INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CKO 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

The CKO relay is a time delayed overcurrent relay equipped with a cylinder unit instantaneous trip. It is used in applications where negligible response by the instantaneous unit to the dc component of fault current and/or high dropout ratio is required. Transient overreach will not exceed 5 percent for this instantaneous trip unit for circuit angles up to 80 degrees. The instantaneous unit may be "torque controlled" by an external contact where desired. Closure of the external contact prevents operation of the instantaneous unit. Dropout ratio of the instantaneous unit will be 97 percent or greater.

CONSTRUCTION AND OPERATION

The various types of relays consist of a time-overcurrent unit (CO), an instantaneous over-current unit (I), an instantaneous overcurrent unit transformer, and two indicating contactor switches (ICS/I) and (ICS/T). The principle component parts of the relays and their location are shown in Fig. 1 through 5.

TIME-OVERCURRENT UNIT (CO)

The electromagnets for the types CKO-5, CKO-6, CKO-7, CKO-8 and CKO-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 electromagnet for the type CKO-2 and CKO-11 relays has 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.

The CO torque control terminals (4 and 5) are internally jumpered, but the jumper may be removed if external torque control is desired.

INDICATING CONTACTOR SWITCH UNITS (ICS/I) and ICS/T)

The dc 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.

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

SUPERSEDES L·836441
COMPLETE REVISION

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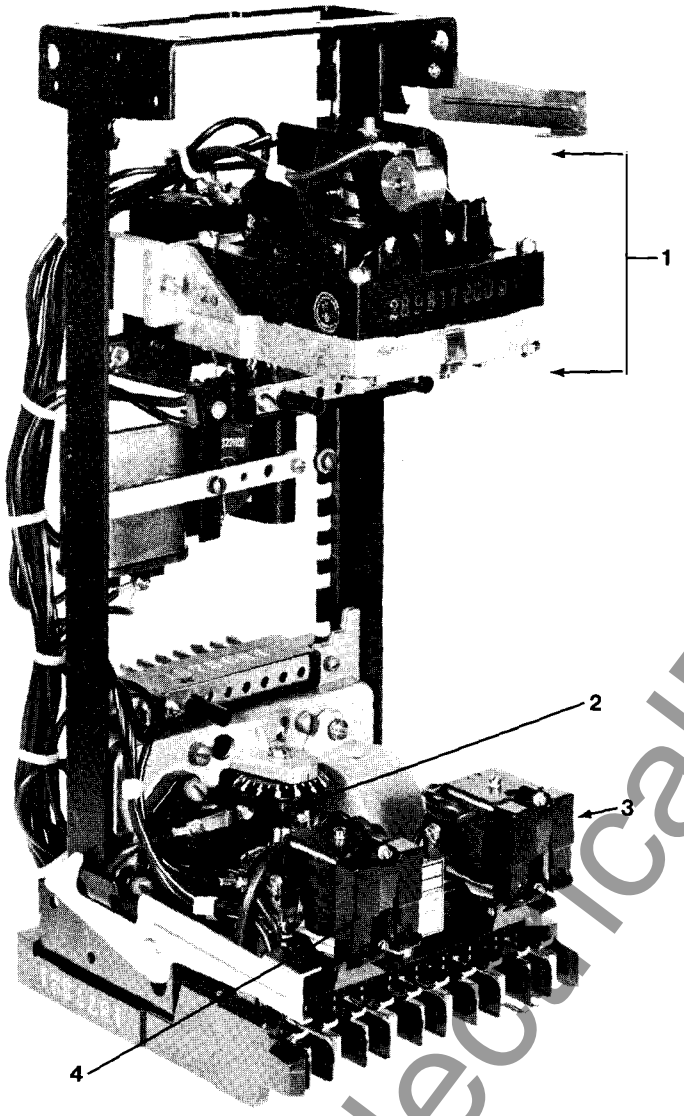

Fig. 1. Type CKO Relay Without Case (Front View). 1 - Instantaneous Overcurrent Unit and Saturating Transformer. 2 - Time Overcurrent Unit. 3 - Indicating Contactor Switch (ICS-T). 4 - Indicating Contactor Switch (ICS-I).

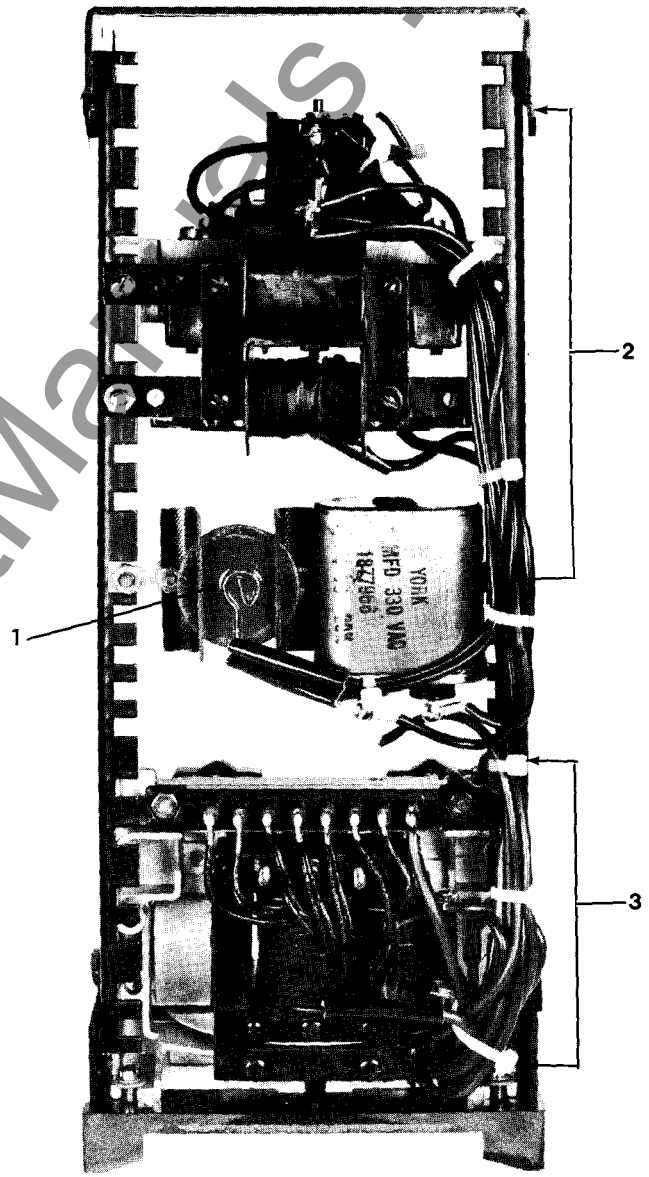

Fig. 2. Type CKO Relay Without Case (Rear View). 1 - Varistor. 2 - Saturating Transformer. 3 - "E" Type Electromagnet.

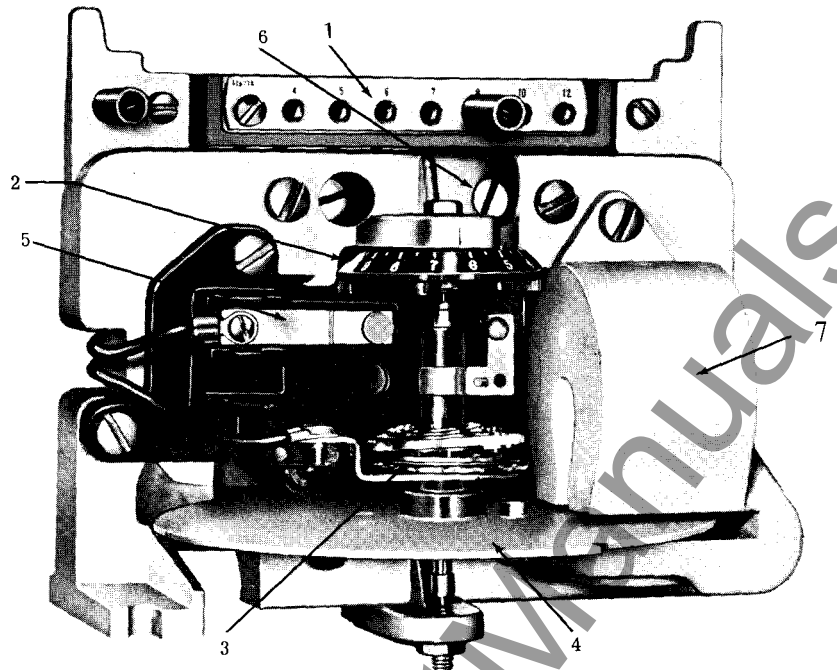

Fig. 3. Time Overcurrent Unit. 1 - Tap Block. 2 - Time Dial. 3 - Control Spring Assembly. 4 - Disc. 5 - Stationary Contact Assembly. 6 - Magnetic Plugs. 7 - Permanent Magnet.

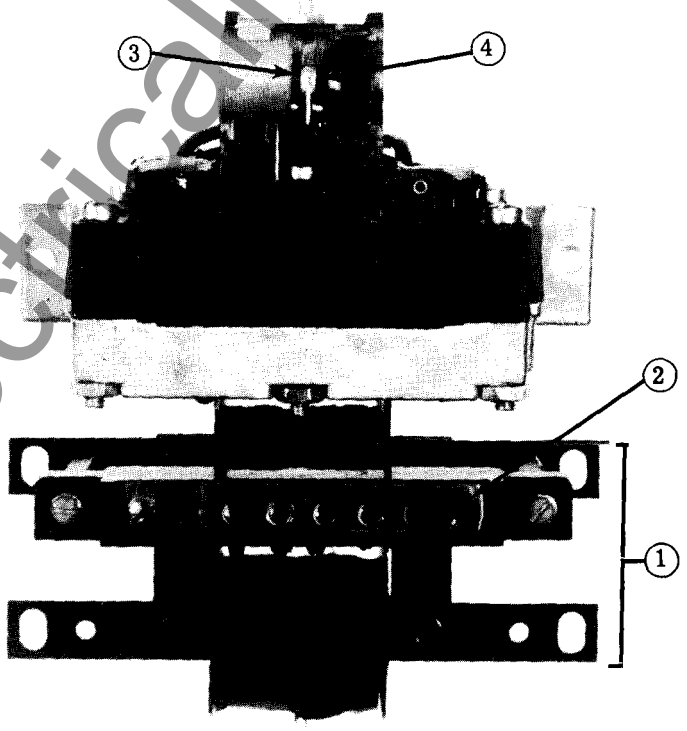

Fig. 4. Instantaneous Overcurrent Unit. 1 - Saturating Transformer. 2 - Tap Block. 3 - Stationary Contact. 4 - Moving Contact.

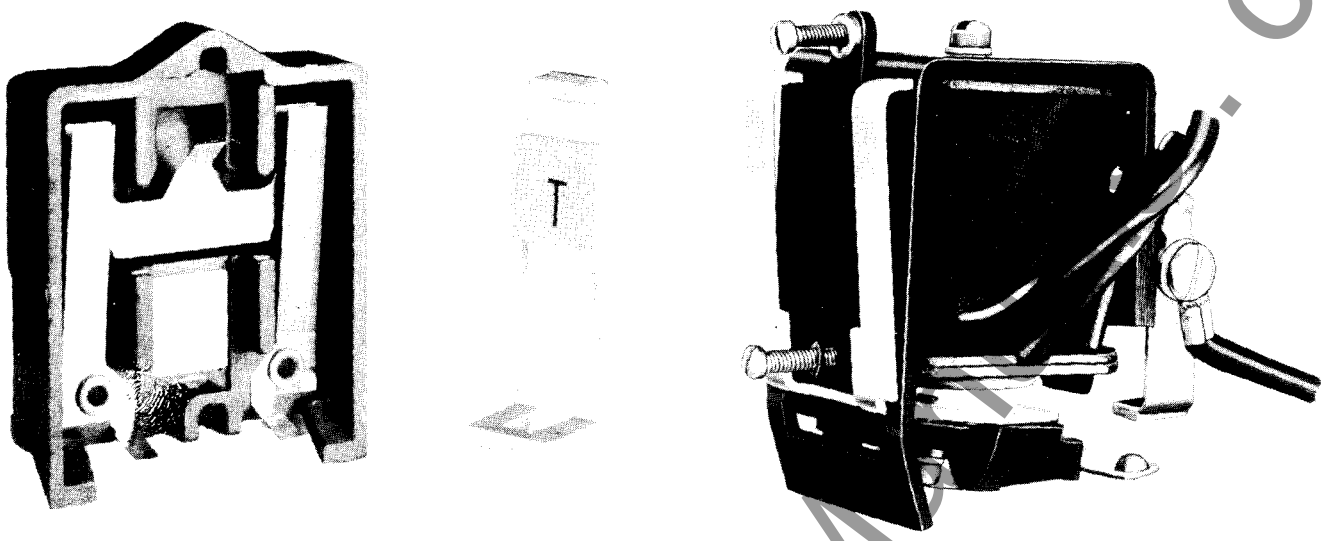

Fig. 5. Indicating Contactor Switch (ICS).

INSTANTANEOUS OVERCURRENT UNIT

CONSTRUCTION

The instantaneous overcurrent unit consists of an induction cylinder unit, capacitor, varistor, and a transformer. The components are connected such that a contact closing torque is produced when the current exceeds a specified value.

INDUCTION CYLINDER UNIT

Mechanically, the cylinder unit is composed of four basic components: a diecast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another, and a capacitor is connected in series with one pair of coils. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearings, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

SATURATING TRANSFORMER

The transformer is a saturating type consisting of a tapped primary winding and a secondary winding. A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction cylinder unit and phase shifting capacitor.

OPERATION

Operation of the instantaneous overcurrent unit occurs when the primary current of the transformer exceeds a value as marked on the tap plate. Upon application of current to the transformer, a voltage is induced in the secondary winding. This voltage is impressed upon the parallel connected pairs of cylinder unit coils. The capacitor connected in series with one pair of coils shifts the current flowing in these coils in reference to the current flowing in the other pair of coils. As a result, the air gap fluxes of the cylinder unit are out of phase and a contact closing torque is produced.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pickup current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

Two terminals, 6 and 7, across one pair of pole windup are brought out so that operating current can be short circuited around the pole windings preventing the unit from developing torque.

CHARACTERISTICS

The time characteristics of the over-current relays are designated by specific numbers as indicated below (e.g., CKO-8).

Time Characteristics	Designation
Short Time	2
Long Time	5
Definite Time	6
Moderately Inverse Time	7
Inverse Time	8
Very Inverse Time	9
Extremely Inverse Time	11

The relays are available in the following current ranges:

Instantaneous Overcurrent Unit (I)

Range	Taps					
0.5-2 Amps	0.5	0.75	1.0	1.25	1.5	2
1-4	1.0	1.5	2.0	2.5	3.0	4.0
2-8	2	3	4	5	6	8
4-16	4	6	8	9	12	16
10-40	10	15	20	24	30	40
20-80	20	30	40	48	60	80

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the instantaneous overcurrent units is shown in Fig. 14.

Time Overcurrent Unit

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.

This time vs. current characteristics for the time-overcurrent unit 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 relay contacts will safely close 30 amperes at 250 volts d c and the seal-in contacts of the indicating contactor switches will safely carry this current long enough to trip a circuit 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 mans of a screw connection.

CONTACTS

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in each stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

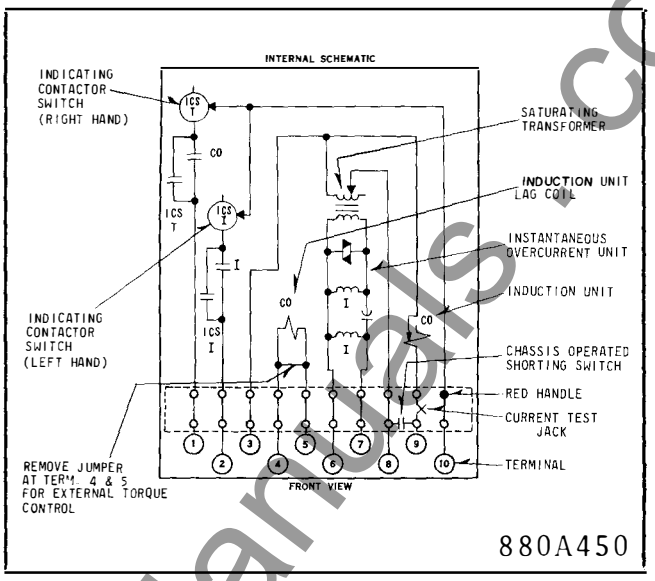

Fig. 6. Internal Schematic of the Type CKO Relay in the Type FT31 Case.

ENERGY REQUIREMENTS

INSTANTANEOUS OVERCURRENT UNIT OPERATING CURRENT CIRCUIT – 60 HERTZ

AMPERE RANGE	TAP	†† VA AT TAP VALUE	Ø P.F. ANGLE	†† VA AT 5 AMPS.	Ø P.F. ANGLE
	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
.5-2	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
1-4	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
2-8	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29
	4	1.5	51	2.4	51
	6	1.7	45	1.2	45
4-16	8	1.8	40	0.7	40
	9	1.9	38	0.6	38
	12	2.2	34	0.37	34
	16	2.5	30	0.24	31
	10	1.7	28	0.43	28
	15	2.4	21	0.27	21
	20	3.1	16	0.20	17
10-40	24	3.6	15	0.15	15
	30	4.2	12	0.11	13
	40	4.9	11	0.08	12
	20	6.6	31	0.40	31
	30	9.3	24	0.25	24
20-80	40	12	20	0.18	20
	48	13.5	18	0.14	18
	60	15.9	16	0.10	16
	80	19.2	15	0.07	15

RANGE	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING † (AMPERES)
0.5-2	5	100
1-4	8	140
2-8	8	140
4-16	10	200
10-40	10	200
20-80	10	200

† 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.

Ø Degrees current lags voltage.

†† Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS
TYPE CKO-2 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE Ø	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	5.53	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 maybe calculated on the basis of time being inversely proportional to the square of the current.

Ø Degrees current lags voltage at tap value current.

†† Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

TYPE CKO-5 AND TYPE CKO-6 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ∅	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	*2.7	88	69	3.92	20.6	103	270
	(0.6	*3.1	88	68	3.96	20.7	106	288
	(0.8	*3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	*4.1	88	66	4.07	21.4	122	360
	(1.5	*5.7	88	62	4.19	23.2	147	462
	(2.0	*6.8	88	60	4.30	24.9	168	548
	(2.5	*7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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

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CKO-7 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ∅	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.

∅ Degrees current lags voltage at tap value current.

†† Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

TYPES CKO-8 AND CKO-9 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE Ø	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	*2.7	88	72	2.38	21	132	350
	(0.6	*3.1	88	71	2.38	21	134	365
	(0.8	*3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	*4.1	88	67	2.42	21.2	150	440
	(1.5	*5.7	88	62	2.51	22	170	530
	(2.0	*6.8	88	57	2.65	23.5	200	675
	(2.5	*7.7	88	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

CKO-11 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE Ø	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	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	2.5	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 calculated on the basis of time being inverselyproportional to the square of the current.

Ø Degrees current lags voltage at tap value current.
††Voltages taken with Rectox type voltmeter.

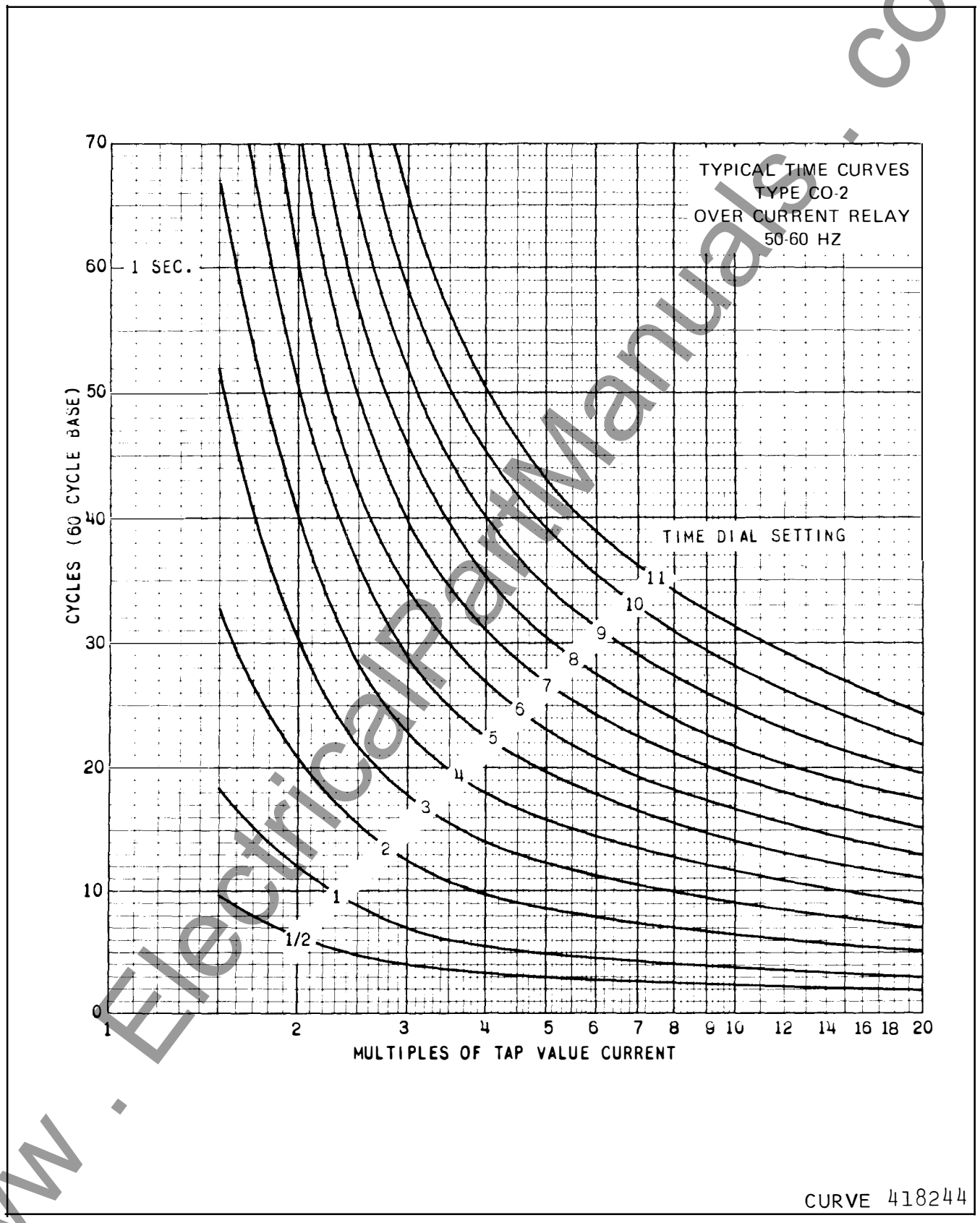


Fig. 7. Typical Time Curves of the Time-Overcurrent Unit of the Short Time (2) Relays.

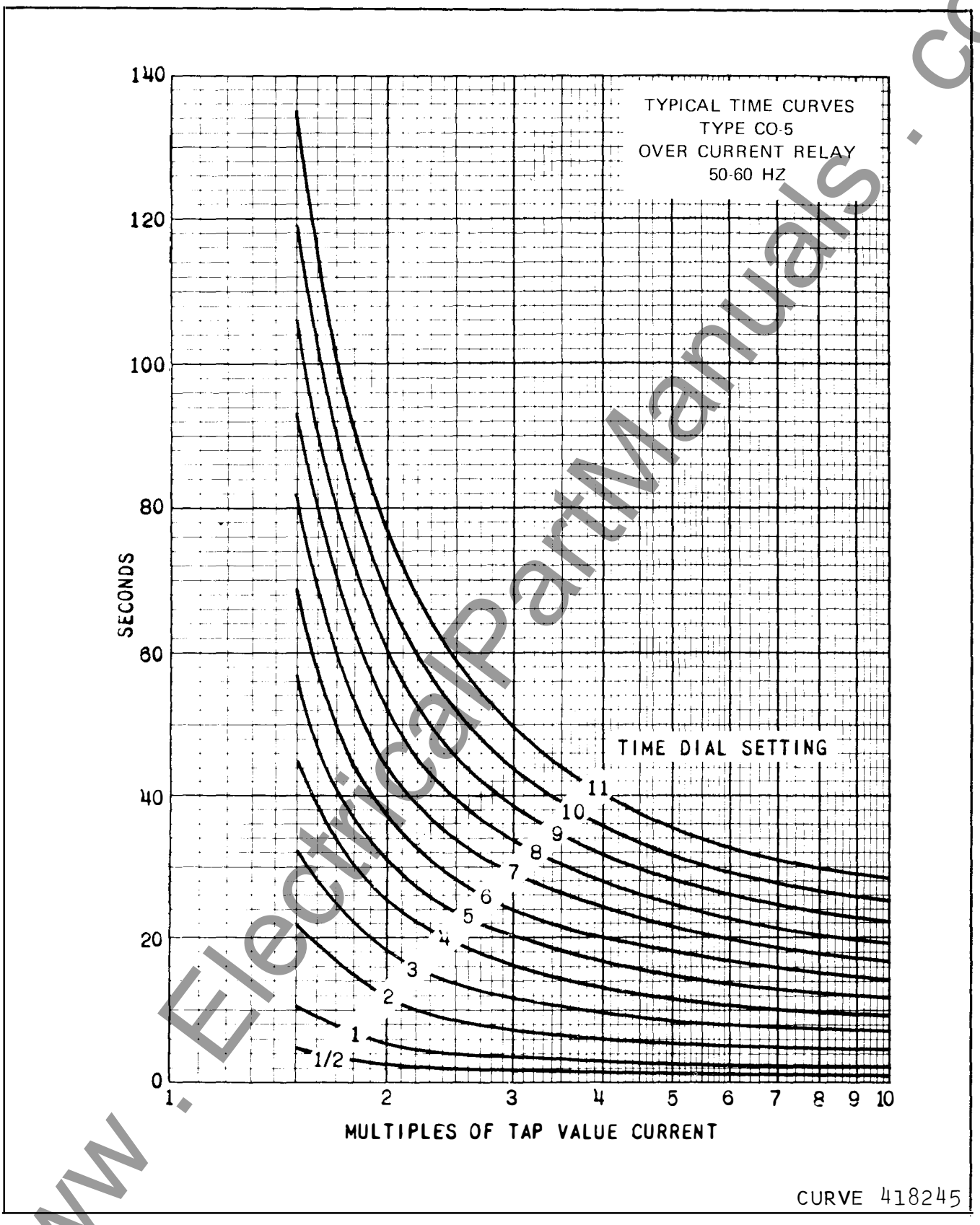


Fig. 8. Typical Time Curve of the Time-Overcurrent Unit of the Long Time (5) Relays.

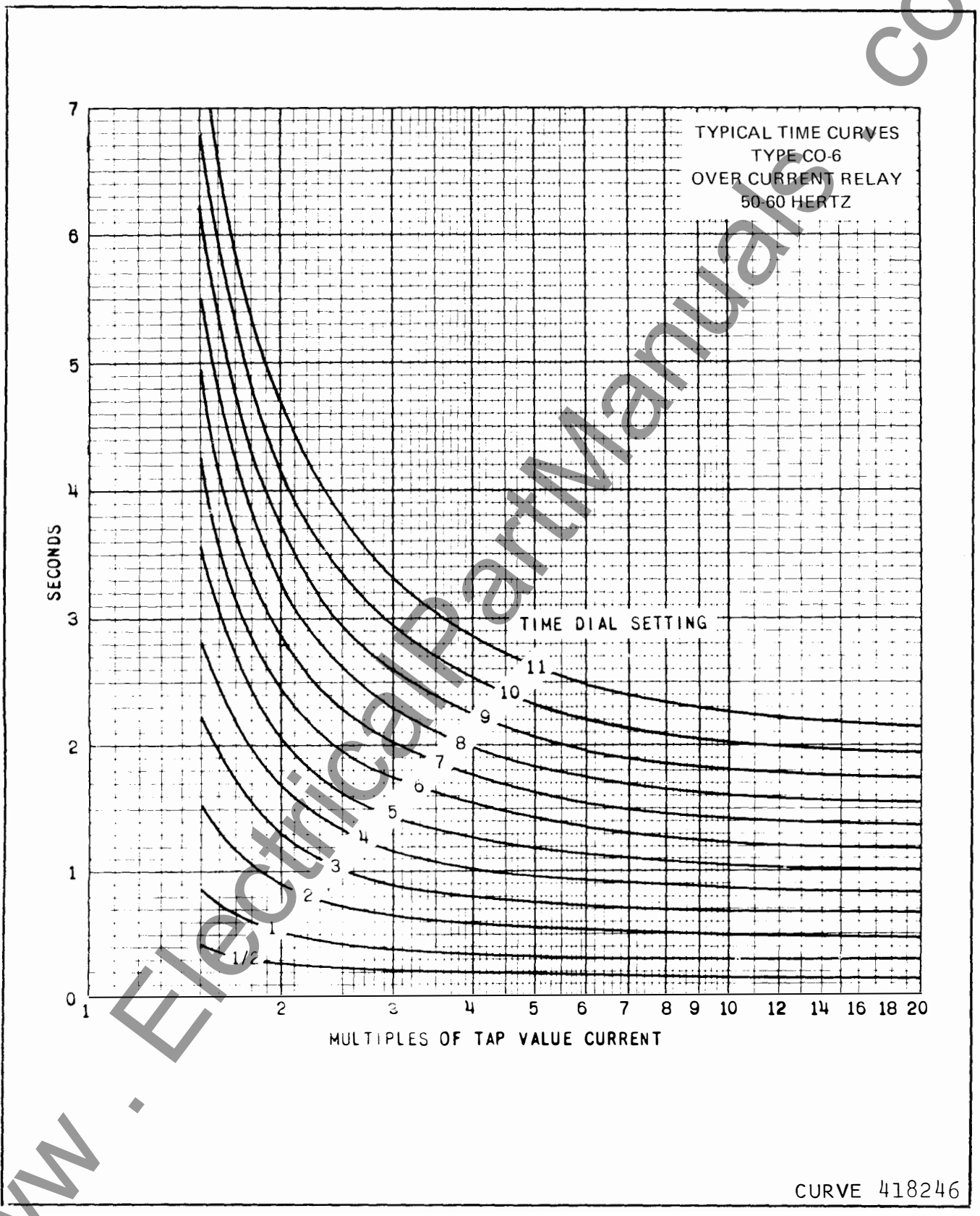


Fig. 9. Typical Time Curve of the Time-Overcurrent Unit of the Definite Time (6) Relays.

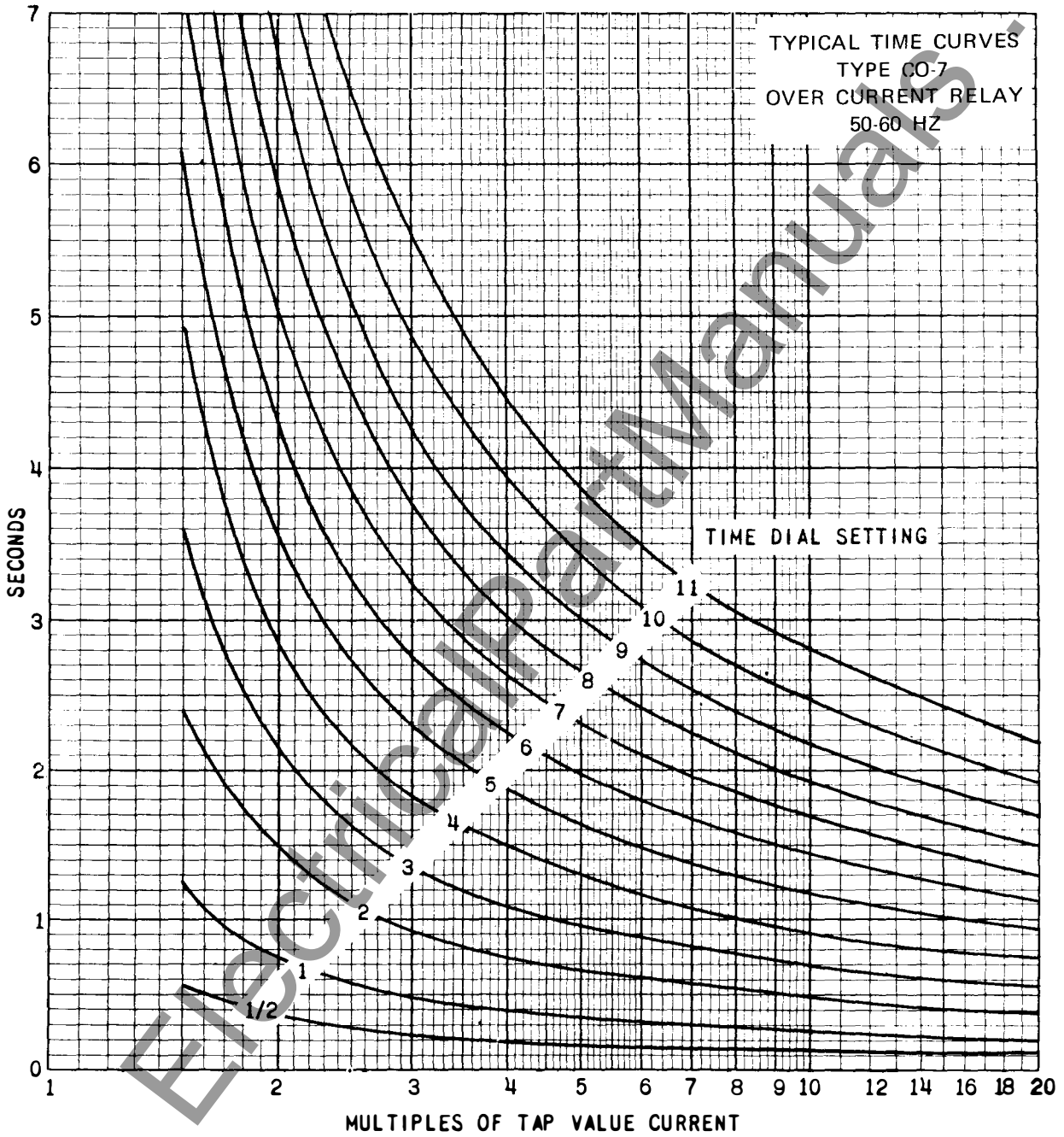


Fig. 10. Typical Time Curve of the Time-Overcurrent Unit of the Moderately Inverse (7) Relays.

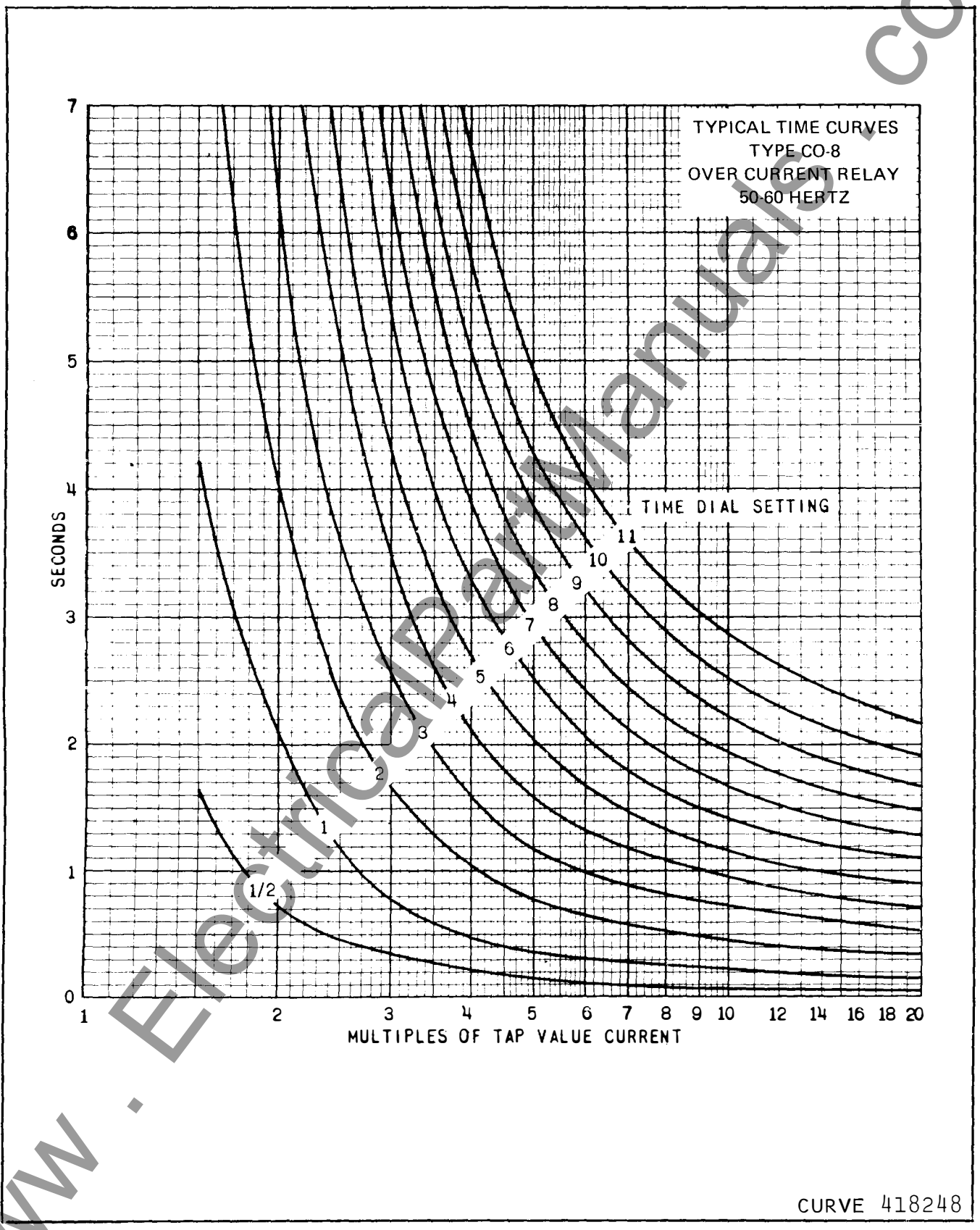


Fig. 11. Typical Time Curve of the Time-Overcurrent Unit of the Inverse (8) Relays.

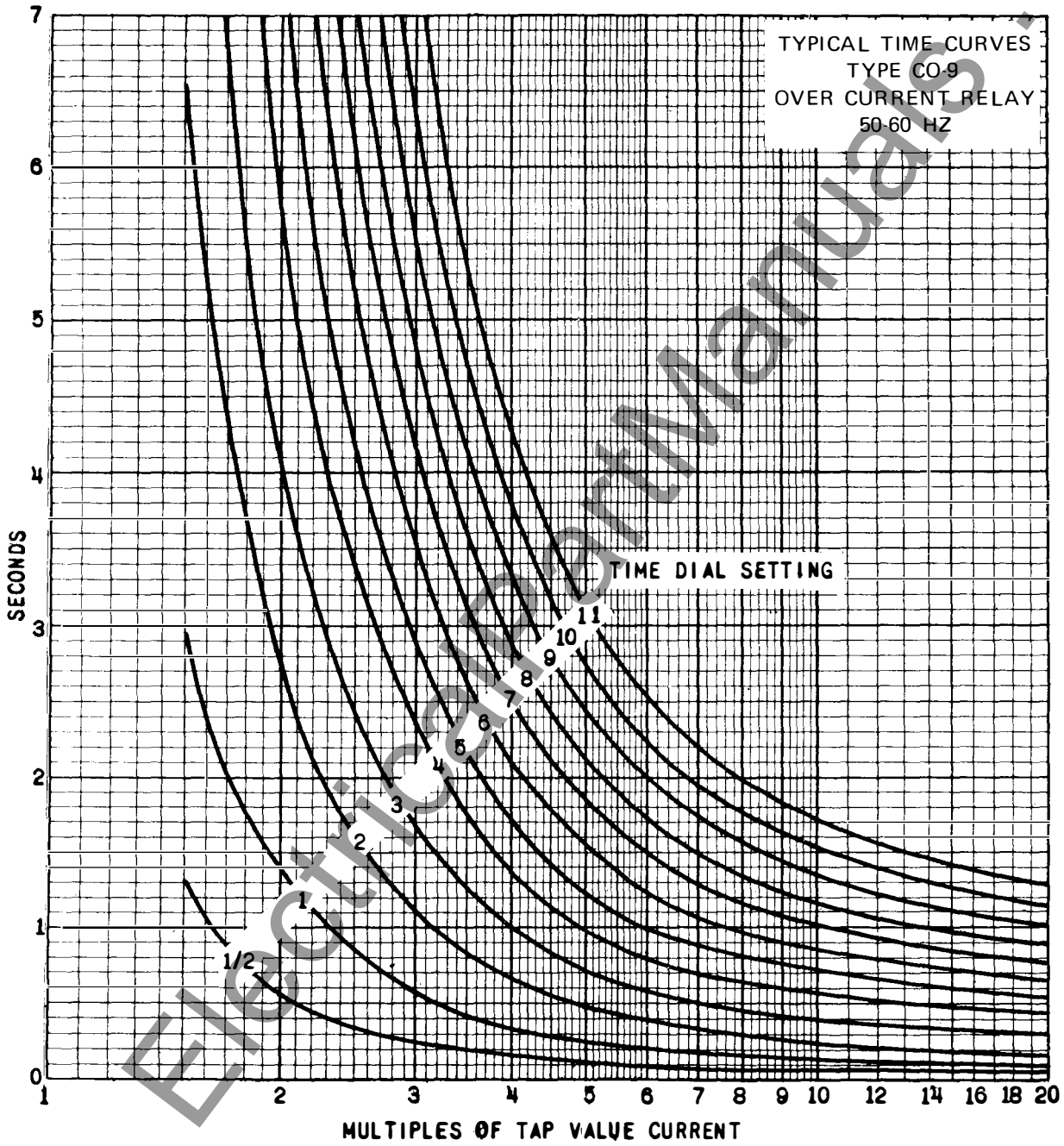


Fig. 12. Typical Time Curve of the Time-Overcurrent Unit of the Very Inverse (9) Relays.

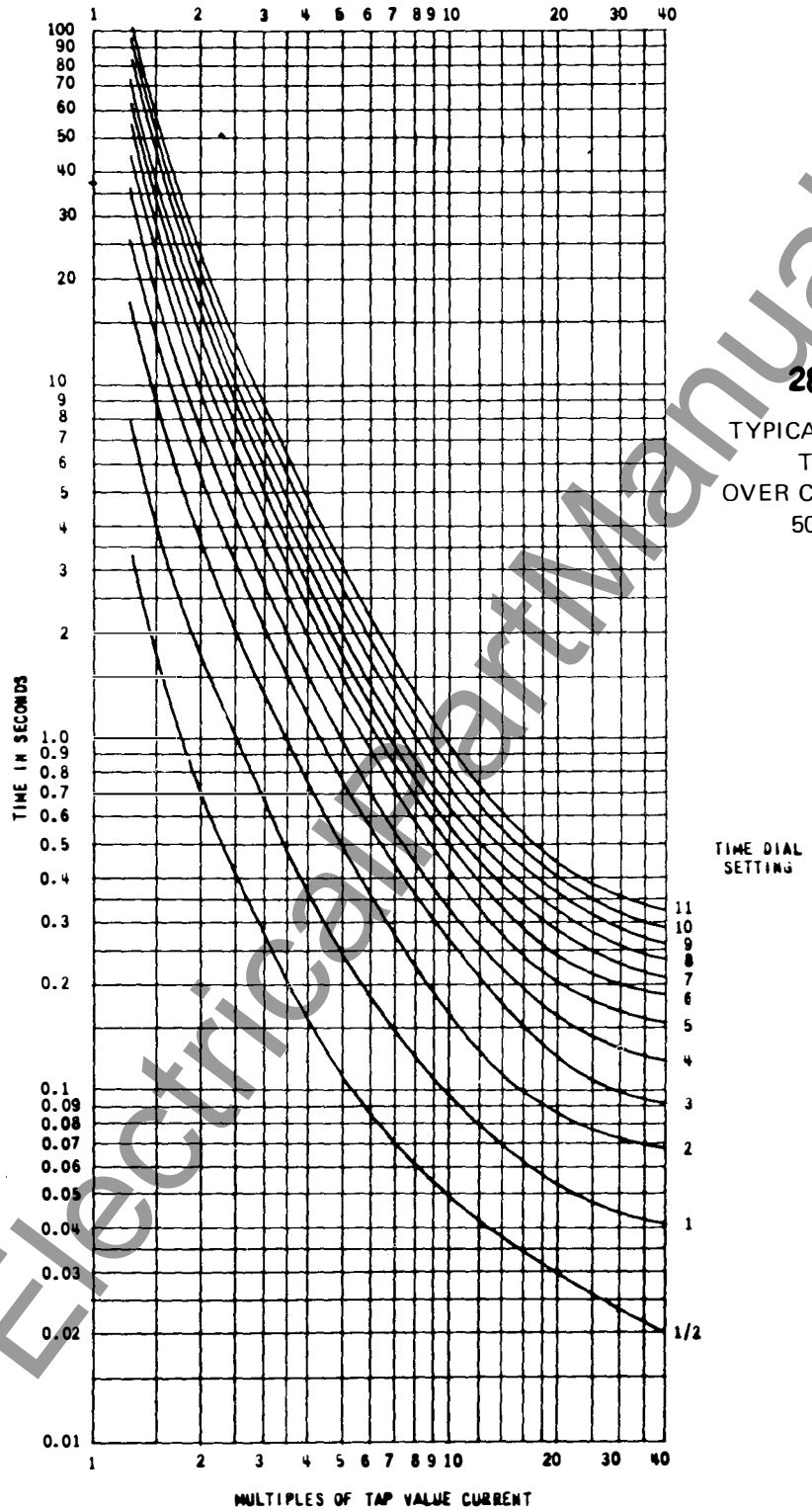


Fig. 13. Typical Time Curve of the Time-Overcurrent Unit of the Extremely Inverse (11) Relays.

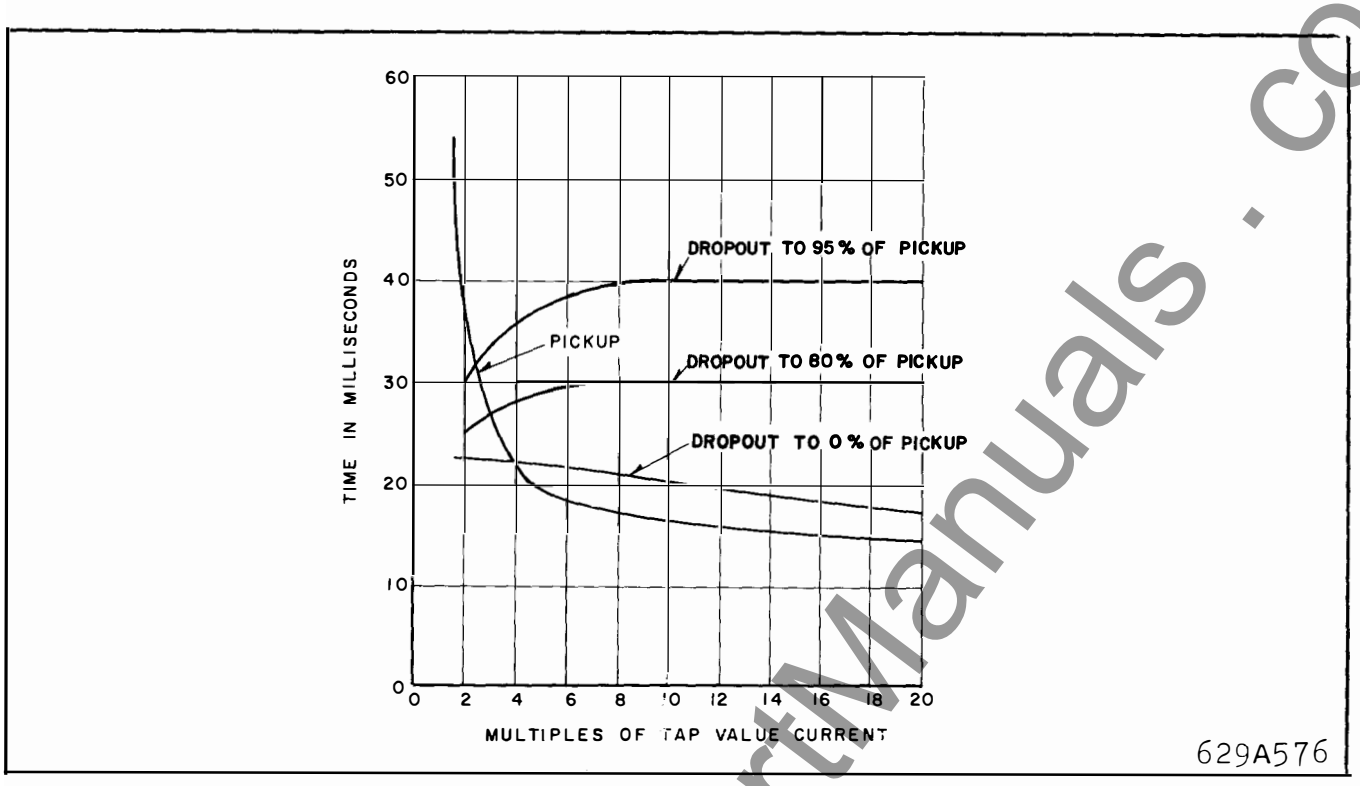


Fig. 14. Maximum Pickup and Dropout Time Curves for Instantaneous Overcurrent Unit.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 ampere tap – 6.5 ohms dc resistance
2.0 ampere tap – 0.15 ohms dc resistance

SETTINGS

TIME OVERCURRENT UNIT (CO)

The time 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 screws on the tap plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various tap 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 tap plates.

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 space connector screw in the desired position before removing the other tap screw from the original tap position.

INSTANTANEOUS RECLOSING

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

INSTANTANEOUS OVERCURRENT UNIT (I)

The only setting required is the pickup current setting which is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

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 tap screw in the desired tap position before removing the other tap screw from the original tap position.

INDICATING CONTACTOR SWITCH (ICS/I and ICS/T)

The setting required on the ICS units is the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs for the type FT projection case or by means of the four mounting holews on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the 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 I.L. 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.

Instantaneous Overcurrent Unit (I)

1. **Contact Gap** – The gap between the stationary and moving contacts with the relay in the de-energized position should be approximately .020".

2. **Minimum Trip Current** –

The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within +5% of tap value current.

Time Overcurrent Unit (CO)

1. **Contacts** – The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately.020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves.

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 1 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 1 (e.g. for the CKO-2, 3 and 20 times tap value current) and measure the operating time of the relay. The oper-

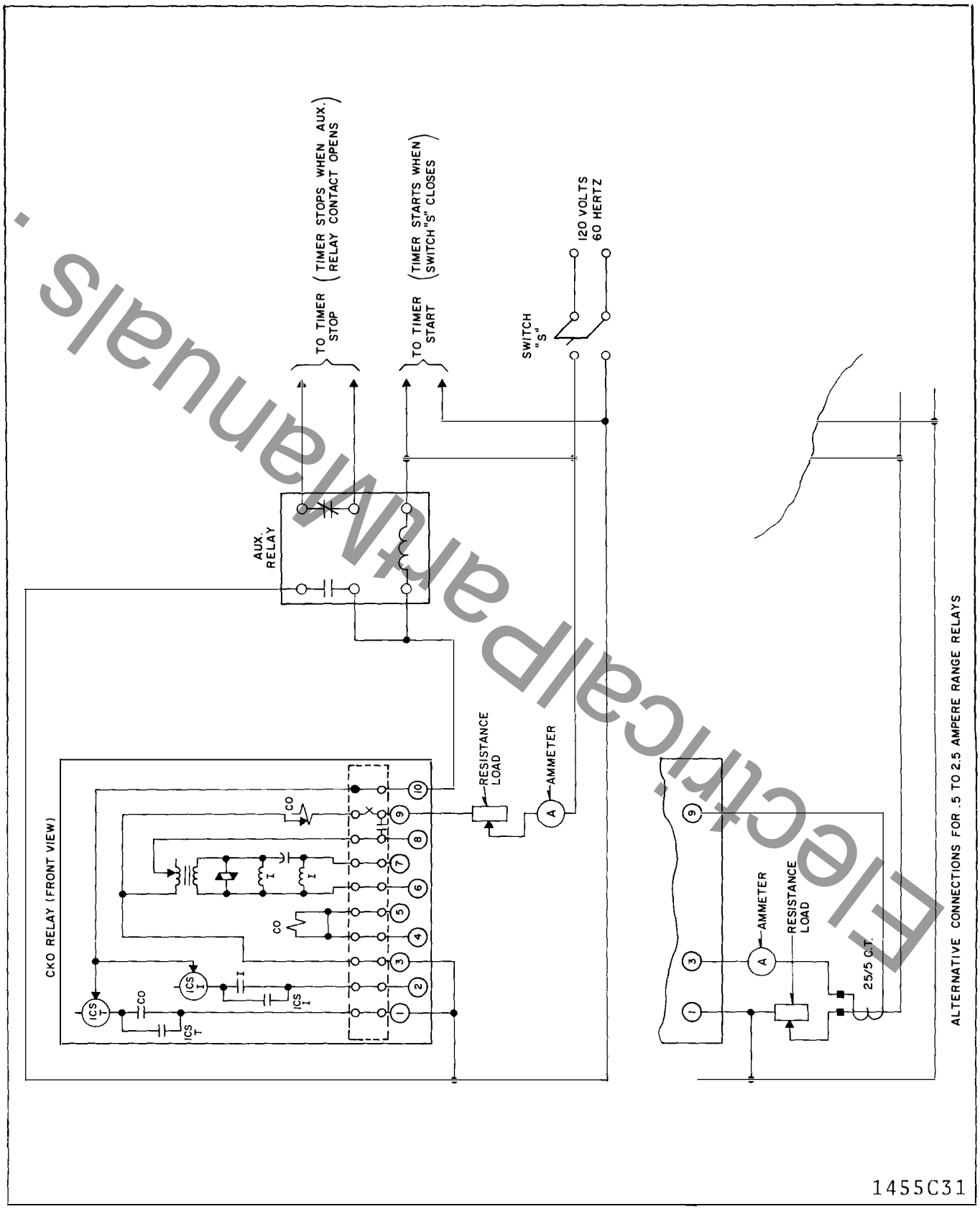


Fig. 15. Diagram of test connections of the time-overcurrent unit.

