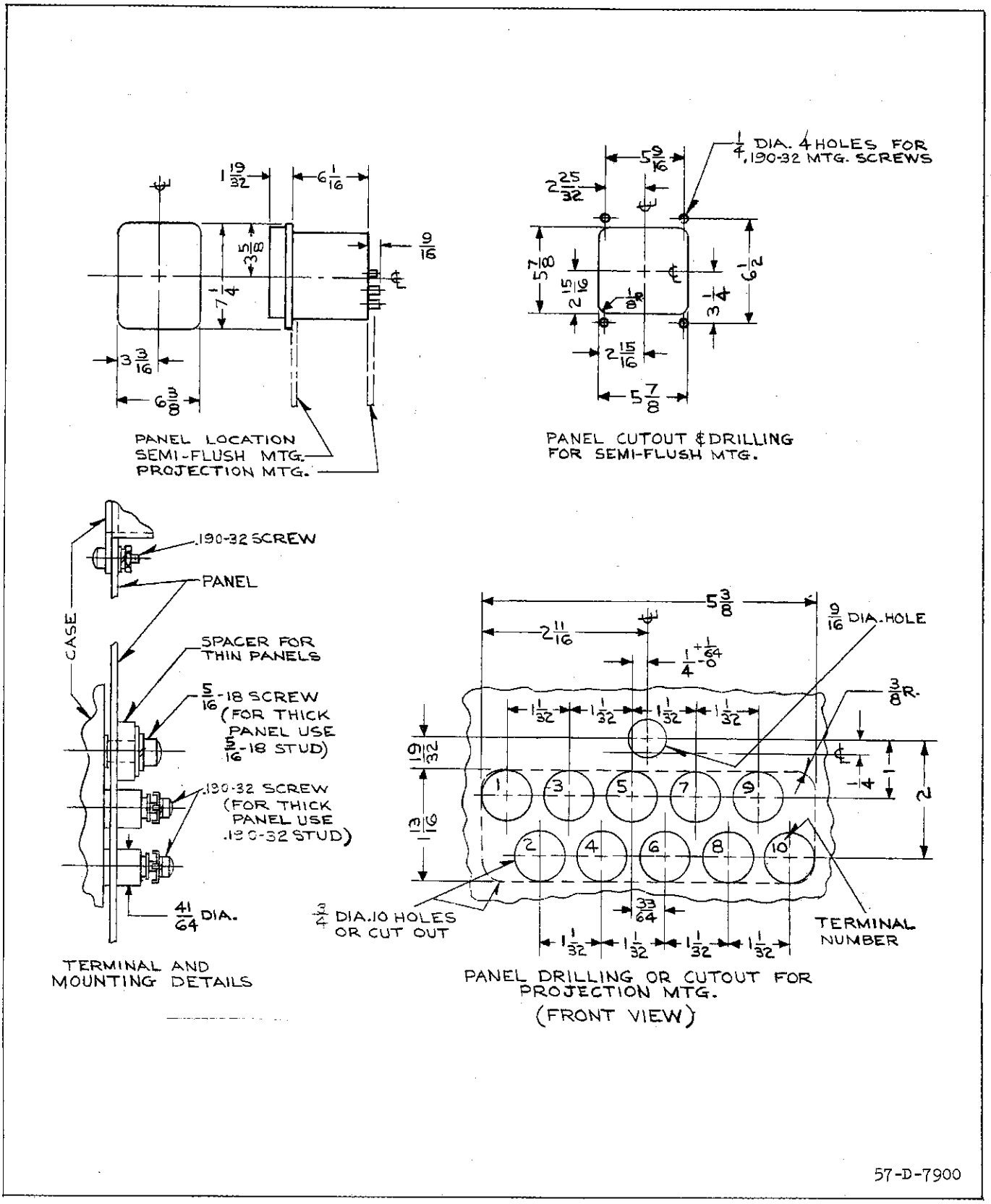

Fig. 17. Outline and Drilling Plan for the Type CO Relay.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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