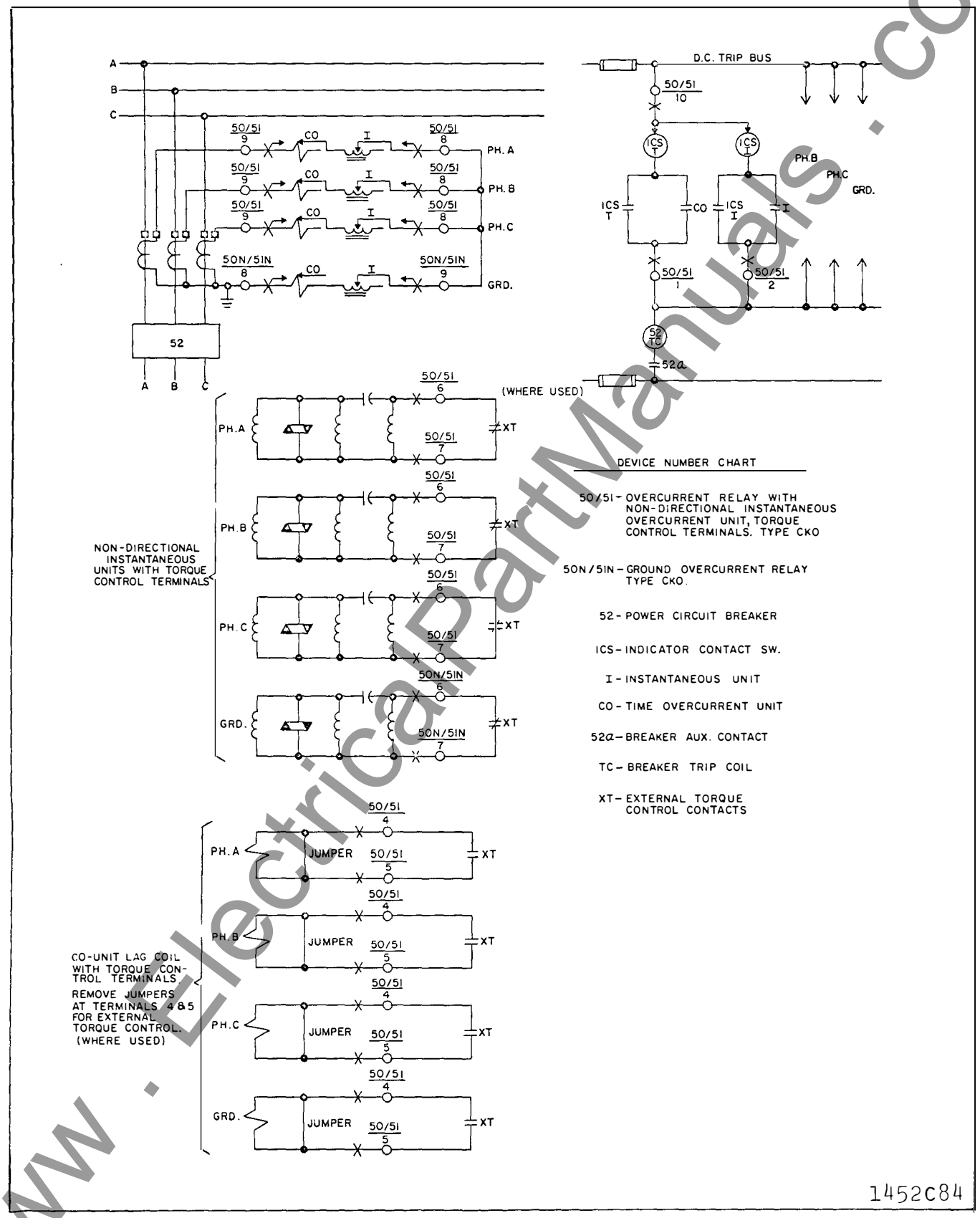


Fig. 16. External Schematic of the CKO Relay.

ating times should equal those of Table 1 plus or minus 5 percent.

Indicating Contactor Switches (ICS/I) and (ICS/T)

A) Close the contacts of the CO and pass sufficient d.c. current through the trip circuit to close the contacts of (ICS/T). This value of current should not be greater than the particular (ICS/T) tap setting being used. The operation indicator target should drop freely, bringing the letter "T" into view.

B) Close the contacts of the instantaneous over-current unit (I) and pass sufficient dc current through the trip circuit to close the contacts of (ICS/I). This value of current should not be greater than the particular (ICS/I) tap setting being used. The operation indicator target should drop freely, bringing the letter "I" into view.

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

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. The use of phantom loads, in testing induction-type relays, should be avoided, since the resulting distorted current wave form will produce an error in timing.

All contacts should be periodically cleaned. A contact burnished #182A836H01 is recomended 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 have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See Acceptance Check).

INSTANTANEOUS OVERCURRENT UNIT (I)

1. The upper pin bearing should be screwed down until there is approximately 0.025 clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted!

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, i.e., against the right side of the bridge. Move in the left-hand stationary contact until it just touches the movcing contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact in position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close as indicated by a neon lamp in the contact circuit when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within $\pm 5\%$ of tap value.

If adjustment of pick-up current in between tap settings is desired insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

TIME OVERCURRENT UNIT (CO)

1. **Contacts** – The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time

dial positions in line with the index mark will give operating times as shown on the respective time-current curves.

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 6¾ 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 1 for permanent magnet adjustment (e.g. CKO-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 1.

Apply the indicated current per Table 1 for the electromagnet plug adjustment (e.g. CKO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table 1. (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.

INDICATING CONTACTOR SWITCHES (ICS/I) and (ICS/T)

Adjust the contact gap for approximately .047".

A) Close the contacts of the CO and pass sufficient dc current through the trip circuit to close the contacts of the (ICS/T). This value of current should ot be greater than the particular (ICS/T) tap setting being used. The operation indicator target should drop freely bringing the letter "T" into view.

B) Close contacts of instantaneous overcurrent unit (I). Pass sufficient dc current through the trip circuit to close contacts of the (ICS/I). This value of current should not be greater than the particular (ICS/I) tap setting being used. The operation indicator target should drop freely bringing the letter "I" into view.

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 I

TIME CURVE CALIBRATION DATA – 60 HERTZ

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

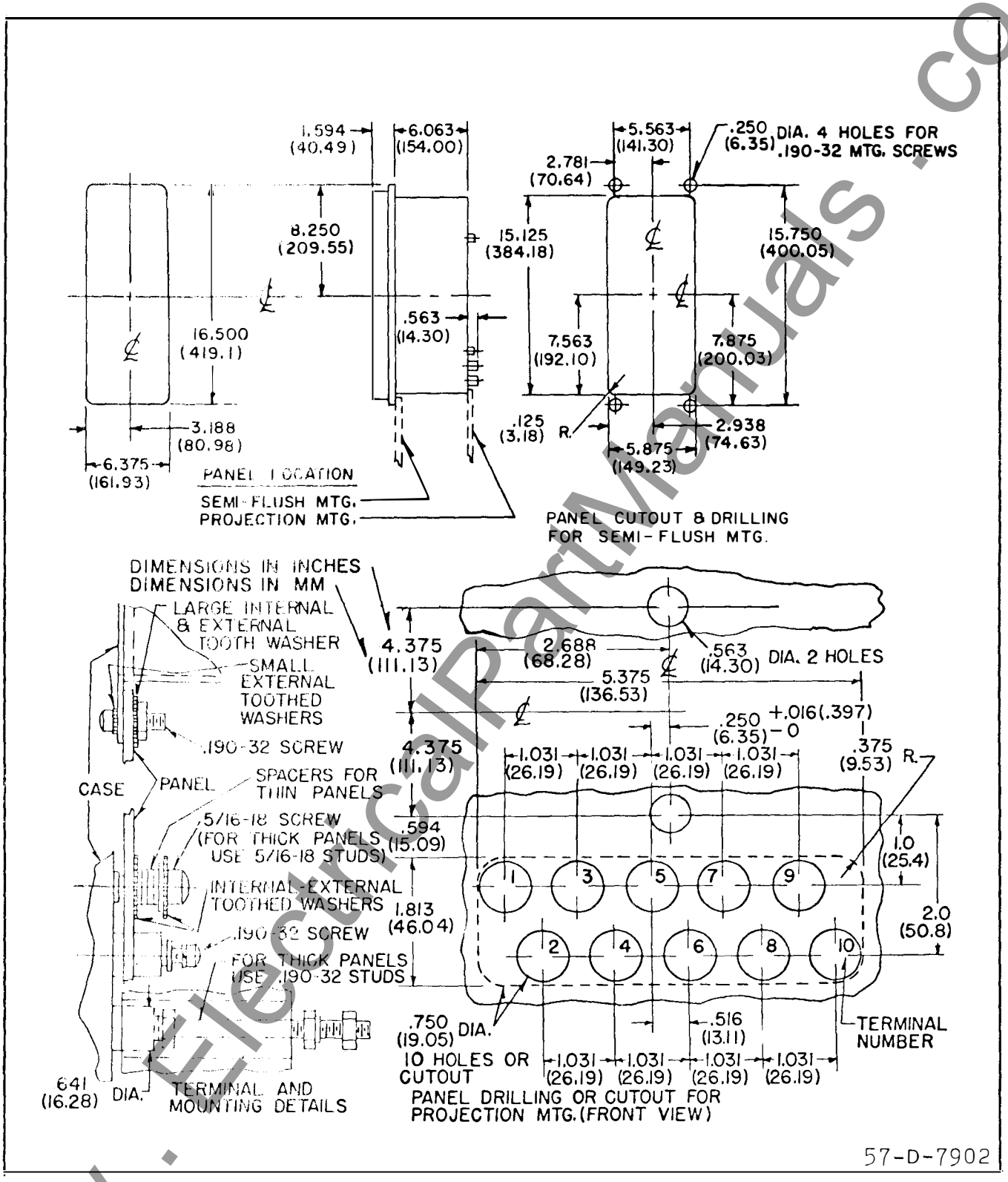


Fig. 17. Outline and Drilling Plan for the CKO Relay in the Type FT31 Case.

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

The CO relay is a single phase non-directional time ac overcurrent device. It is used to sense current level above the setting and normally is used to trip a circuit breaker to clear faults. A wide range of characteristics permit applications involving coordination with fuses, reclosers, cold load pickup, motor starting, or essentially fixed time applications.

✪ The following describes typical applications of the CO Relay:

RELAY TYPE	TIME CURVE	TYPICAL APPLICATIONS
CO-2	Short	1) Differential protection where saturation of current transformers is not expected, or where delayed tripping is permissible. 2) Overcurrent protection, phase or ground, where coordination with downstream devices is not involved and 2 to 60 tripping cycle is allowable.
CO-5	Long	Motor locked rotor protection where allowable locked rotor time is approximately between 10 and 70 seconds.
CO-6	Definite	Overcurrent protection where coordination with downstream devices is not involved and CO-2 is too fast. The operating time of this relay does not vary greatly as current level varies.
CO-7	Moderately Inverse	1) Overcurrent protection where coordination with other devices is required, and generation varies. 2) Backup protection for relays on other circuits.
CO-8	Inverse	
CO-9	Very Inverse	
CO-11	Extremely Inverse	1) Motor protection where allowable locked rotor time is less than 10 sec. 2) Overcurrent protection where coordination with fuses and reclosers is involved, or where cold load pickup or transformer inrush are factors.

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

SUPERSEDES I.L. 41-101Q, DATED MARCH 1978 AND ADDENDUM 41-101 DATED JUNE 1980

✪ Denotes changed since previous issue.

EFFECTIVE SEPTEMBER 1980

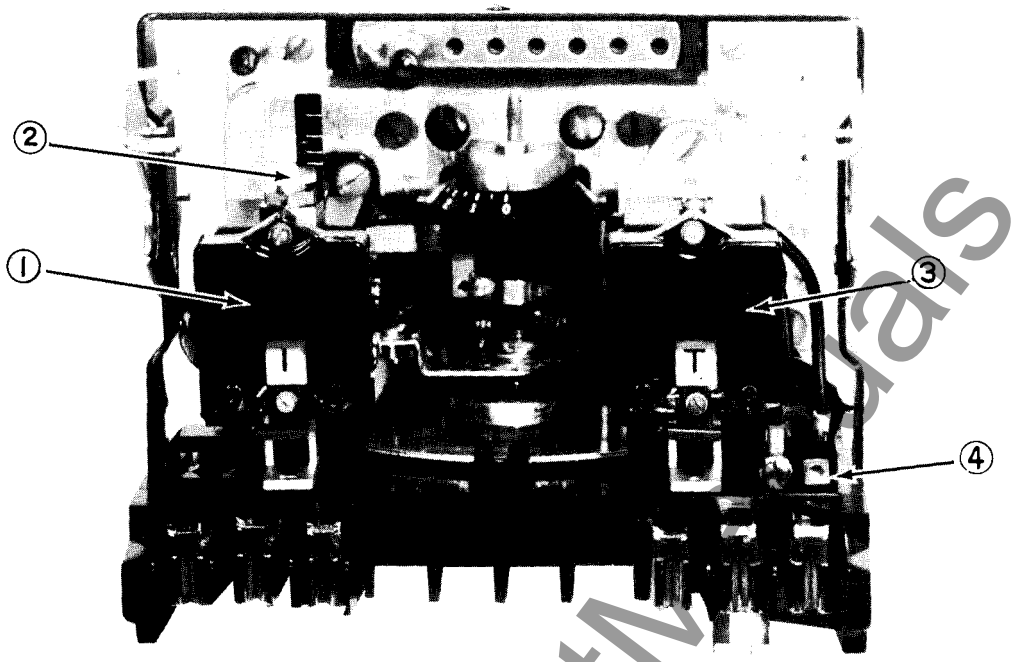


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous Trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

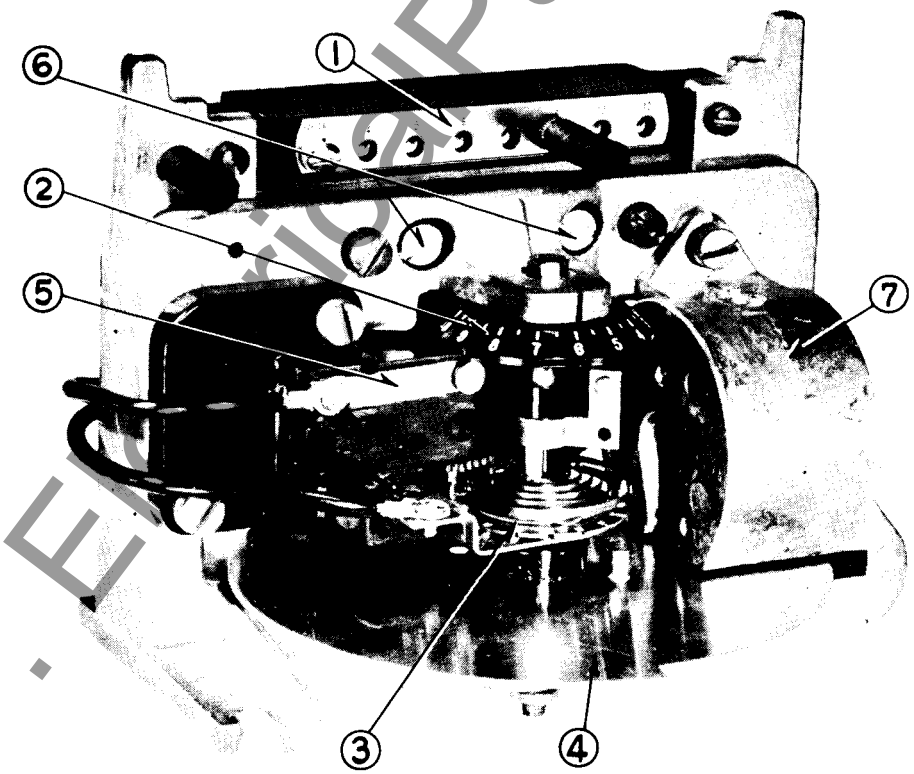


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

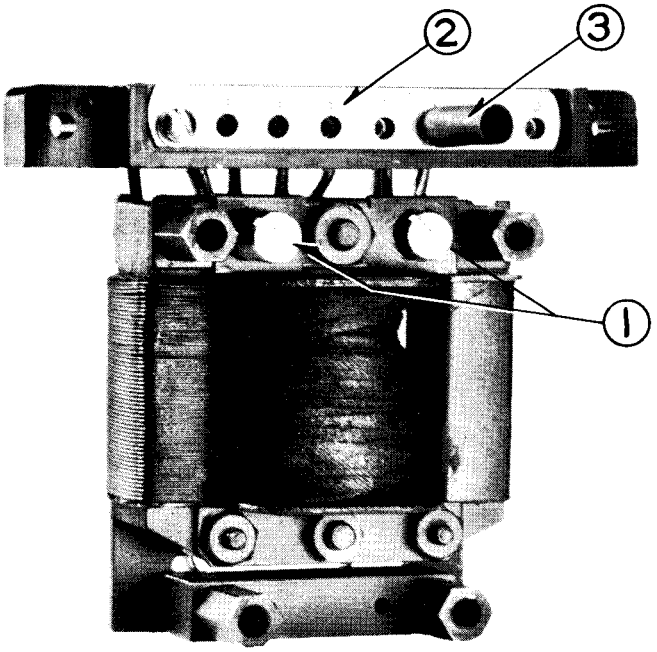


Fig. 3. "E" Type Electromagnet. 1-Magnet Plugs. 2-Tap Block. 3-Tap Screw.

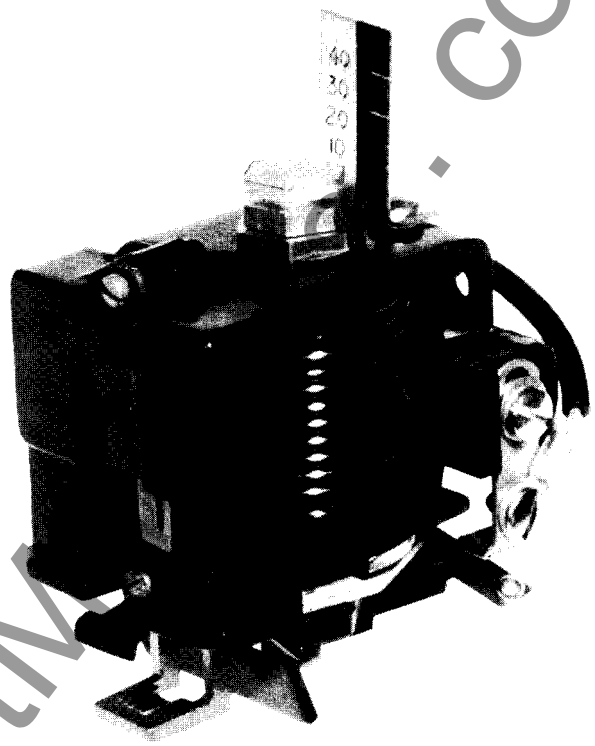


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

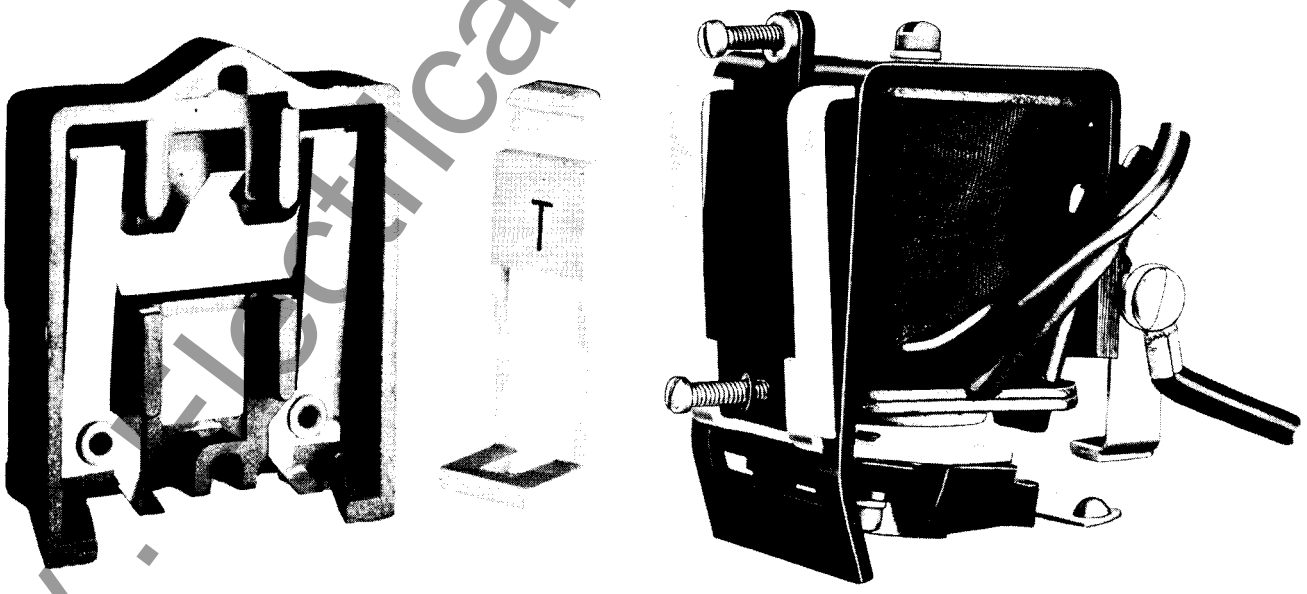


Fig. 5. Indicating Contactor Switch (ICS).

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. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

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 dc 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 ac operated clapper type device. A magnetic ar-

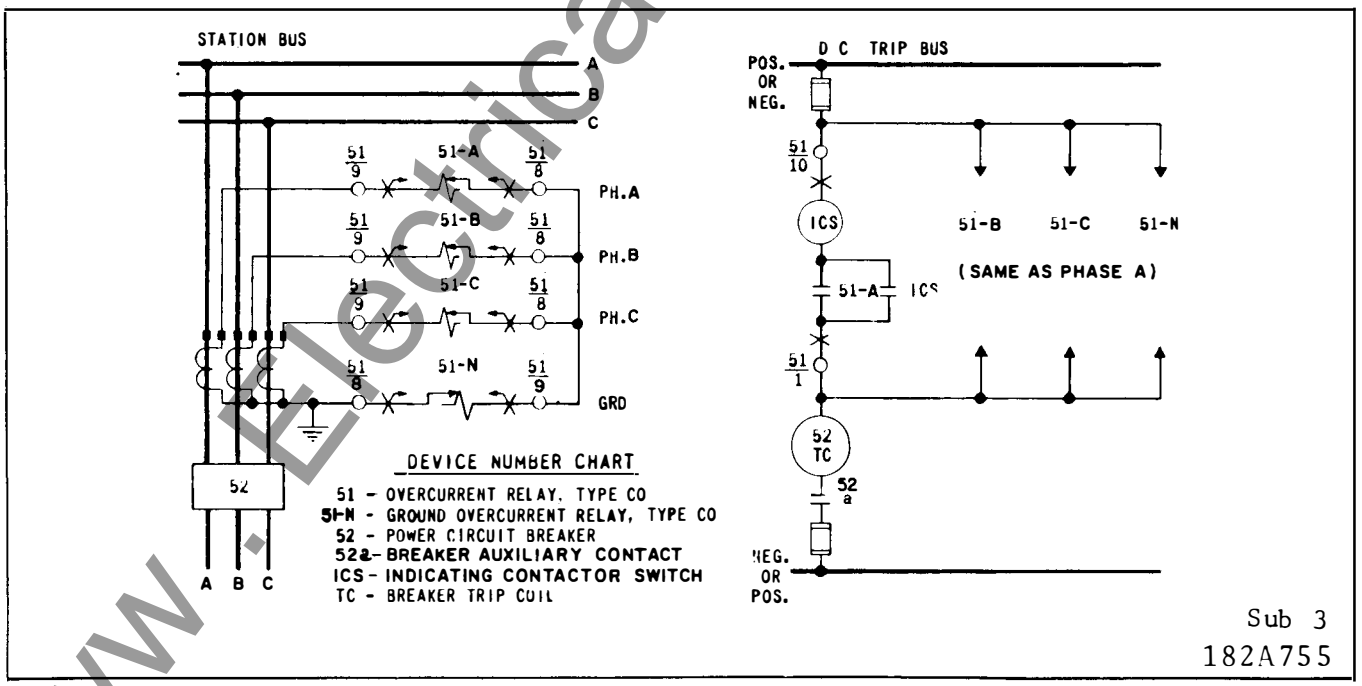


Fig. 6 External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System

ENERGY REQUIREMENTS

TYPE CO-2 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	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	64	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	5.53	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

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	69	3.92	20.6	103	270
	0.6	3.1	88	68	3.96	20.7	106	288
	0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	1.0	4.1	88	66	4.07	21.4	122	360
	1.5	5.7	88	62	4.19	23.2	147	462
	2.0	6.8	88	60	4.30	24.9	168	548
	2.5	7.7	88	58	4.37	26.2	180	630
	2	8	230	67	3.88	21	110	308
	2.5	8.8	230	66	3.90	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	4.12	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	4.35	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

**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.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

CO-7 MODERATELY INVERSE TIME RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	68	3.88	20.7	103	278
	0.6	3.1	88	67	3.93	20.9	107	288
	0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	1.0	4.1	88	64	4.00	21.6	122	356
	1.5	5.7	88	61	4.08	22.9	148	459
	2.0	6.8	88	58	4.24	24.8	174	552
	2.5	7.7	88	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
	6	19.3	460	60	4.62	25.9	168	540
4/12	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	37.6	308	1032

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	72	2.38	21	132	350
	0.6	3.1	88	71	2.38	21	134	365
	0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	1.0	4.1	88	67	2.42	21.2	150	440
	1.5	5.7	88	62	2.51	22	170	530
	2.0	6.8	88	57	2.65	23.5	200	675
	2.5	7.7	88	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

**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.*

ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

TYPE CO-11 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	VOLT AMPERES** At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
	0.1	0.4	11.5	34	0.64	6.5	70.3	240
	0.12	0.4	11.5	32	0.67	6.66	75.4	264
	0.16	0.4	11.5	30	0.76	7.3	82.4	297
0.1/0.5	0.20	0.4	11.5	26	0.83	8.3	87.8	336
	0.30	0.4	11.5	22	1.01	10.3	117.6	420
	0.40	0.4	11.5	18	1.21	11.22	140.0	520
	0.50	0.4	11.5	16	1.38	13.8	168.0	630
	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	2.5	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 calculated on the basis of time being inversely proportional to the square of the current.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

INSTANTANEOUS TRIP UNIT (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

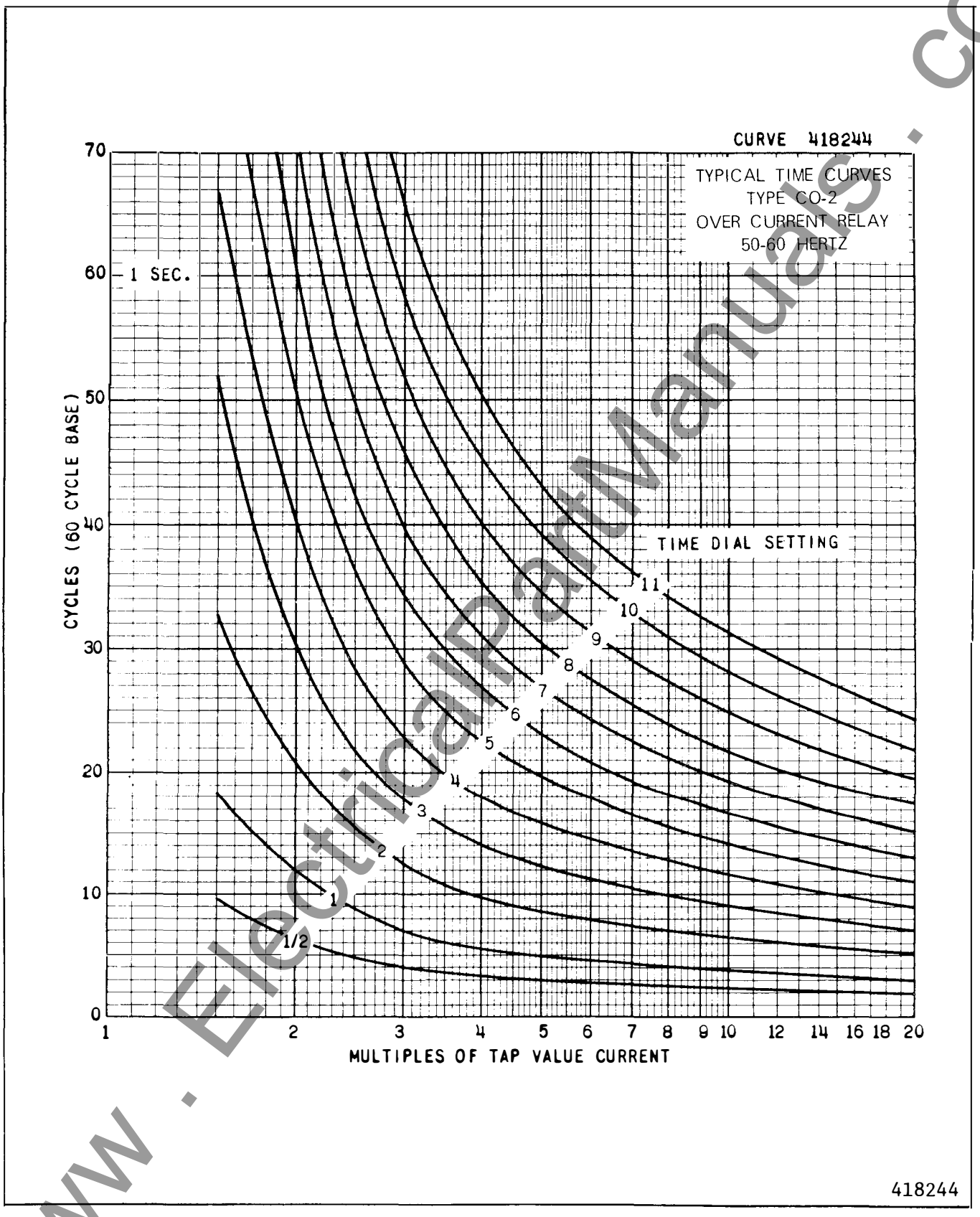


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

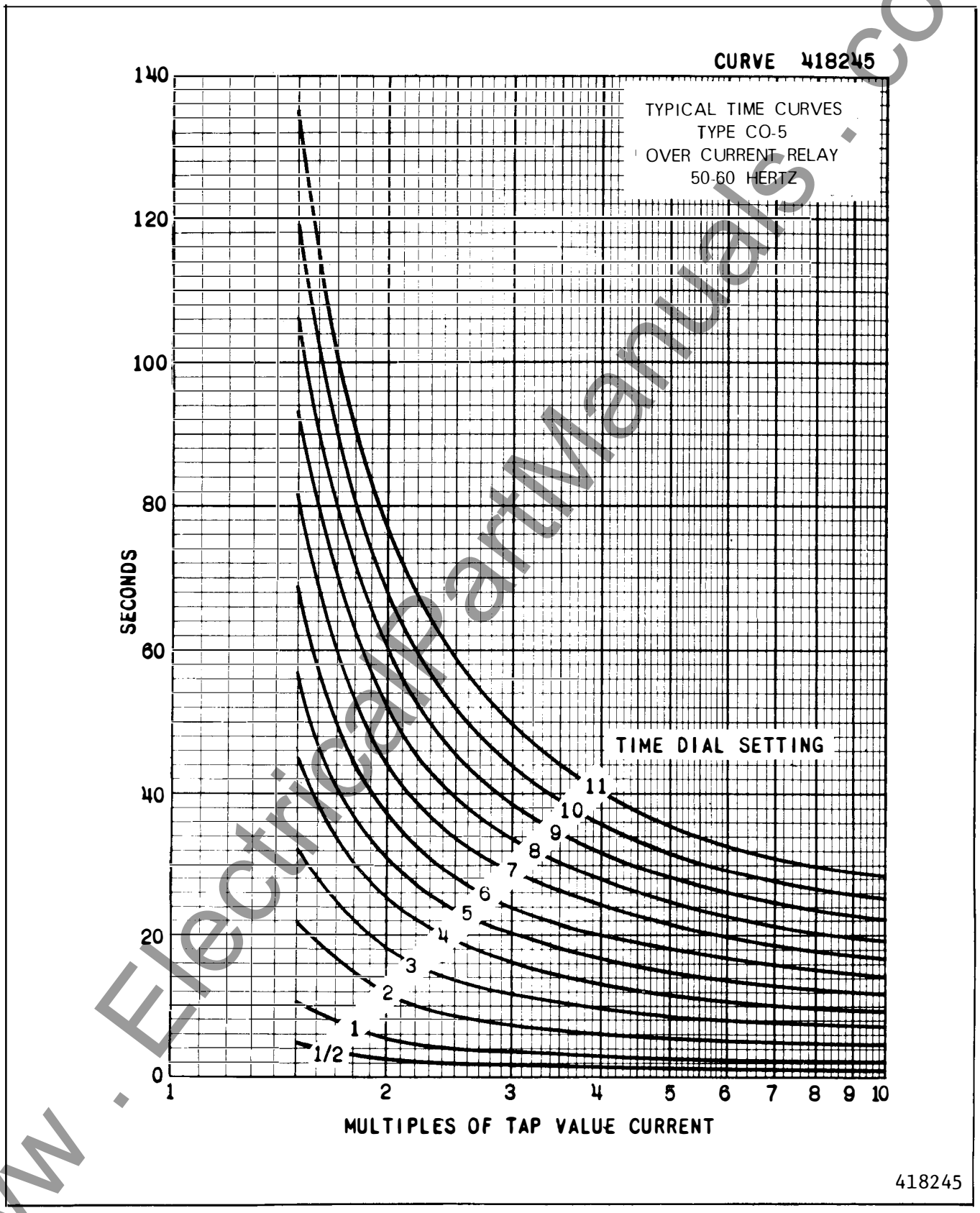


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

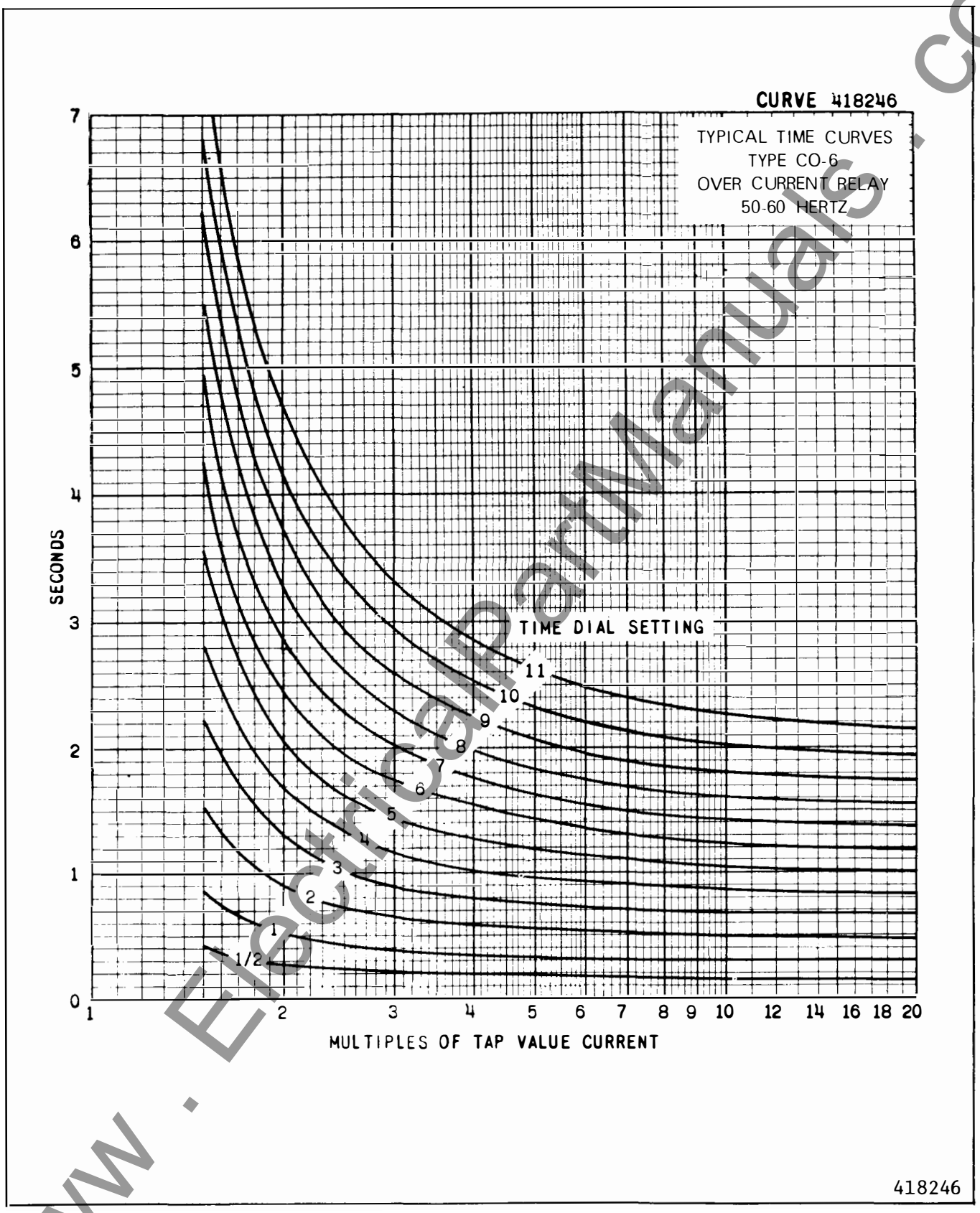


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

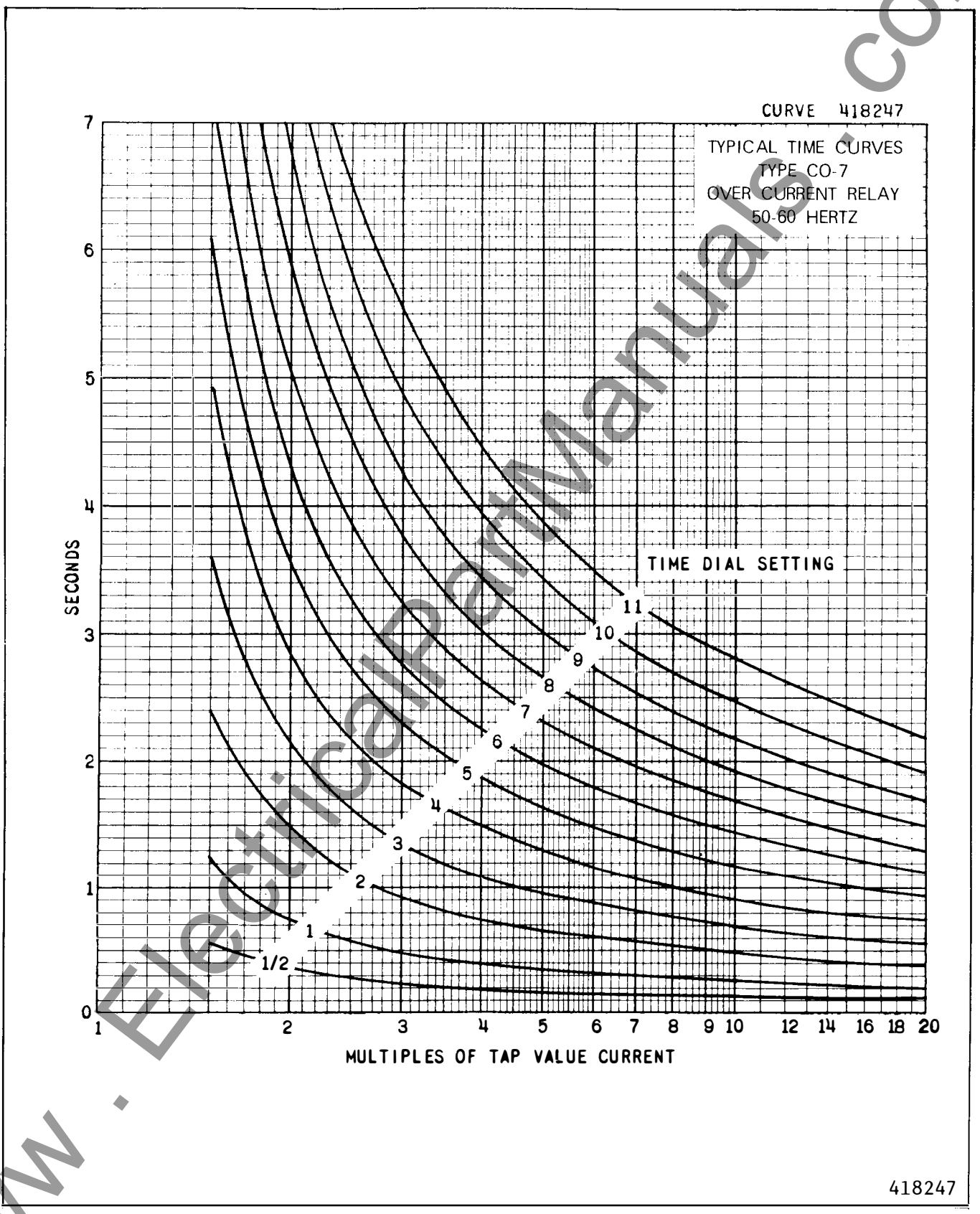


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

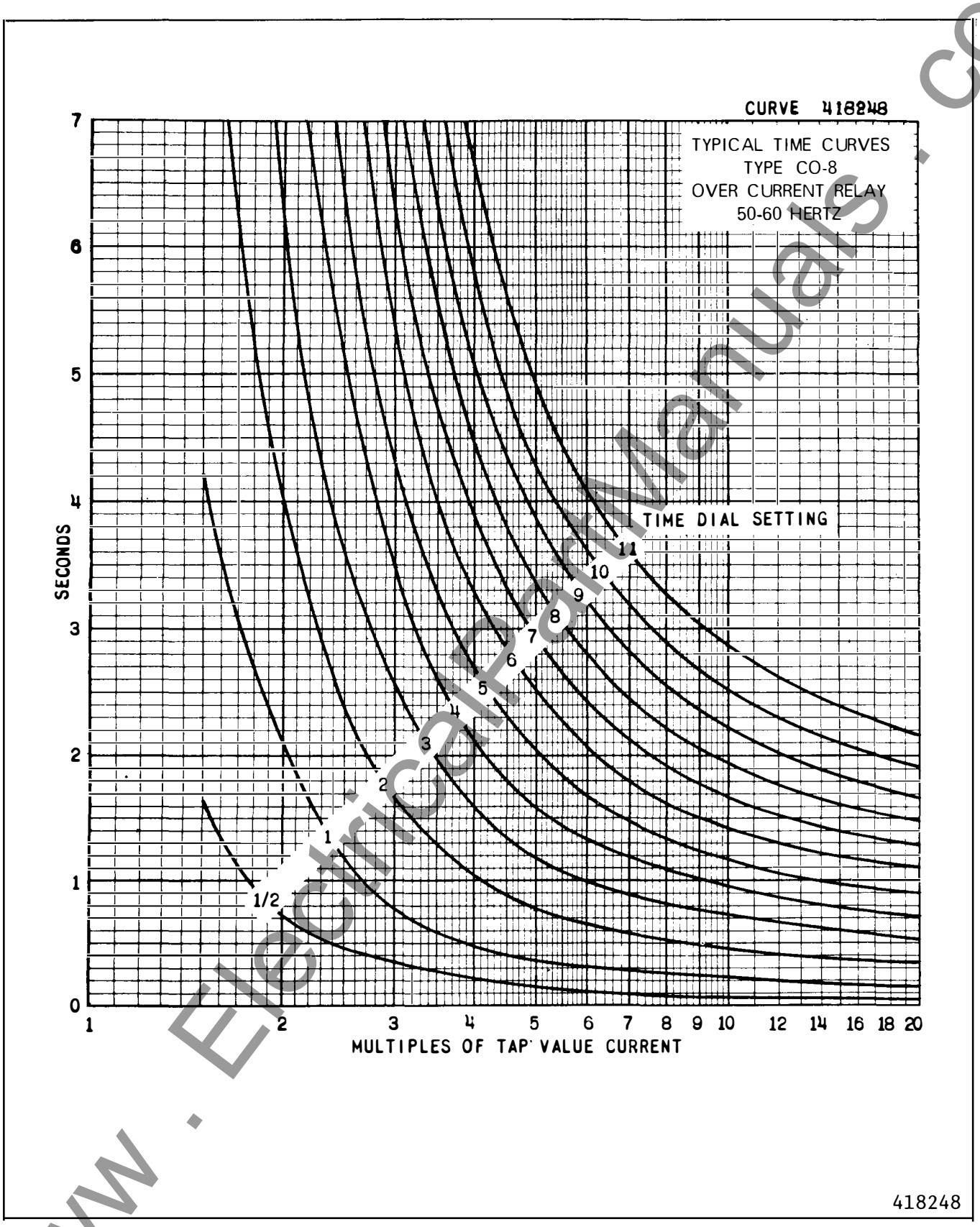


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

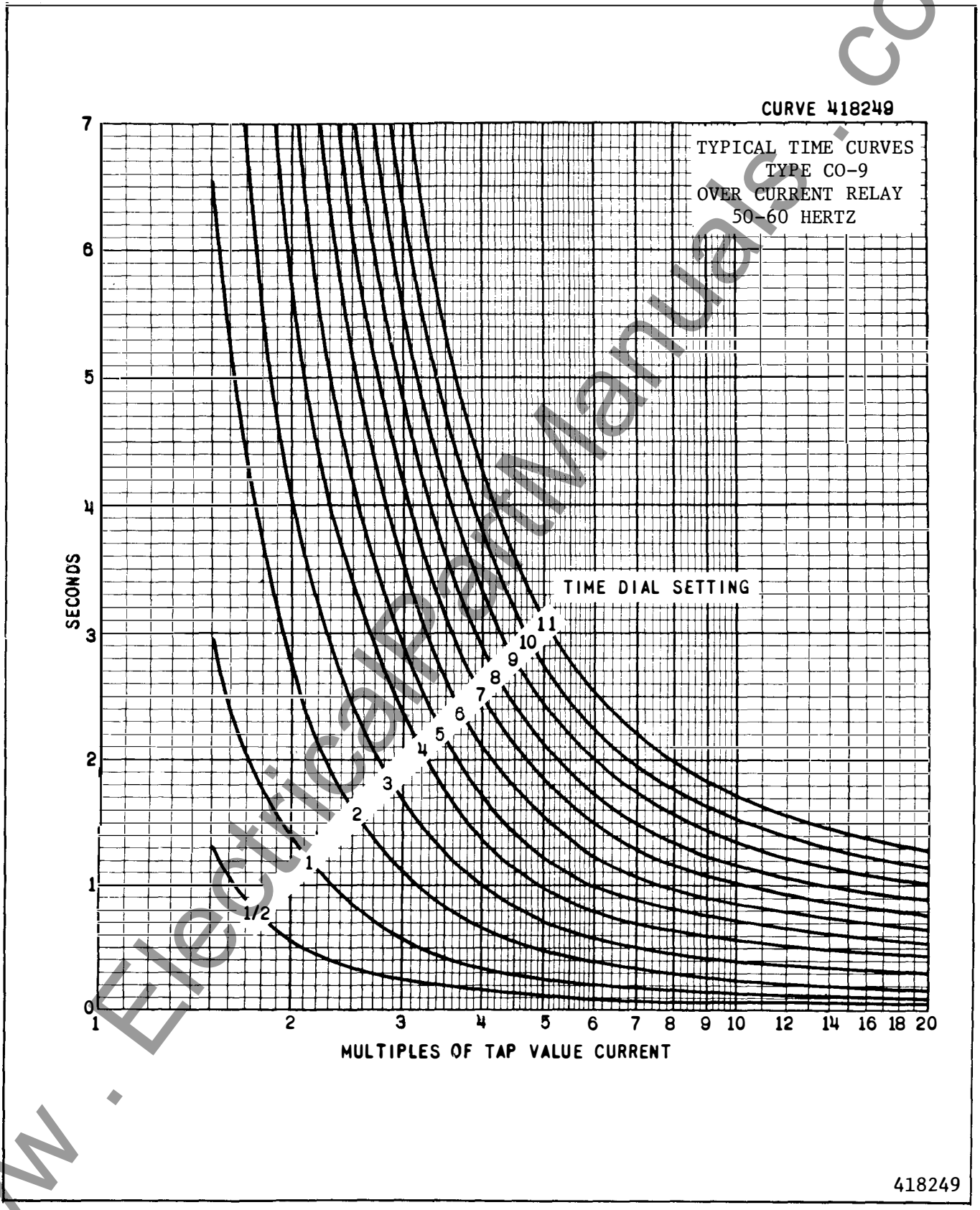


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

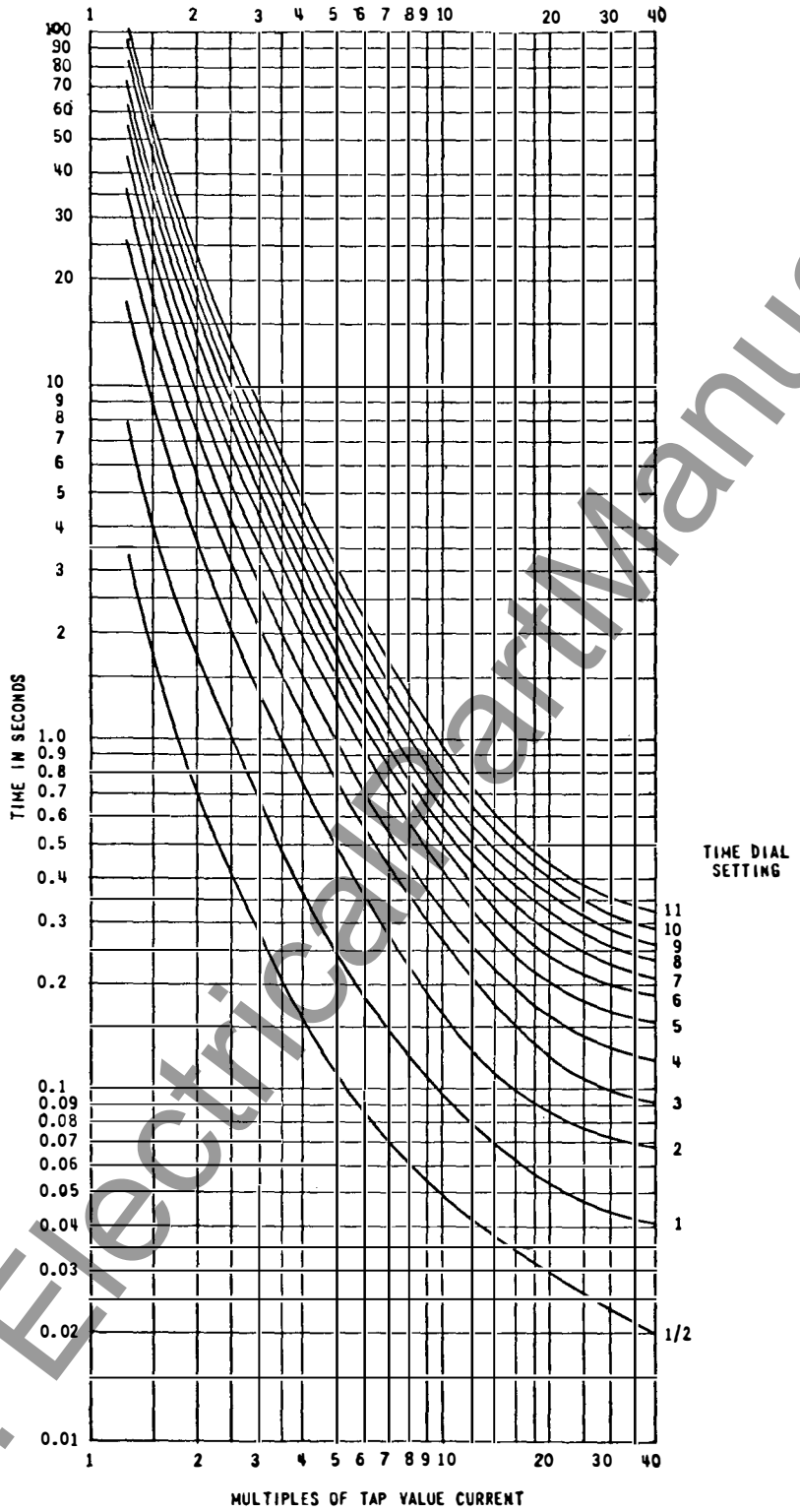


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

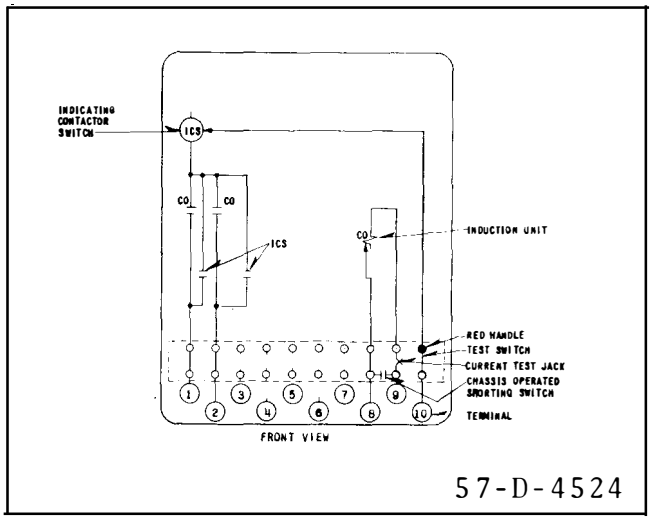


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

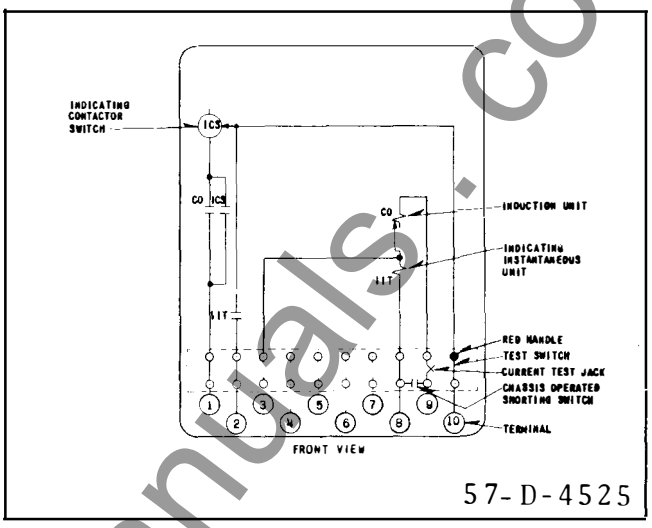


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

mature, 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.

CHARACTERISTICS

The relays are generally available in the following current ranges.

Range	Taps						
† .1-.5	0.1	0.12	0.16	0.2	0.3	0.4	0.5
.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

†Available for Type CO-11 Relay.

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 dc 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 dc, 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 to 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 dc resistance
2.0 ampere tap – 0.15 ohms dc resistance

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)

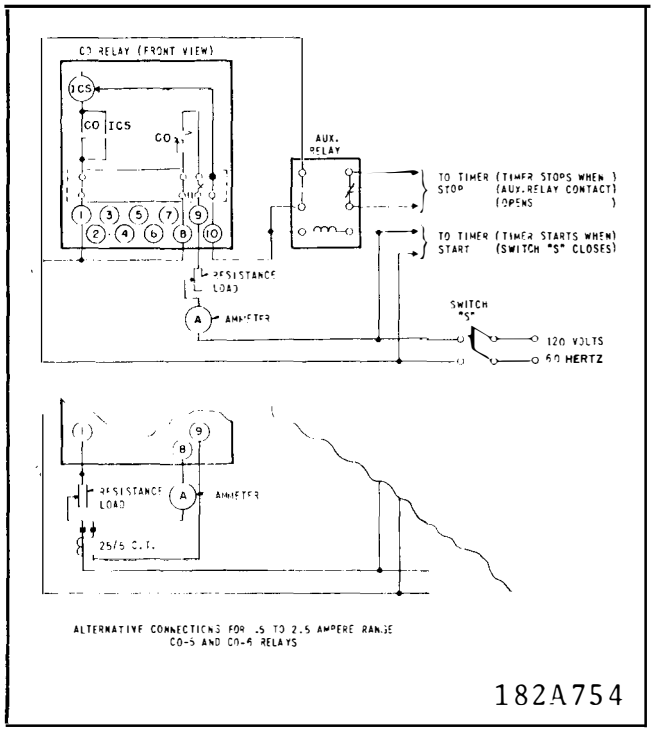


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rest solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

INDICATING CONTACT SWITCH (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere 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)

The IIT setting is the level of ac current at which it will pickup. It should be set to coordinate with other devices so it will never operate for a fault in protective zone where tripping should be produced by other devices. The transient reach will not exceed 130% for an 80° circuit angle or 108% for a 60° circuit.

The proper tap must be selected and the core screw must be adjusted to the value of pick-up current desired.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs 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. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its

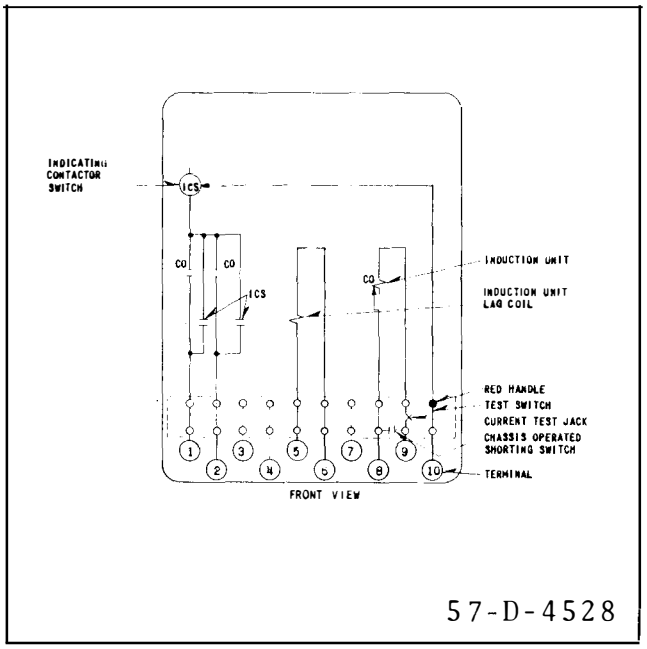


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted, Dwg. 57-D-4527.

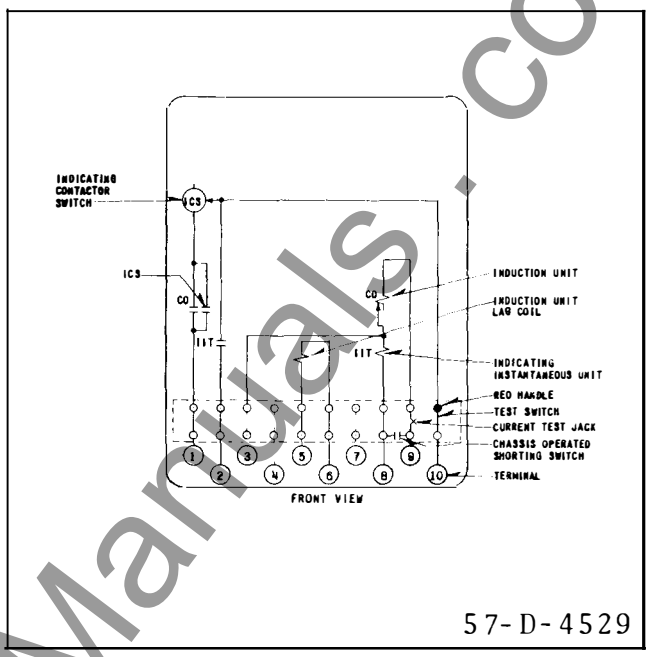


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

mounting screws or studs. and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the 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 I.L. 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.

For relays which include an indicating instantaneous trip unit (ITT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

ACCEPTANCE CHECK

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

1. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately

.020''. The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. **Minimum Trip Current** – Set the time dial to position 6 using the lowest tap setting, 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** – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation, ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effects of different taps can make the total variations appear to be ±15%.

Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, 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% (Use .5 tap for .1 to .5 range).

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

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

ROUTINE MAINTENANCE

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 at "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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effect of different taps can make the total variations appear to be ±15%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. The check is to be made after the 2 times tap value adjustment has been completed.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

5. **Indicating Instantaneous Trip Unit (IIT)**

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 – 50 & 60 HERTZ

	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 Δ

Δ For 50 hertz CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

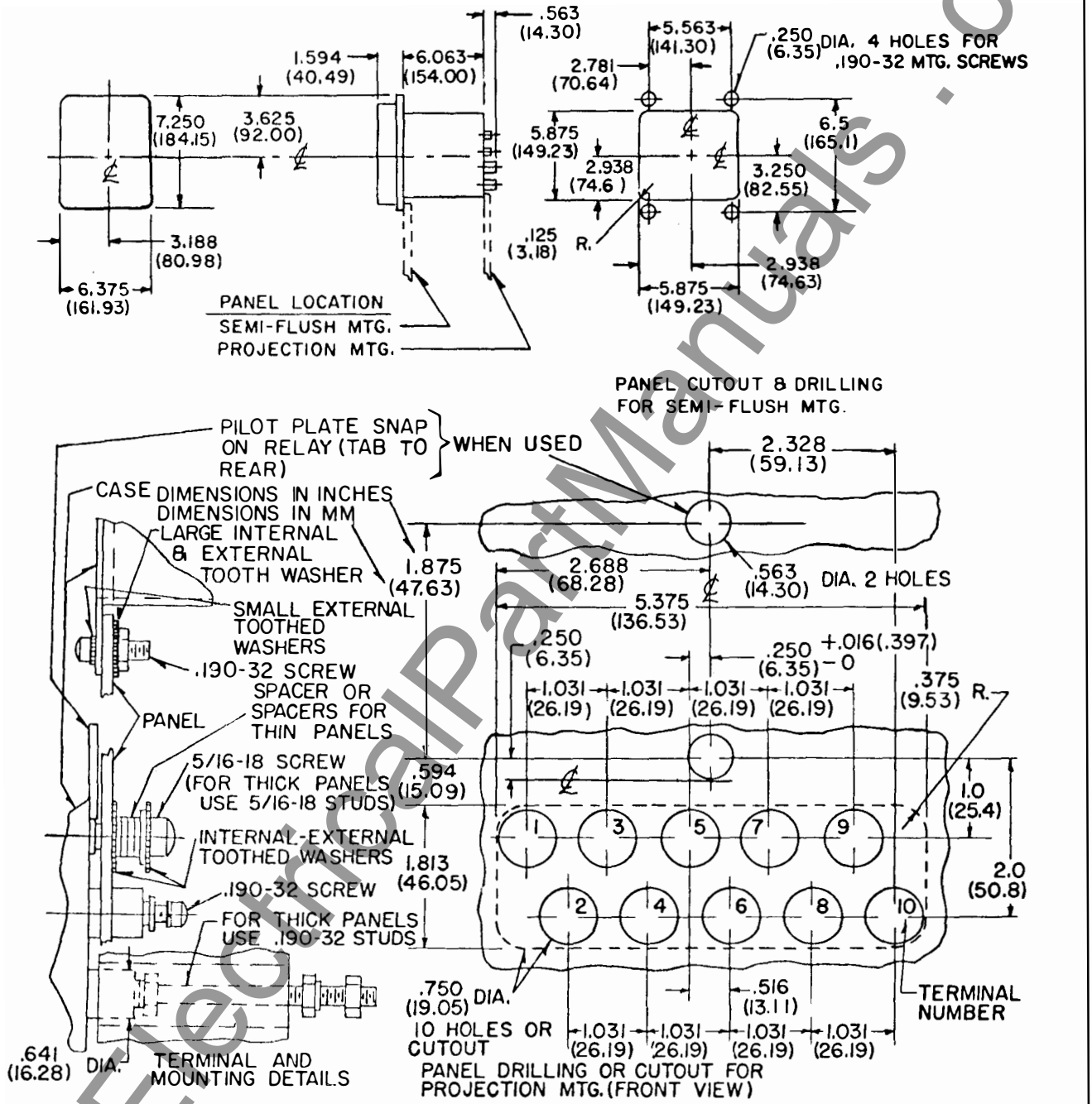


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

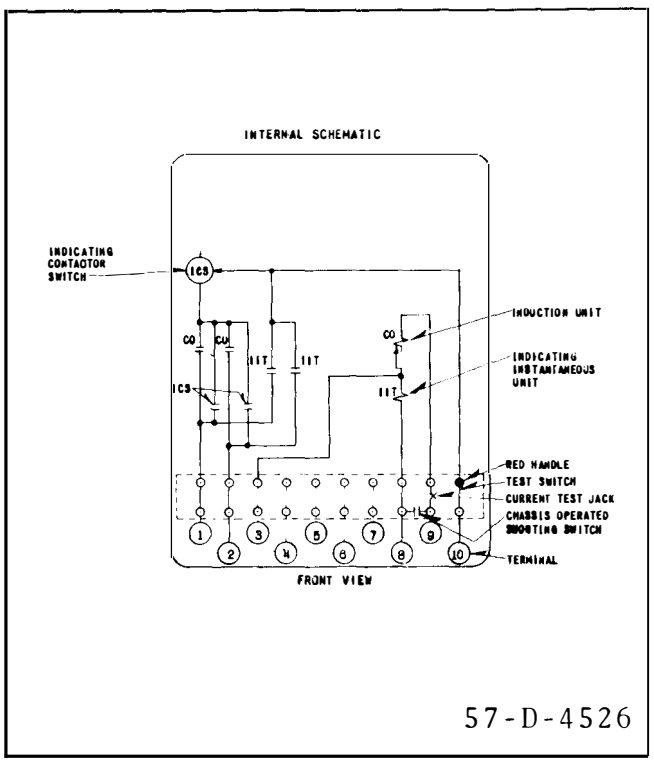


Fig. 20. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

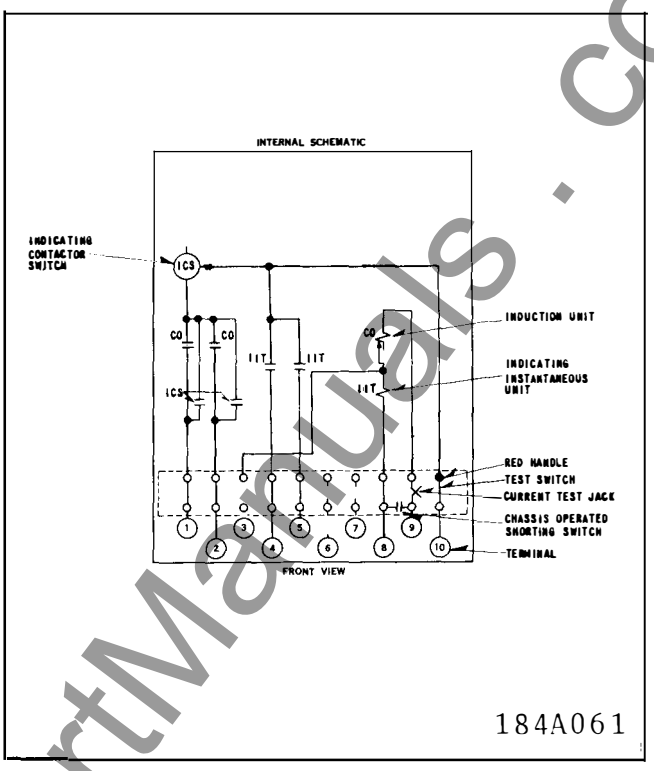


Fig. 21. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit to Separate Terminals.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

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. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

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.

SUPERSEDES I.L. 41-101M
*Denotes change from superseded issue.

EFFECTIVE APRIL 1974

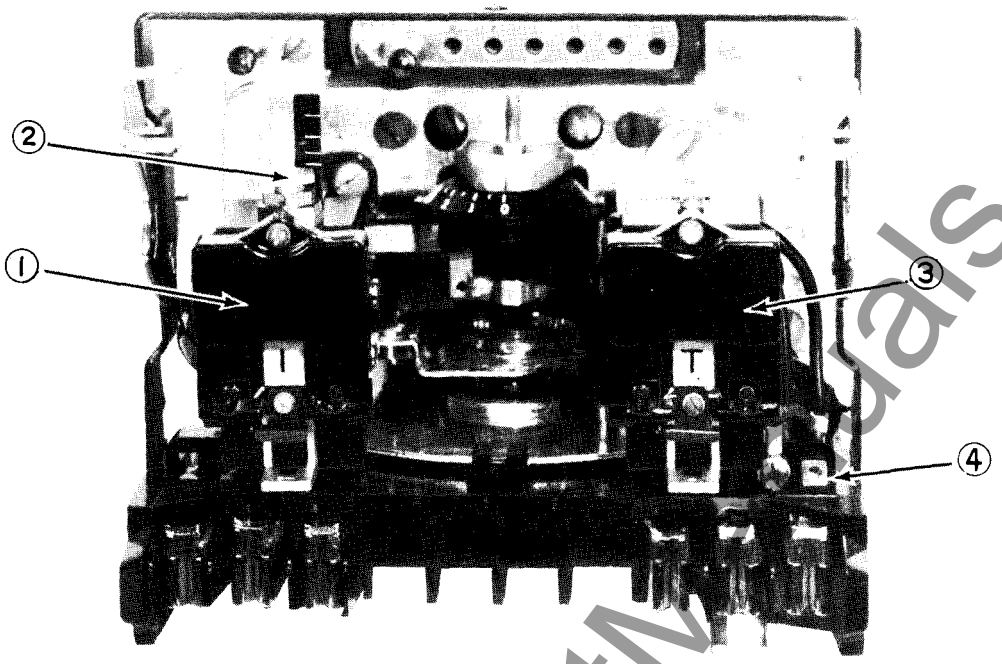


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

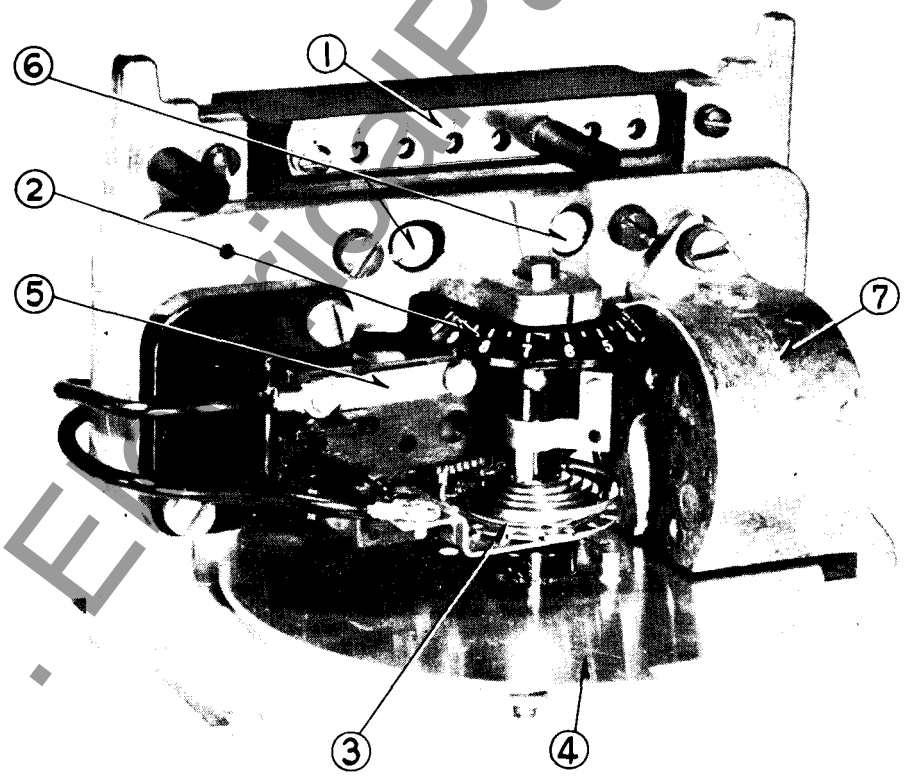


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

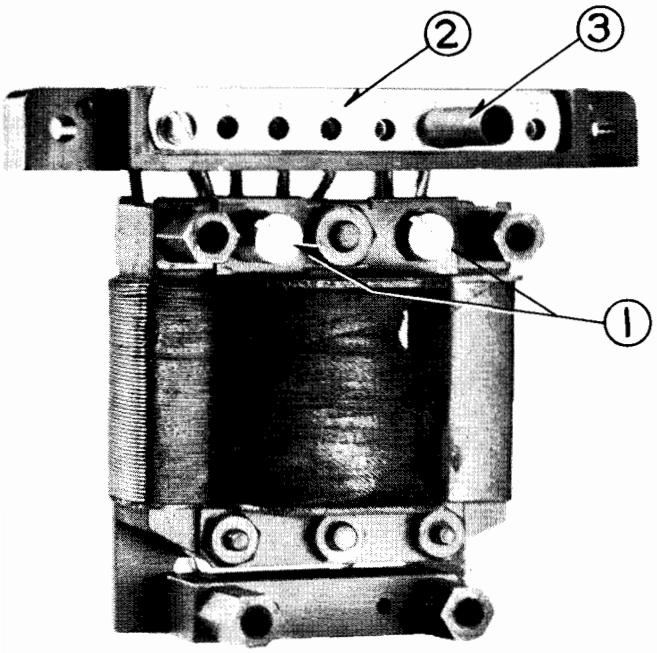


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

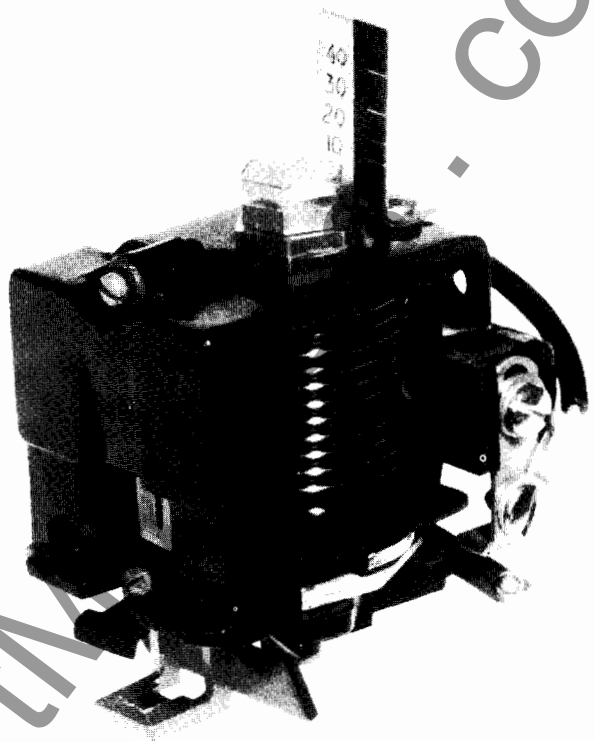


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

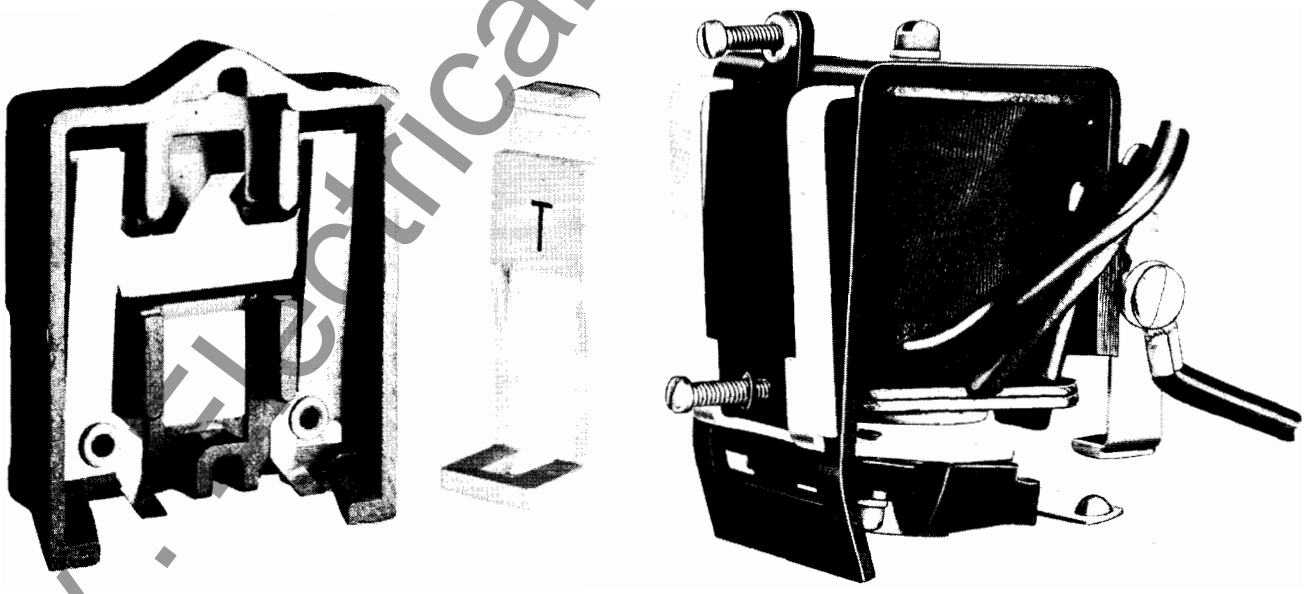


Fig. 5. Indicating Contactor Switch (ICS).

CHARACTERISTICS

The relays are generally available in the following current ranges:

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

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

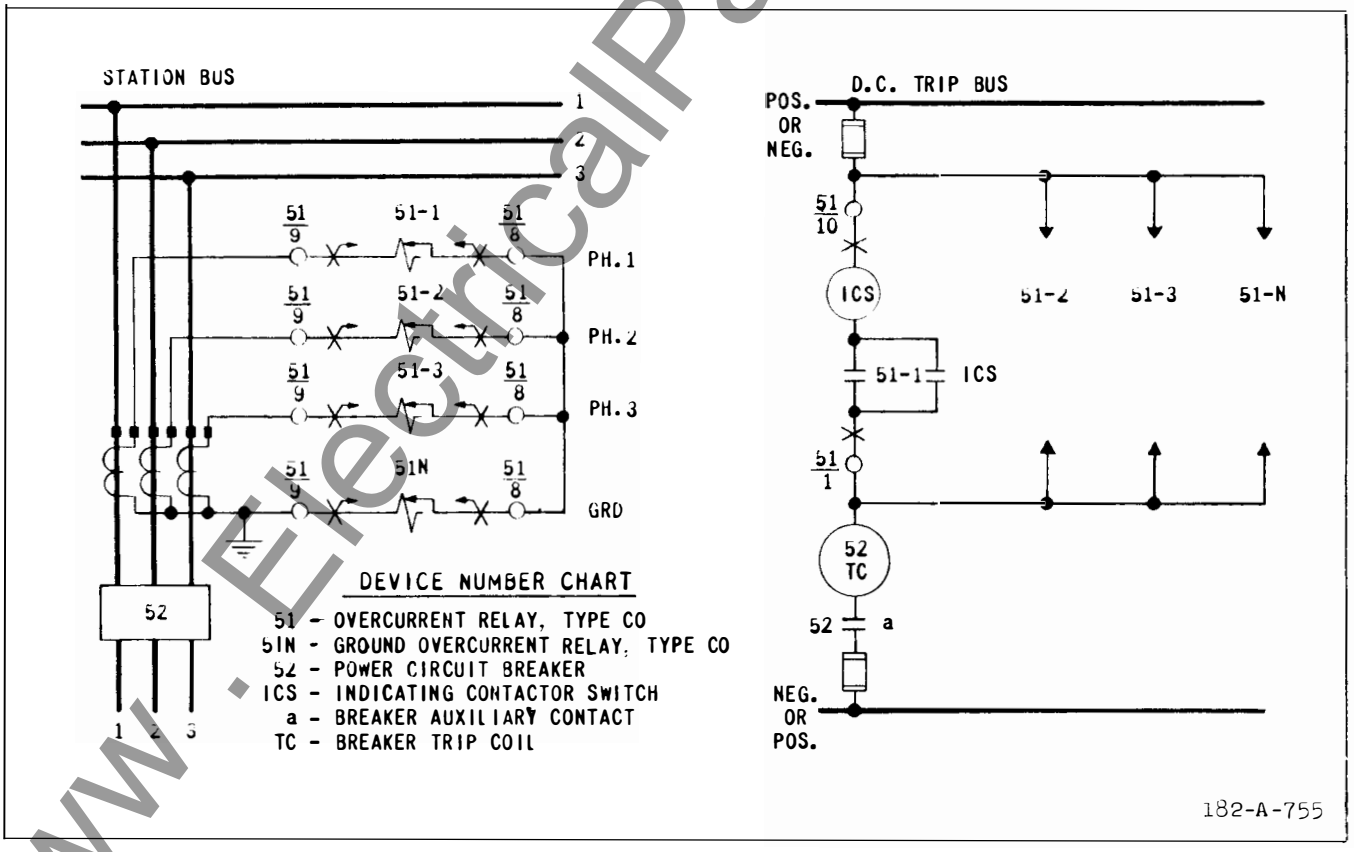


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

* ENERGY REQUIREMENTS Δ

Instantaneous Trip Unit (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

TYPE CO-2 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	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	5.53	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.*

Δ *Further information can be obtained in Performance Data 41-100.*

ENERGY REQUIREMENTS

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	2.7	88	69	3.92	20.6	103	270
	(0.6	3.1	88	68	3.96	20.7	106	288
	(0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	4.1	88	66	4.07	21.4	122	360
	(1.5	5.7	88	62	4.19	23.2	147	462
	(2.0	5.8	88	60	4.30	24.9	168	548
	(2.5	7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.*

ENERGY REQUIREMENTS

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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	88	72	2.38	21	132	350
	(0.6	3.1	88	71	2.38	21	134	365
	(0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	4.1	88	67	2.42	21.2	150	440
	(1.5	5.7	88	62	2.51	22	170	530
	(2.0	6.8	88	57	2.65	23.5	200	675
	(2.5	7.7	88	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	2.5	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 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.*

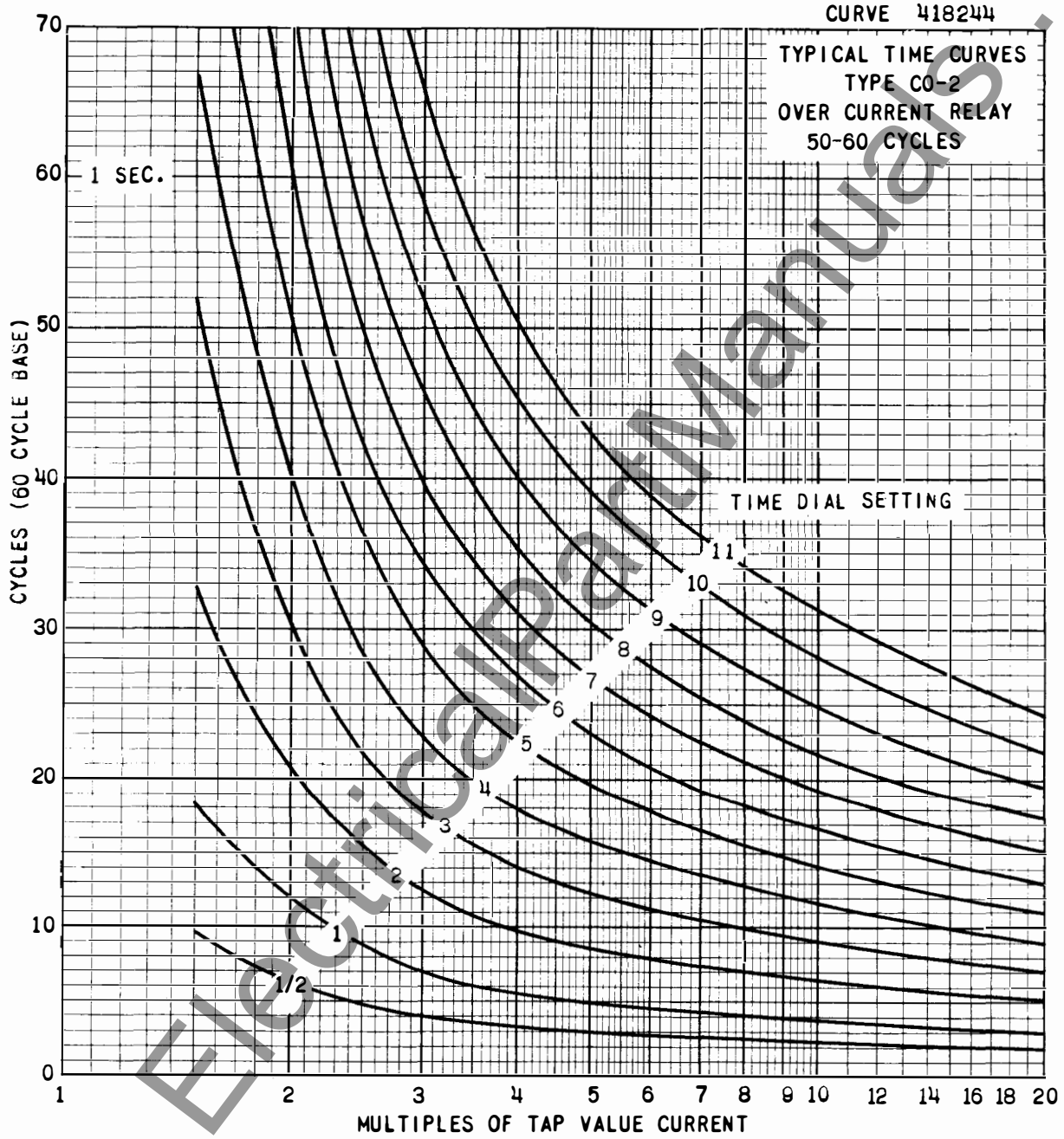


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

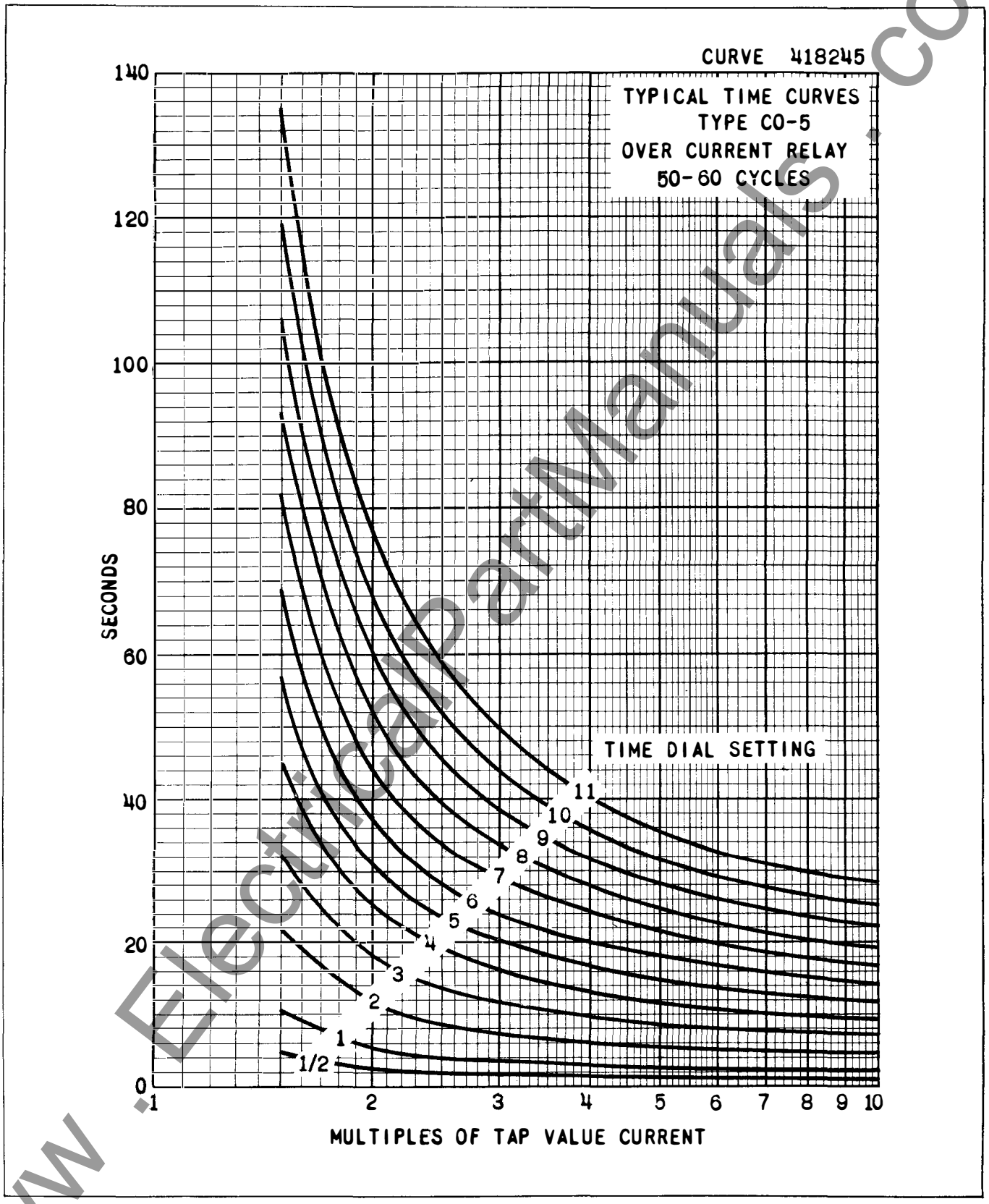


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

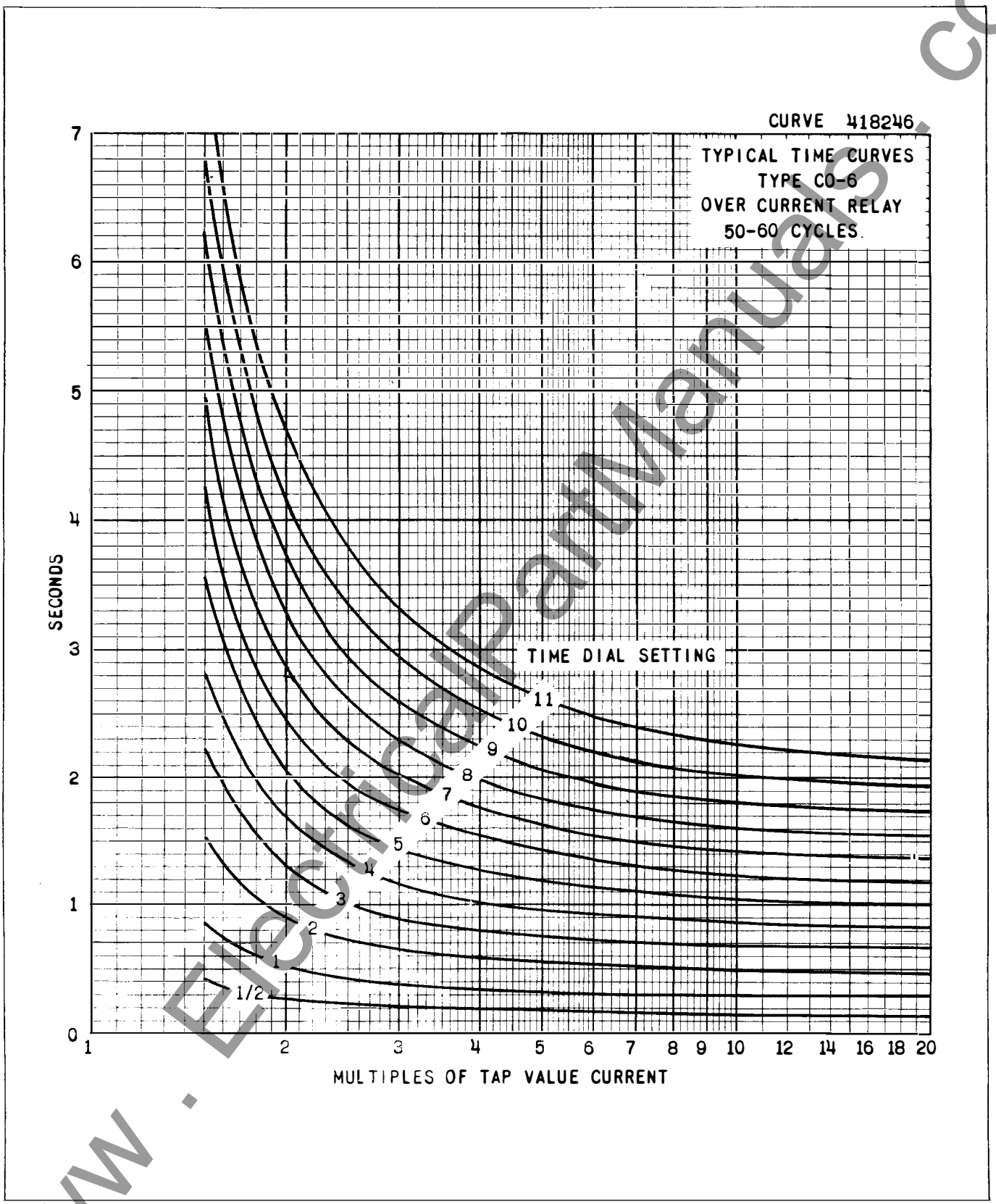


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

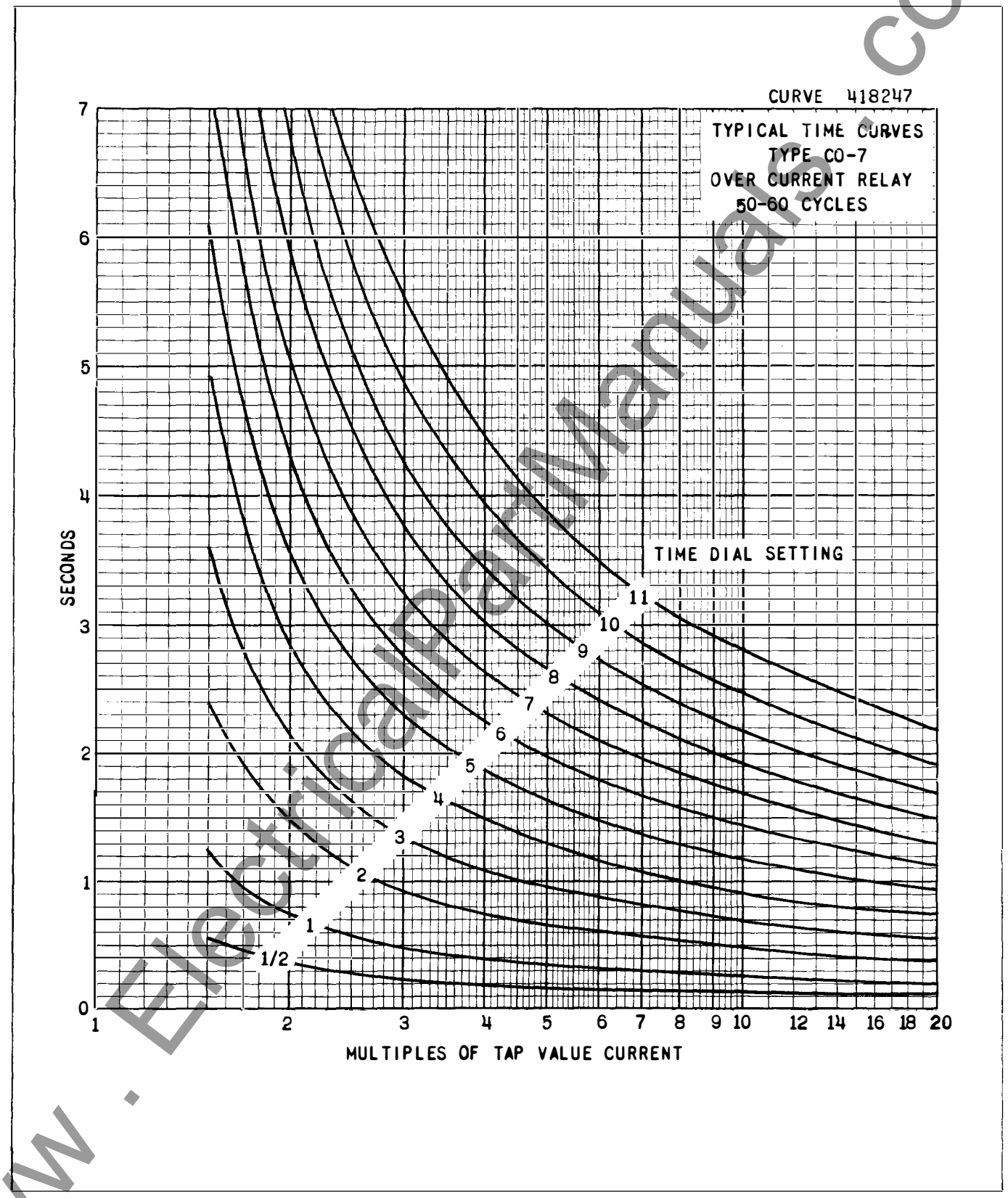


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

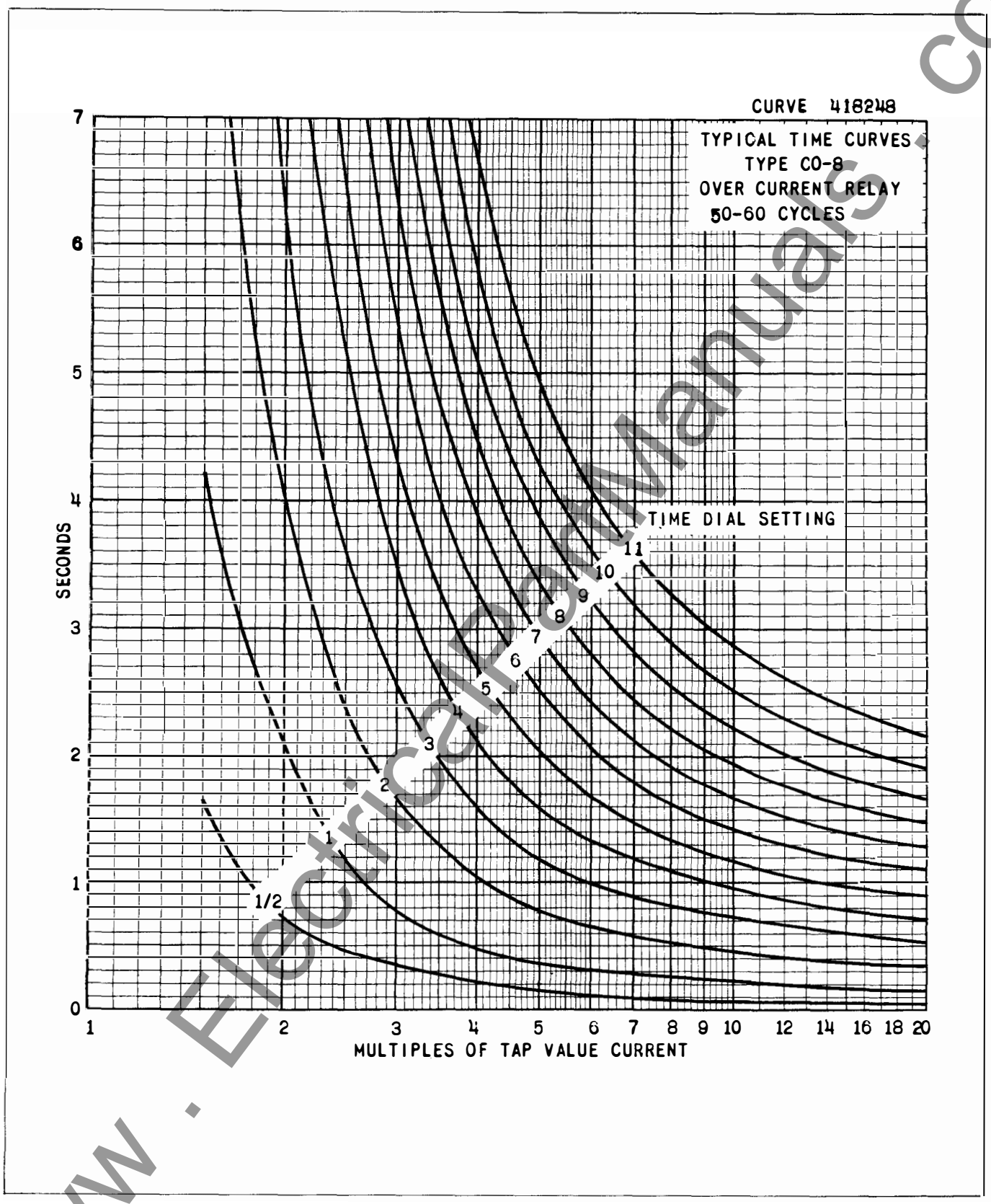


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

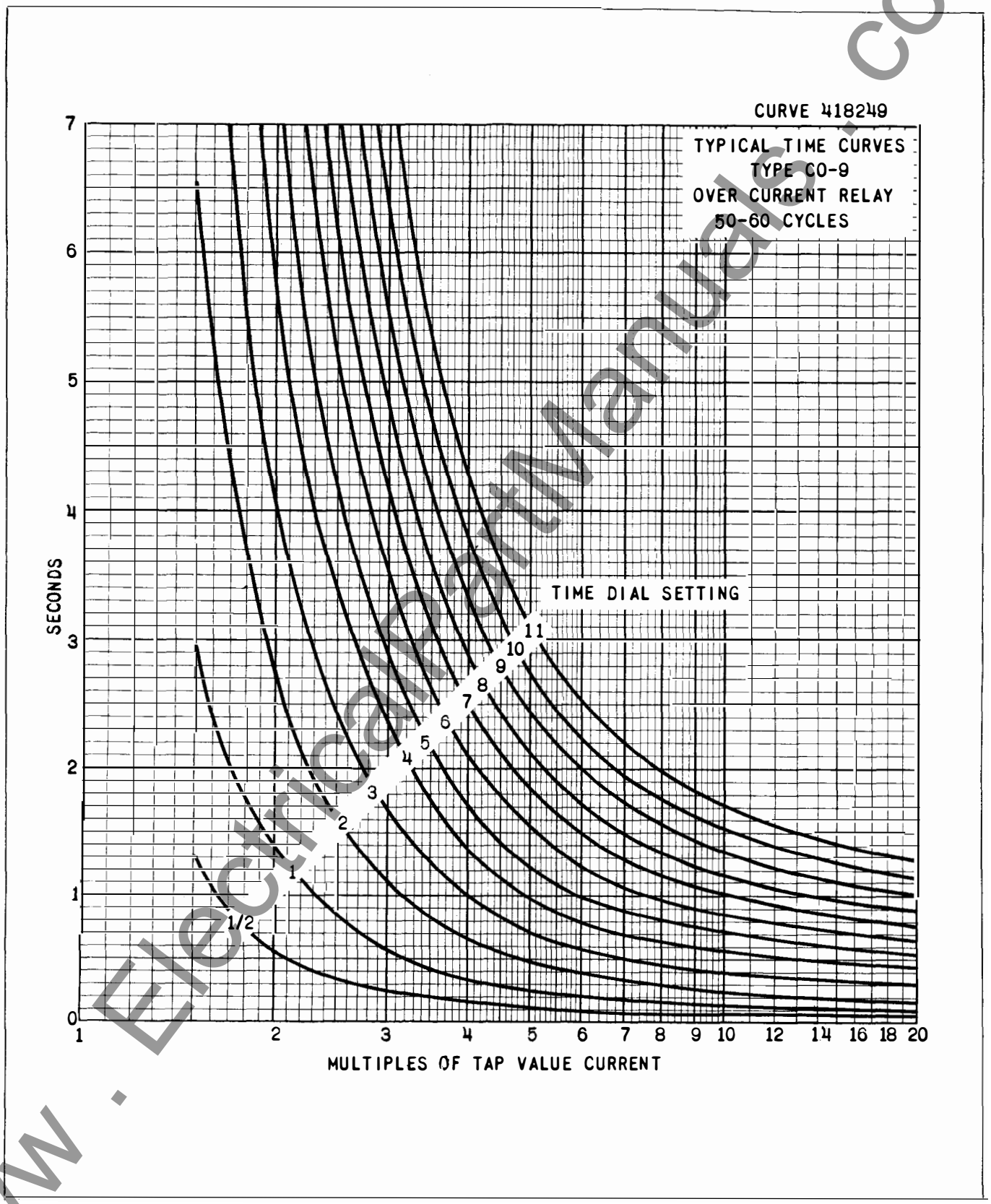


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

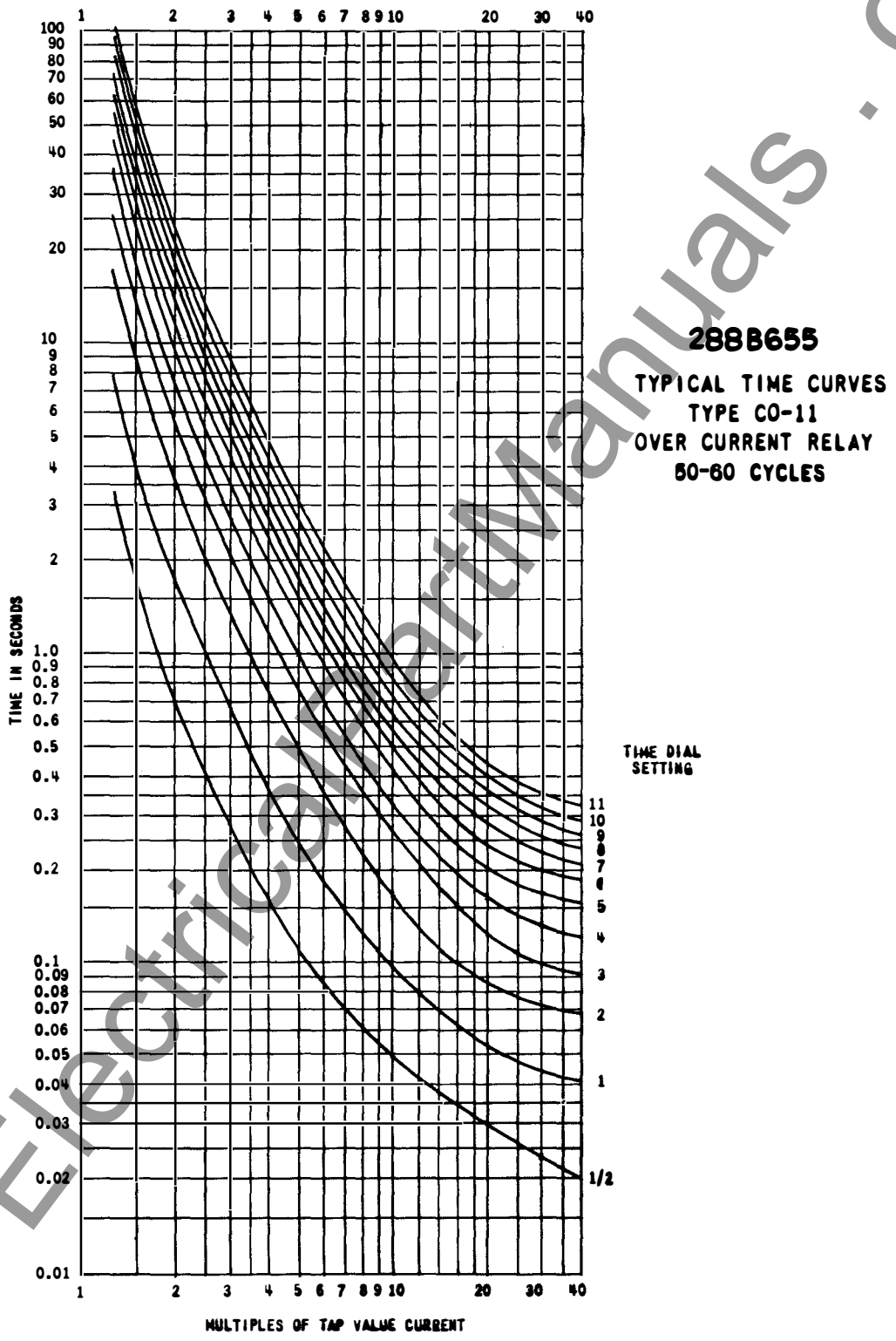


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

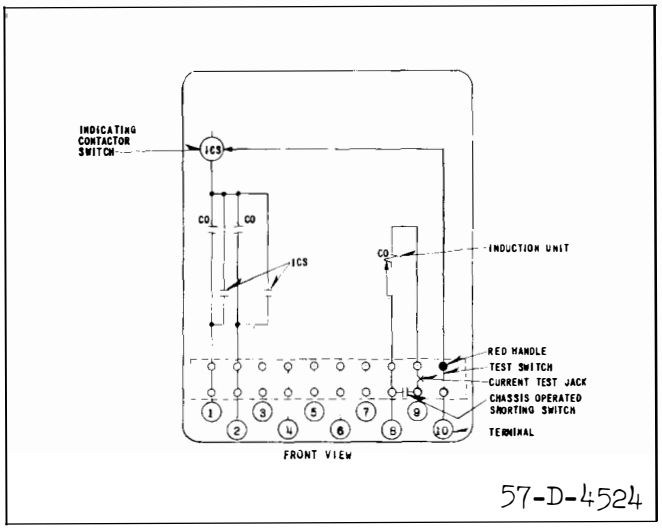


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

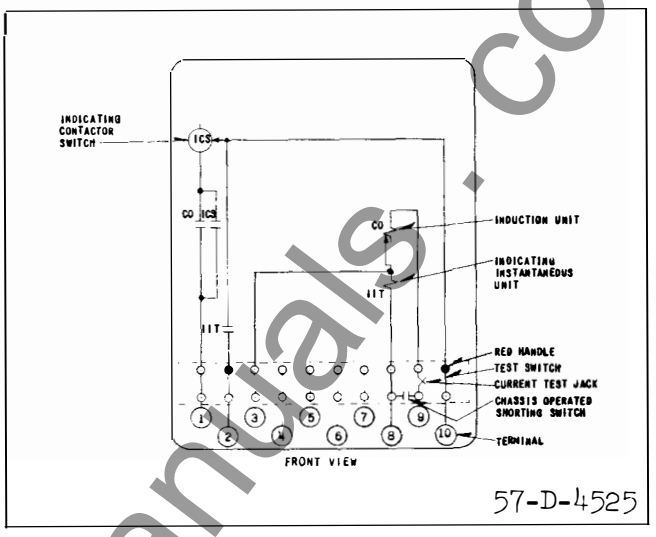


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is 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)

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.

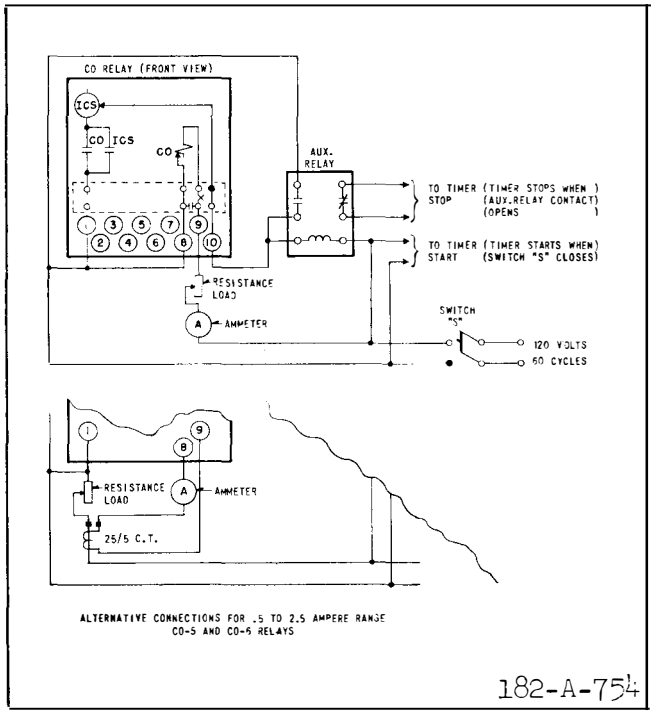


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

Acceptance Check

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

1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current – Set the time dial to position 6 using the lowest tap setting, 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 – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

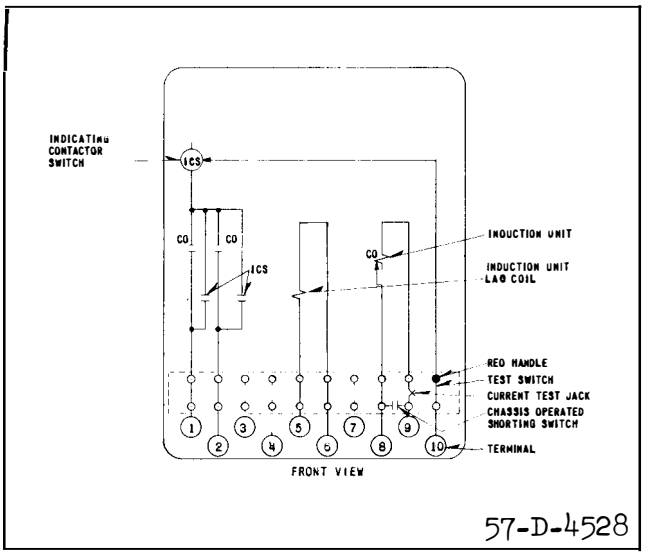


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

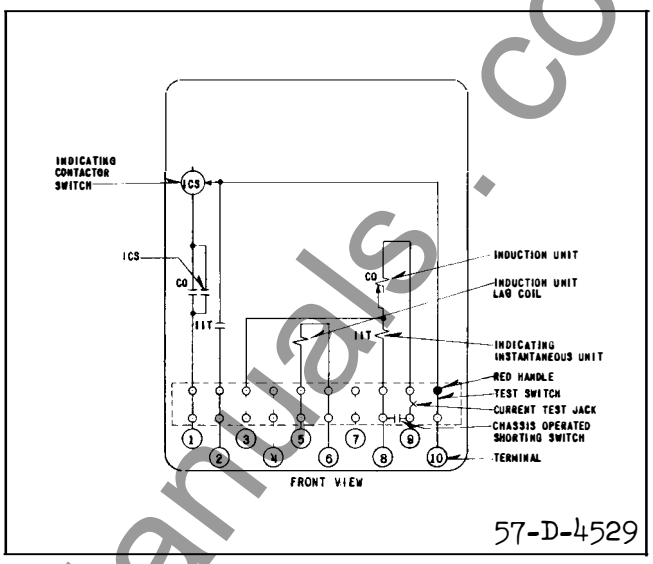


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

dial set to the indicated position and the relay set on the lowest tap setting, 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%

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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.

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

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ± 5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

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)

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.

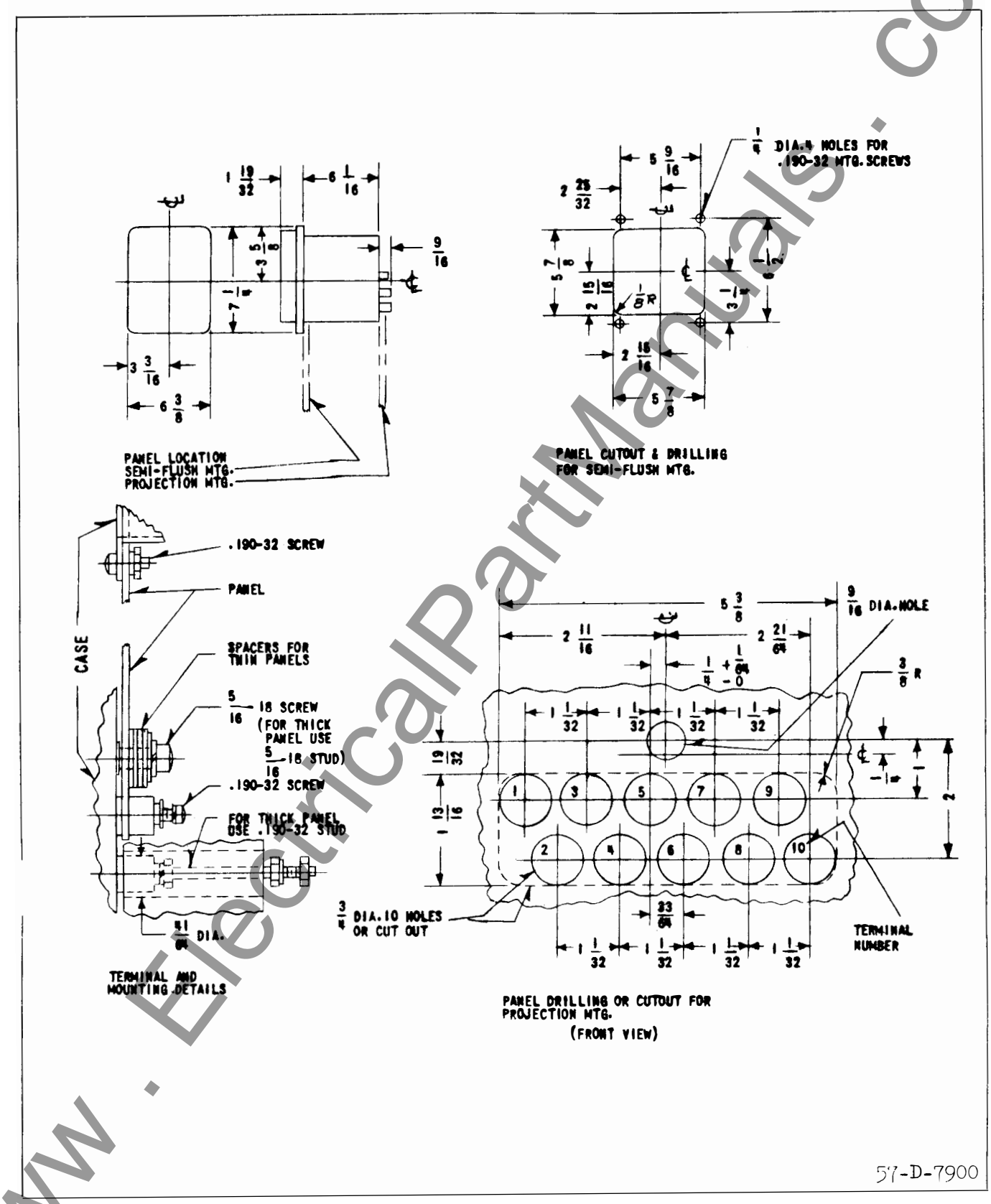


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 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 Δ

Δ For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

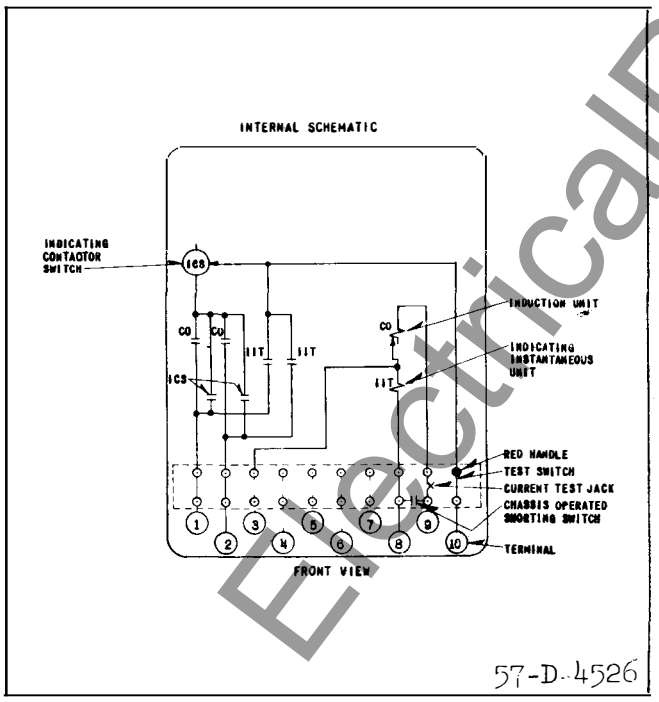


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

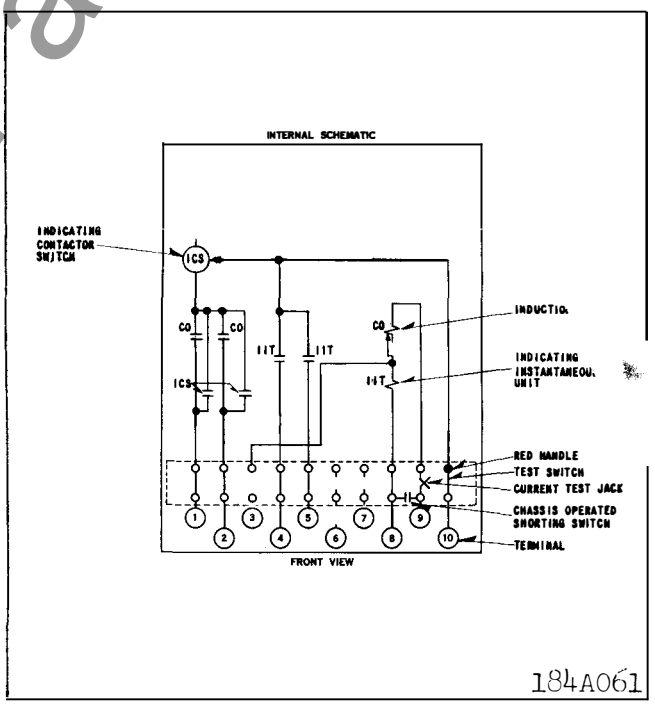


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO RELAY COORDINATION AND IMPULSE MARGIN TIME

These instructions define the significance of the impulse or coasting characteristic of CO units upon the time-coordination of two relays.

Relay I operating time in figure 1 should be delayed sufficiently for fault 1, to allow Relay II to complete its operation and breaker II to clear the fault. At the instant that fault 1 is cleared, the disc of relay I will be moving towards the closed position; therefore, the disc will coast for a while after being deenergized. Allowance for coasting must be included in the coordin ating time interval, which is time S-W in figure 2, where O-W is the relay II operating time.

A coordinating time interval of 0.3 seconds plus breaker time is recommended; however, for those who wish to consider using a shorter interval, the impulse margin times of Table I should be used.

TABLE I

Disc Unit Type	T_{IM} Impulse Margin Time - Seconds
CO-2	0.05
CO-6	0.06
CO-7	0.05
CO-8	0.03
CO-9	0.03
CO-11	0.03

In Fig. 2 the interval, Y-Z, of 0.03 seconds is the impulse margin time. Its significance will now be explained.

Impulse margin time, T_{IM} is defined as:

$$T_{IM} = T_{OP} - T_I \qquad (1)$$

where T_{OP} = operating time from time-current curves at some time-dial & tap-multiple setting.

EFFECTIVE SEPTEMBER 1963

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION NEWARK, N. J.

Printed in U.S.A.

T_I = Minimum impulse time during which sufficient inertia is supplied to the disc to eventually cause the disc to coast closed, following deenergization; based upon test at same setting & current as used to determine T_{OP}.

For example, in figure 2, assume that the CO-8 relay is energized at 7.8 times tap current, with a #2 time dial setting. From published curve, T_{OP} = 0.53 seconds. From test data,

$\frac{T_I}{T_{OP}}$ = 0.947; this means that the relay must be deenergized before

0.947 x 0.53 = 0.50 seconds to prevent eventual closure.

From equation (1), T_{IM} = 0.53 (1-0.947) = 0.028 secs. An analysis of and calculations from test data of the various disc units in the manner just illustrated resulted in the representative data of Table I.

A relay I curve in Fig. 2, producing a delay of time O - Z, would make no allowance for the following:

a) Error in fault current calculations
b) CT errors
c) Setting errors
d) Relay operating time variations
e) Changes caused by system growth

By exercising extreme care, a coordinating time interval as low as 0.15 secs. plus breaker time is possible.

FIG. 1 OPERATION OF PROTECTED RELAY, I, SHOULD BE DELAYED TO PERMIT THE PROTECTING RELAY, II, TO CLEAR FAULT 1.

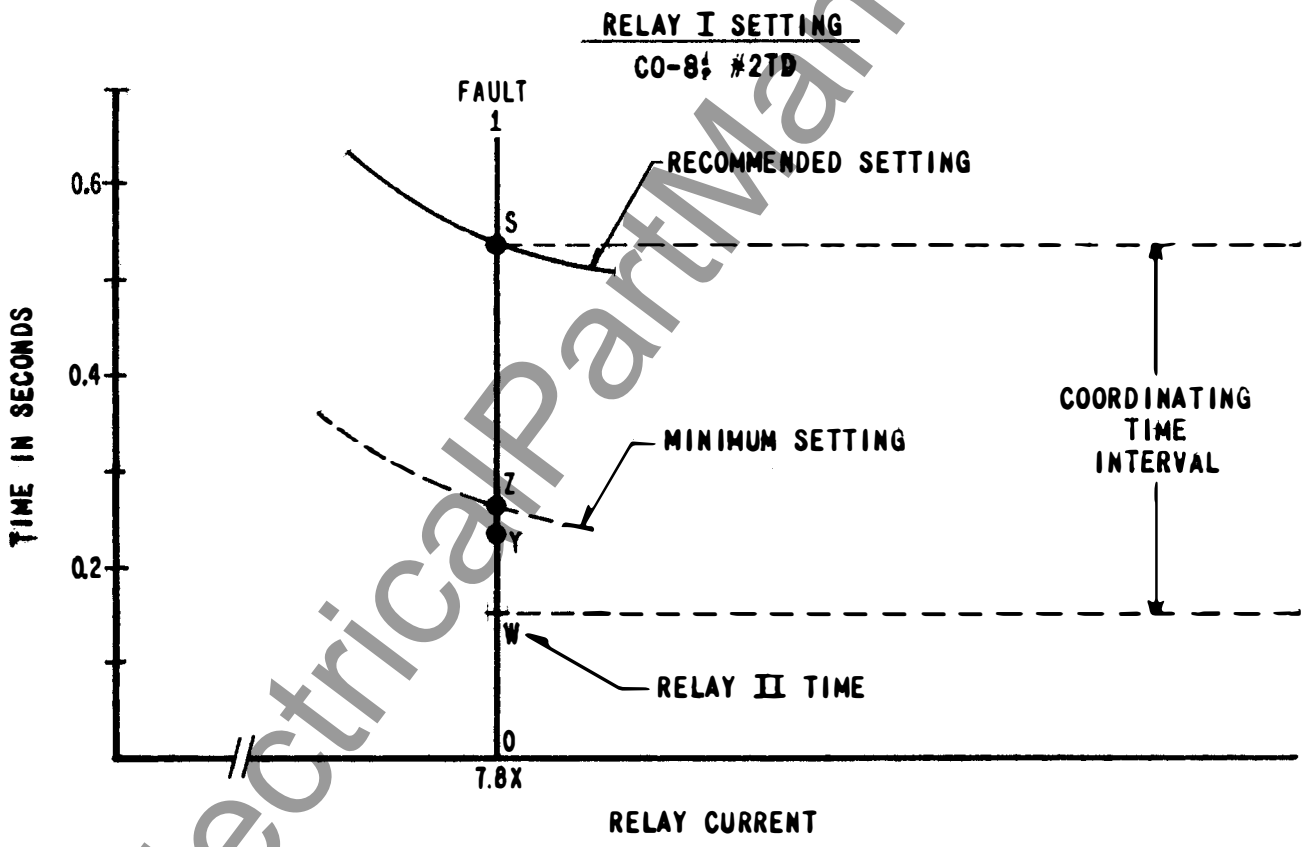
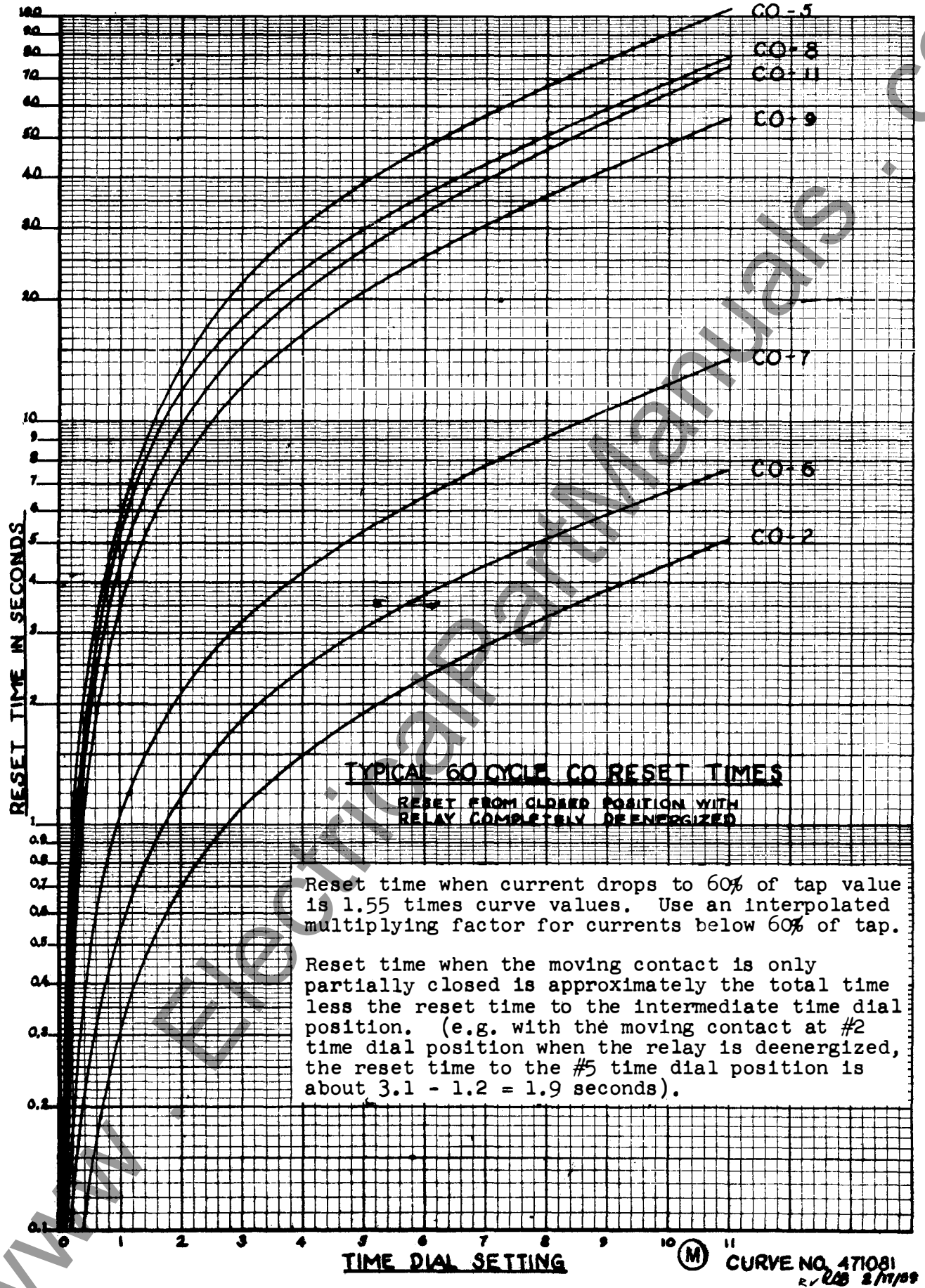


FIG. 2 - IF RELAY I IS SET TO OPERATE IN TIME, Z, ALLOWANCE IS MADE FOR COASTING BUT NO ALLOWANCE IS MADE FOR ERRORS AND RELAY TIMING VARIATIONS.



TYPICAL 60 CYCLE CO RESET TIMES

RESET FROM CLOSED POSITION WITH RELAY COMPLETELY DEENERGIZED

Reset time when current drops to 60% of tap value is 1.55 times curve values. Use an interpolated multiplying factor for currents below 60% of tap.

Reset time when the moving contact is only partially closed is approximately the total time less the reset time to the intermediate time dial position. (e.g. with the moving contact at #2 time dial position when the relay is deenergized, the reset time to the #5 time dial position is about 3.1 - 1.2 = 1.9 seconds).

Ⓜ CURVE NO. 471081
R/RAB 2/17/89

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

The CO relay is a single phase non-directional time ac overcurrent device. It is used to sense current level above the setting and normally is used to trip a circuit breaker to clear faults. A wide range of characteristics permit applications involving coordination with fuses, reclosers, cold load pickup, motor starting, or essentially fixed time applications.

✪ The following describes typical applications of the CO Relay:

RELAY TYPE	TIME CURVE	TYPICAL APPLICATIONS
CO-2	Short	1) Differential protection where saturation of current transformers is not expected, or where delayed tripping is permissible. 2) Overcurrent protection, phase or ground, where coordination with downstream devices is not involved and 2 to 60 tripping cycle is allowable.
CO-5	Long	Motor locked rotor protection where allowable locked rotor time is approximately between 10 and 70 seconds.
CO-6	Definite	Overcurrent protection where coordination with downstream devices is not involved and CO-2 is too fast. The operating time of this relay does not vary greatly as current level varies.
CO-7	Moderately Inverse	1) Overcurrent protection where coordination with other devices is required, and generation varies. 2) Backup protection for relays on other circuits.
CO-8	Inverse	
CO-9	Very Inverse	
CO-11	Extremely Inverse	1) Motor protection where allowable locked rotor time is less than 10 sec. 2) Overcurrent protection where coordination with fuses and reclosers is involved, or where cold load pickup or transformer inrush are factors.

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

SUPERSEDES I.L. 41-101Q, DATED MARCH 1978 AND ADDENDUM 41-101 DATED JUNE 1980

✪ Denotes changed since previous issue.

EFFECTIVE SEPTEMBER 1980

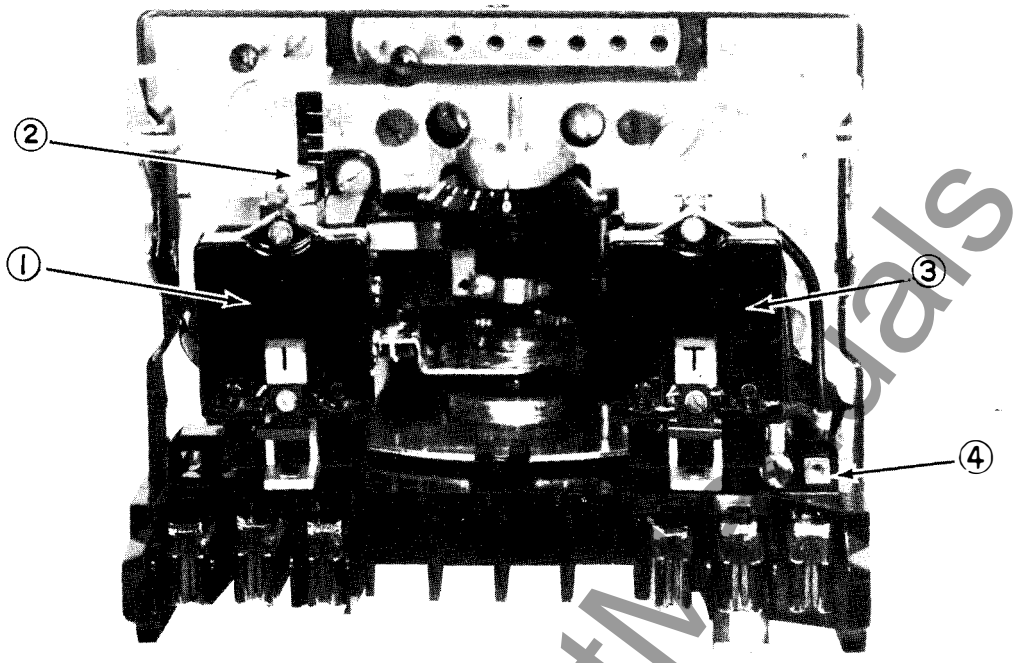


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous Trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

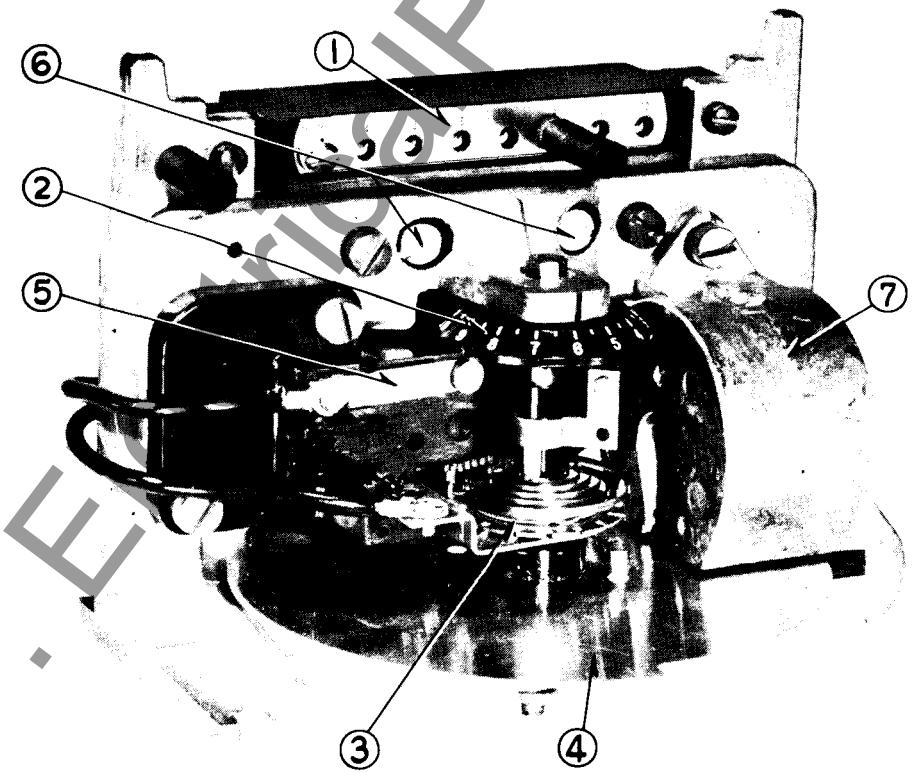


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

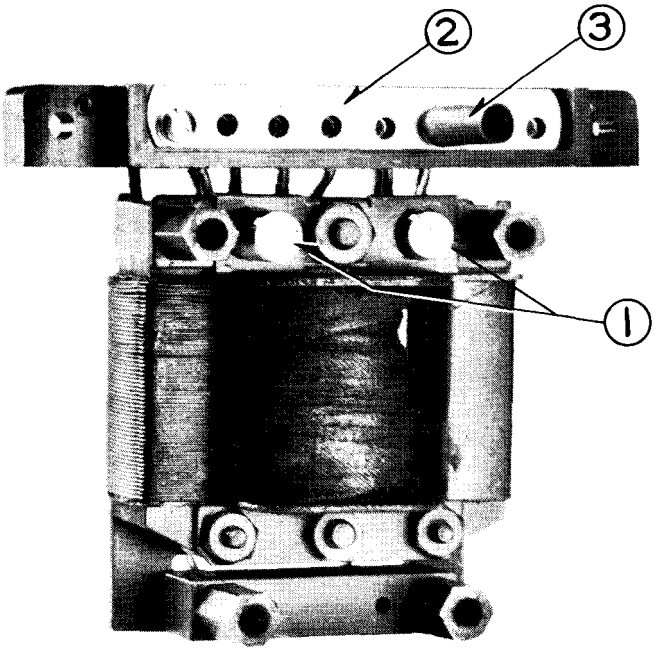


Fig. 3. "E" Type Electromagnet. 1-Magnet Plugs. 2-Tap Block. 3-Tap Screw.

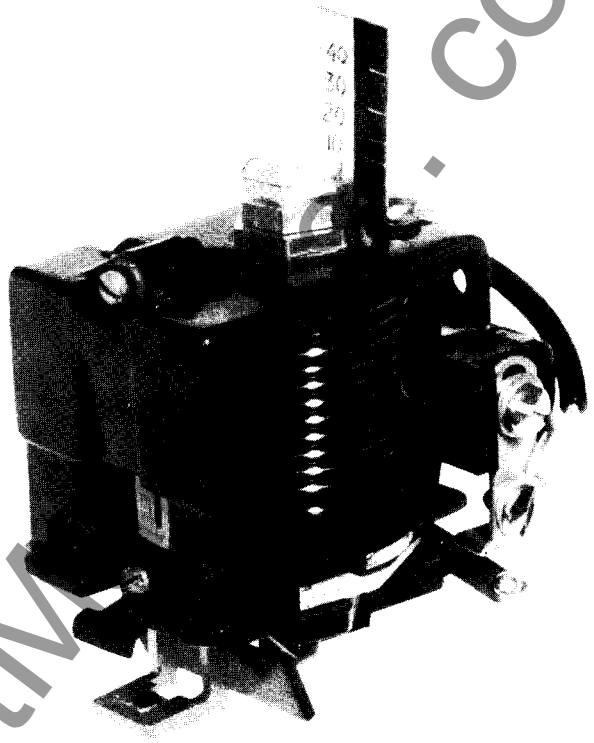


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

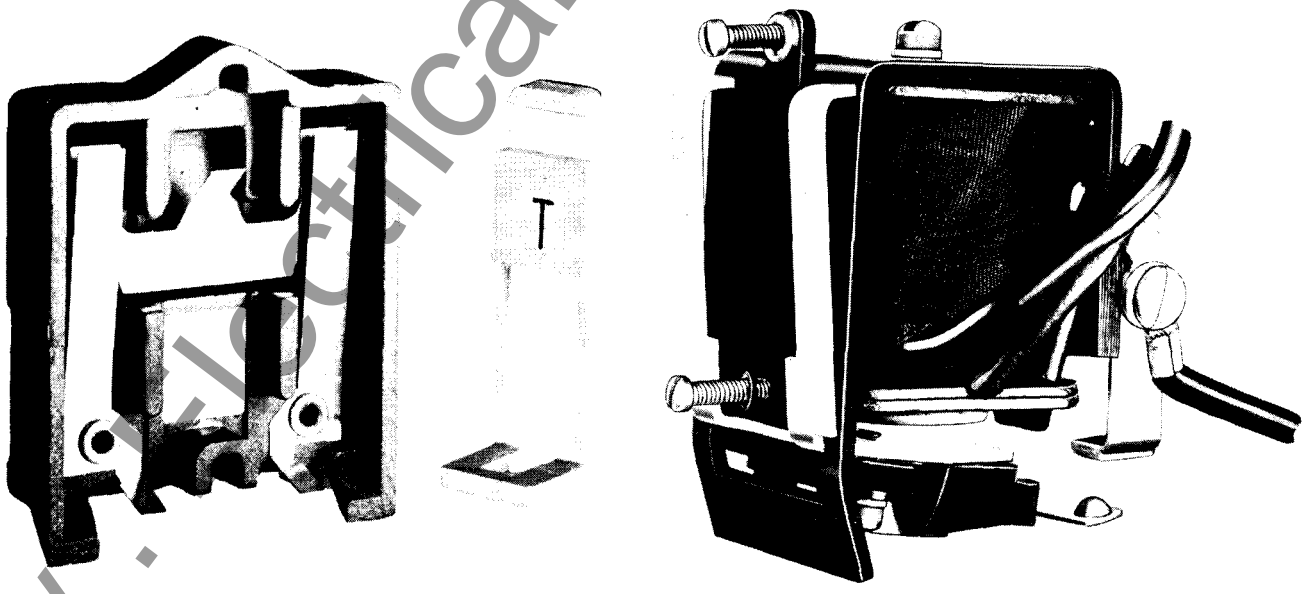


Fig. 5. Indicating Contactor Switch (ICS).

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. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

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 dc 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 ac operated clapper type device. A magnetic ar-

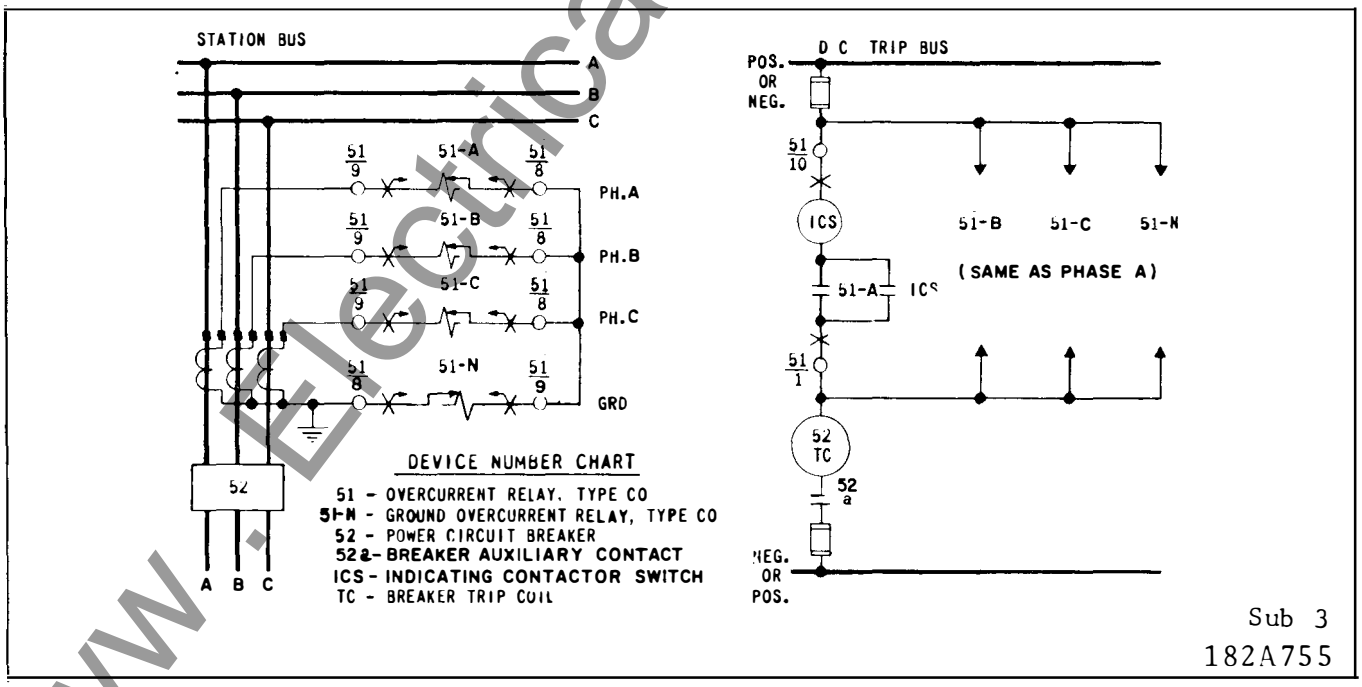


Fig. 6 External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System

ENERGY REQUIREMENTS

TYPE CO-2 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	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	64	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	5.53	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

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	69	3.92	20.6	103	270
	0.6	3.1	88	68	3.96	20.7	106	288
	0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	1.0	4.1	88	66	4.07	21.4	122	360
	1.5	5.7	88	62	4.19	23.2	147	462
	2.0	6.8	88	60	4.30	24.9	168	548
	2.5	7.7	88	58	4.37	26.2	180	630
	2	8	230	67	3.88	21	110	308
	2.5	8.8	230	66	3.90	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	4.12	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	4.35	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

**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.*

ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

CO-7 MODERATELY INVERSE TIME RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	68	3.88	20.7	103	278
	0.6	3.1	88	67	3.93	20.9	107	288
	0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	1.0	4.1	88	64	4.00	21.6	122	356
	1.5	5.7	88	61	4.08	22.9	148	459
	2.0	6.8	88	58	4.24	24.8	174	552
	2.5	7.7	88	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
	6	19.3	460	60	4.62	25.9	168	540
4/12	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	37.6	308	1032

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	72	2.38	21	132	350
	0.6	3.1	88	71	2.38	21	134	365
	0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	1.0	4.1	88	67	2.42	21.2	150	440
	1.5	5.7	88	62	2.51	22	170	530
	2.0	6.8	88	57	2.65	23.5	200	675
	2.5	7.7	88	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

**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.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

TYPE CO-11 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	VOLT AMPERES** At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
	0.1	0.4	11.5	34	0.64	6.5	70.3	240
	0.12	0.4	11.5	32	0.67	6.66	75.4	264
	0.16	0.4	11.5	30	0.76	7.3	82.4	297
0.1/0.5	0.20	0.4	11.5	26	0.83	8.3	87.8	336
	0.30	0.4	11.5	22	1.01	10.3	117.6	420
	0.40	0.4	11.5	18	1.21	11.22	140.0	520
	0.50	0.4	11.5	16	1.38	13.8	168.0	630
	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	2.5	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 calculated on the basis of time being inversely proportional to the square of the current.*

Ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

INSTANTANEOUS TRIP UNIT (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

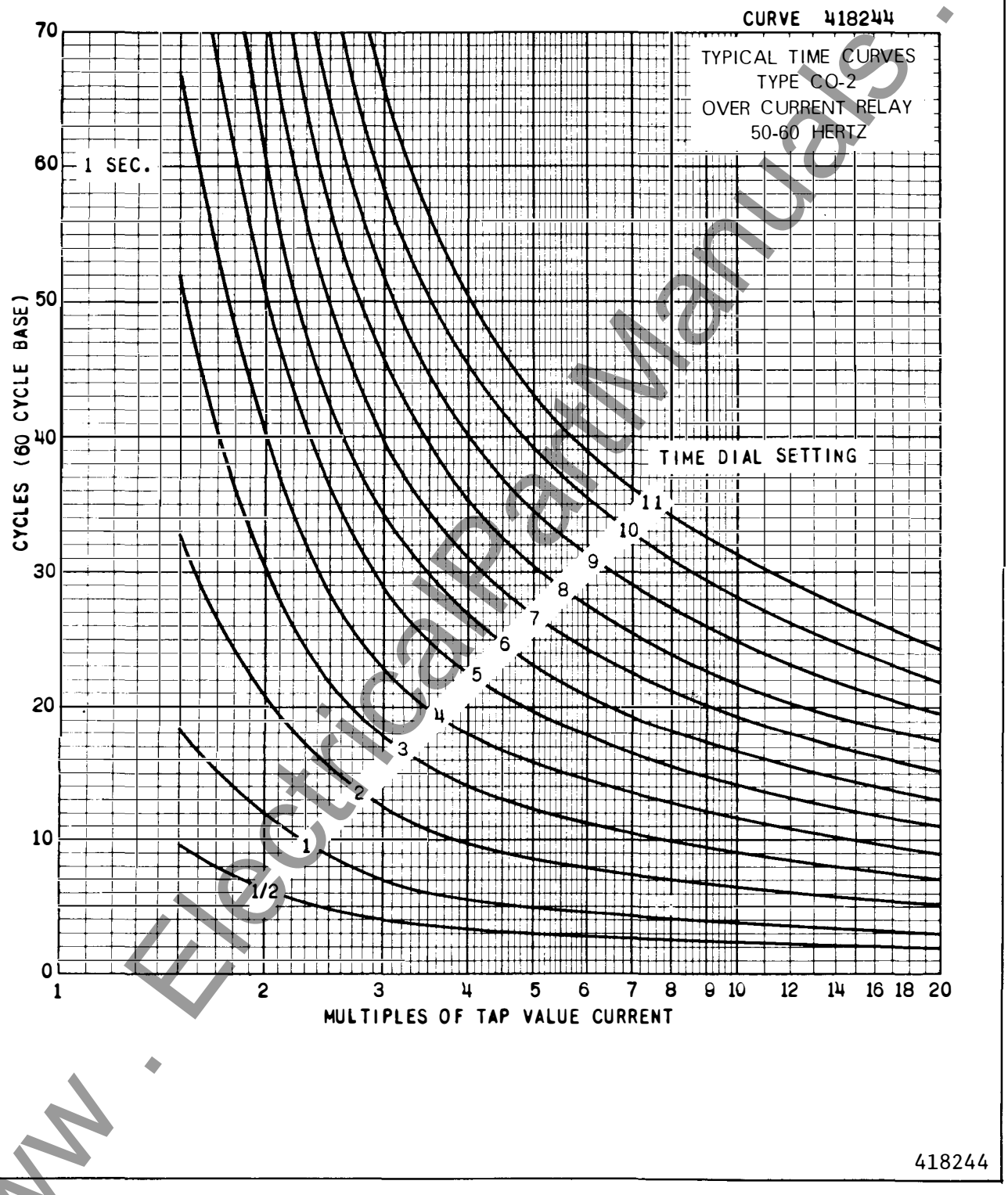


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

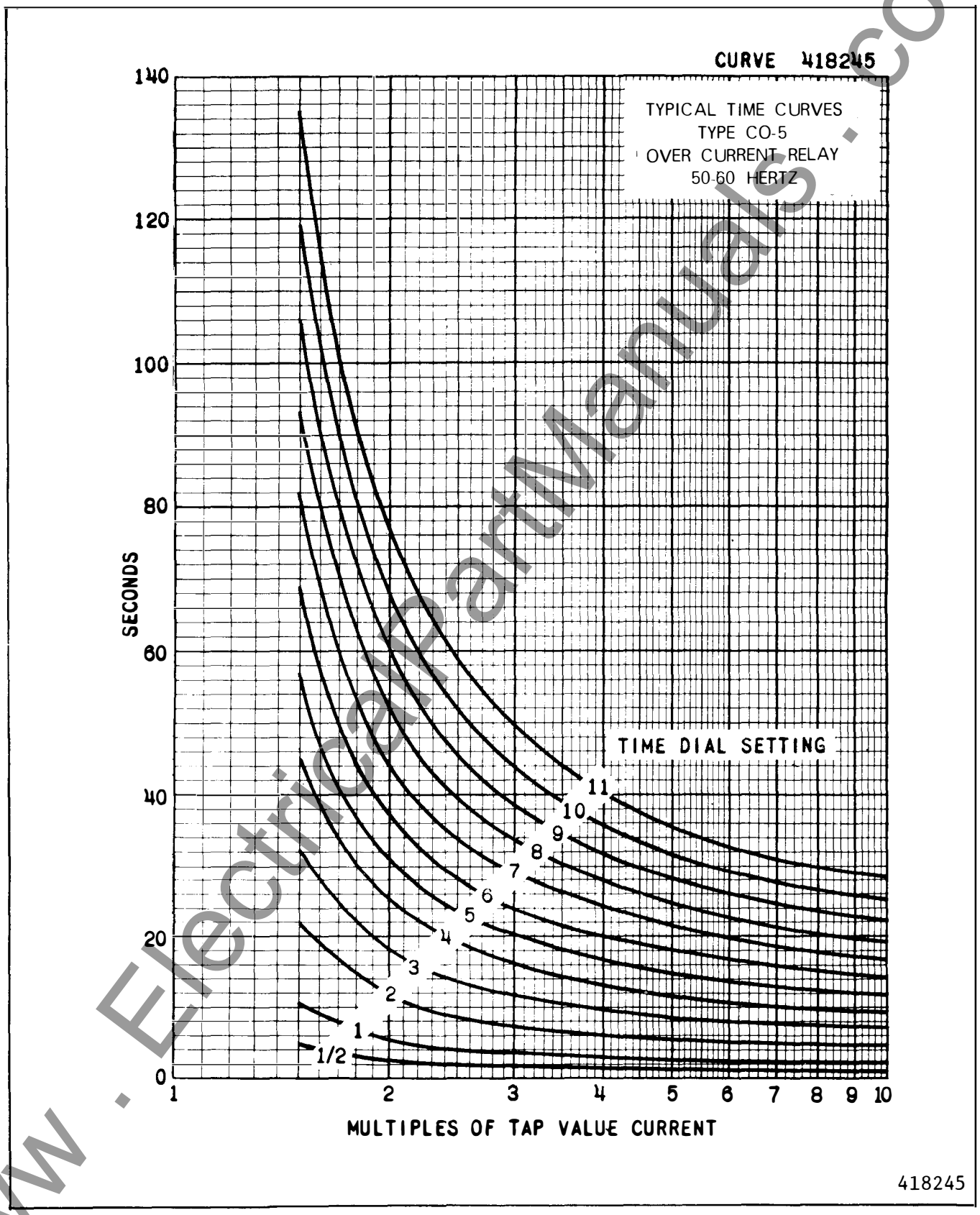


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

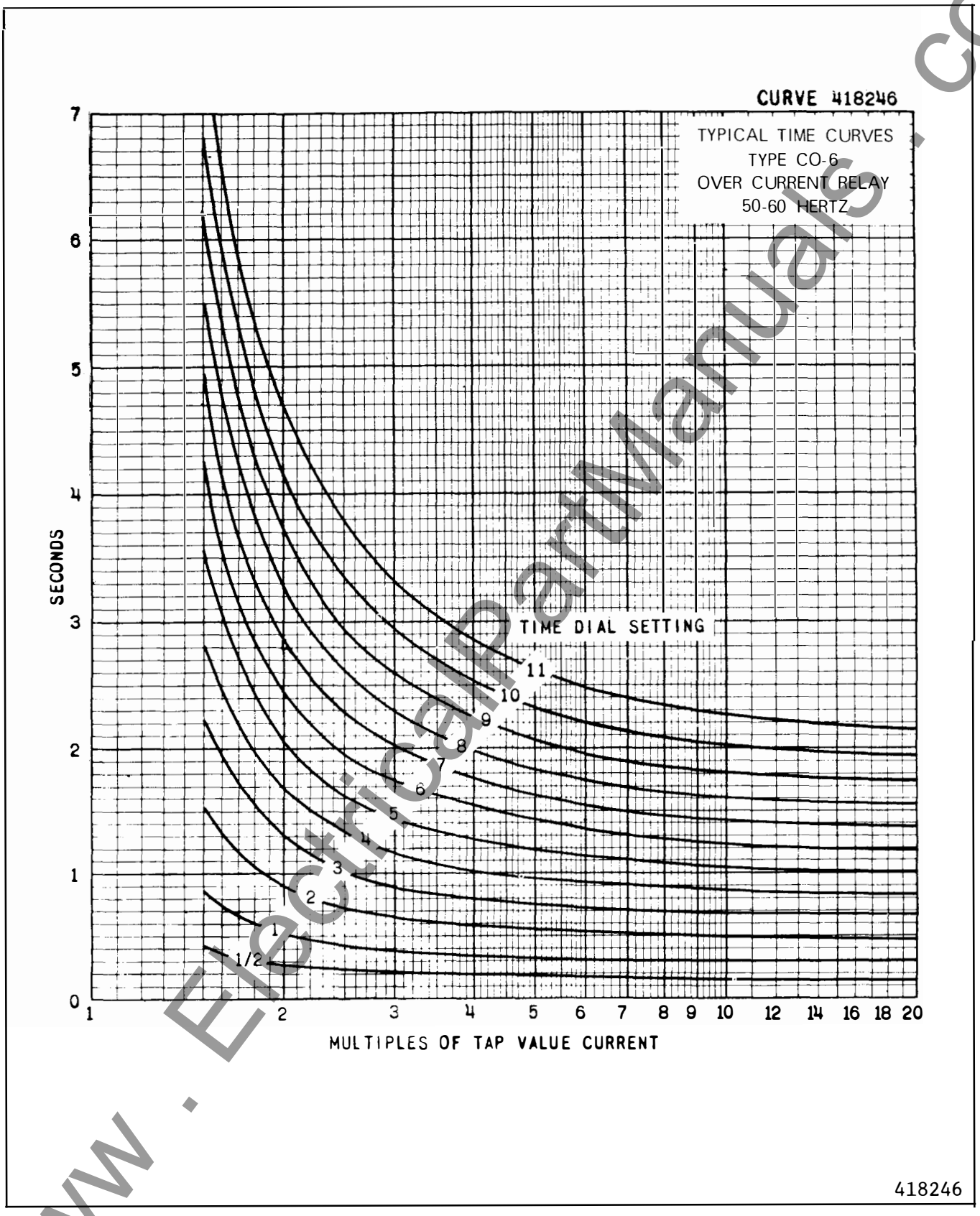


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

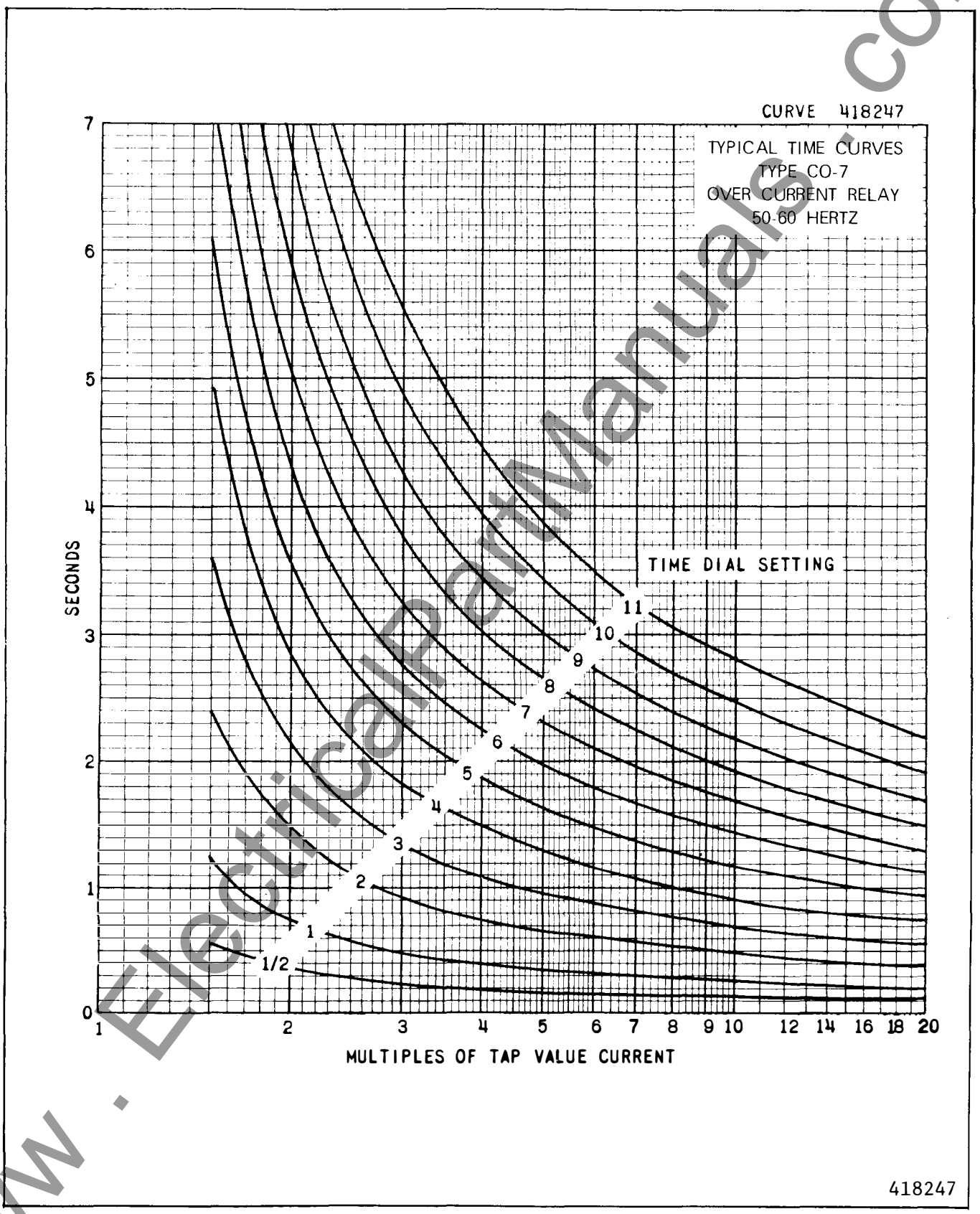


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

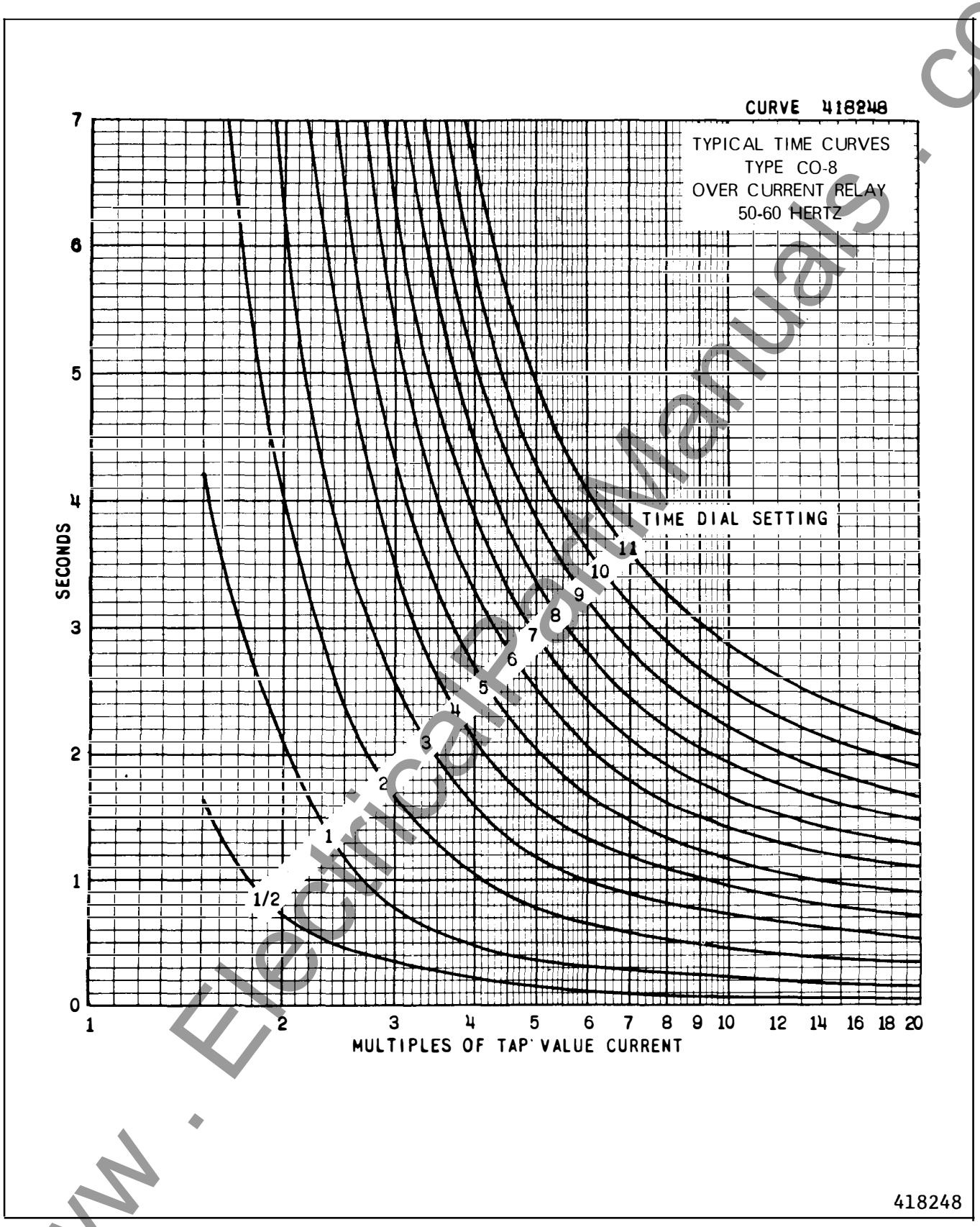


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

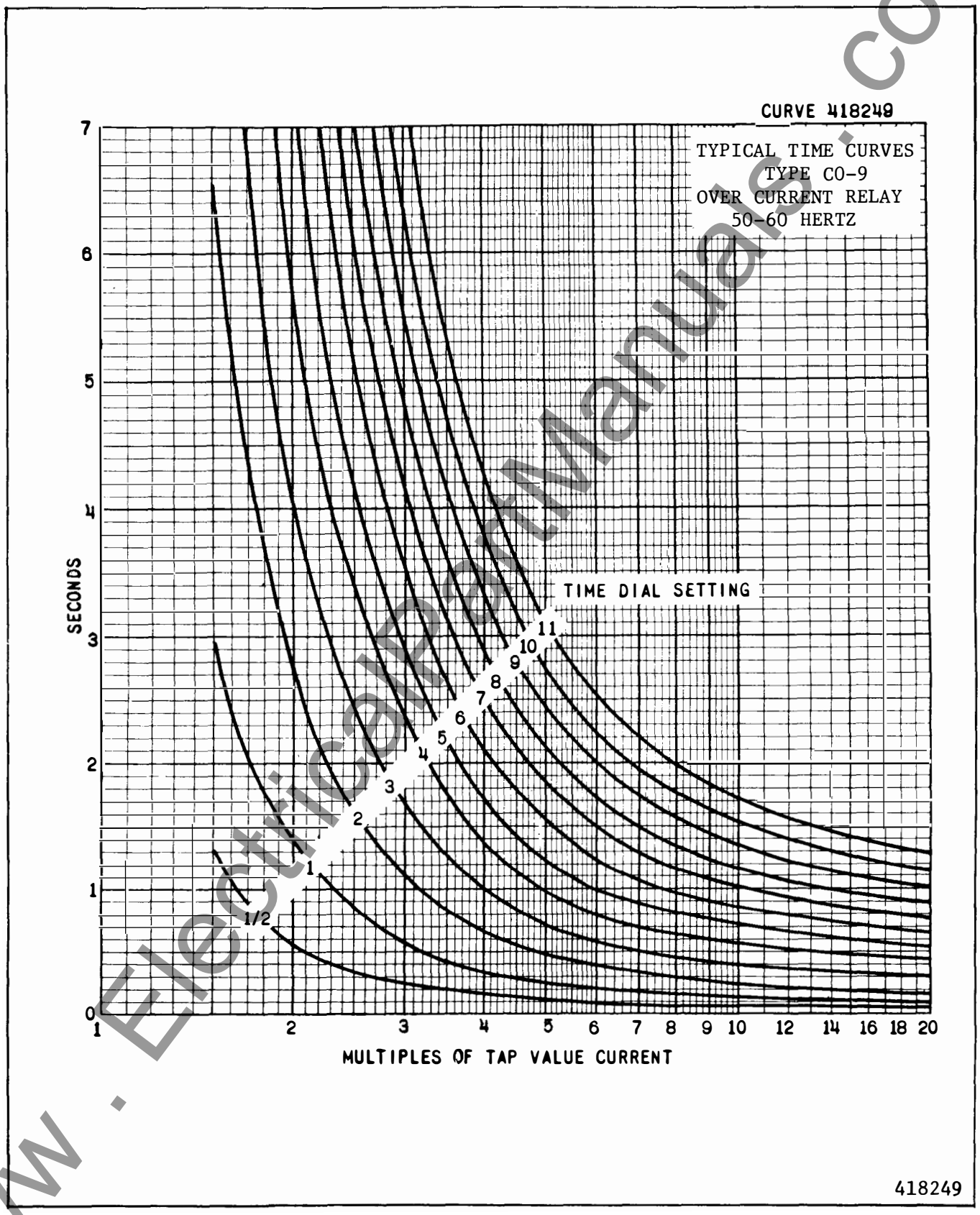


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

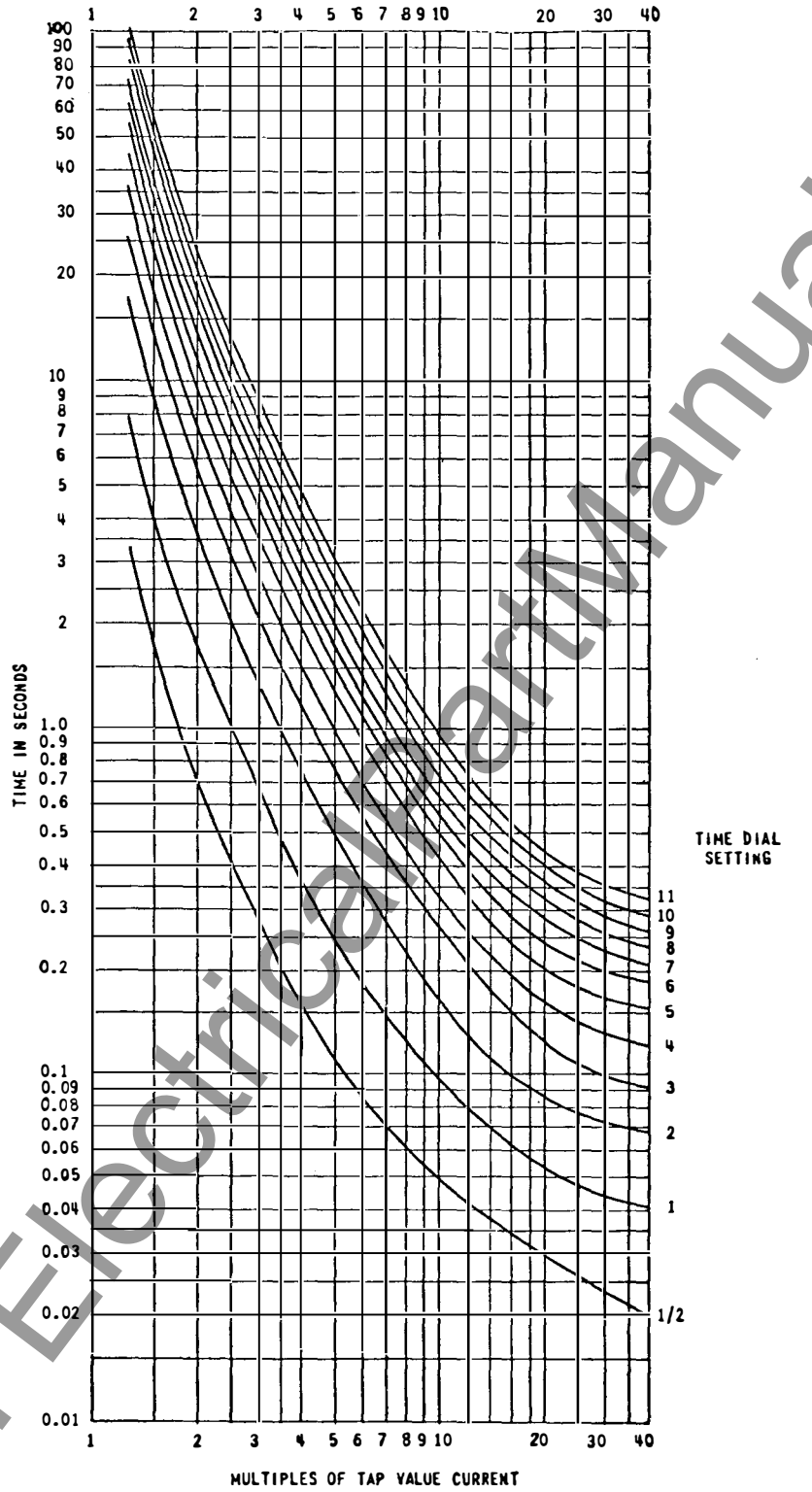


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

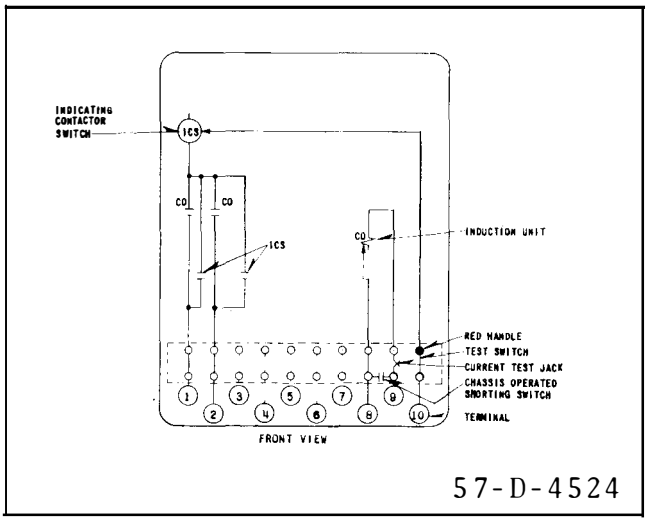


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

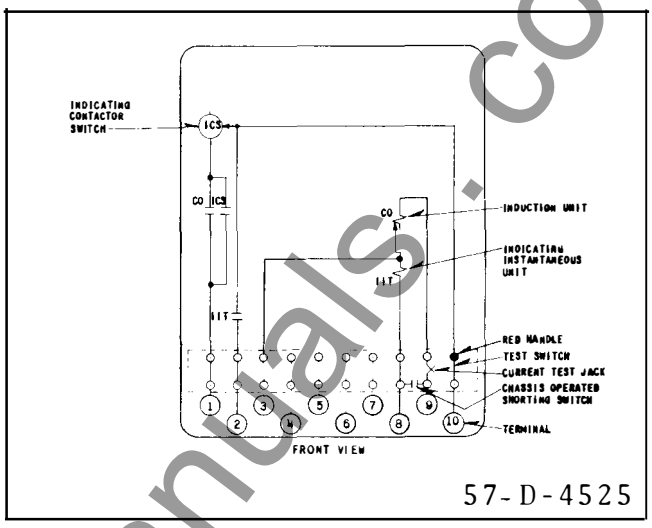


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

mature, 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.

CHARACTERISTICS

The relays are generally available in the following current ranges.

Range	Taps						
† .1-.5	0.1	0.12	0.16	0.2	0.3	0.4	0.5
.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

†Available for Type CO-11 Relay.

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 dc 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 dc, 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 to 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 dc resistance
2.0 ampere tap – 0.15 ohms dc resistance

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)

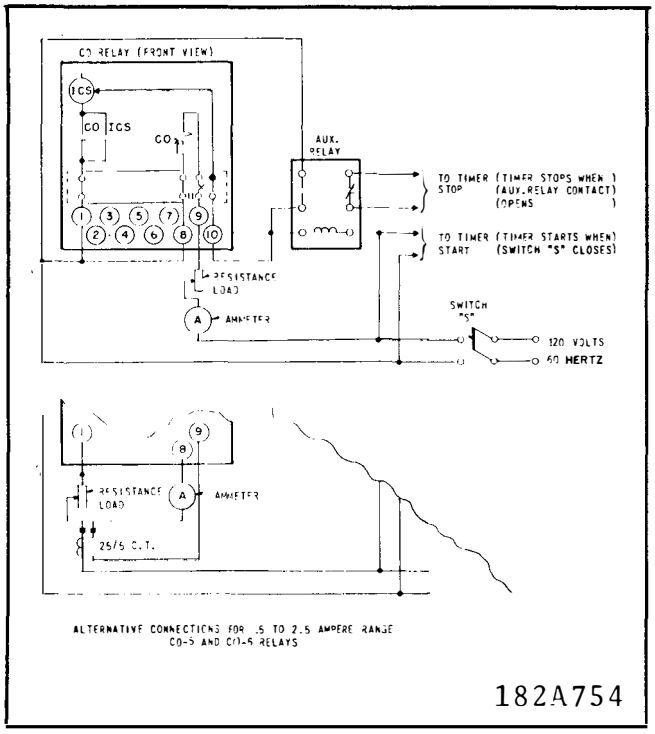


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rest solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

INDICATING CONTACT SWITCH (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere 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)

The IIT setting is the level of ac current at which it will pickup. It should be set to coordinate with other devices so it will never operate for a fault in protective zone where tripping should be produced by other devices. The transient reach will not exceed 130% for an 80° circuit angle or 108% for a 60° circuit.

The proper tap must be selected and the core screw must be adjusted to the value of pick-up current desired.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs 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. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its

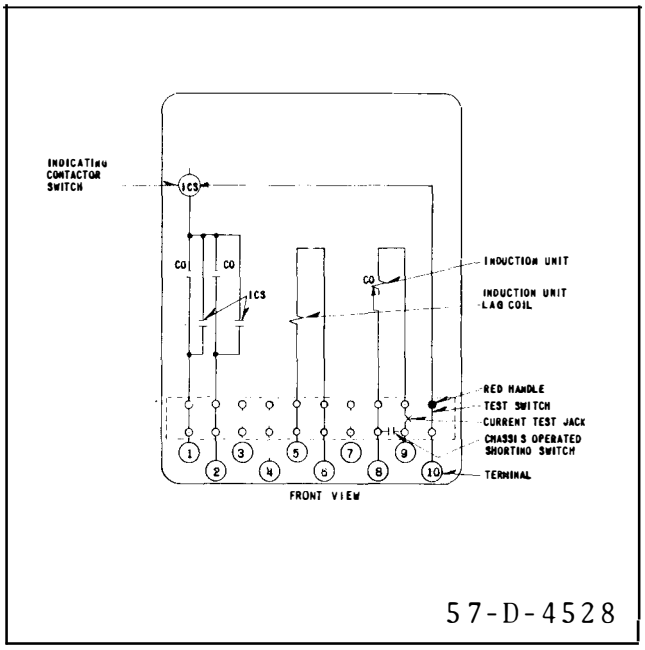


Fig 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

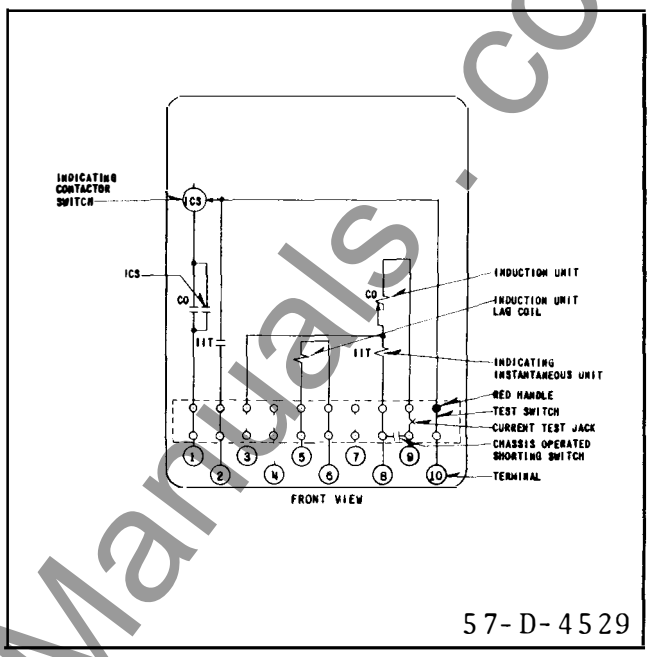


Fig 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

mounting screws or studs. and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the 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 I.L. 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.

For relays which include an indicating instantaneous trip unit (ITT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

ACCEPTANCE CHECK

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

1. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately

.020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. **Minimum Trip Current** – Set the time dial to position 6 using the lowest tap setting, 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** – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation, ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effects of different taps can make the total variations appear to be ±15%.

Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, 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% (Use .5 tap for .1 to .5 range).

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

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

ROUTINE MAINTENANCE

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 at "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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effect of different taps can make the total variations appear to be ±15%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. The check is to be made after the 2 times tap value adjustment has been completed.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

5. **Indicating Instantaneous Trip Unit (IIT)**

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 – 50 & 60 HERTZ

	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 Δ

Δ For 50 hertz CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

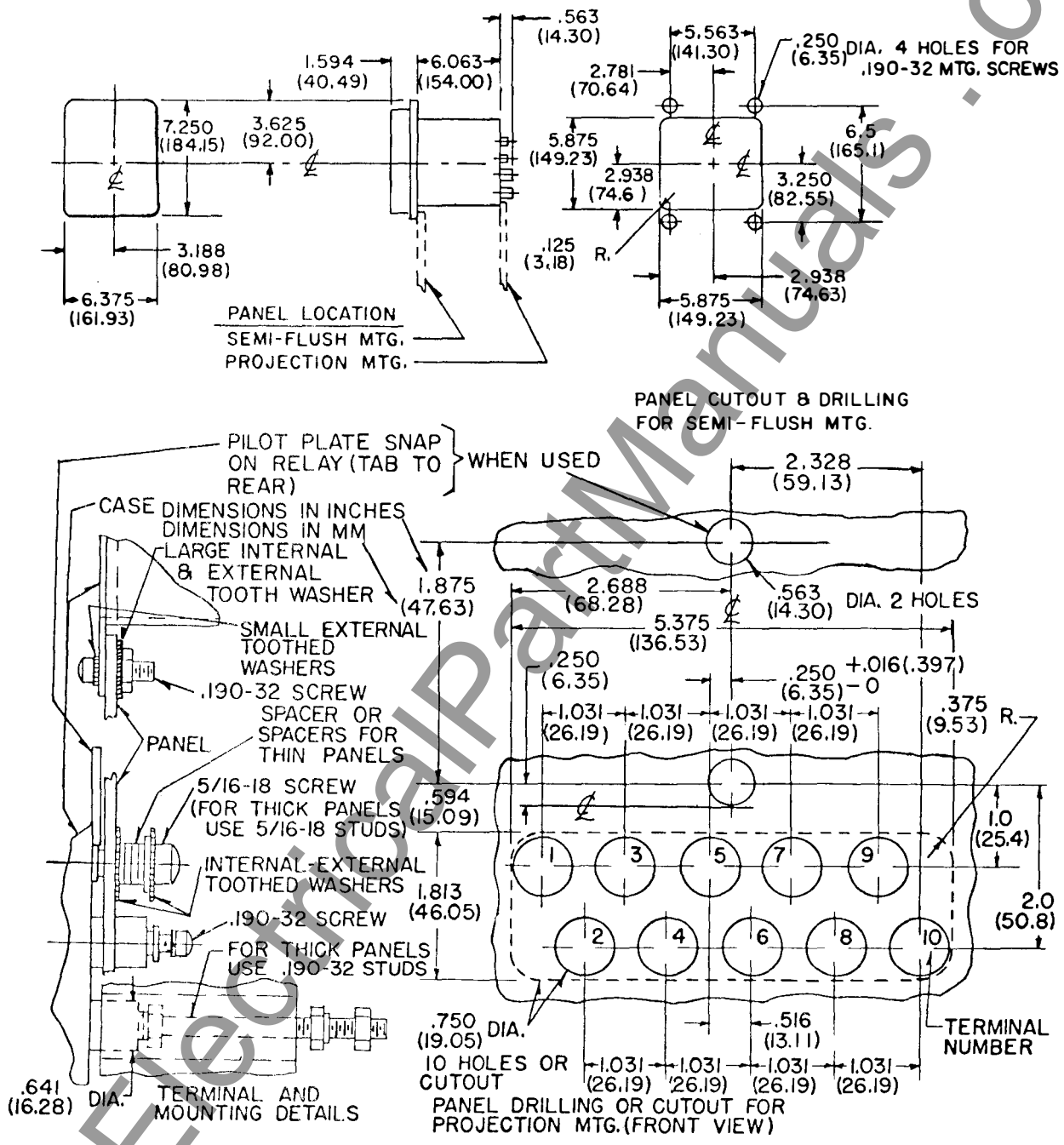


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

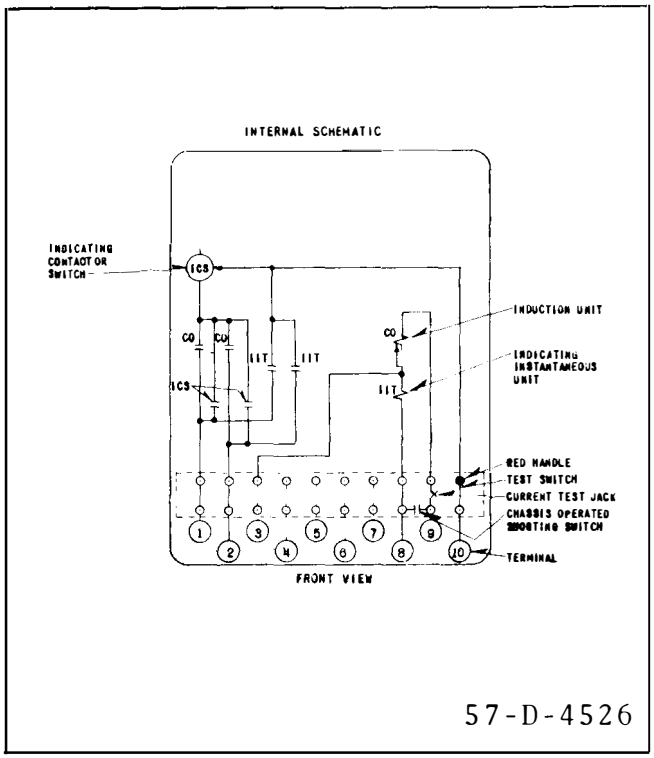


Fig. 20. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

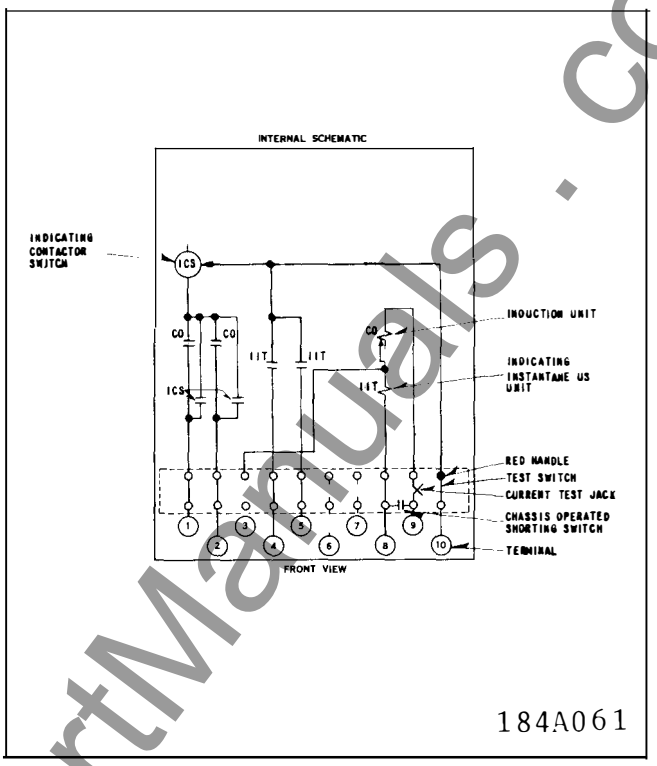


Fig. 21. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit to Separate Terminals.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

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.

CHARACTERISTICS

The relays are generally available in the following current ranges:

SUPERSEDES I.L. 41-101L
* Denotes change from superseded issue.

EFFECTIVE MAY 1967

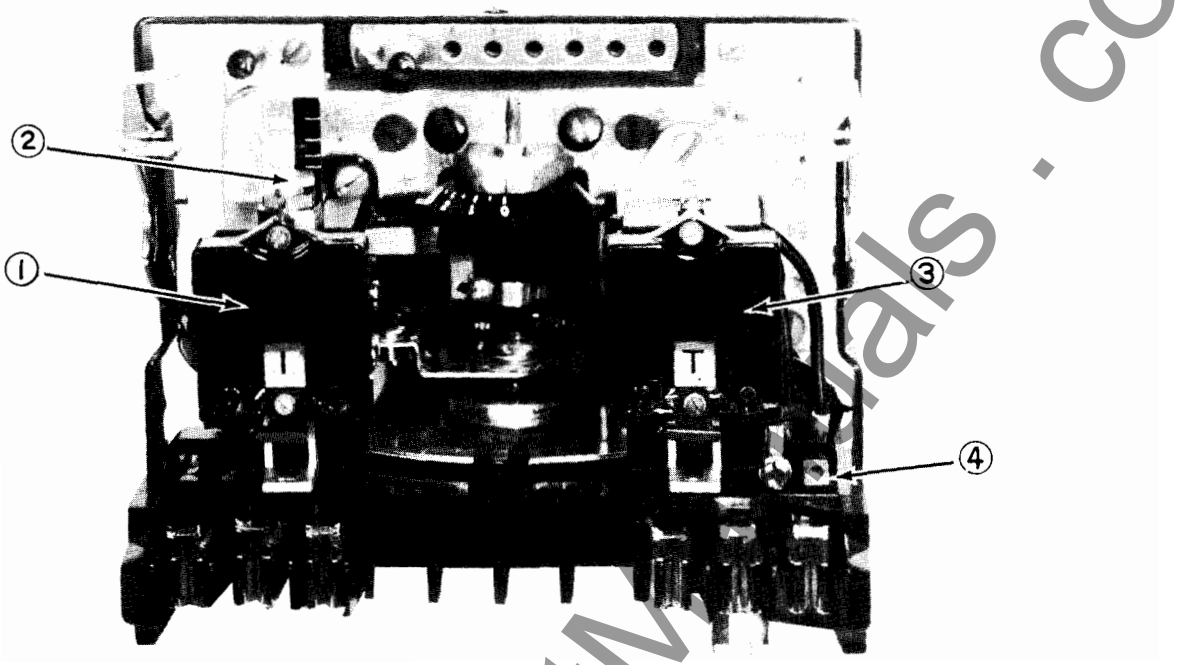


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

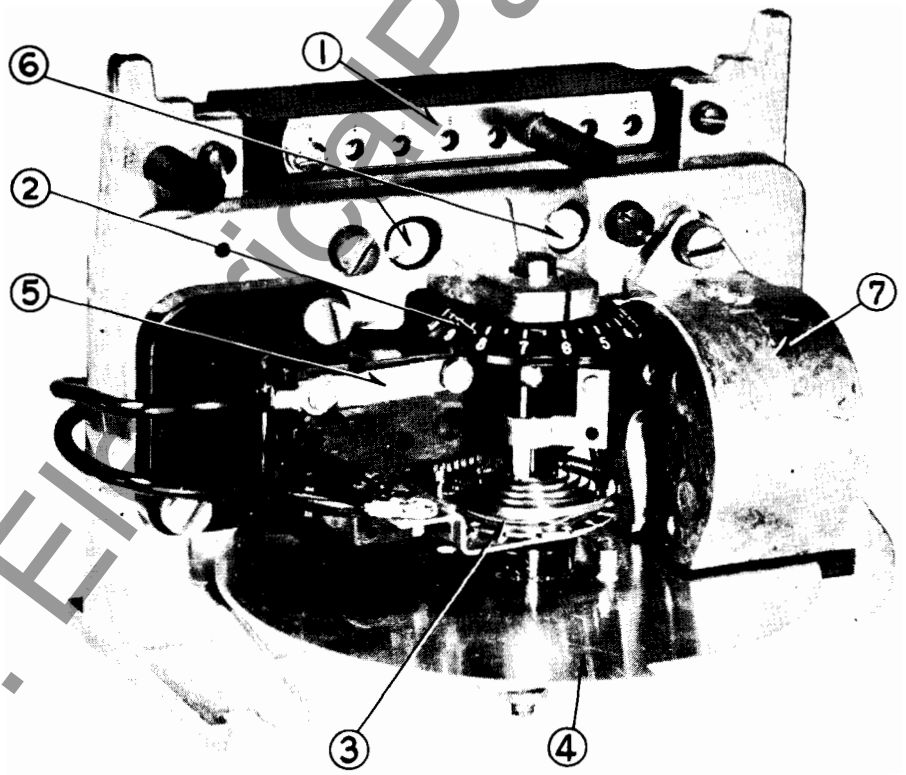


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

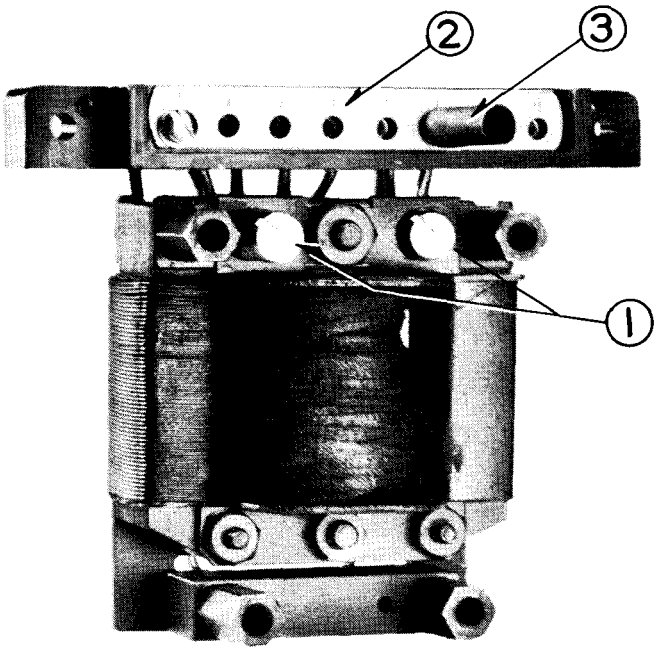


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

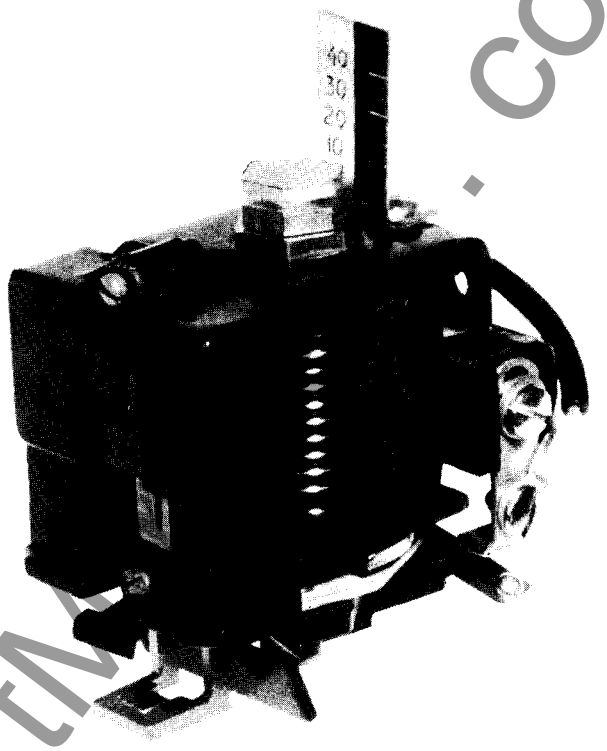


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

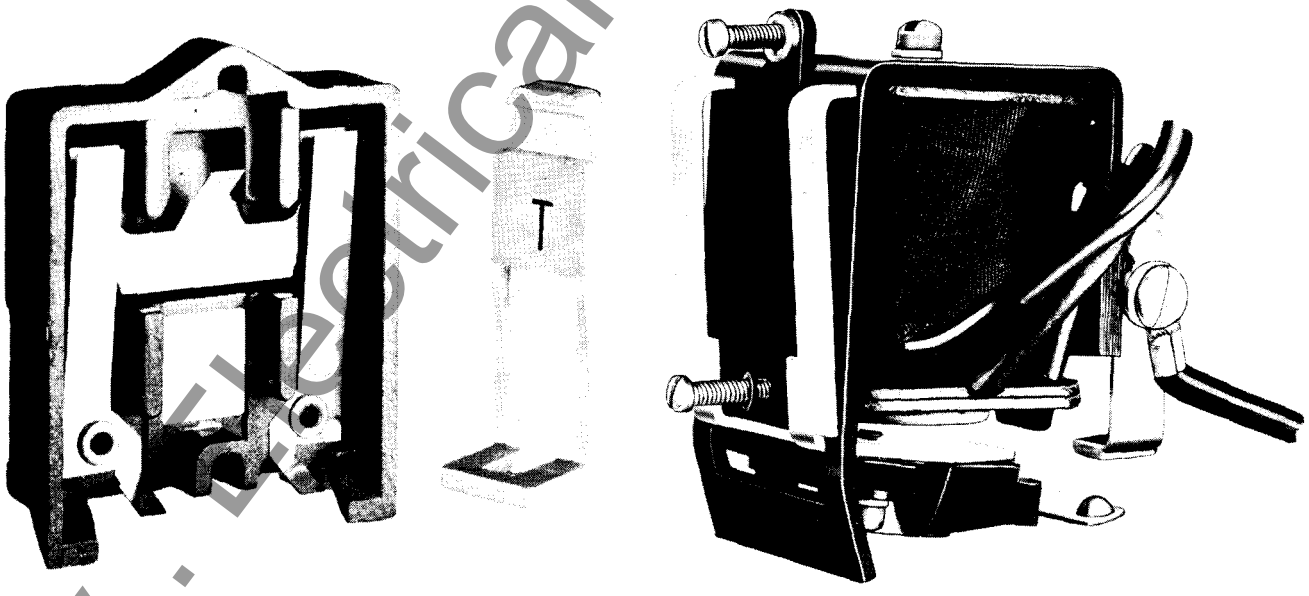


Fig. 5. Indicating Contactor Switch (ICS).

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

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

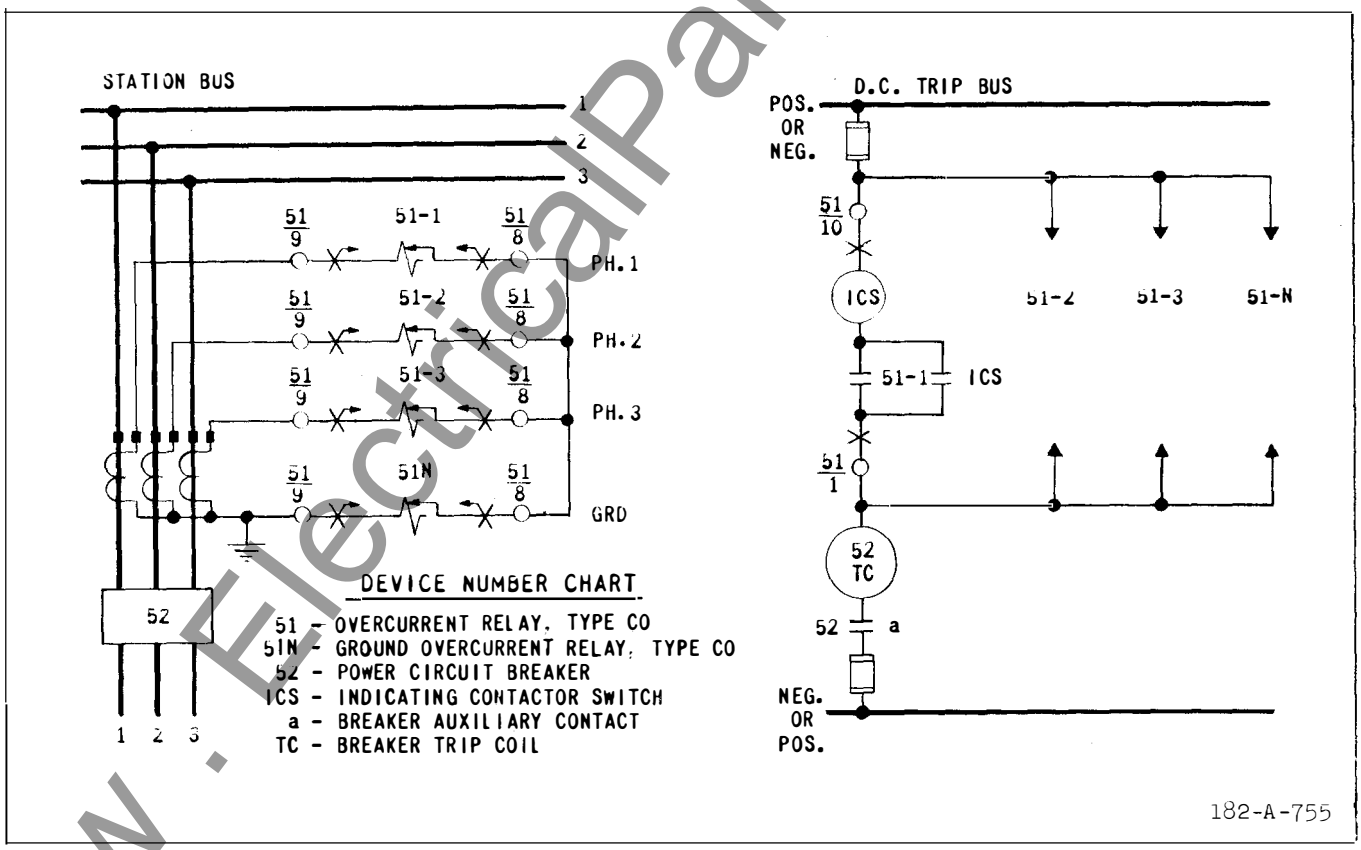


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

*** Instantaneous Trip Unit (IIT)**

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

TYPE CO-2 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	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	5.53	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.*

ENERGY REQUIREMENTS

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	2.7	88	69	3.92	20.6	103	270
	(0.6	3.1	88	68	3.96	20.7	106	288
	(0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	4.1	88	66	4.07	21.4	122	360
	(1.5	5.7	88	62	4.19	23.2	147	462
	(2.0	6.8	88	60	4.30	24.9	168	548
	(2.5	7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.*

ENERGY REQUIREMENTS

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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	88	72	2.38	21	132	350
	(0.6	3.1	88	71	2.38	21	134	365
	(0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	4.1	88	67	2.42	21.2	150	440
	(1.5	5.7	88	62	2.51	22	170	530
	(2.0	6.8	88	57	2.65	23.5	200	675
	(2.5	7.7	88	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	2.5	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 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.*

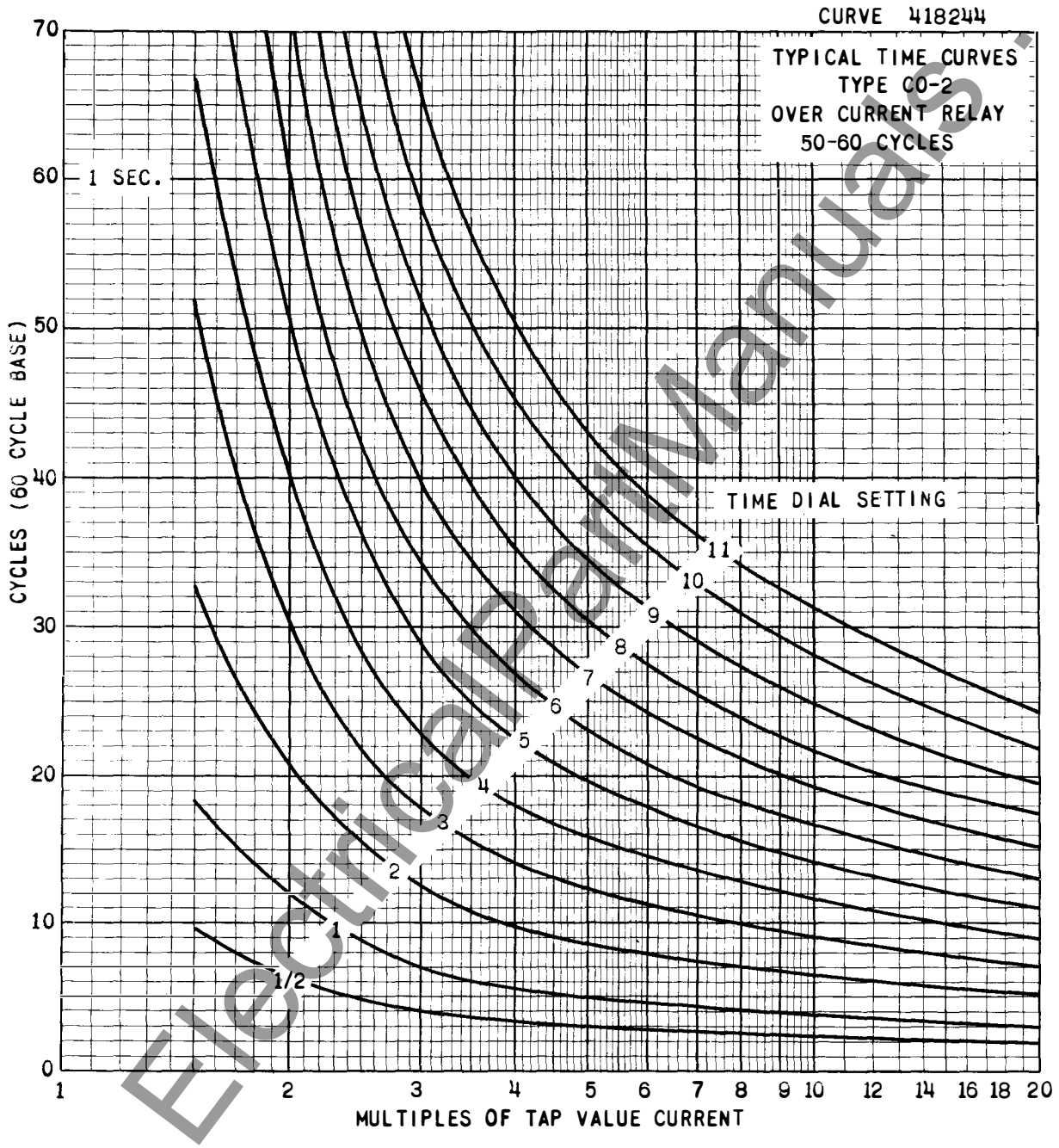


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

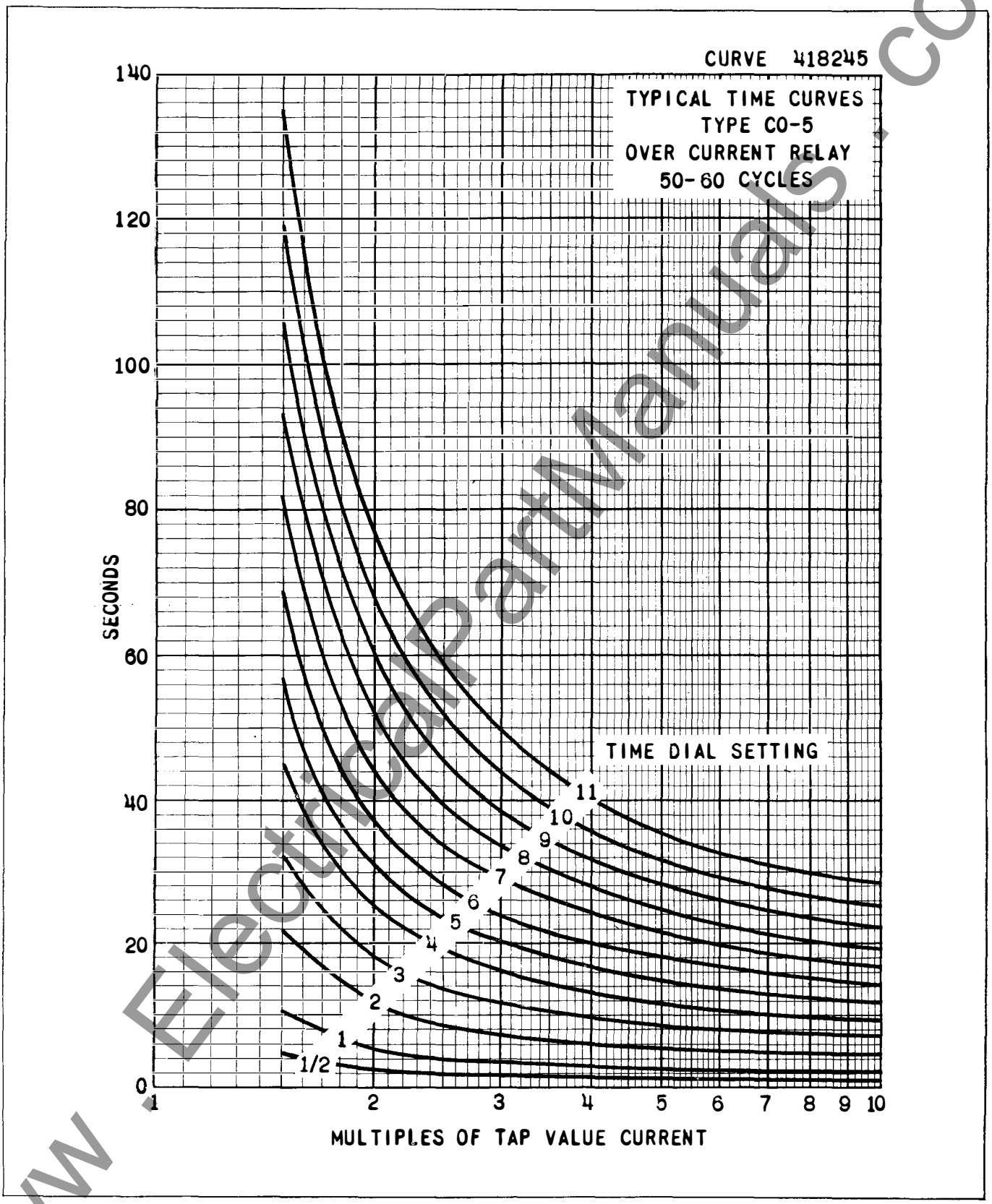


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

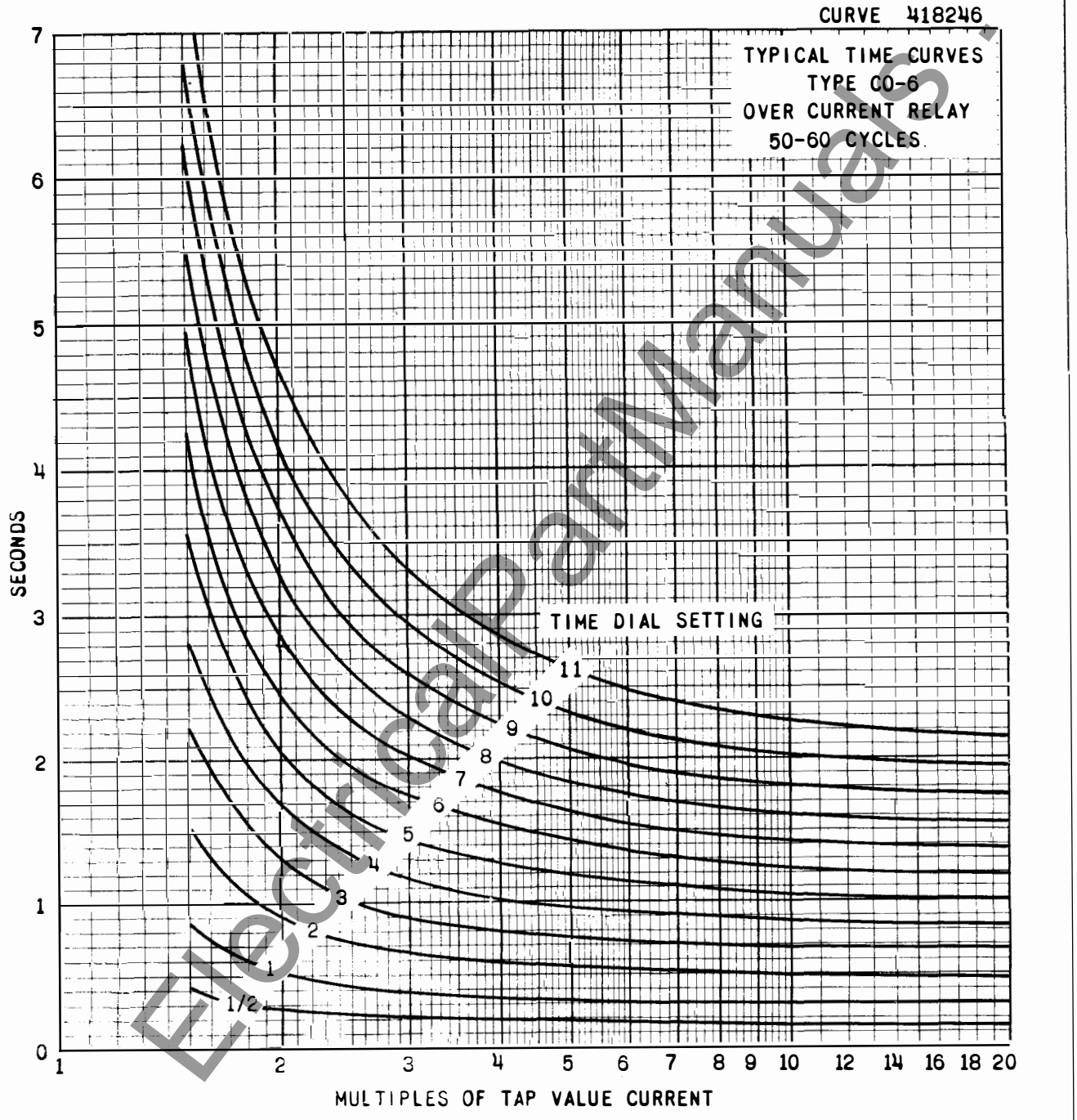


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

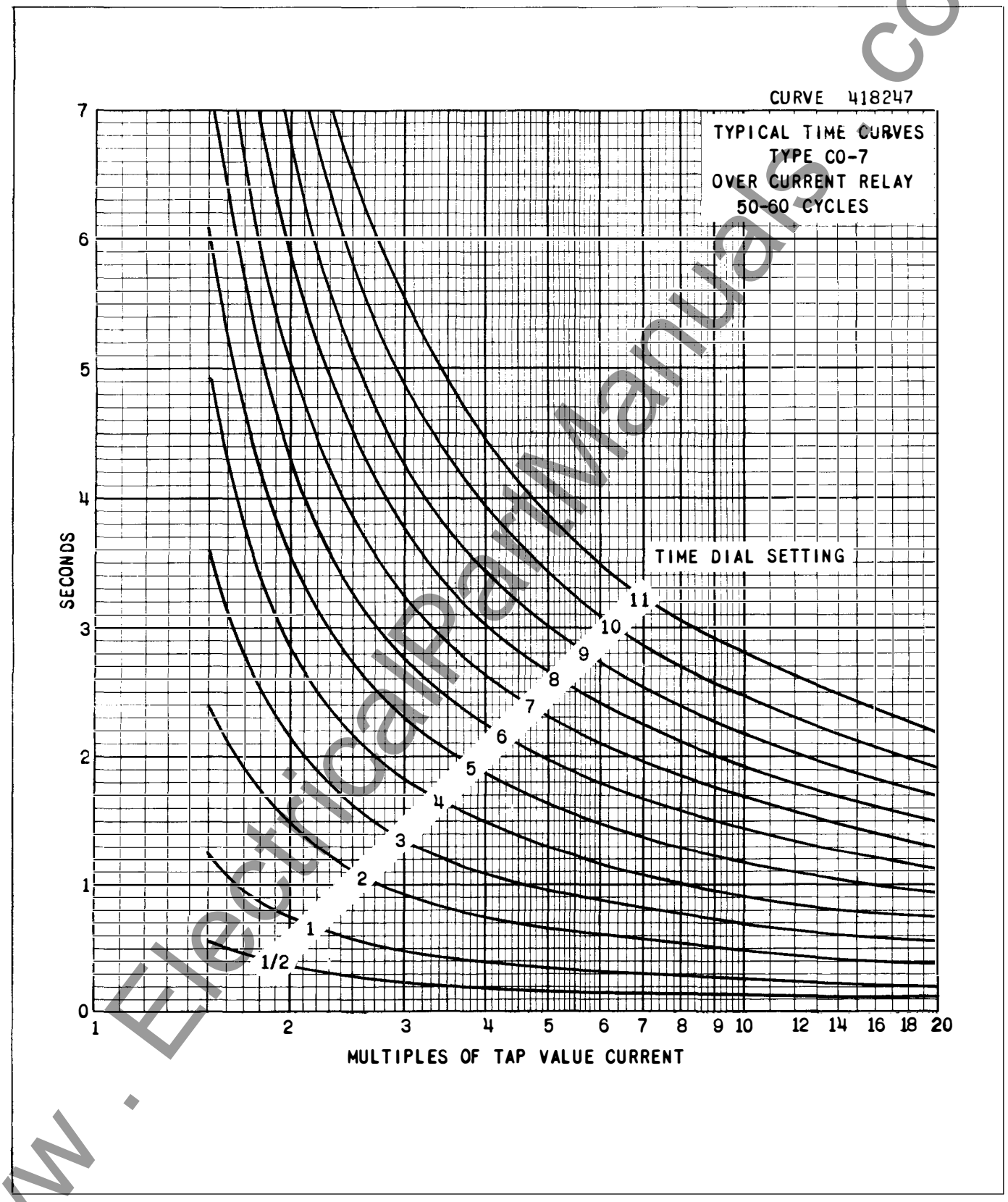


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

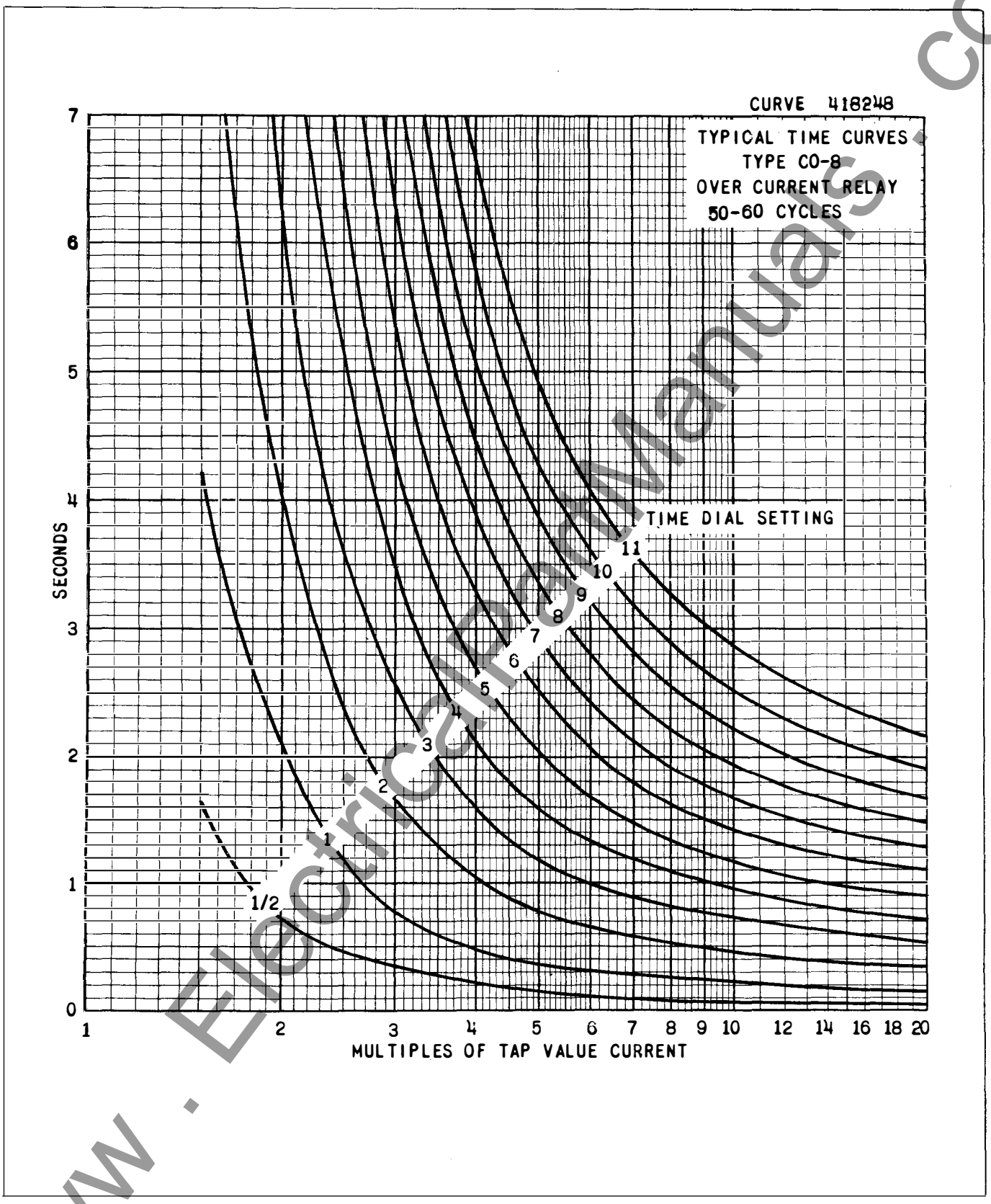


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

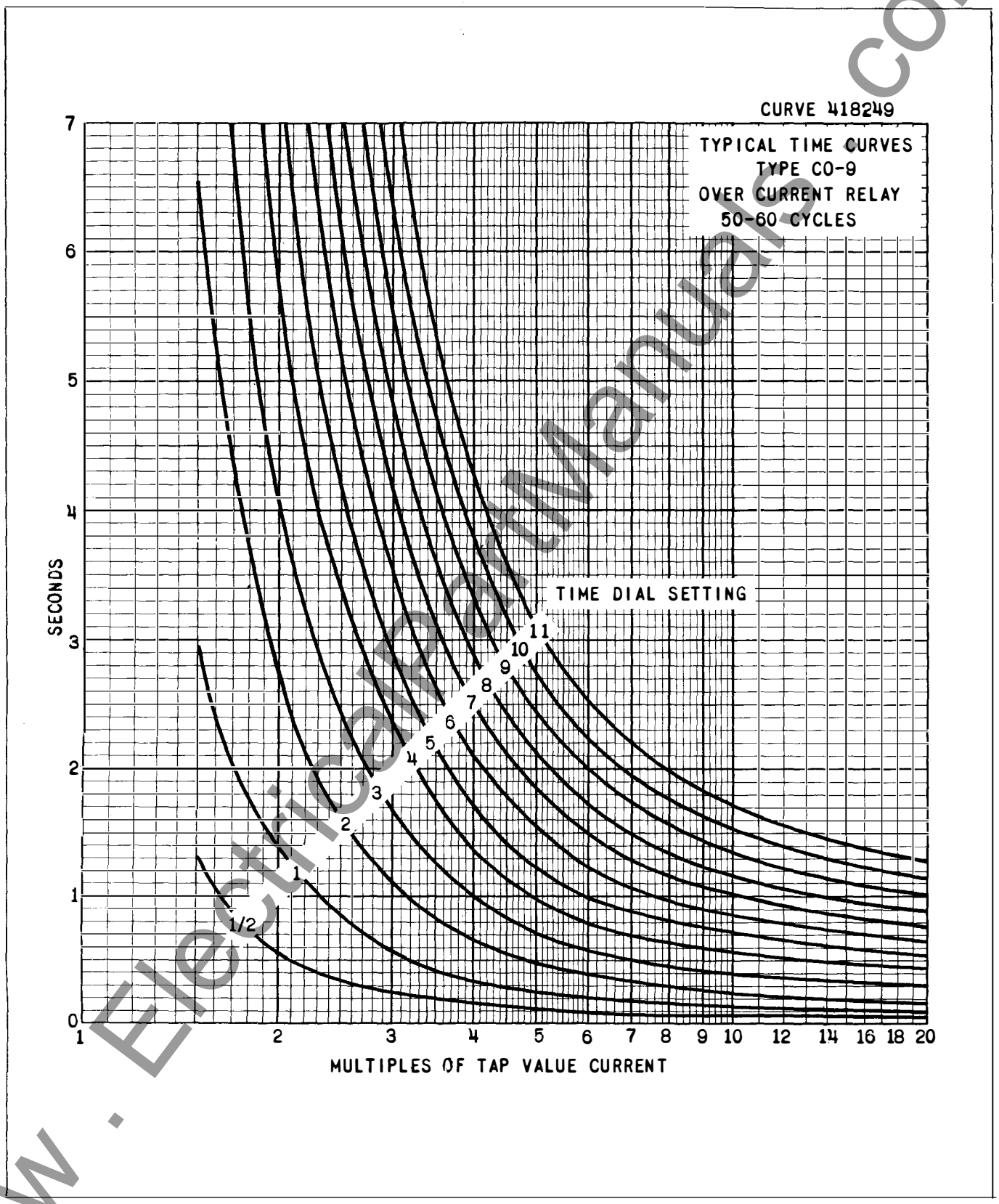


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

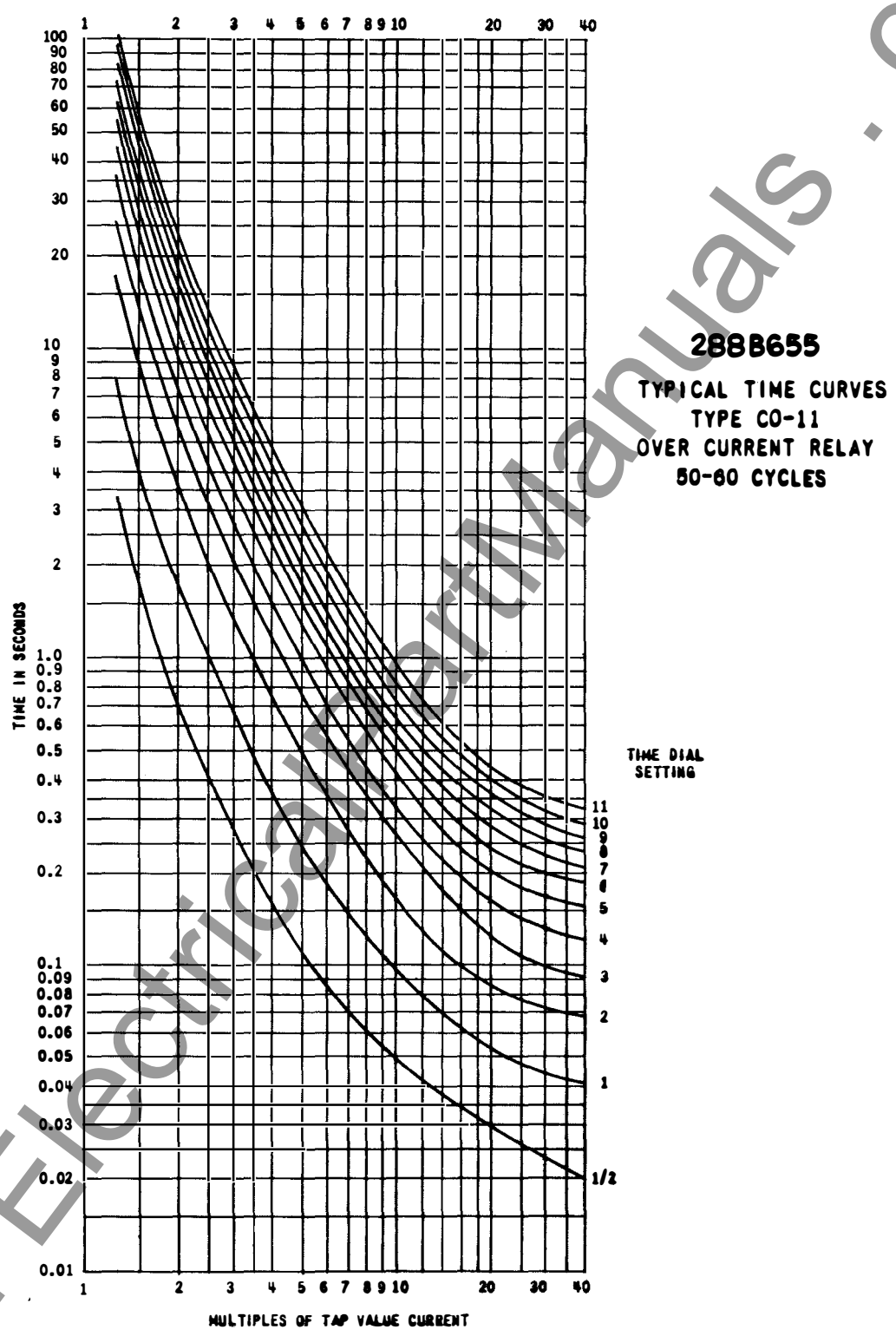
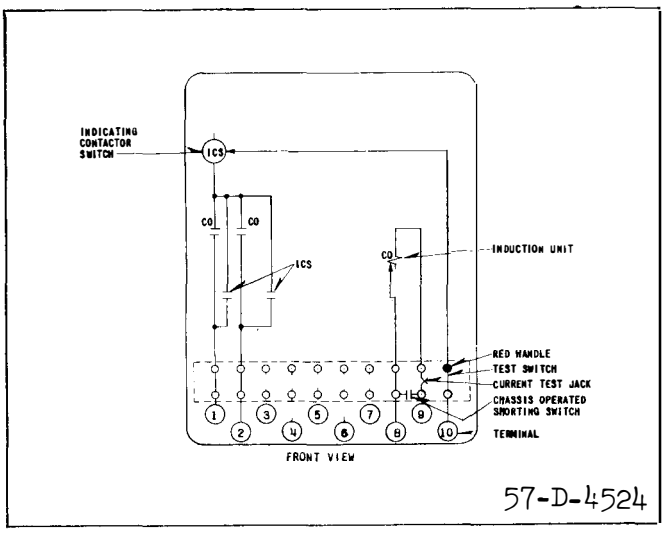


Fig. 13. Typical Time Curves of the Type CO-11 Relay.



* *Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.*

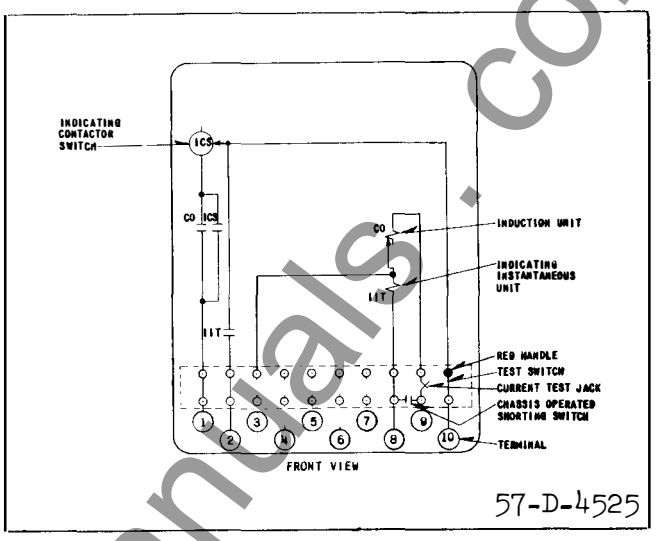


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is 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)

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.

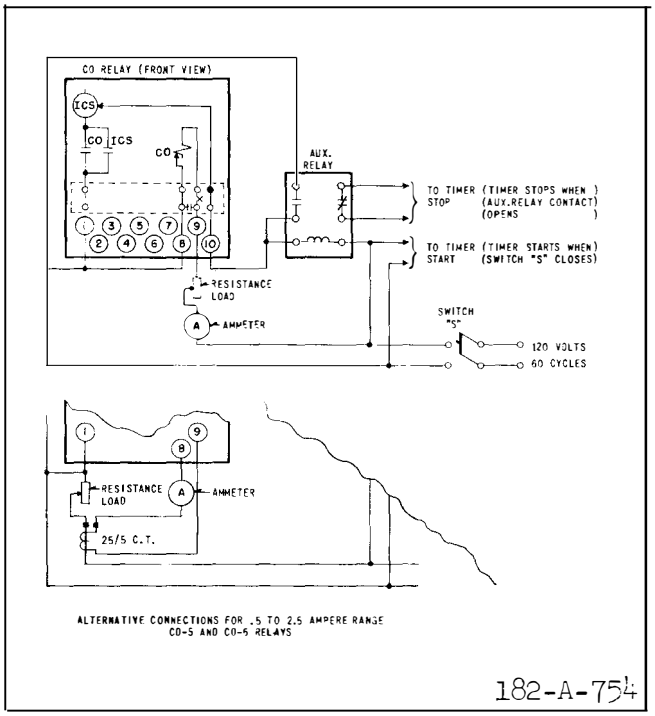


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

Acceptance Check

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

1. Contact

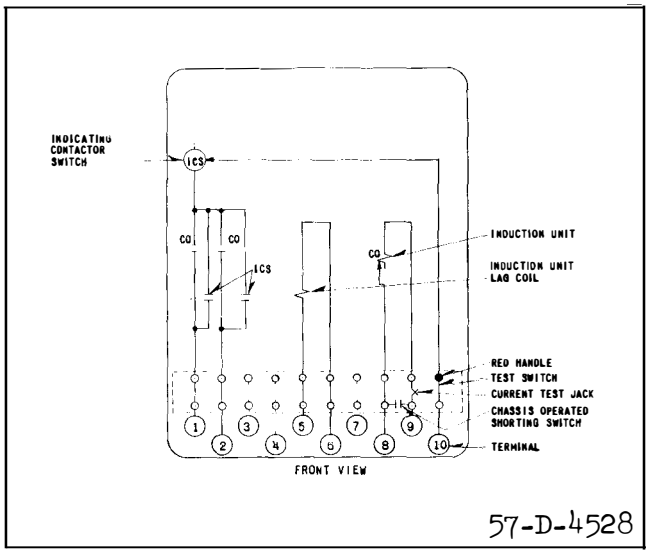
a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current – Set the time dial to position 6 using the lowest tap setting, 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 – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time



* *Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.*

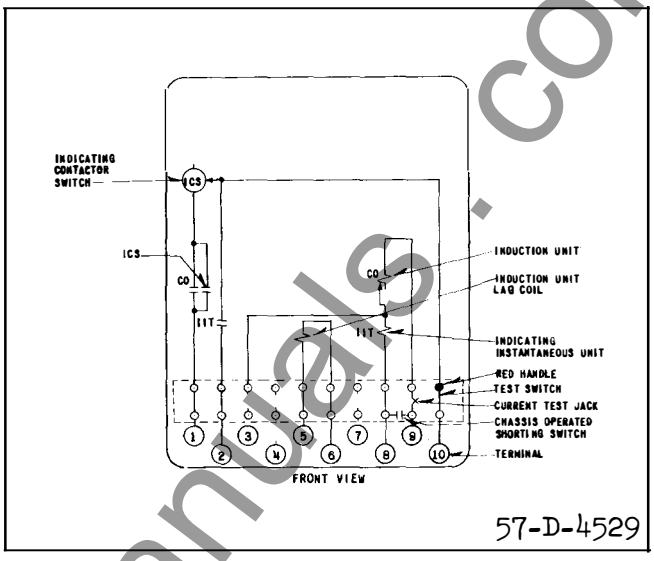


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

dial set to the indicated position and the relay set on the lowest tap setting, 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%

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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.

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

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

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.

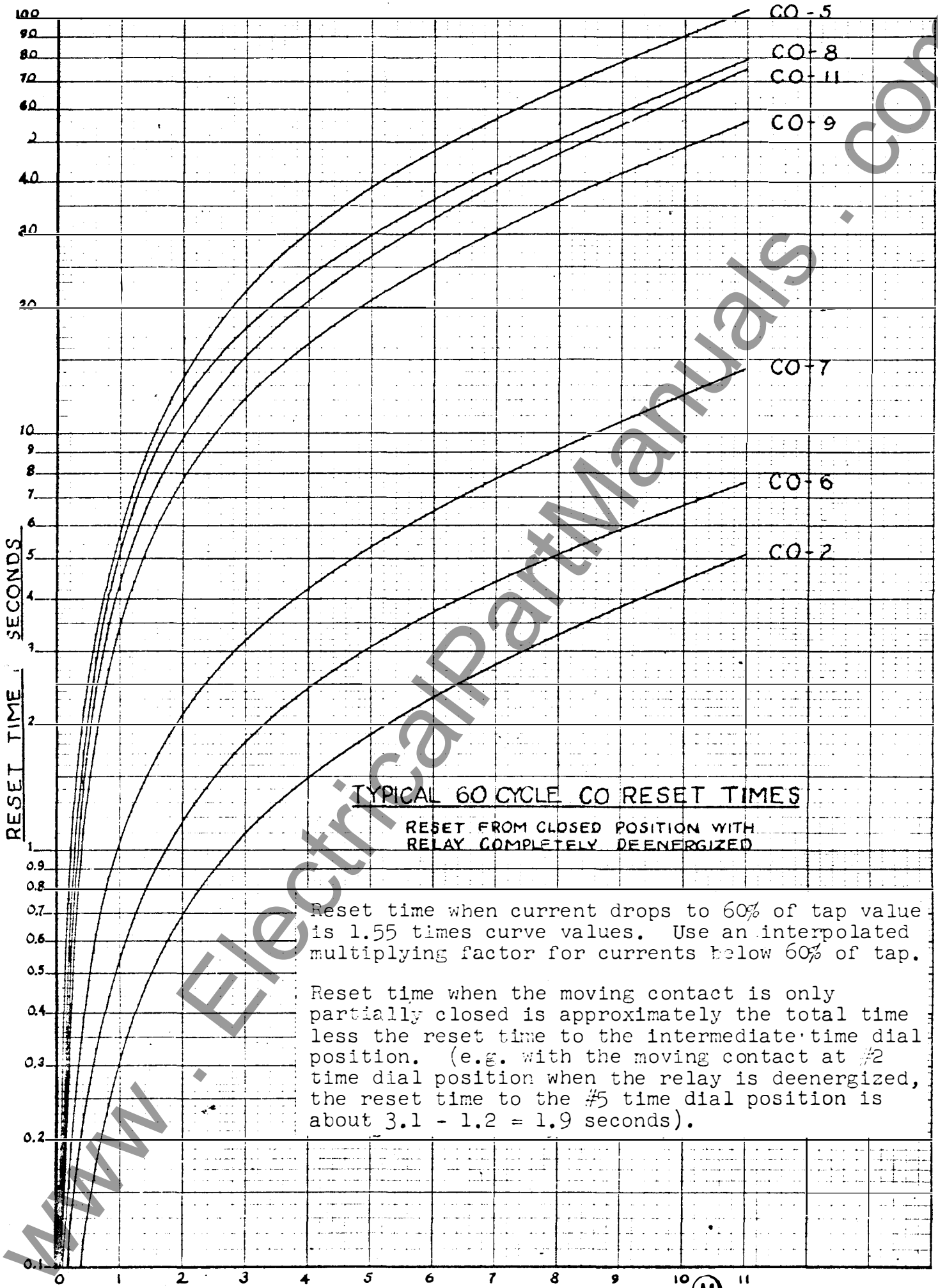
5. Indicating Instantaneous Trip Unit (IIT)

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.



TYPICAL 60 CYCLE CO RESET TIMES

RESET FROM CLOSED POSITION WITH RELAY COMPLETELY DEENERGIZED

Reset time when current drops to 60% of tap value is 1.55 times curve values. Use an interpolated multiplying factor for currents below 60% of tap.

Reset time when the moving contact is only partially closed is approximately the total time less the reset time to the intermediate time dial position. (e.g. with the moving contact at #2 time dial position when the relay is deenergized, the reset time to the #5 time dial position is about 3.1 - 1.2 = 1.9 seconds).

Ⓜ CURVE NO. 471081

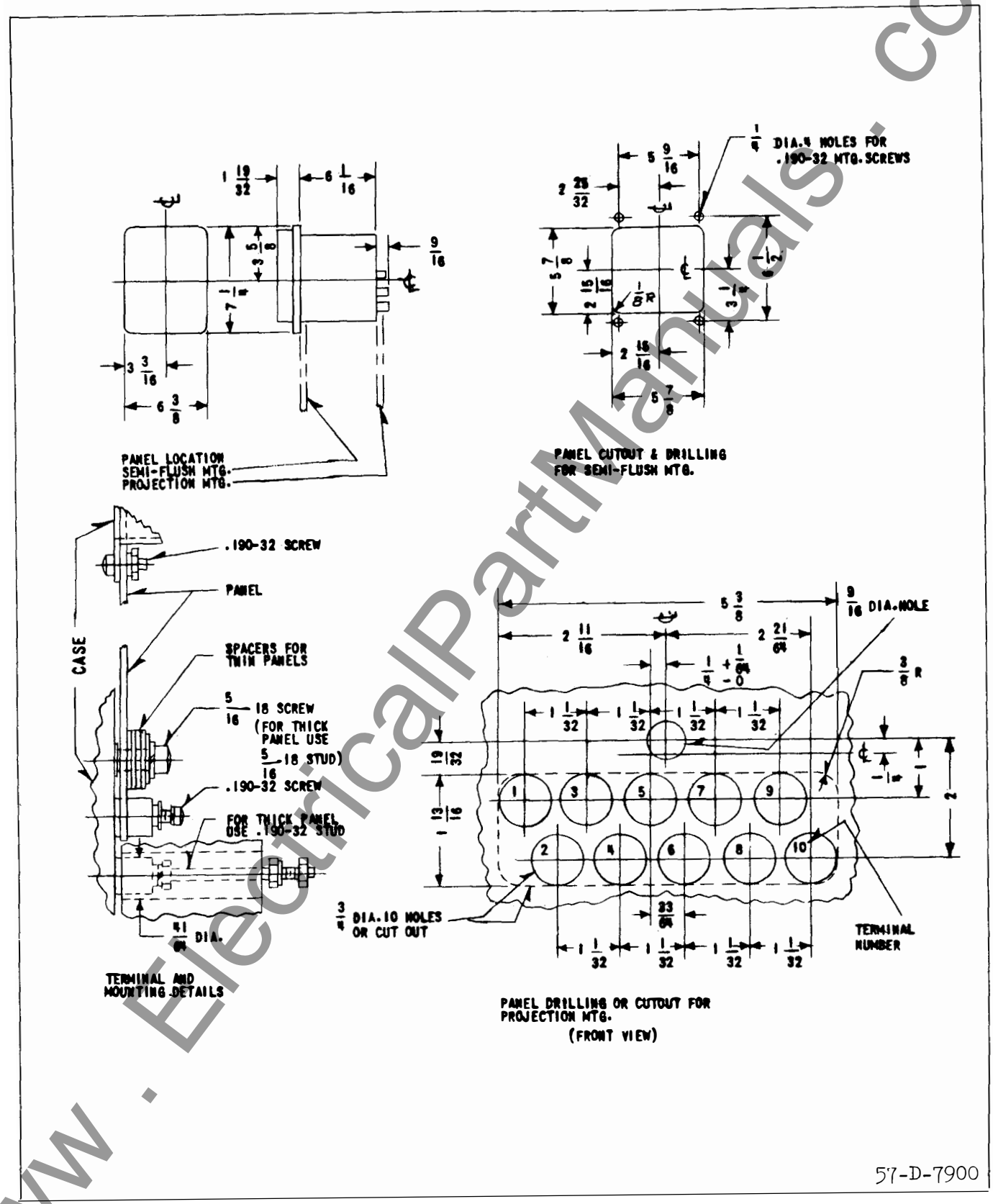


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 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 Δ

Δ For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

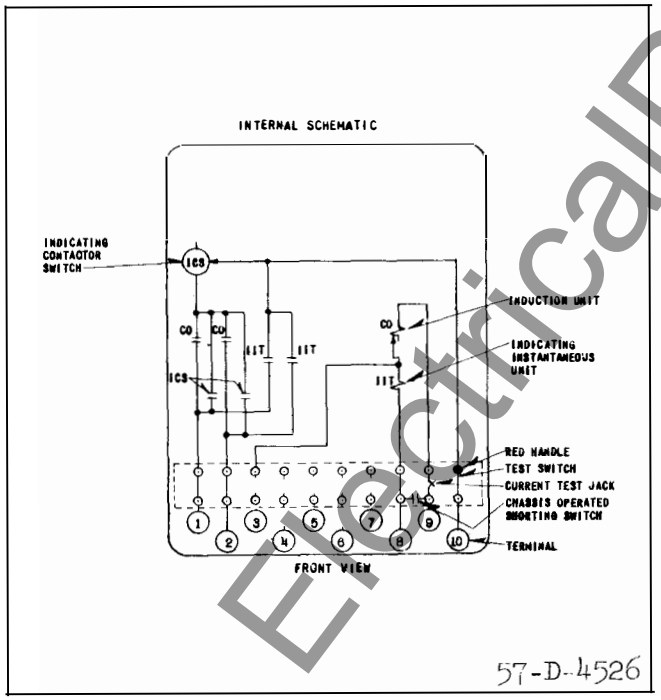


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

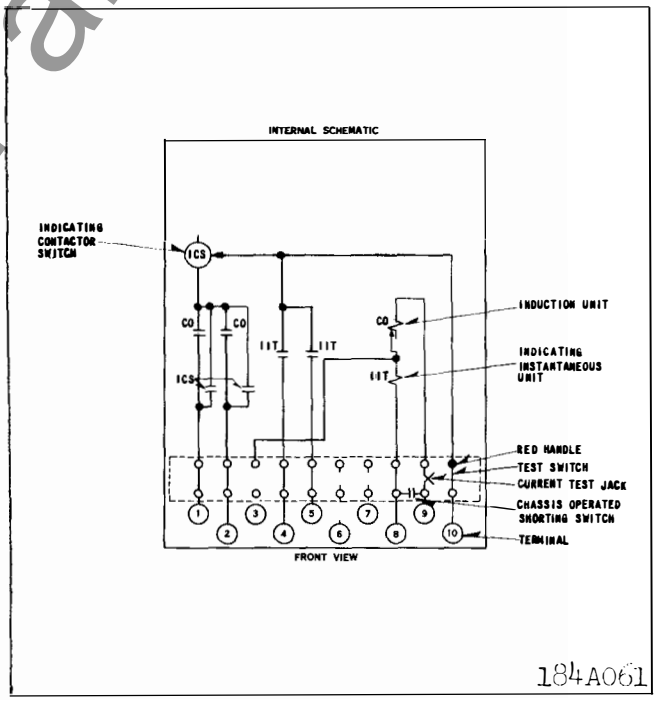


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

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.

CHARACTERISTICS

The relays are generally available in the following current ranges:

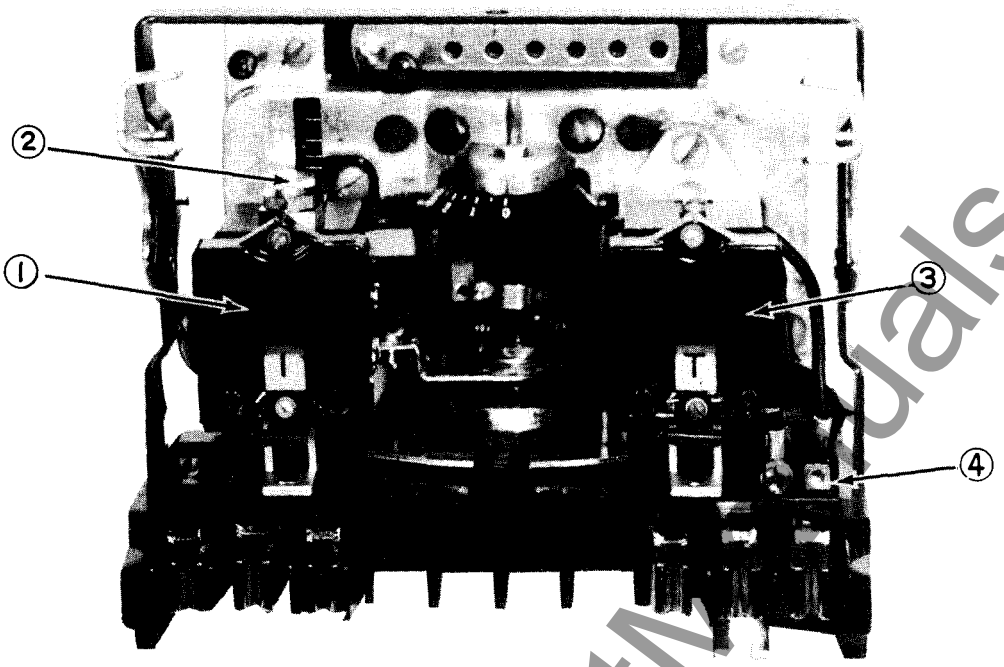


*Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

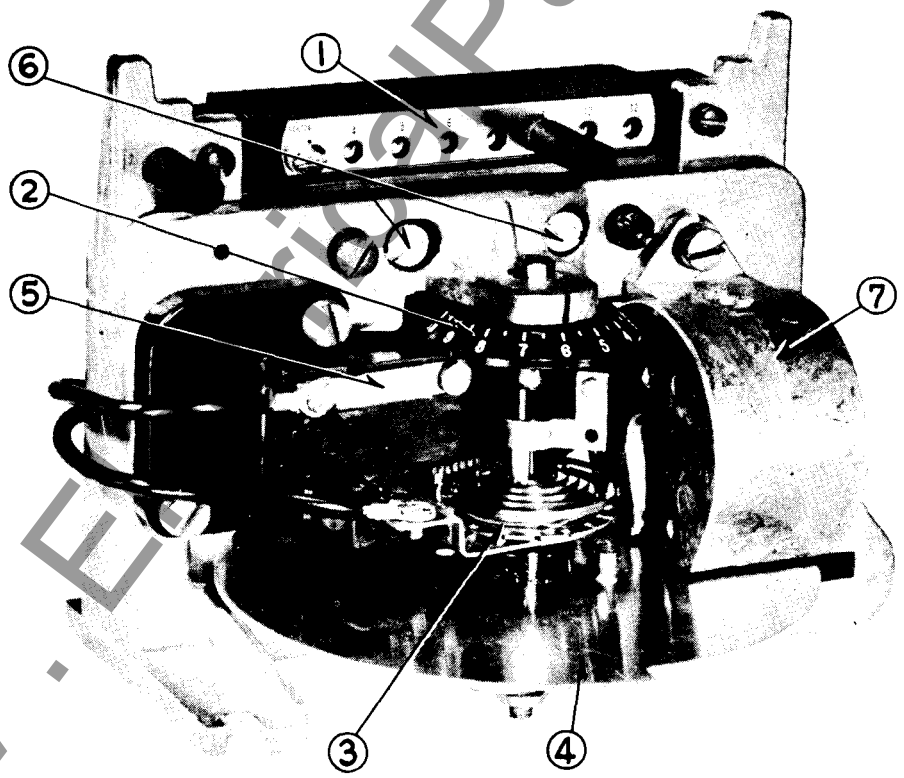


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

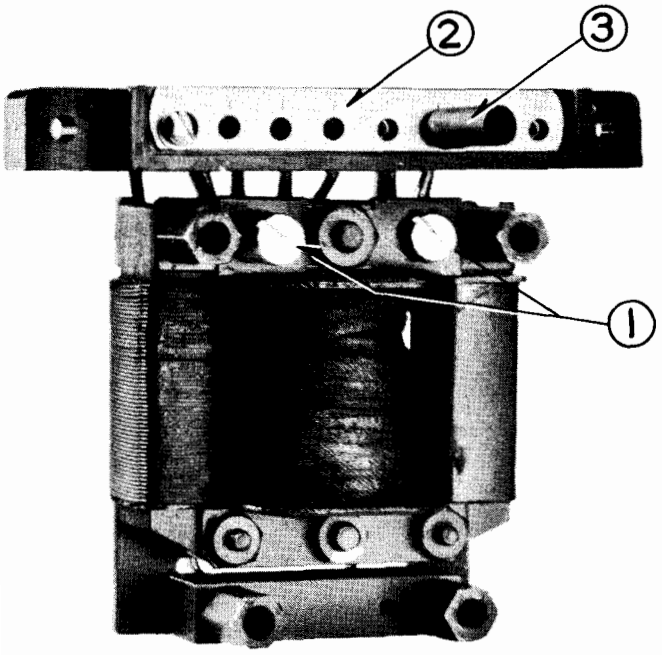


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

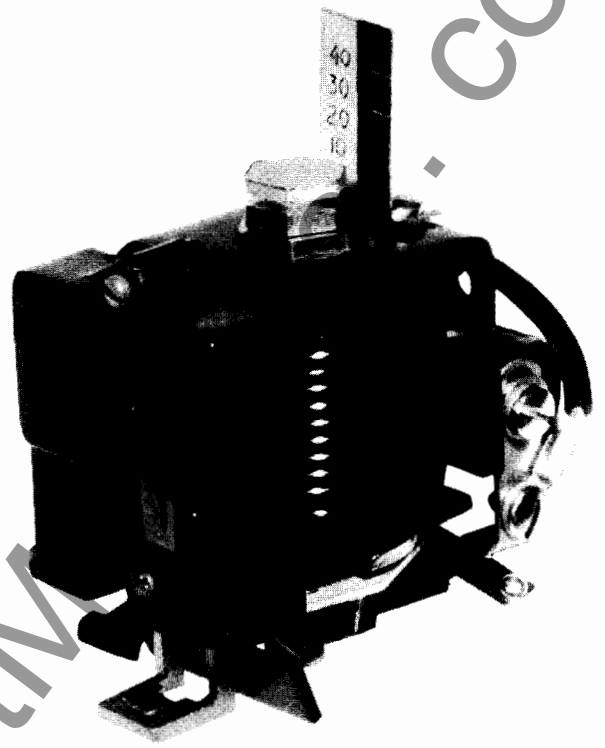


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

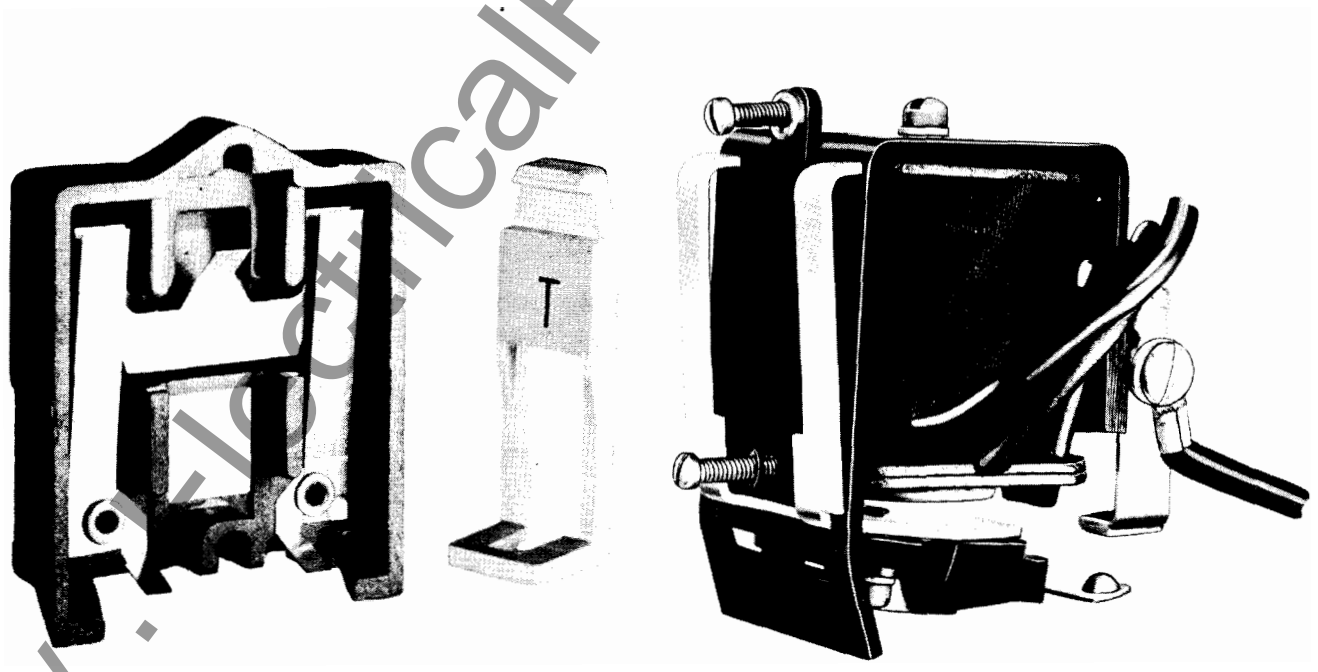


Fig. 5. Indicating Contactor Switch (ICS).

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

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

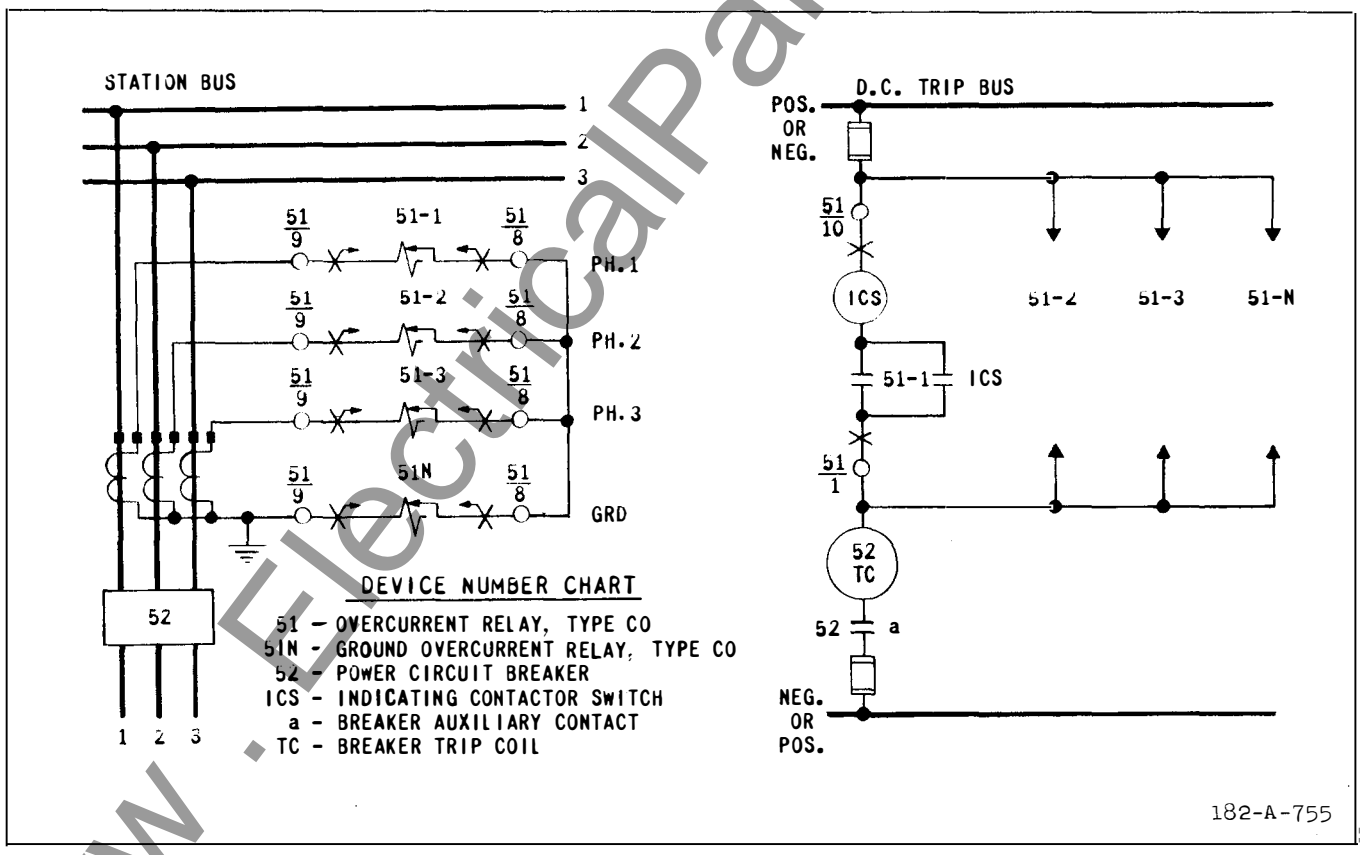


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

*** Instantaneous Trip Unit (IIT)**

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

TYPE CO-2 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	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	5.53	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.*

ENERGY REQUIREMENTS

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	2.7	88	69	3.92	20.6	103	270
	(0.6	3.1	88	68	3.96	20.7	106	288
	(0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	4.1	88	66	4.07	21.4	122	360
	(1.5	5.7	88	62	4.19	23.2	147	462
	(2.0	6.8	88	60	4.30	24.9	168	548
	(2.5	7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.*

ENERGY REQUIREMENTS

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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	88	72	2.38	21	132	350
	(0.6	3.1	88	71	2.38	21	134	365
	(0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	4.1	88	67	2.42	21.2	150	440
	(1.5	5.7	88	62	2.51	22	170	530
	(2.0	6.8	88	57	2.65	23.5	200	675
	(2.5	7.7	88	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	2.5	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 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.*

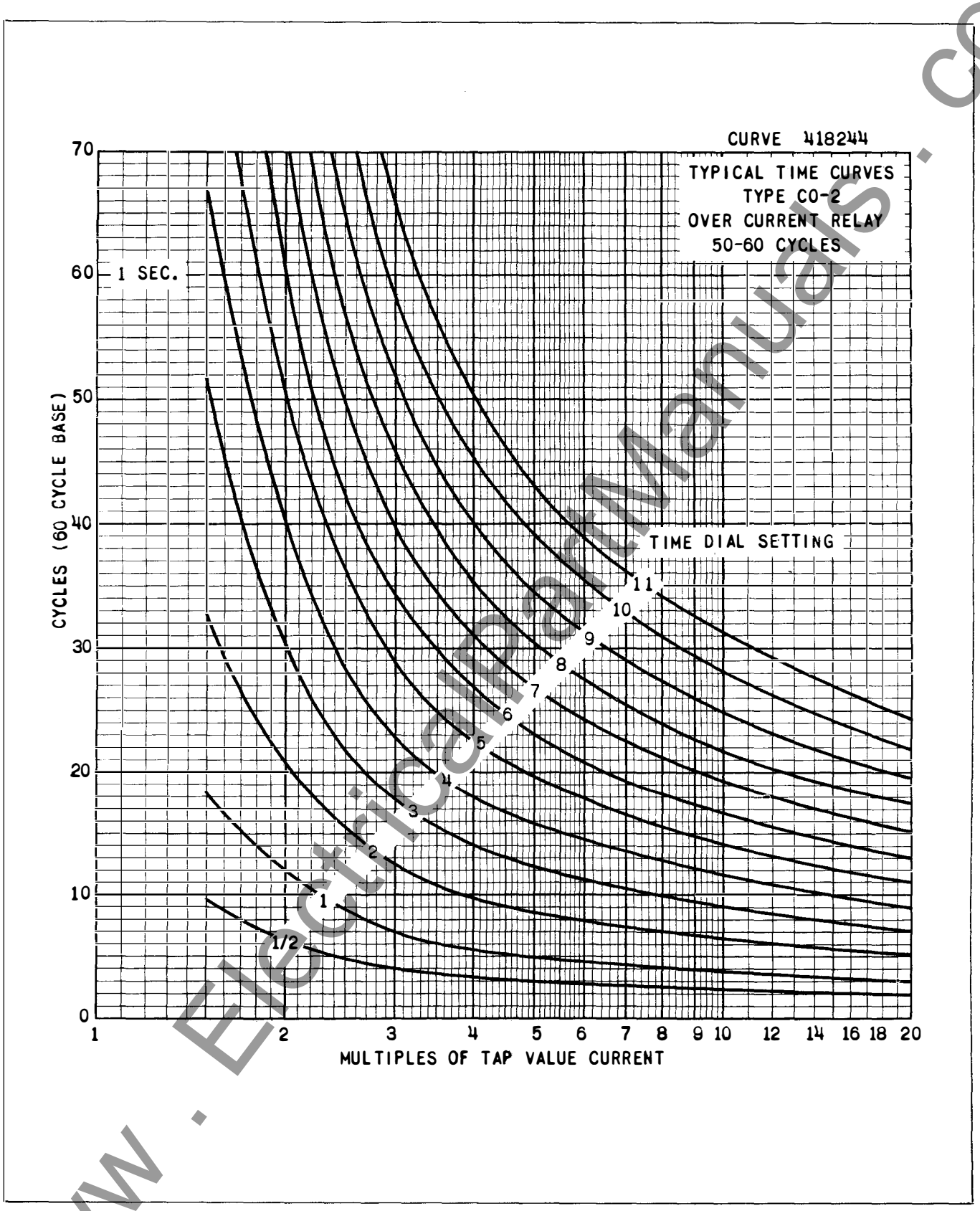


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

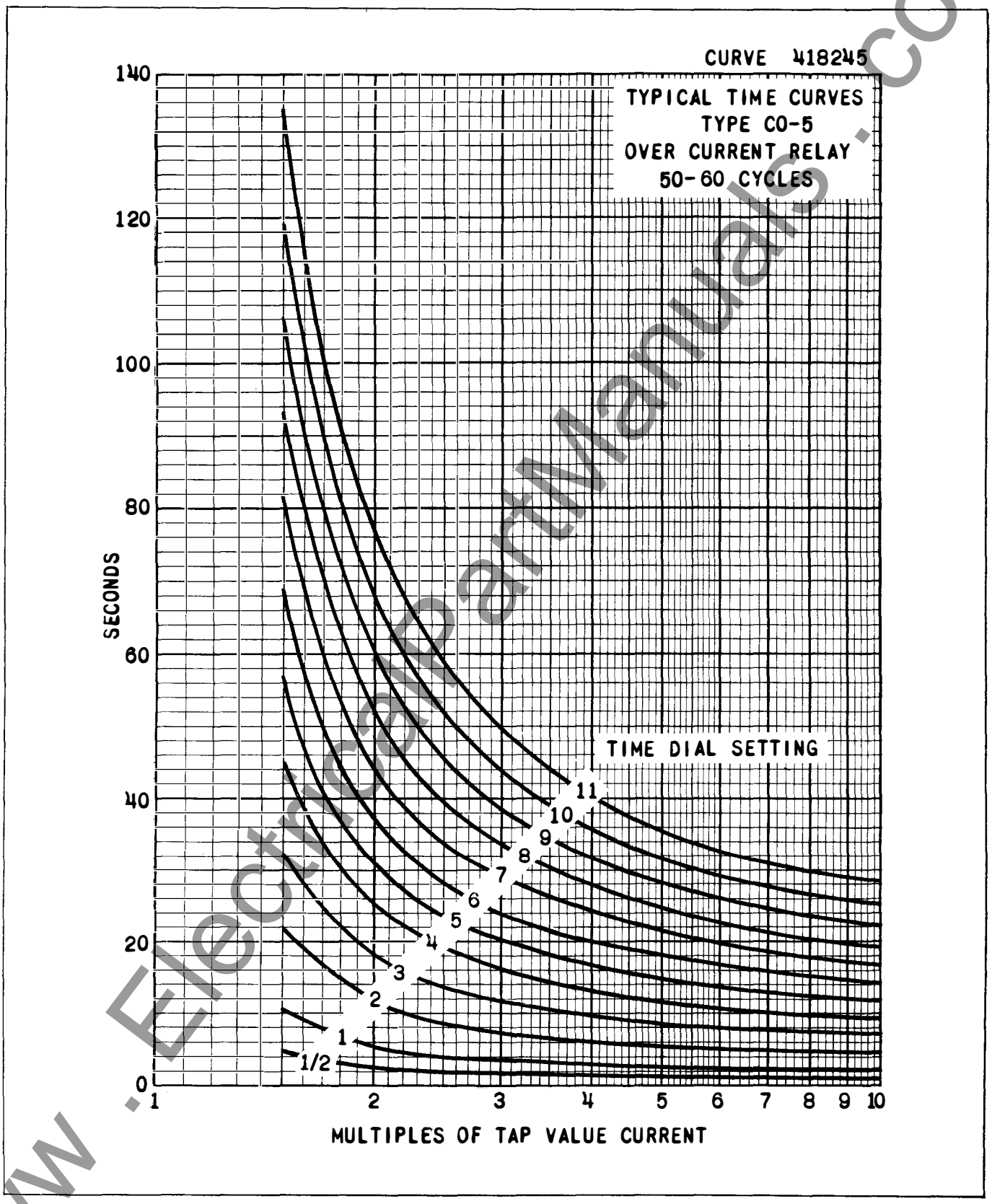


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

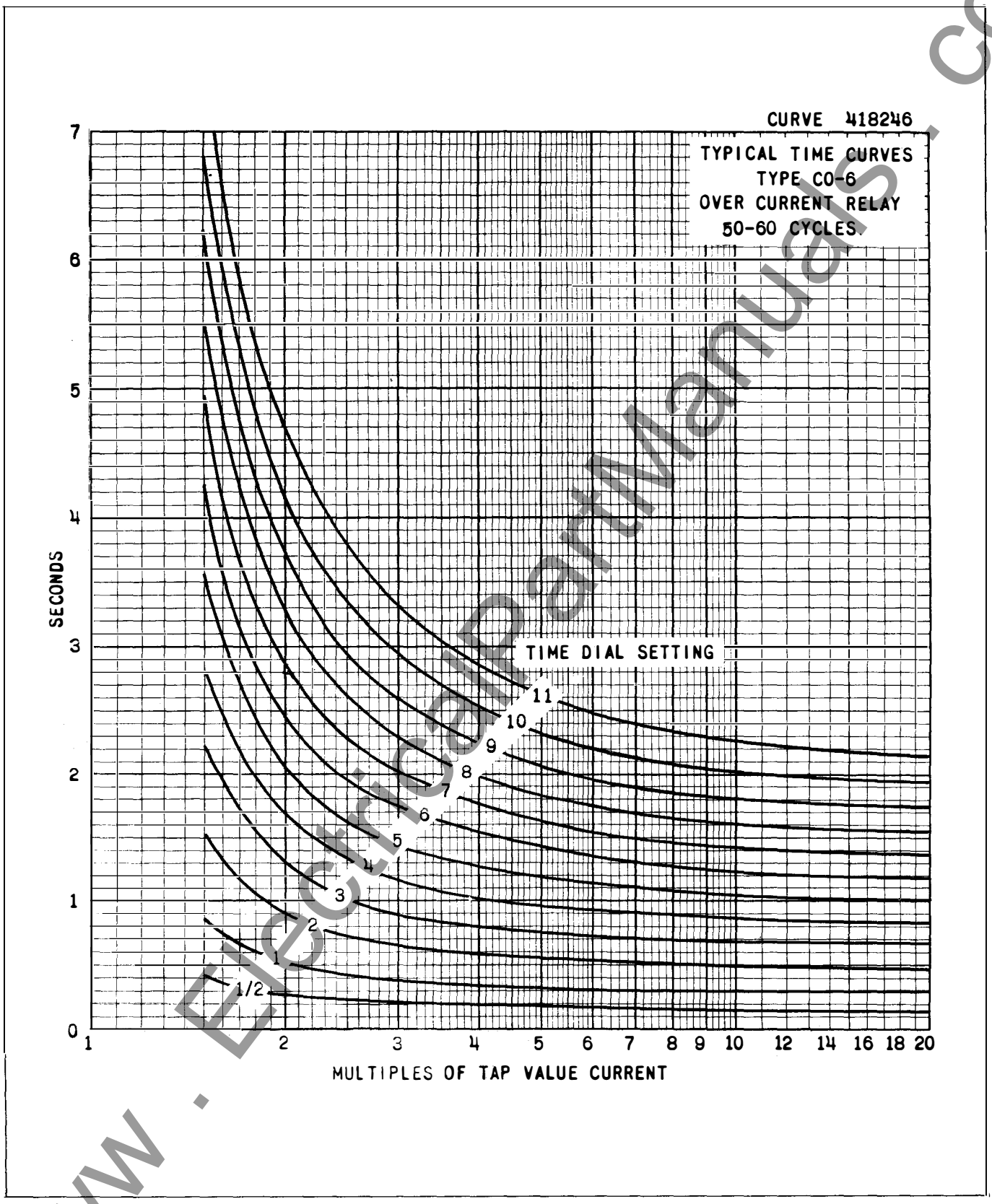


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

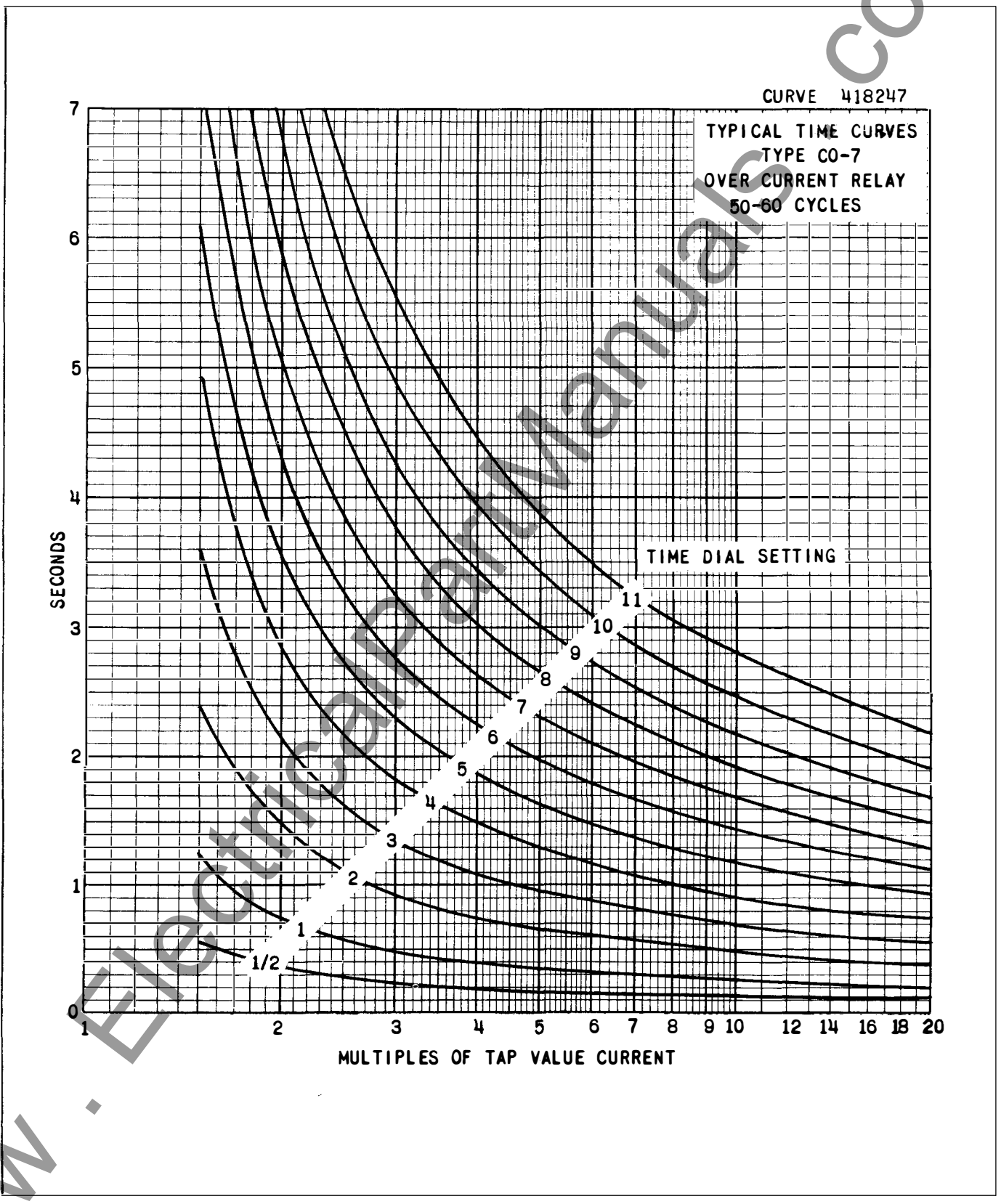


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

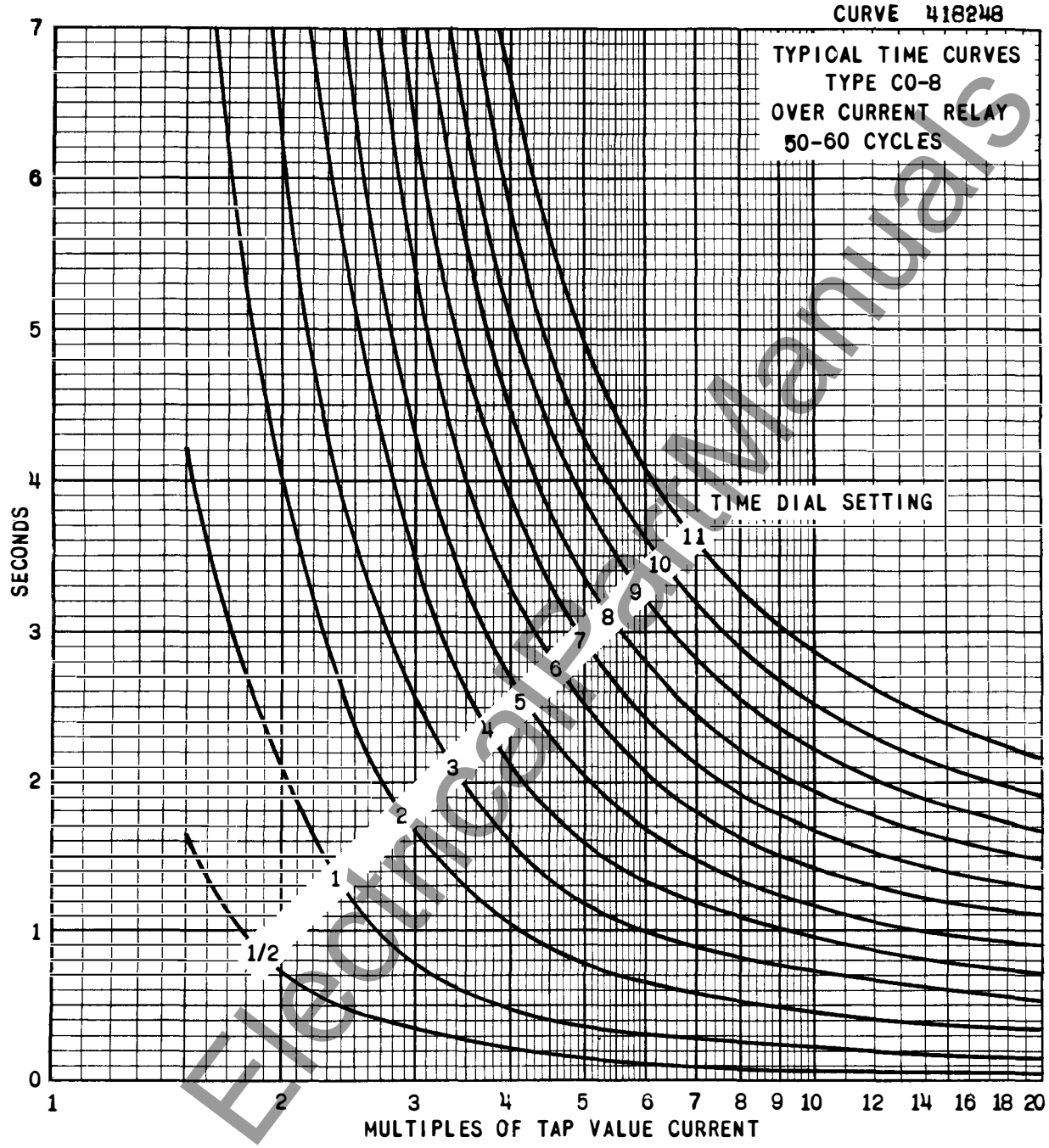


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

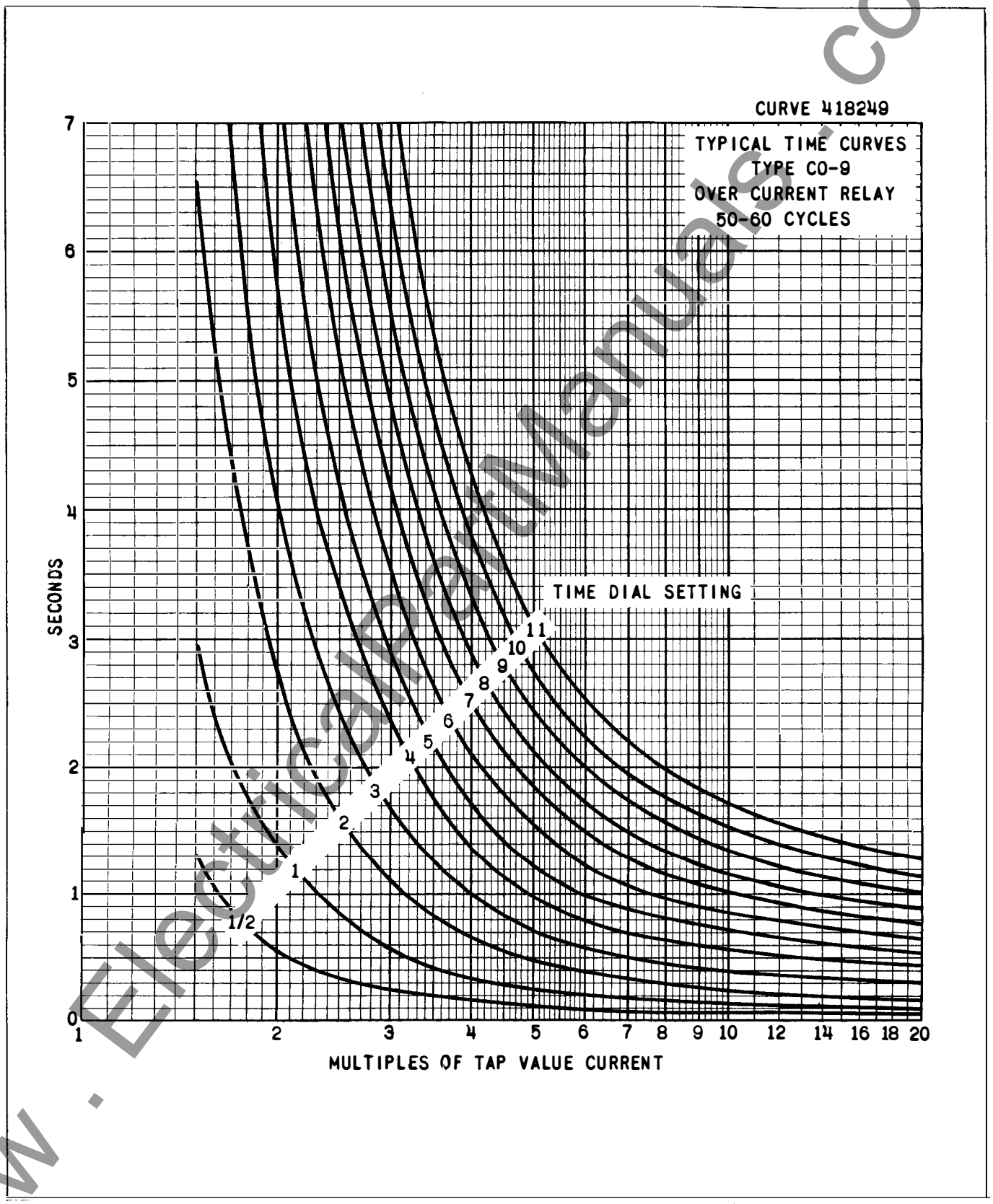


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

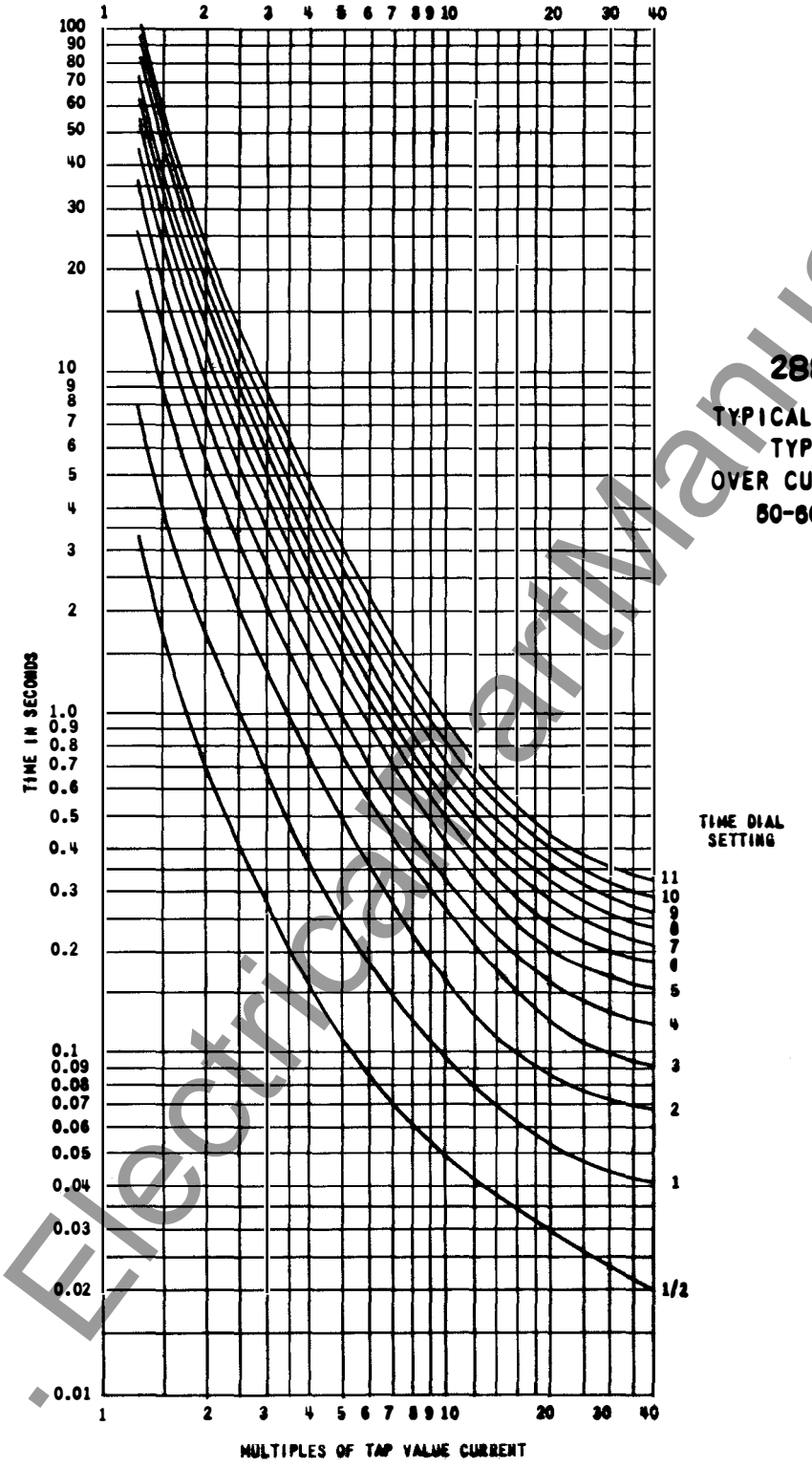


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

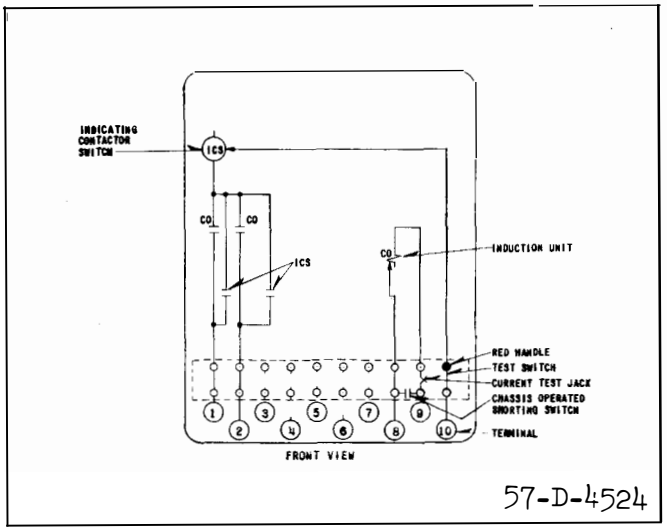


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted.

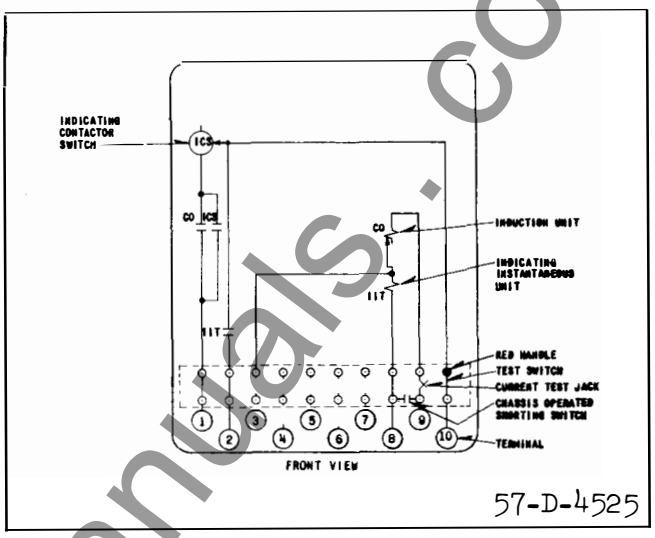


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is 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)

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.

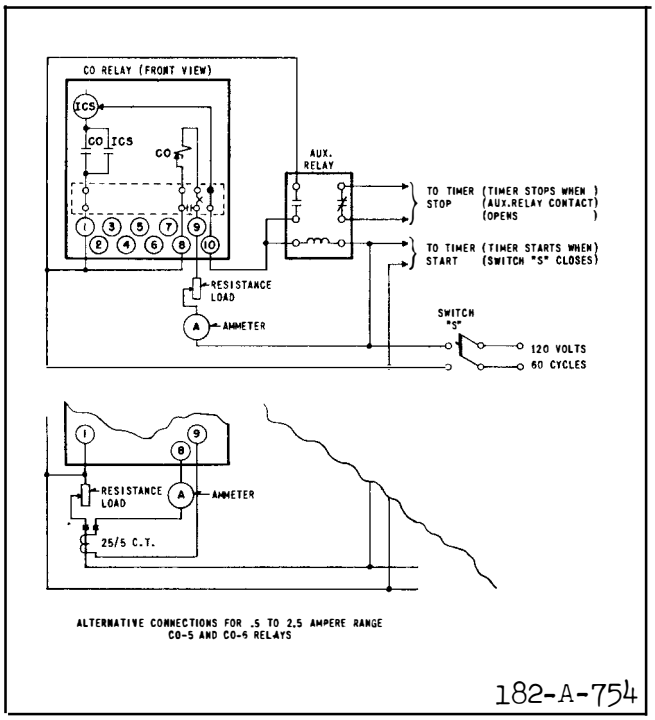


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

Acceptance Check

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

1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current – Set the time dial to position 6 using the lowest tap setting, 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 – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

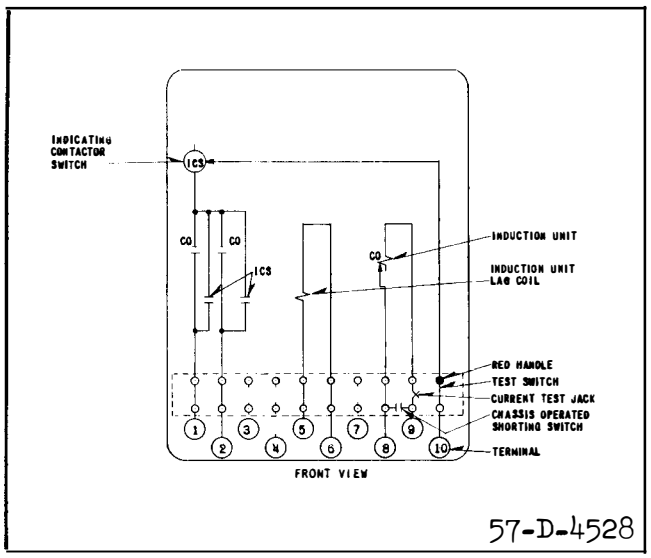


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

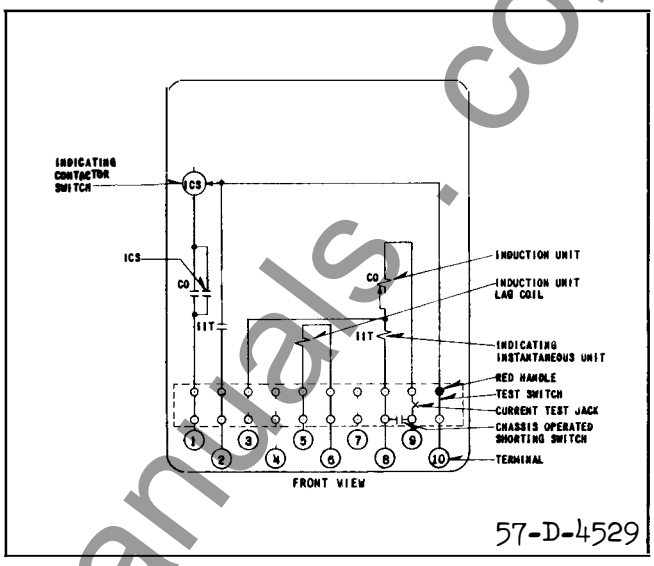


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

dial set to the indicated position and the relay set on the lowest tap setting, 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%

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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.

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

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

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)

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.

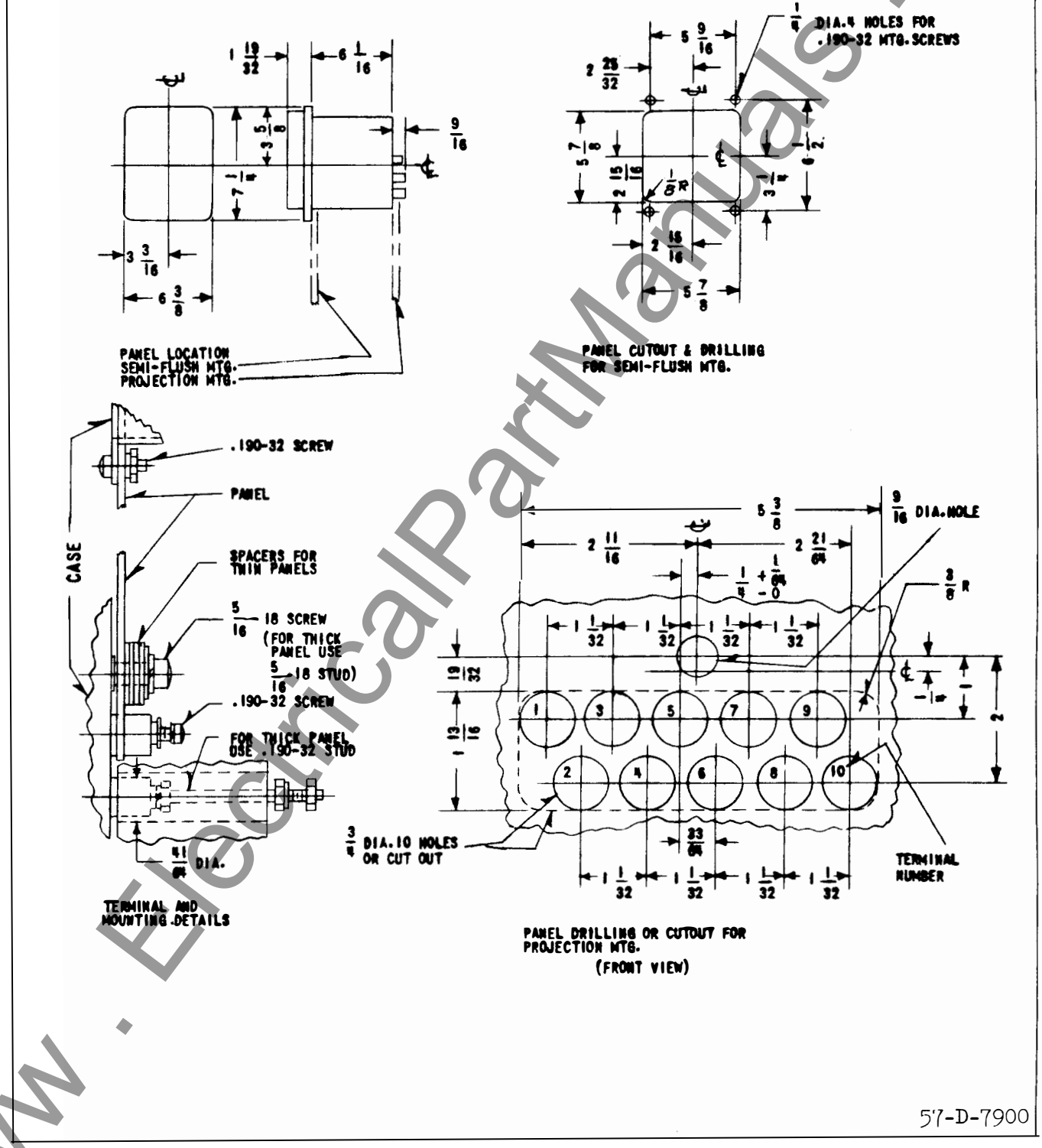


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 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 △

△ For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

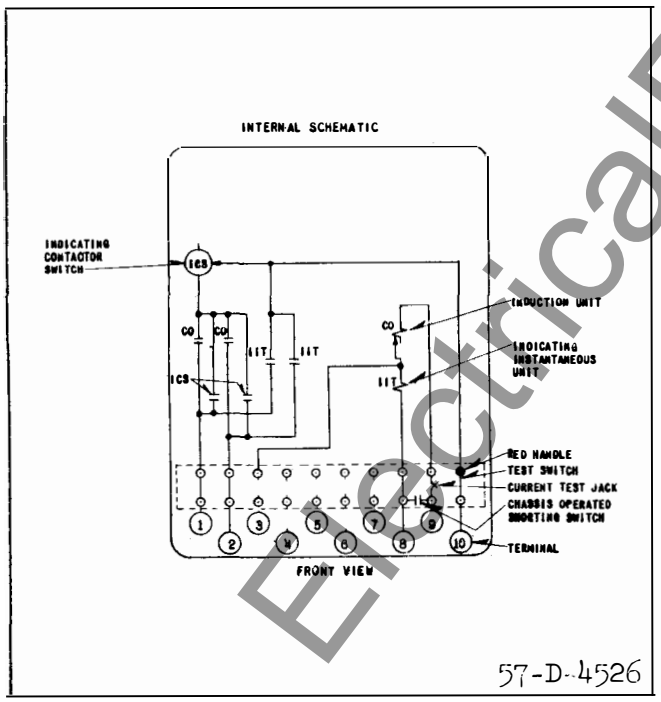


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

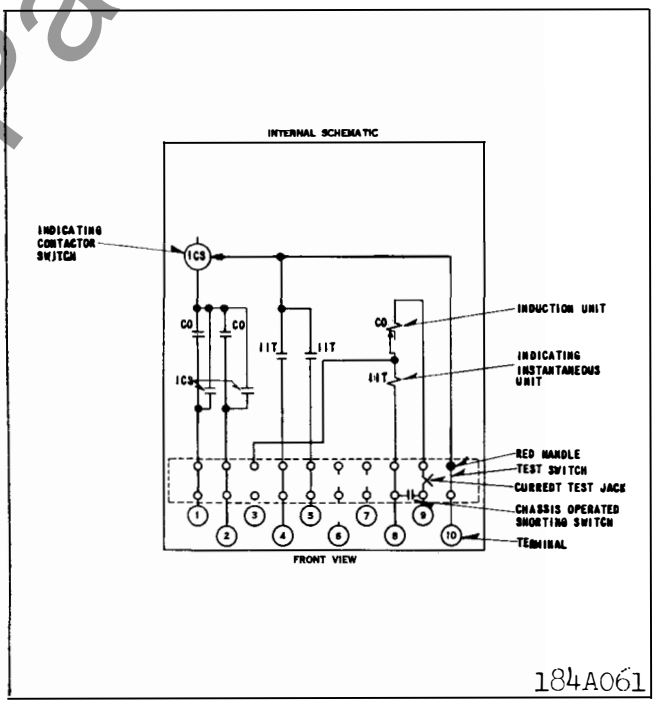


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

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

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

The CO relay is a single phase non-directional time ac overcurrent device. It is used to sense current level above the setting and normally is used to trip a circuit breaker to clear faults. A wide range of characteristics permit applications involving coordination with fuses, reclosers, cold load pickup, motor starting, or essentially fixed time applications.

✪ The following describes typical applications of the CO Relay:

RELAY TYPE	TIME CURVE	TYPICAL APPLICATIONS
CO-2	Short	1) Differential protection where saturation of current transformers is not expected, or where delayed tripping is permissible. 2) Overcurrent protection, phase or ground, where coordination with downstream devices is not involved and 2 to 60 tripping cycle is allowable.
CO-5	Long	Motor locked rotor protection where allowable locked rotor time is approximately between 10 and 70 seconds.
CO-6	Definite	Overcurrent protection where coordination with downstream devices is not involved and CO-2 is too fast. The operating time of this relay does not vary greatly as current level varies.
CO-7	Moderately Inverse	1) Overcurrent protection where coordination with other devices is required, and generation varies. 2) Backup protection for relays on other circuits.
CO-8	Inverse	
CO-9	Very Inverse	
CO-11	Extremely Inverse	1) Motor protection where allowable locked rotor time is less than 10 sec. 2) Overcurrent protection where coordination with fuses and reclosers is involved, or where cold load pickup or transformer inrush are factors.

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

SUPERSEDES I.L. 41-101Q, DATED MARCH 1978 AND ADDENDUM 41-101 DATED JUNE 1980

✪ Denotes changed since previous issue.

EFFECTIVE SEPTEMBER 1980

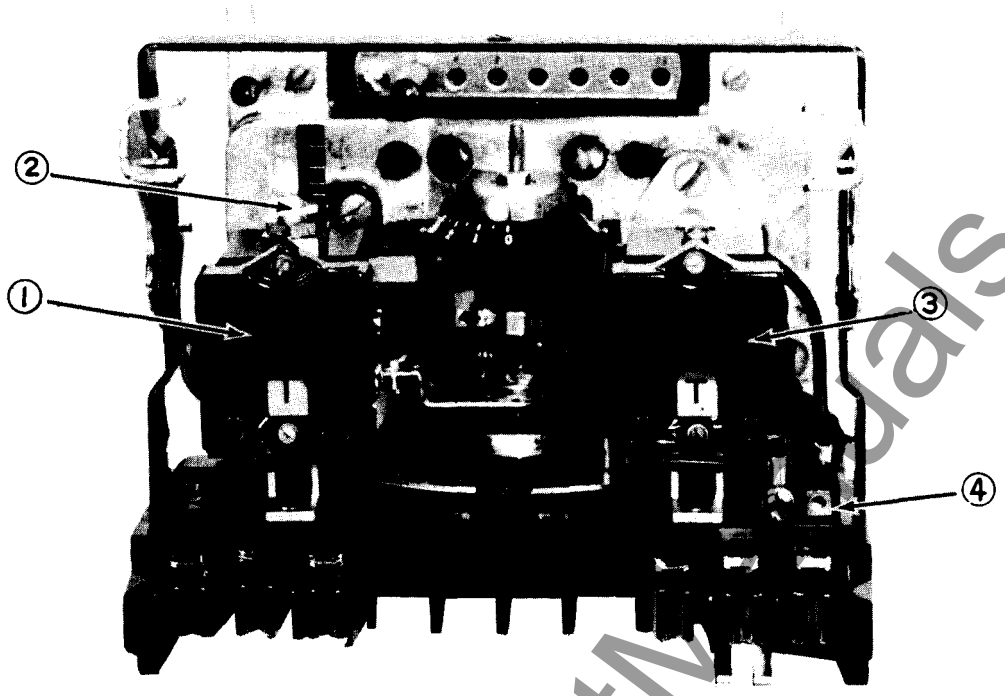


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous Trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

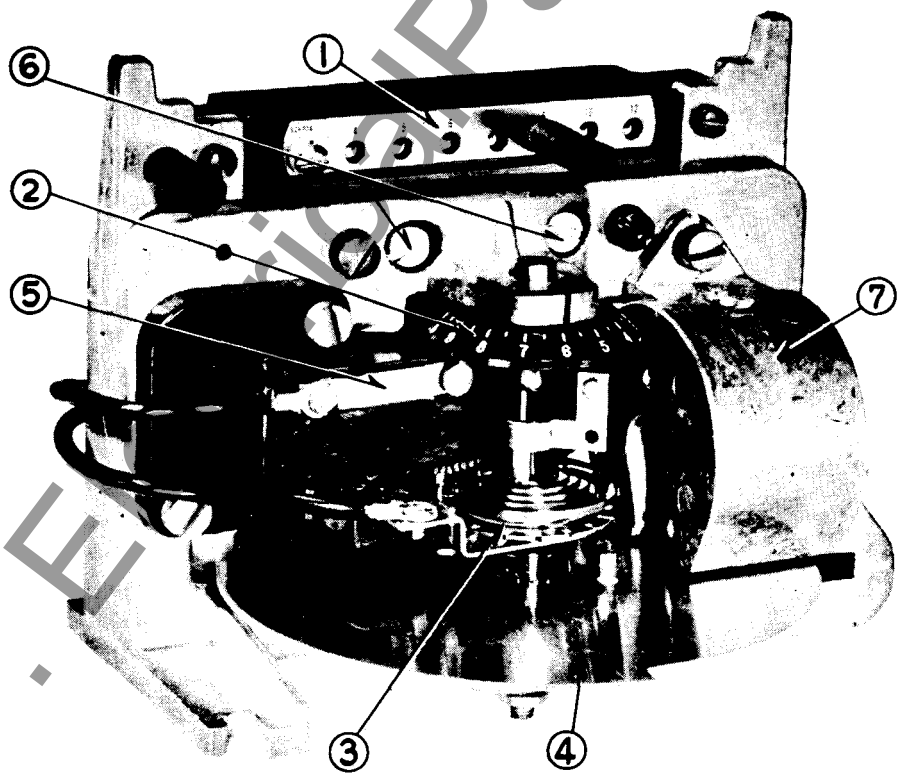


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

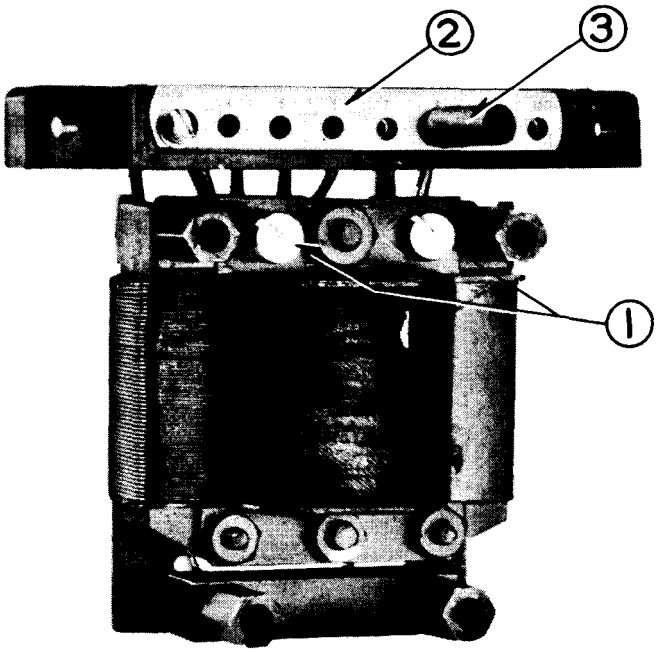


Fig. 3. "E" Type Electromagnet. 1-Magnet Plugs. 2-Tap Block. 3-Tap Screw.

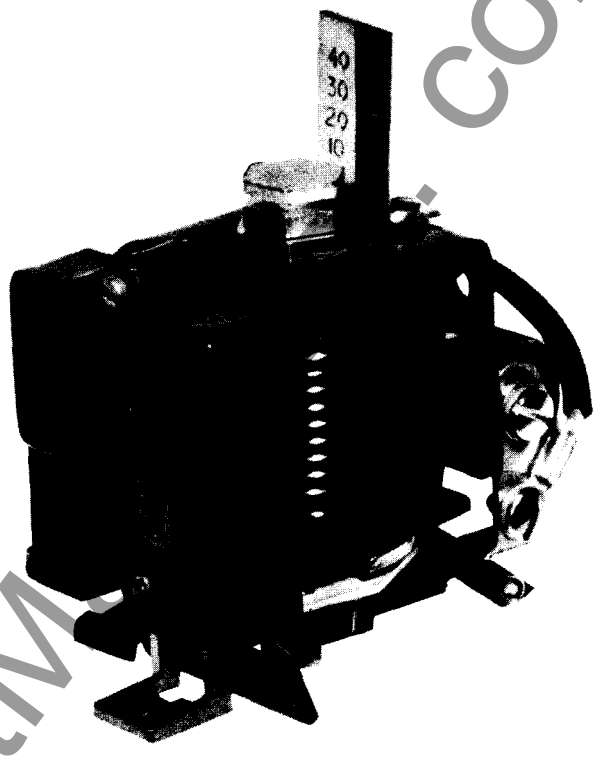


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

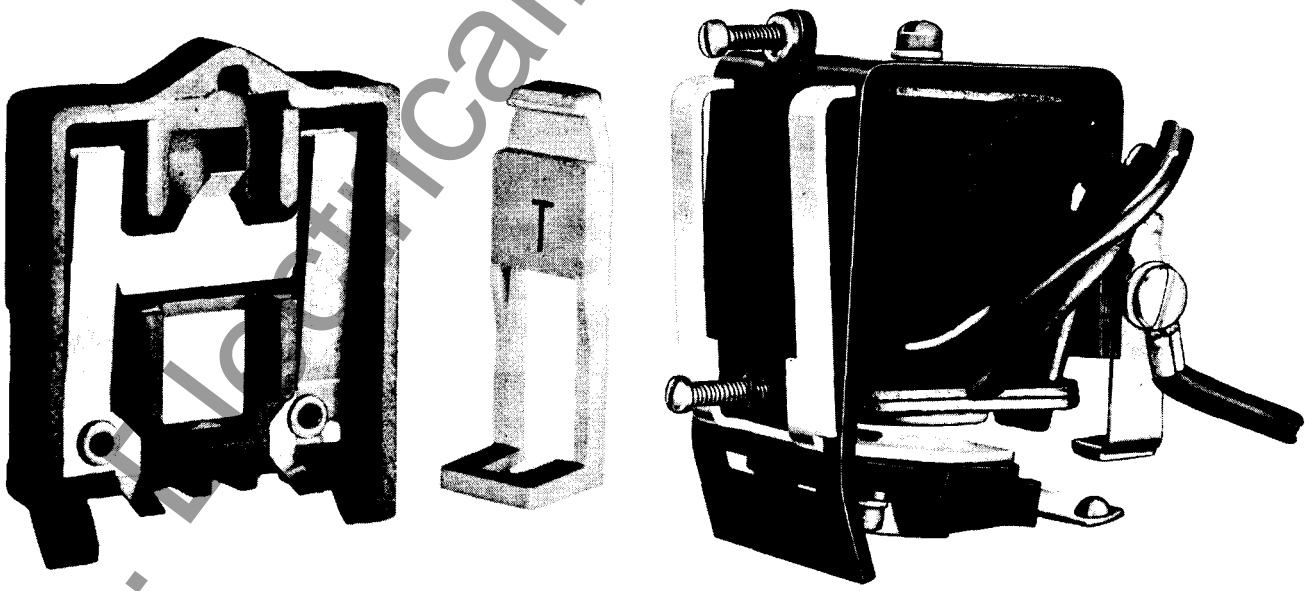


Fig. 5. Indicating Contactor Switch (ICS).

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. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

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 dc 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 ac operated clapper type device. A magnetic ar-

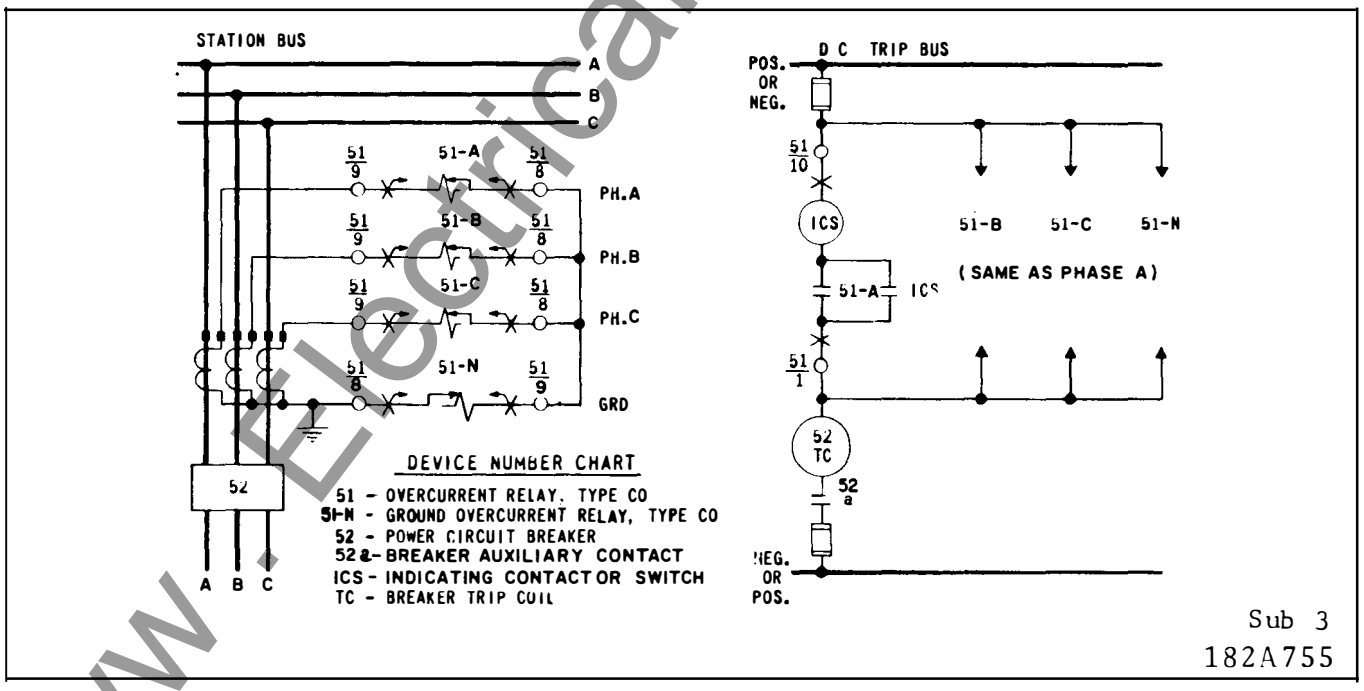


Fig 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

TYPE CO-2 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	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	64	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	5.53	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

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	69	3.92	20.6	103	270
	0.6	3.1	88	68	3.96	20.7	106	288
	0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	1.0	4.1	88	66	4.07	21.4	122	360
	1.5	5.7	88	62	4.19	23.2	147	462
	2.0	6.8	88	60	4.30	24.9	168	548
	2.5	7.7	88	58	4.37	26.2	180	630
	2	8	230	67	3.88	21	110	308
	2.5	8.8	230	66	3.90	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	4.12	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	4.35	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

**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.*

ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

CO-7 MODERATELY INVERSE TIME RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	68	3.88	20.7	103	278
	0.6	3.1	88	67	3.93	20.9	107	288
	0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	1.0	4.1	88	64	4.00	21.6	122	356
	1.5	5.7	88	61	4.08	22.9	148	459
	2.0	6.8	88	58	4.24	24.8	174	552
	2.5	7.7	88	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
	6	19.3	460	60	4.62	25.9	168	540
4/12	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	37.6	308	1032

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	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	2.7	88	72	2.38	21	132	350
	0.6	3.1	88	71	2.38	21	134	365
	0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	1.0	4.1	88	67	2.42	21.2	150	440
	1.5	5.7	88	62	2.51	22	170	530
	2.0	6.8	88	57	2.65	23.5	200	675
	2.5	7.7	88	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

**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.*

ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

TYPE CO-11 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ø	VOLT AMPERES** At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
	0.1	0.4	11.5	34	0.64	6.5	70.3	240
	0.12	0.4	11.5	32	0.67	6.66	75.4	264
	0.16	0.4	11.5	30	0.76	7.3	82.4	297
0.1/0.5	0.20	0.4	11.5	26	0.83	8.3	87.8	336
	0.30	0.4	11.5	22	1.01	10.3	117.6	420
	0.40	0.4	11.5	18	1.21	11.22	140.0	520
	0.50	0.4	11.5	16	1.38	13.8	168.0	630
	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	2.5	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 calculated on the basis of time being inversely proportional to the square of the current.*

ø Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

INSTANTANEOUS TRIP UNIT (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

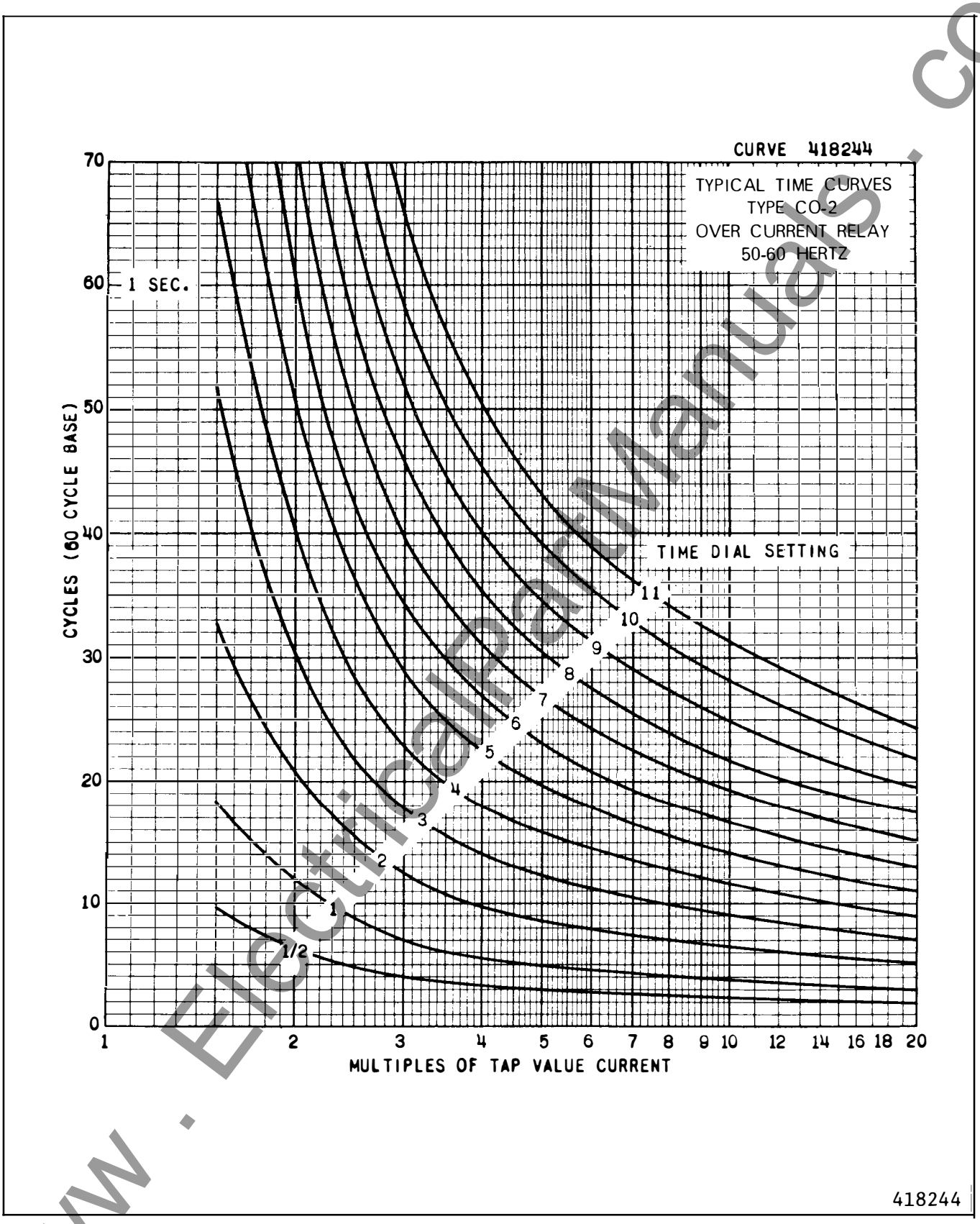


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

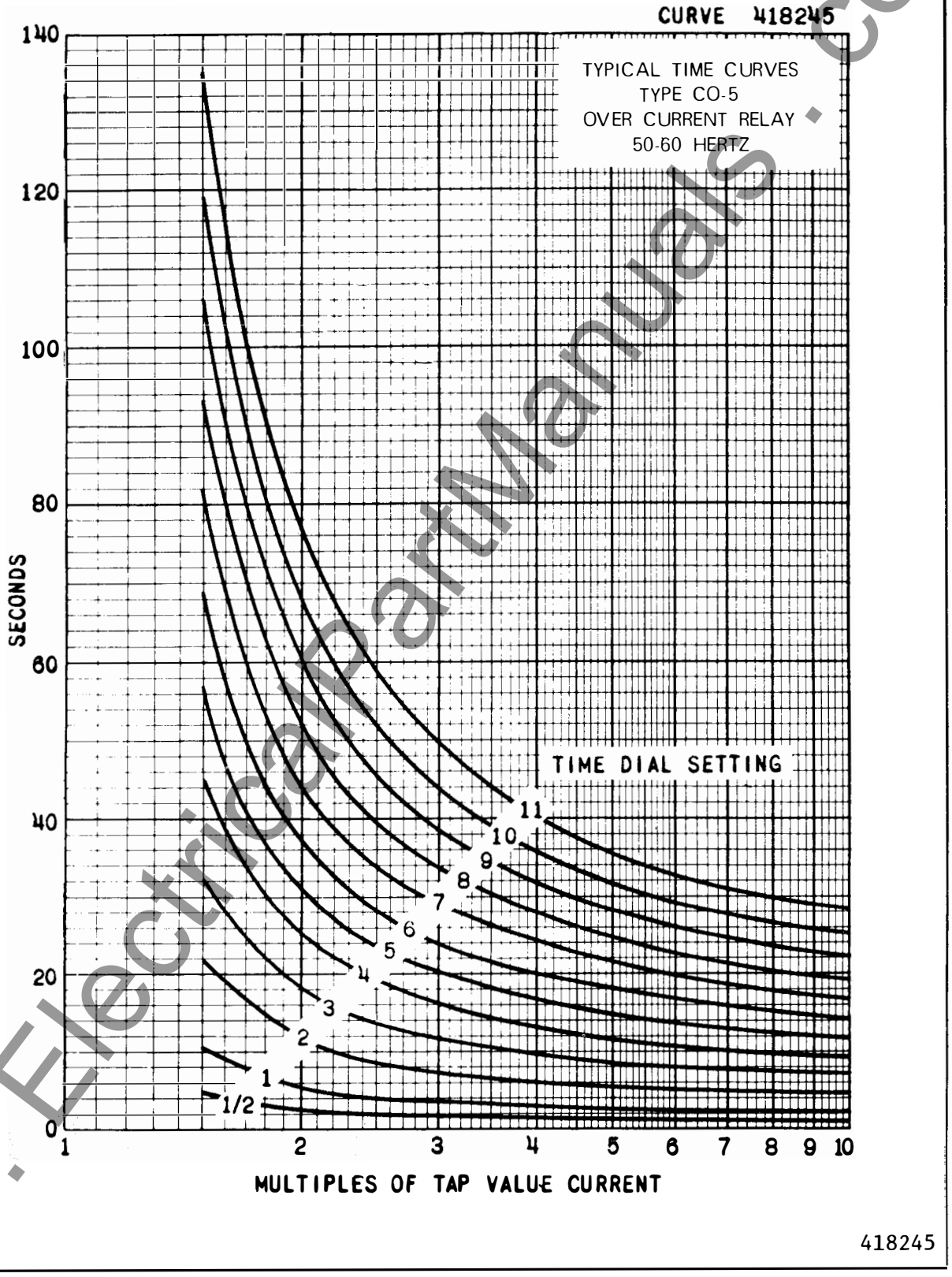


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

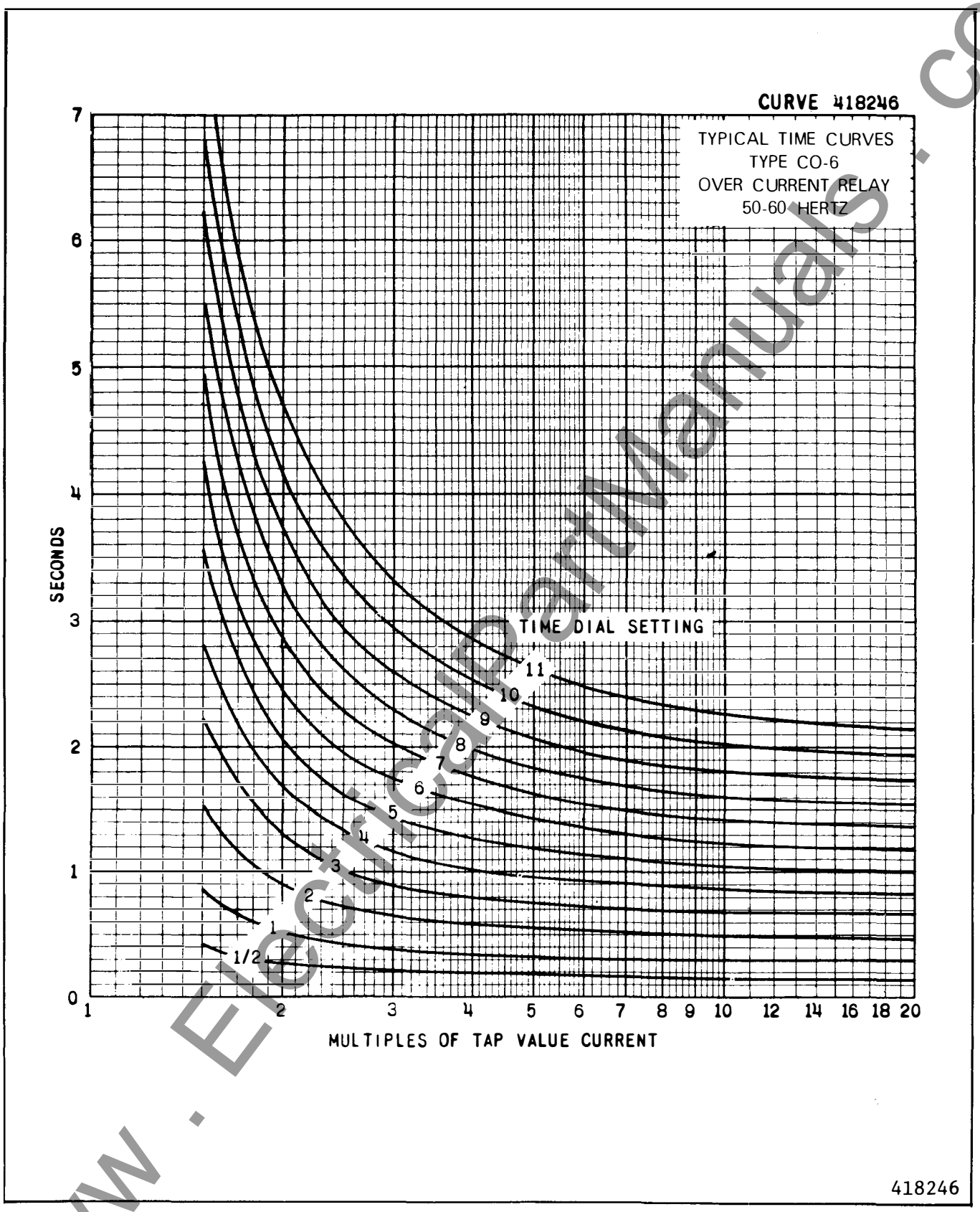


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

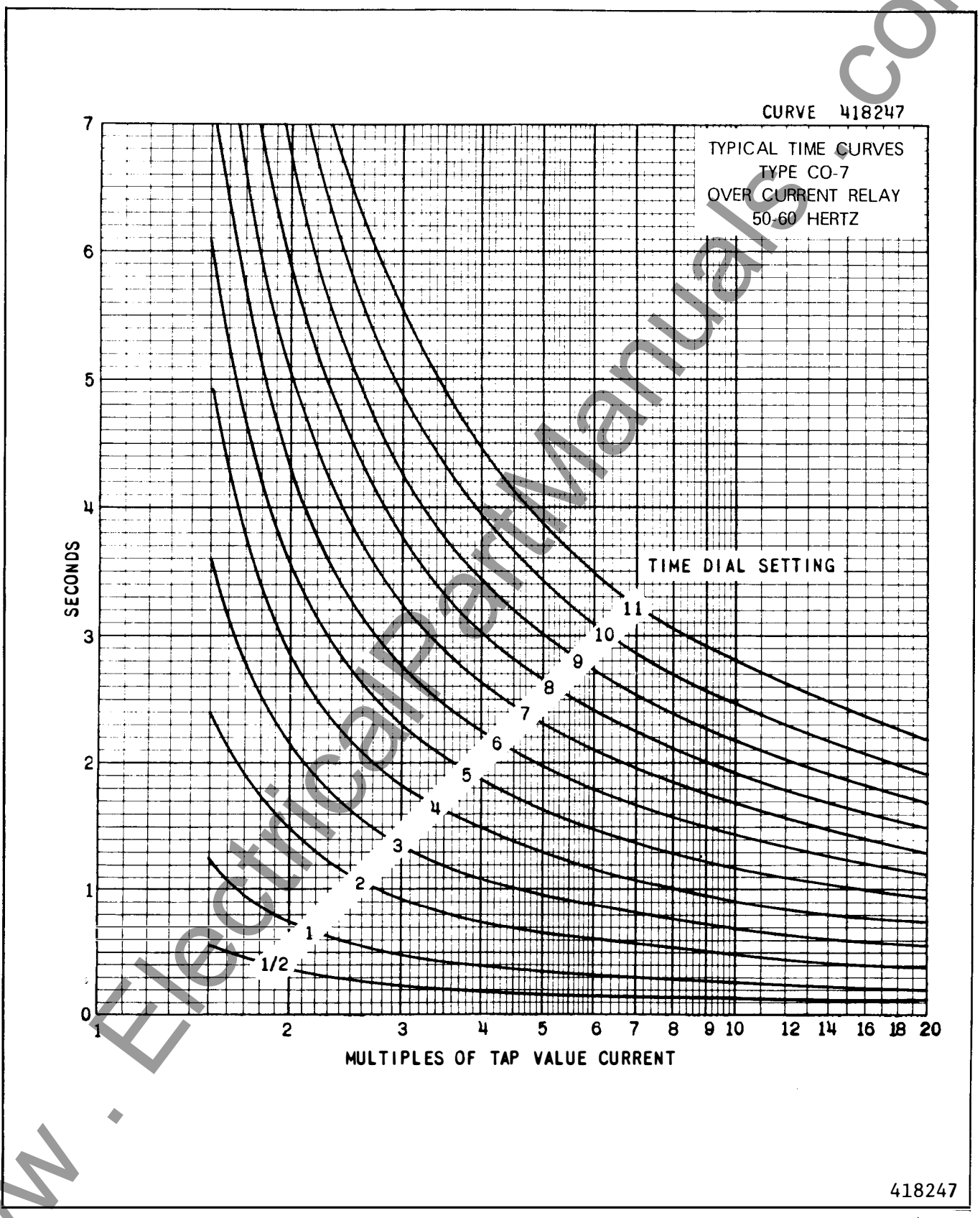


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

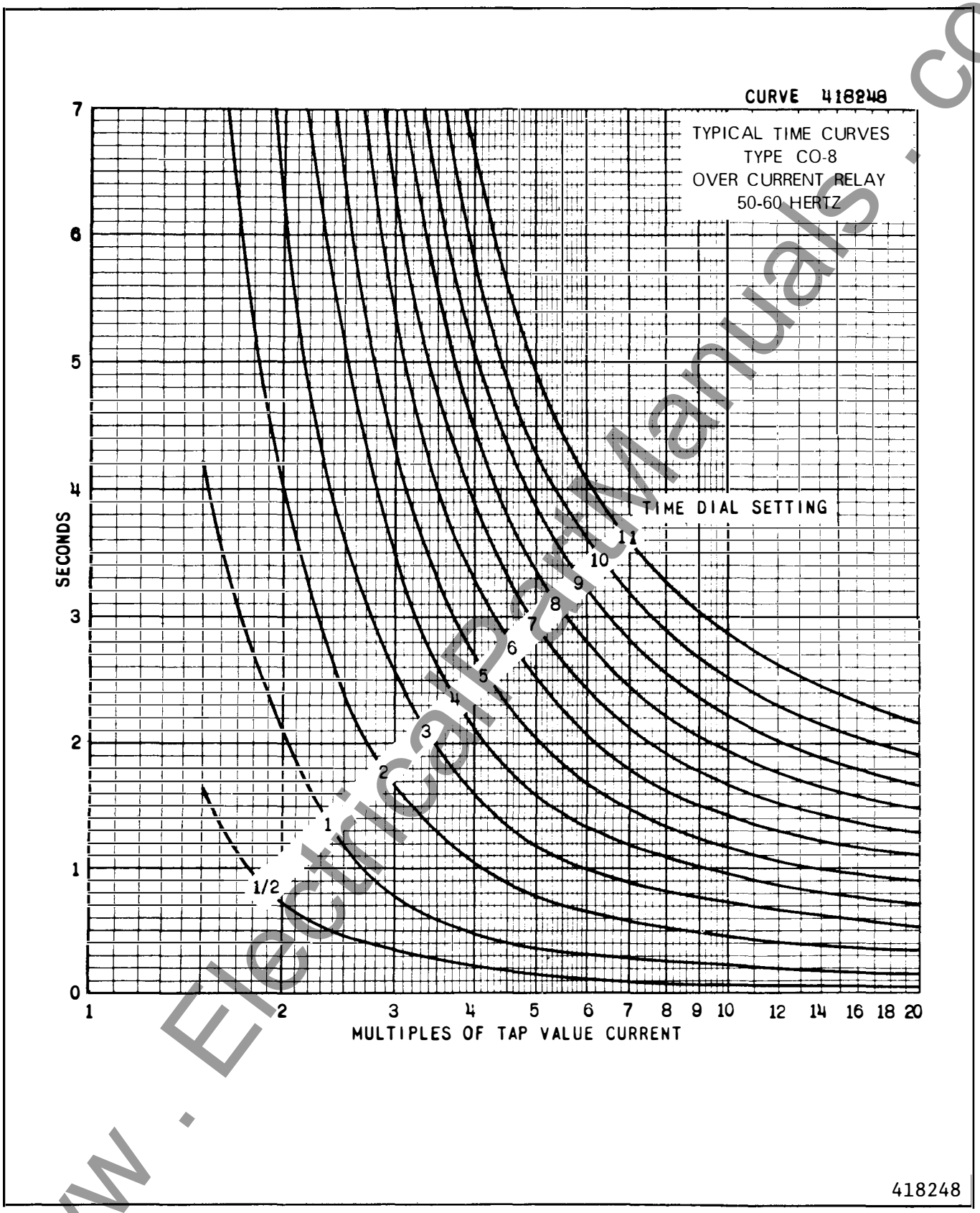


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

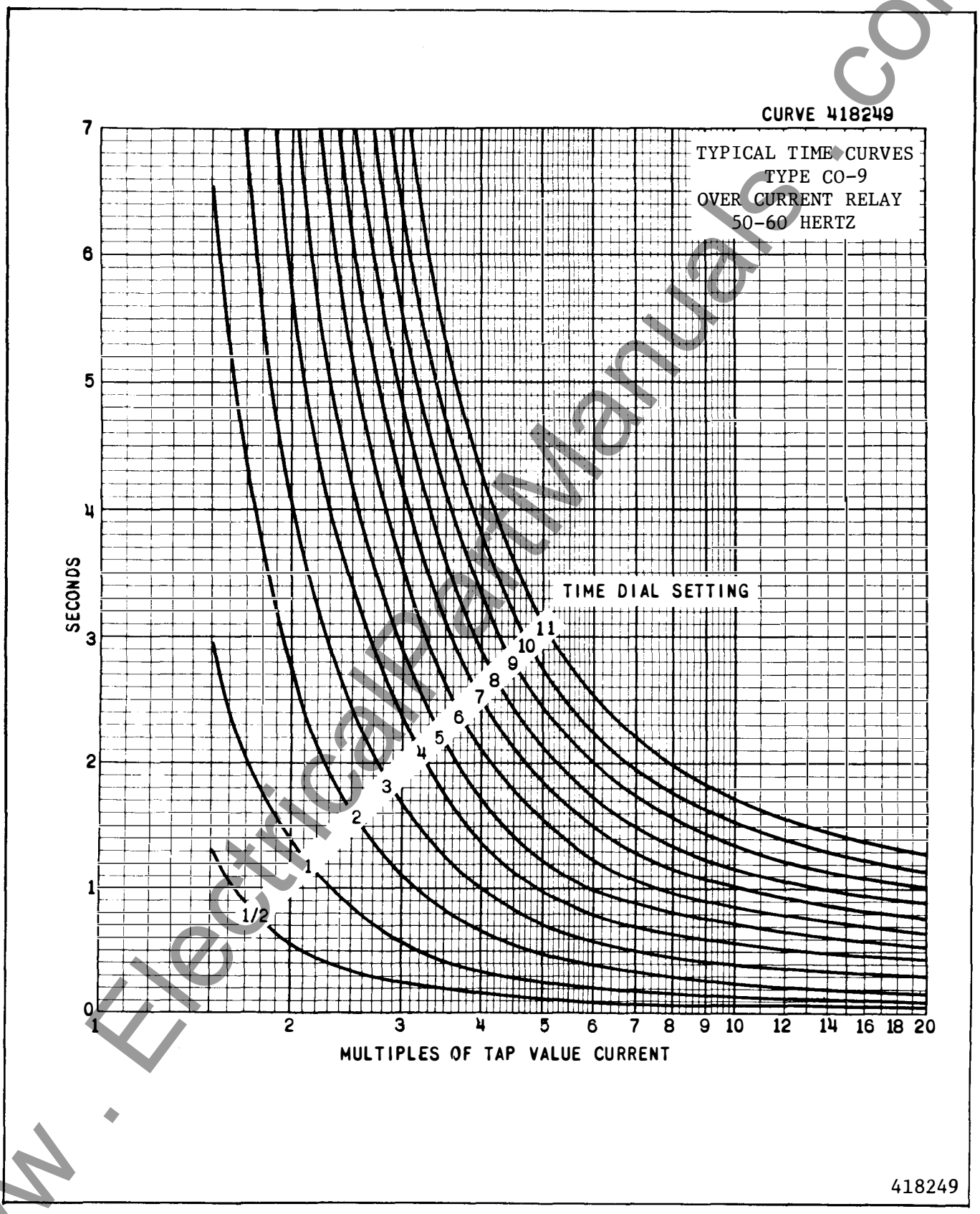


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

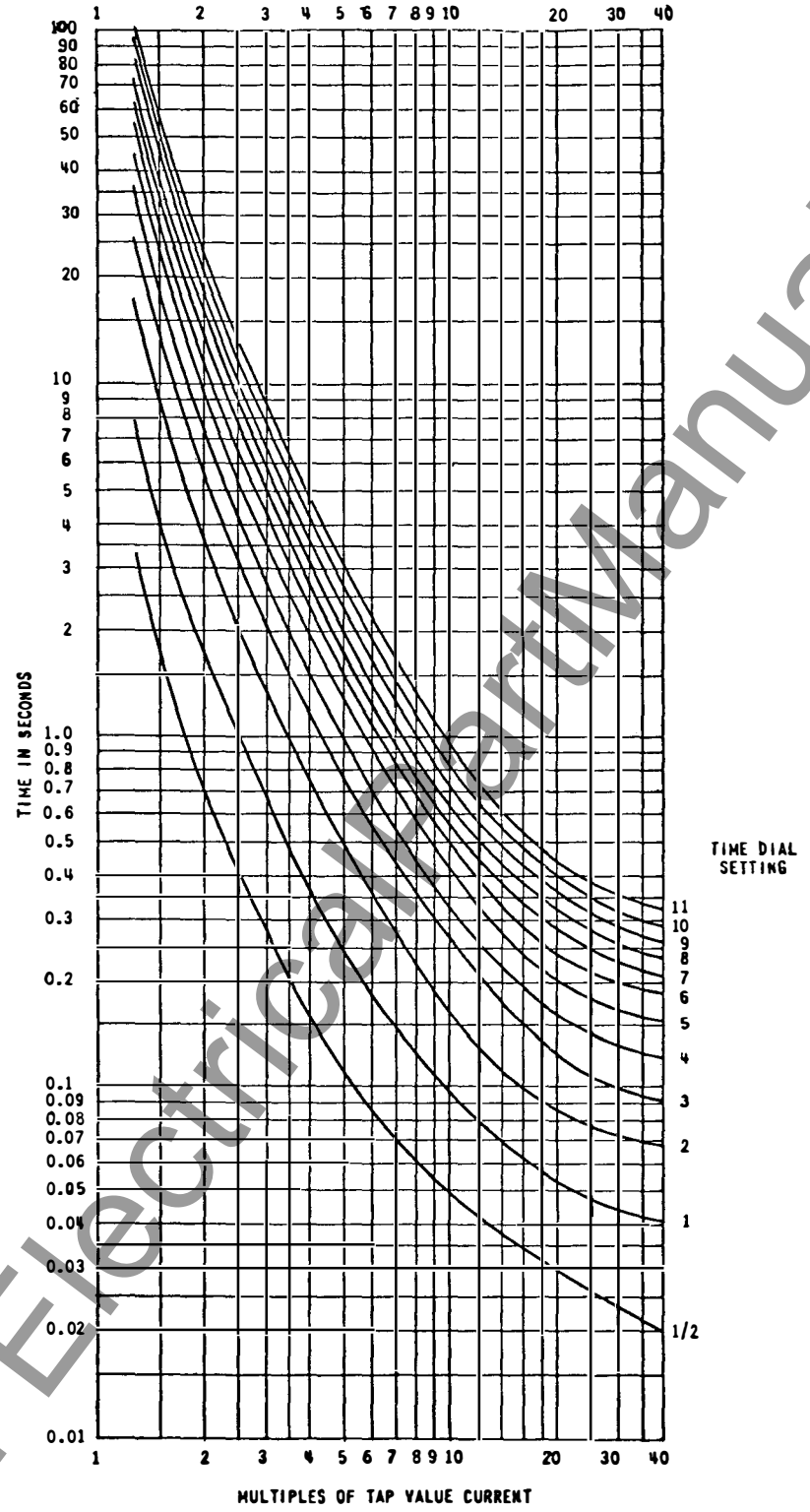


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

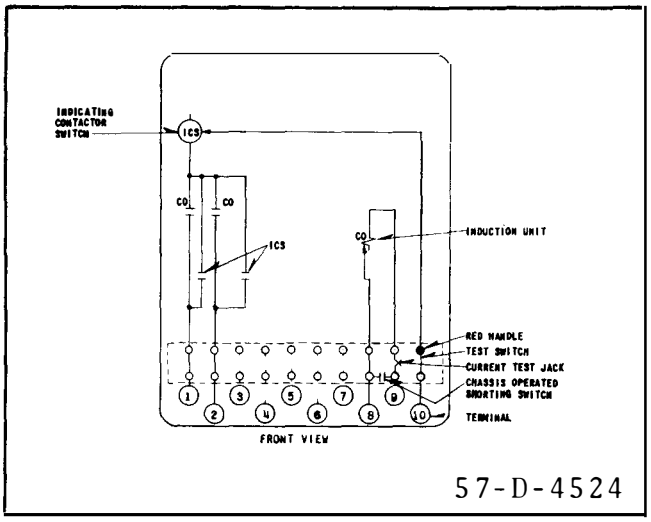


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.

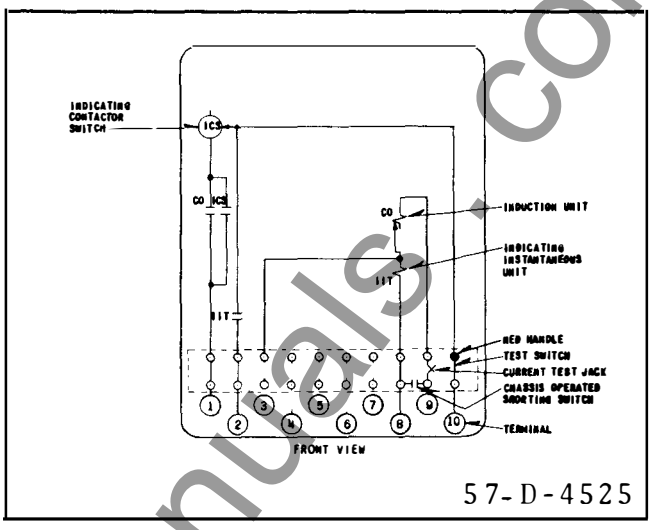


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

mature, 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.

CHARACTERISTICS

The relays are generally available in the following current ranges.

Range	Taps						
† .1-.5	0.1	0.12	0.16	0.2	0.3	0.4	0.5
.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

†Available for Type CO-11 Relay.

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 dc 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 dc, 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 to 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 dc resistance
2.0 ampere tap – 0.15 ohms dc resistance

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)

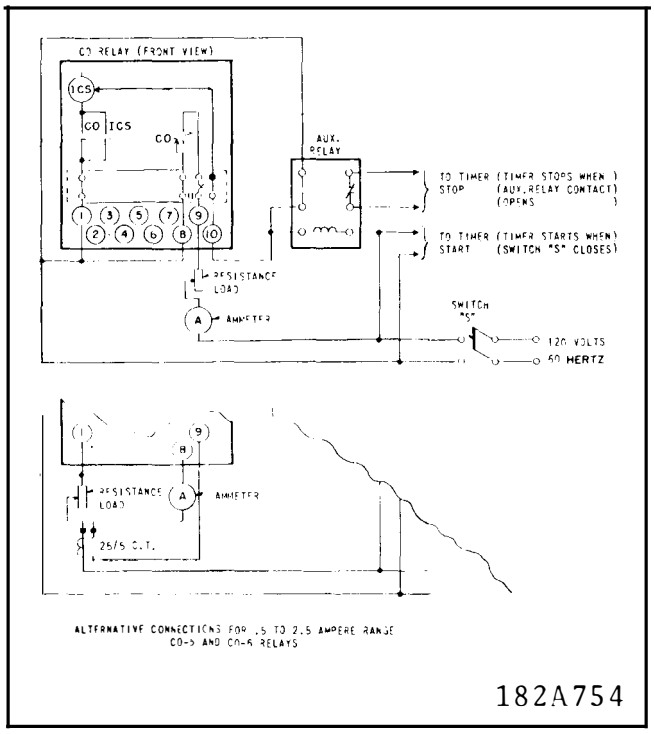


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rest solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

INDICATING CONTACT SWITCH (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere 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)

The IIT setting is the level of ac current at which it will pickup. It should be set to coordinate with other devices so it will never operate for a fault in protective zone where tripping should be produced by other devices. The transient reach will not exceed 130% for an 80° circuit angle or 108% for a 60° circuit.

The proper tap must be selected and the core screw must be adjusted to the value of pick-up current desired.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs 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. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its

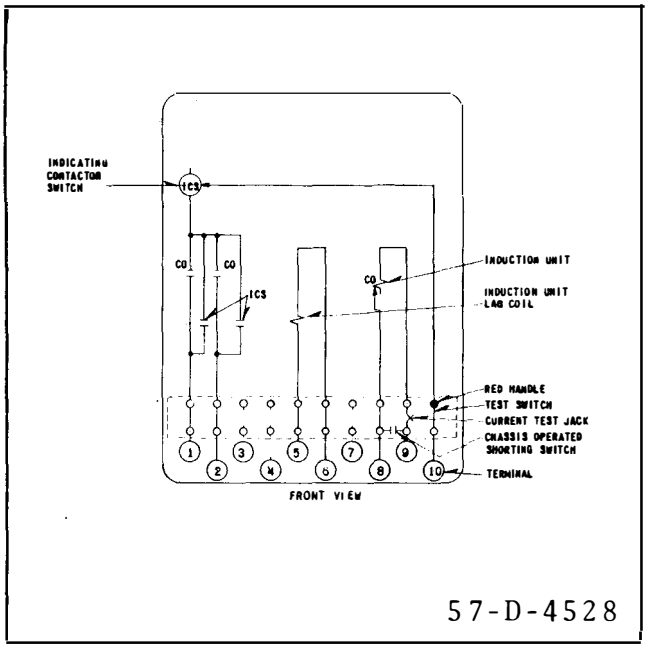


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

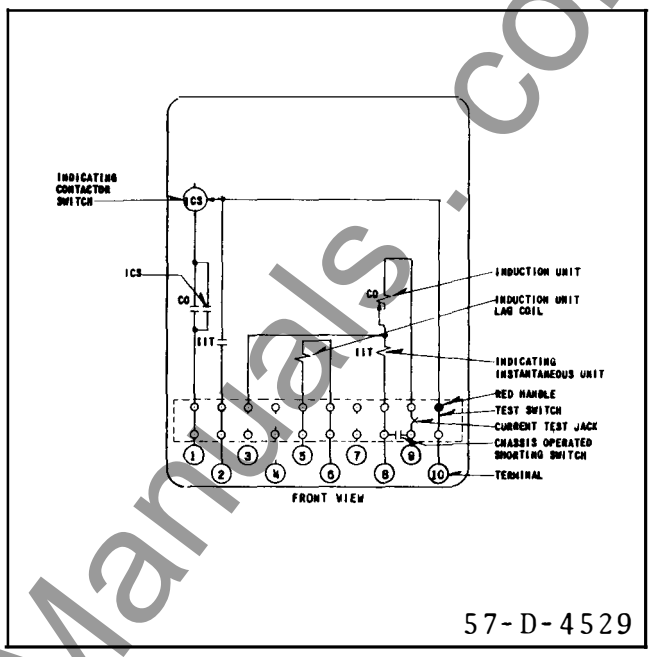


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

mounting screws or studs, and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the 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 I.L. 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.

For relays which include an indicating instantaneous trip unit (ITT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

ACCEPTANCE CHECK

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

1. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately

.020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. **Minimum Trip Current** – Set the time dial to position 6 using the lowest tap setting, 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** – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation, ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effects of different taps can make the total variations appear to be ±15%.

Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, 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% (Use .5 tap for .1 to .5 range).

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

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

ROUTINE MAINTENANCE

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

   b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O"mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 at "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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). "A slight variation ±1%, in the 1.3 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effect of different taps can make the total variations appear to be ±15%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. The check is to be made after the 2 times tap value adjustment has been completed.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

5. **Indicating Instantaneous Trip Unit (IIT)**

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 – 50 & 60 HERTZ

	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 Δ

Δ For 50 hertz CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

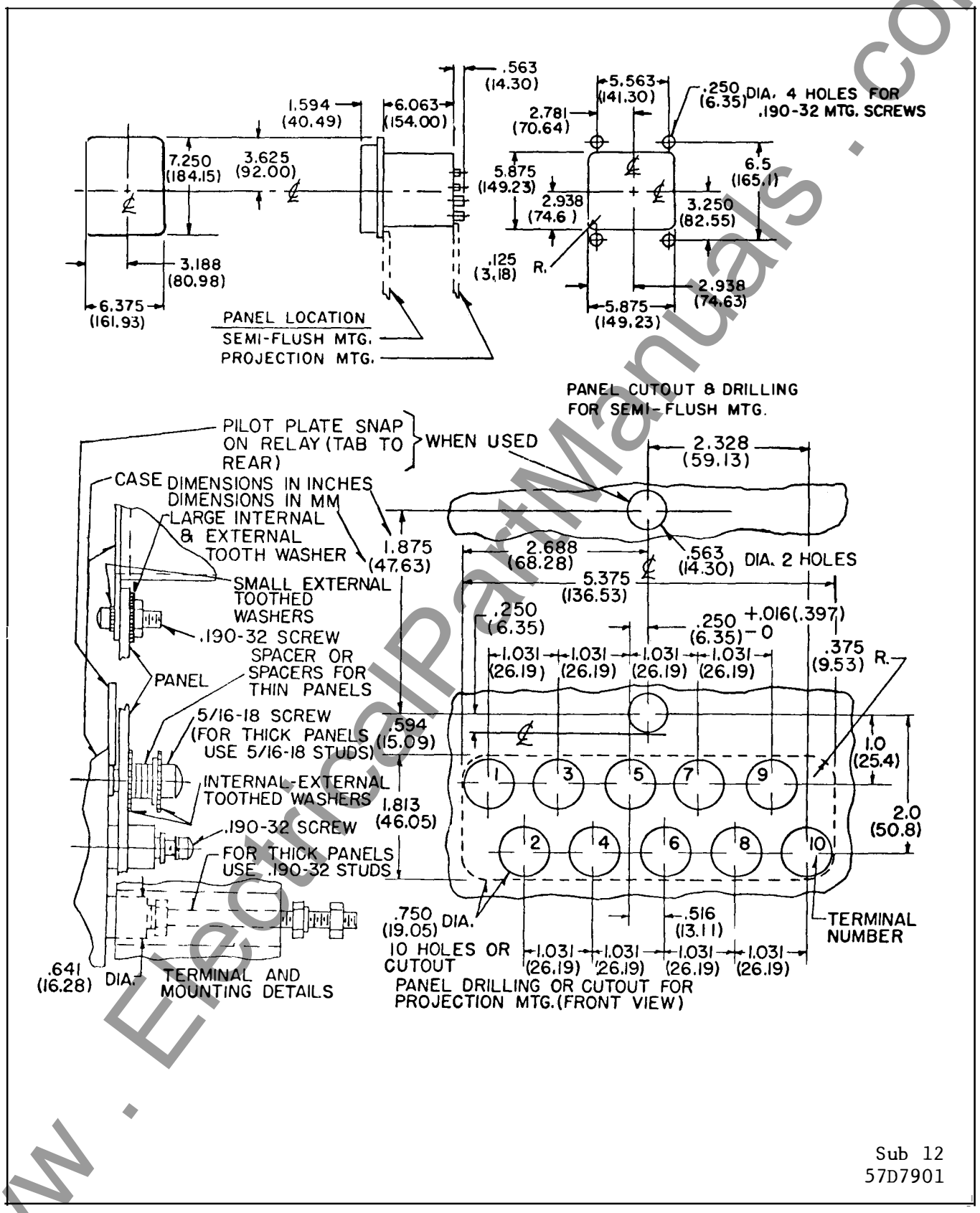


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

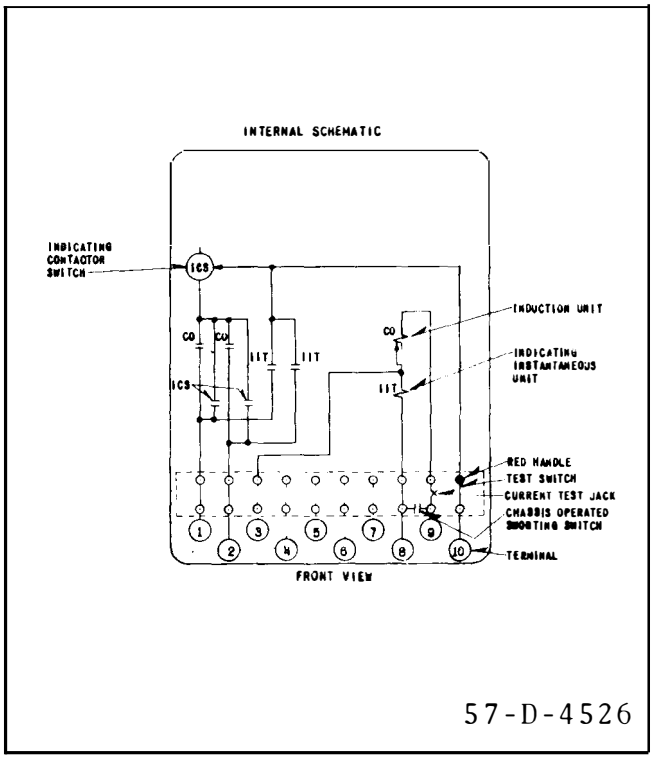


Fig. 20. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

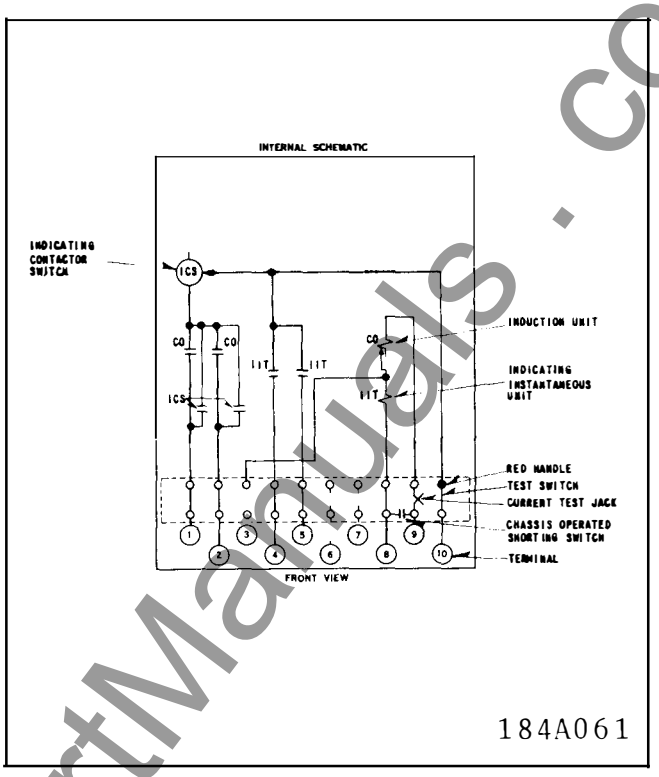
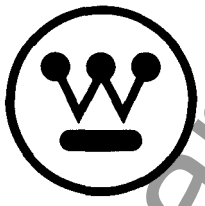


Fig. 21. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit to Separate Terminals.



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

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 type of relays are single phase, non-directional, ac current sensitive devices. They are used for phase or ground overcurrent protection of feeders, transmission lines, ac machines, transformers, capacitors, reactors, and in other application where a relay is required whose operating time inversely is related to operating current.

For selective coordination between relays, 7 different types of relays are available as listed below. Their time curves are as shown in figures 7 to 13.

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

In general, the application will indicate the use of a specific type of CO relay. Short time relays act fast to avoid equipment damage. Long time relays hold off tripping on heavy initial overload or more extended moderate overloads. At higher fault currents, definite-time and moderately inverse relays maintain more nearly constant operating time, despite variation in fault currents. Inverse and extremely inverse relays operate respectively faster on higher fault currents.

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. A torque controlled CO has the lag coil connections of the electromagnet brought out to separate terminals. This permits control of the closing torque such that only when these terminals are connected together will the unit operate.

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 dc 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

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

SUPERSEDES I.L. 41-101P, DATED JULY, 1976
✪ DENOTES CHANGE FROM SUPERSEDED ISSUE.
EFFECTIVE MARCH 1978

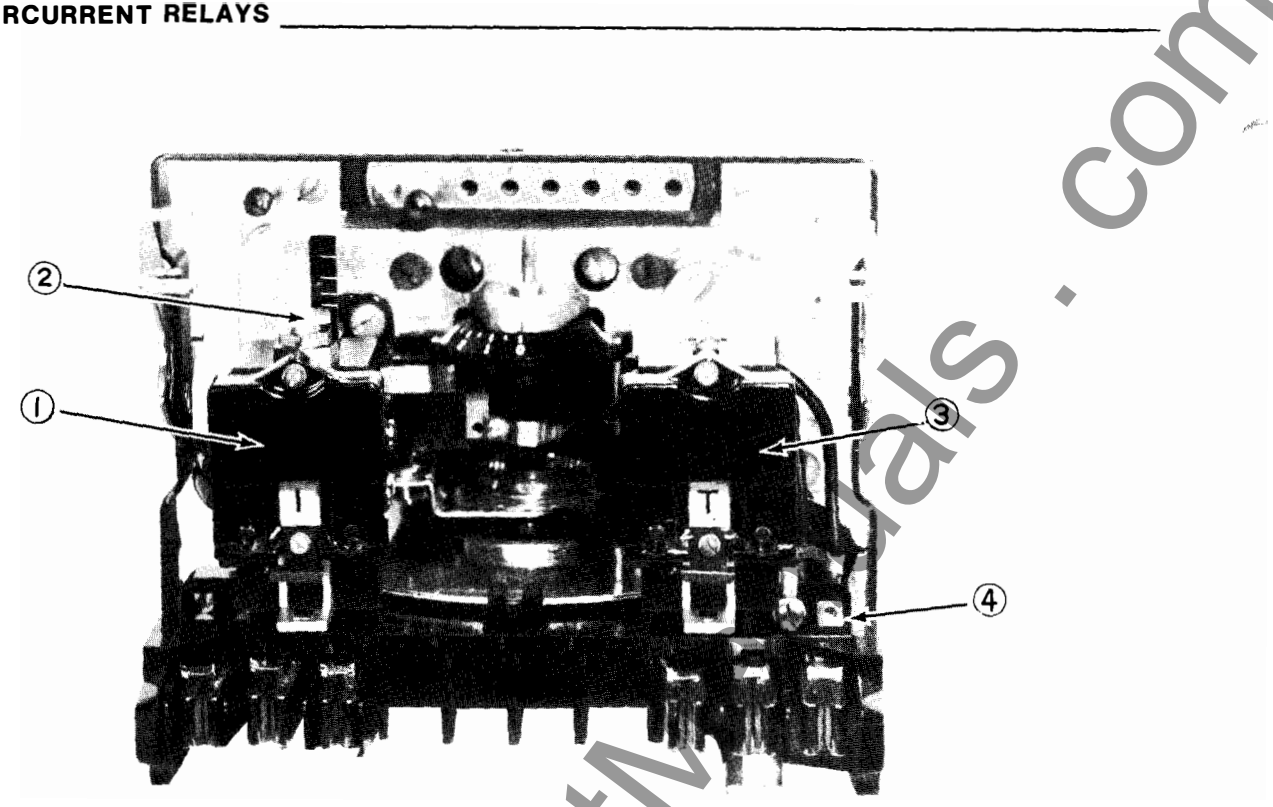


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous Trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

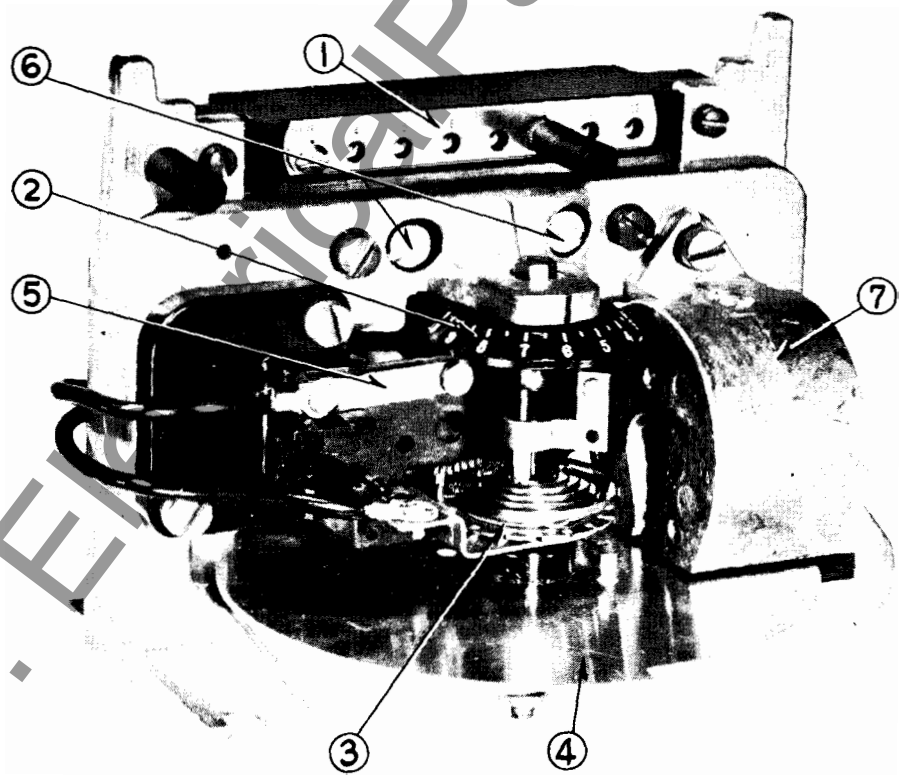


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

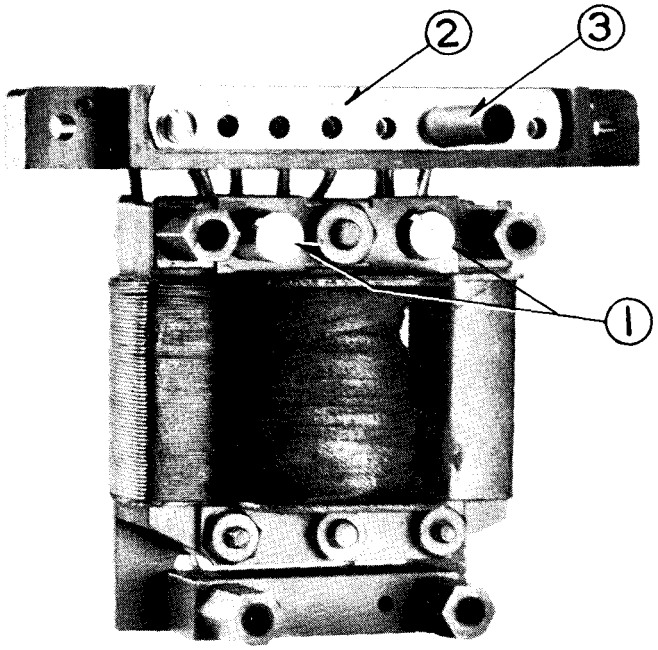


Fig. 3. "E" Type Electromagnet. 1-Magnet Plugs. 2-Tap Block. 3-Tap Screw.

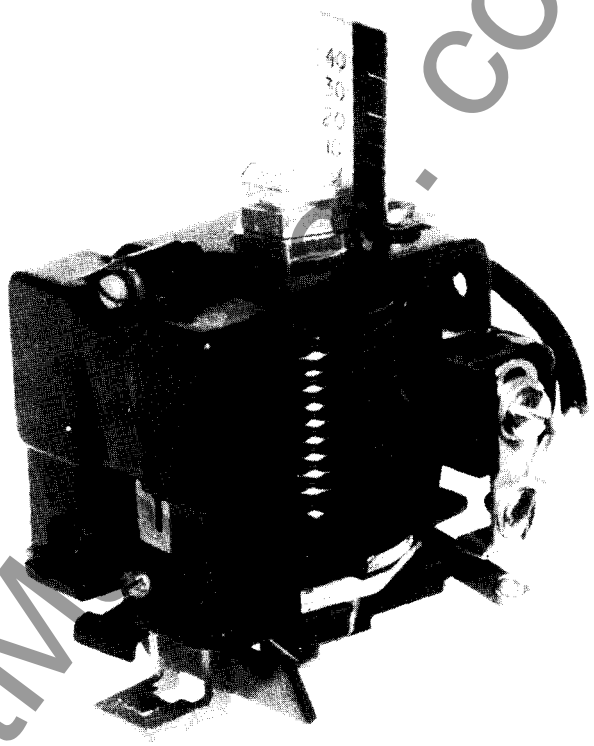


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

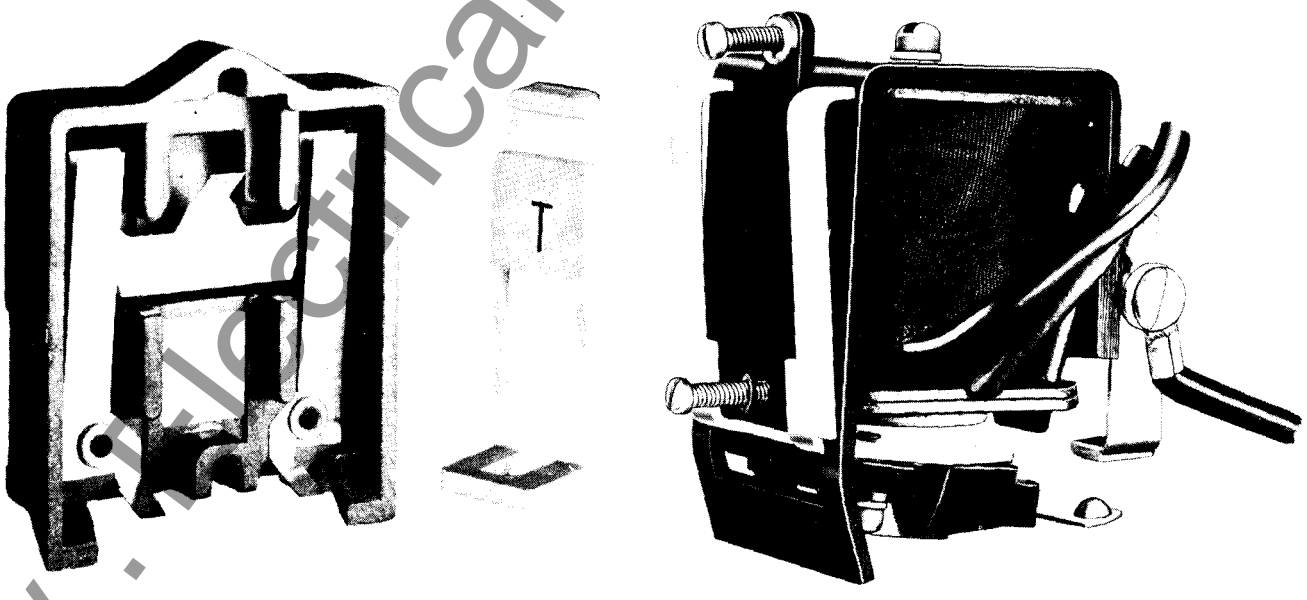


Fig. 5. Indicating Contactor Switch (ICS).

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 pick up value of the switch.

INDICATING INSTANTANEOUS TRIP UNIT (IIT)

The instantaneous trip unit is a small ac 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.

CHARACTERISTICS

The relays are generally available in the following current ranges.

Range	Taps						
† .1 - .5	0.1	0.12	0.16	0.2	0.3	0.4	0.5
.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

† Available for Type CO-11 Relay.

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 dc 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 dc, 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 to 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 dc resistance
2.0 ampere tap – 0.15 ohms dc resistance

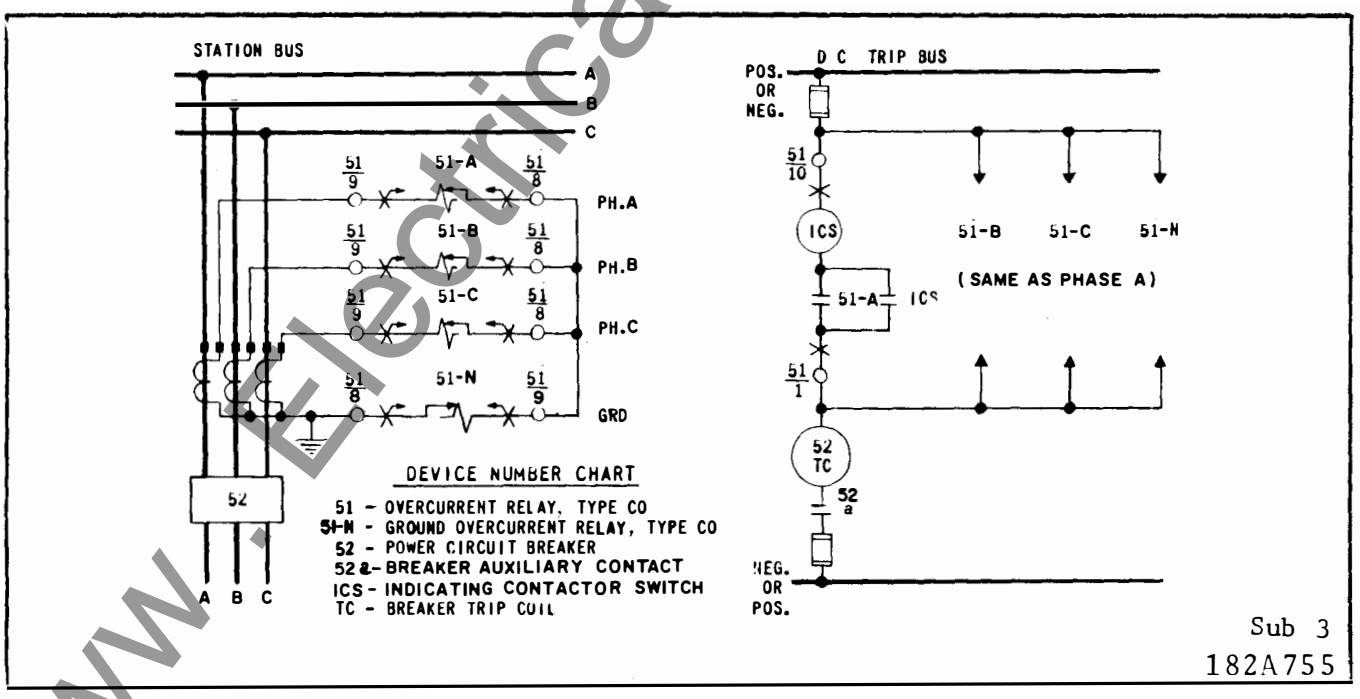


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

TYPE CO-2 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	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	64	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	5.53	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

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	69	3.92	20.6	103	270
	0.6	3.1	88	68	3.96	20.7	106	288
	0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	1.0	4.1	88	66	4.07	21.4	122	360
	1.5	5 7	88	62	4.19	23.2	147	462
	2.0	6.8	88	60	4.30	24.9	168	548
	2.5	7.7	88	58	4.37	26.2	180	630
	2	8	230	67	3.88	21	110	308
	2.5	8.8	230	66	3.90	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	4.12	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	4.35	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

**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.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

CO-7 MODERATELY INVERSE TIME RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	68	3.88	20.7	103	278
	0.6	3.1	88	67	3.93	20.9	107	288
	0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	1.0	4.1	88	64	4.00	21.6	122	356
	1.5	5.7	88	61	4.08	22.9	148	459
	2.0	6.8	88	58	4.24	24.8	174	552
	2.5	7.7	88	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
	6	19.3	460	60	4.62	25.9	168	540
4/12	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	37.6	308	1032

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

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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	2.7	88	72	2.38	21	132	350
	0.6	3.1	88	71	2.38	21	134	365
	0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	1.0	4.1	88	67	2.42	21.2	150	440
	1.5	5.7	88	62	2.51	22	170	530
	2.0	6.8	88	57	2.65	23.5	200	675
	2.5	7.7	88	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

**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.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

✪ ENERGY REQUIREMENTS

TYPE CO-11 RELAY

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ∅	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
	0.1	0.4	11.5	34	0.64	6.5	70.3	240
	0.12	0.4	11.5	32	0.67	6.66	75.4	264
	0.16	0.4	11.5	30	0.76	7.3	82.4	297
0.1/0.5	0.20	0.4	11.5	26	0.83	8.3	87.8	336
	0.30	0.4	11.5	22	1.01	10.3	117.6	420
	0.40	0.4	11.5	18	1.21	11.22	140.0	520
	0.50	0.4	11.5	16	1.38	13.8	168.0	630
	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	2.5	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 calculated on the basis of time being inversely proportional to the square of the current.*

∅ Degrees current lags voltage at tap value current.

***Voltages taken with Rectox type voltmeter.*

✪ INSTANTANEOUS TRIP UNIT (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT MINIMUM SETTING	BURDEN IN VOLT-AMPS. AT MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

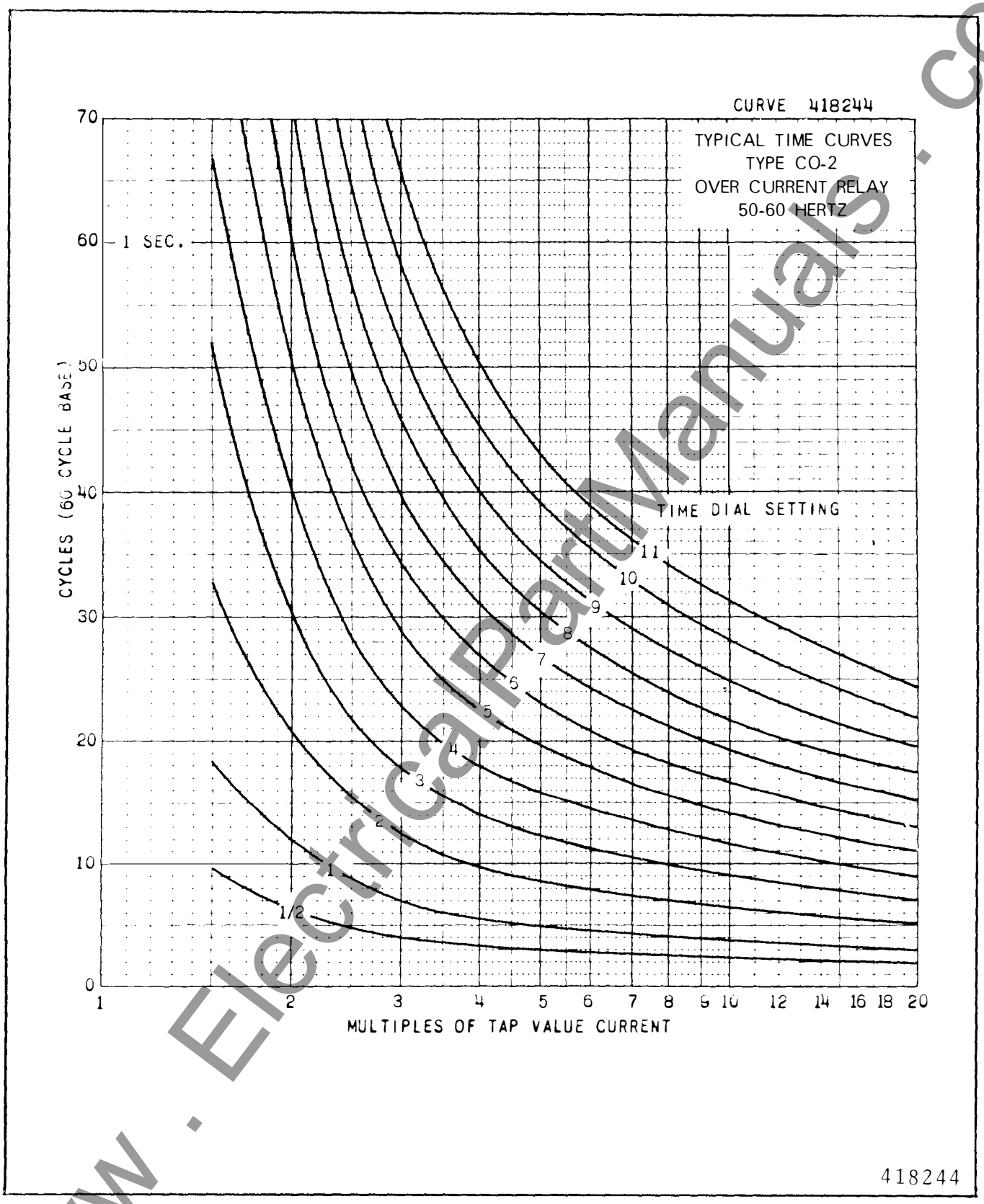


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

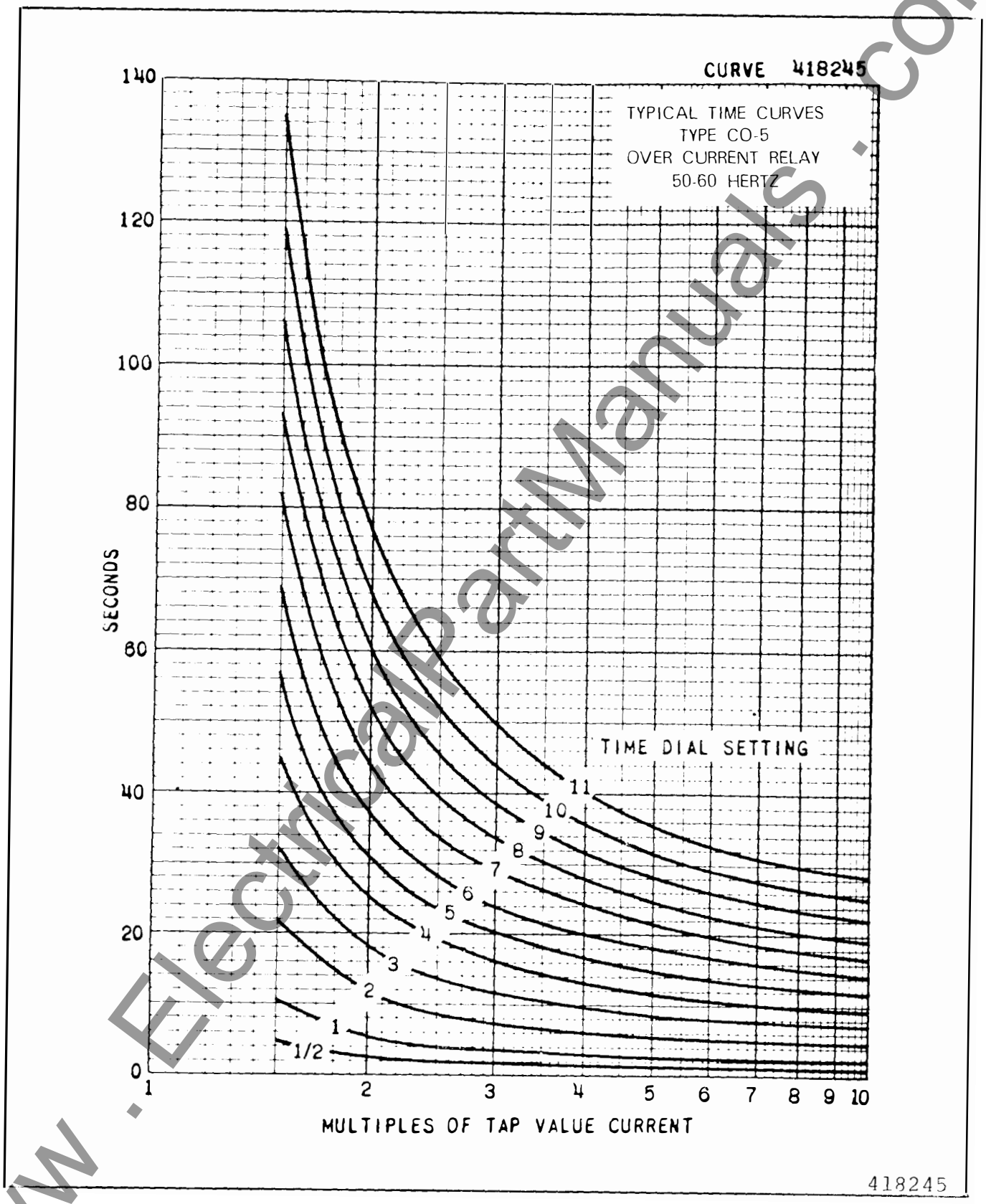


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

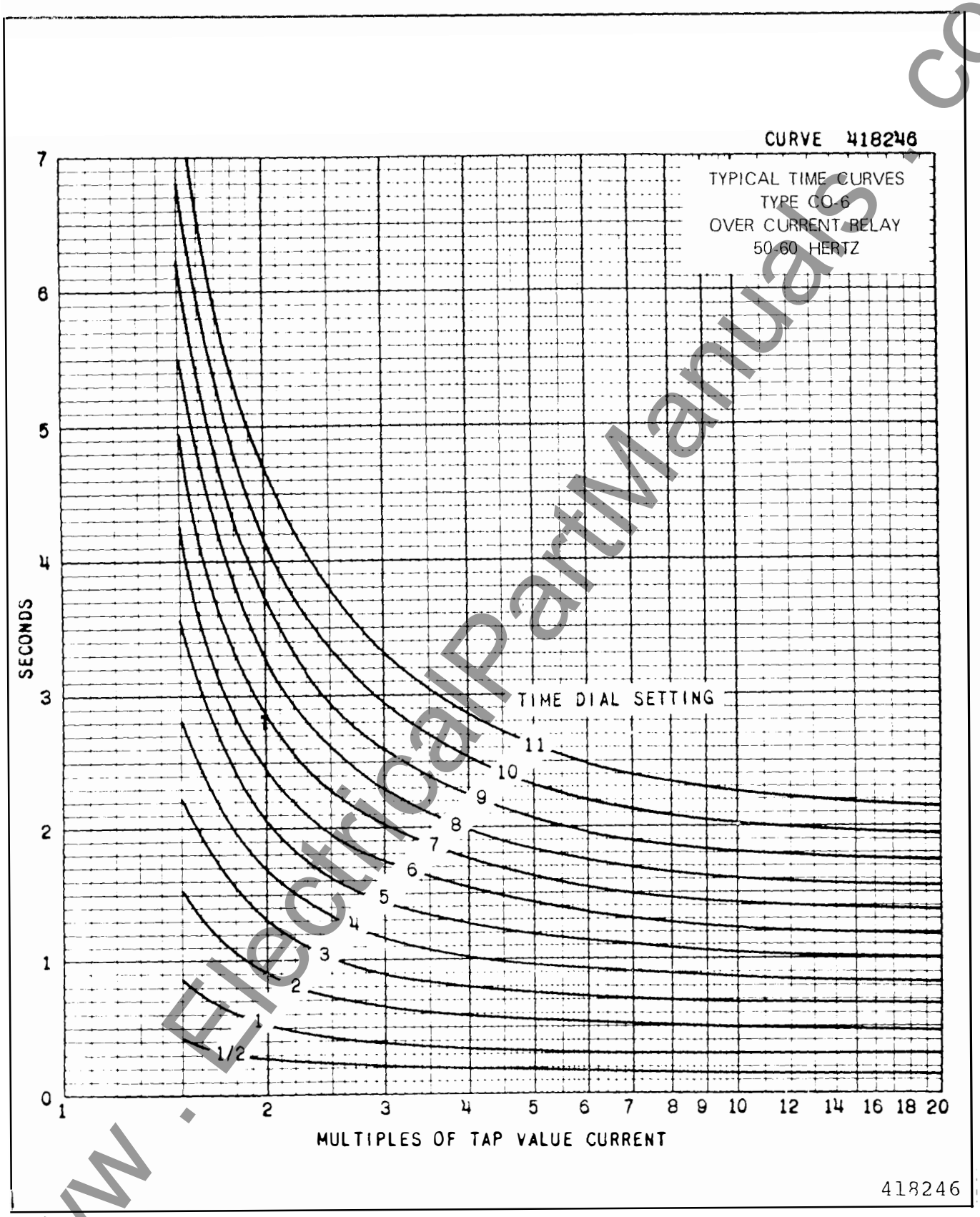


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

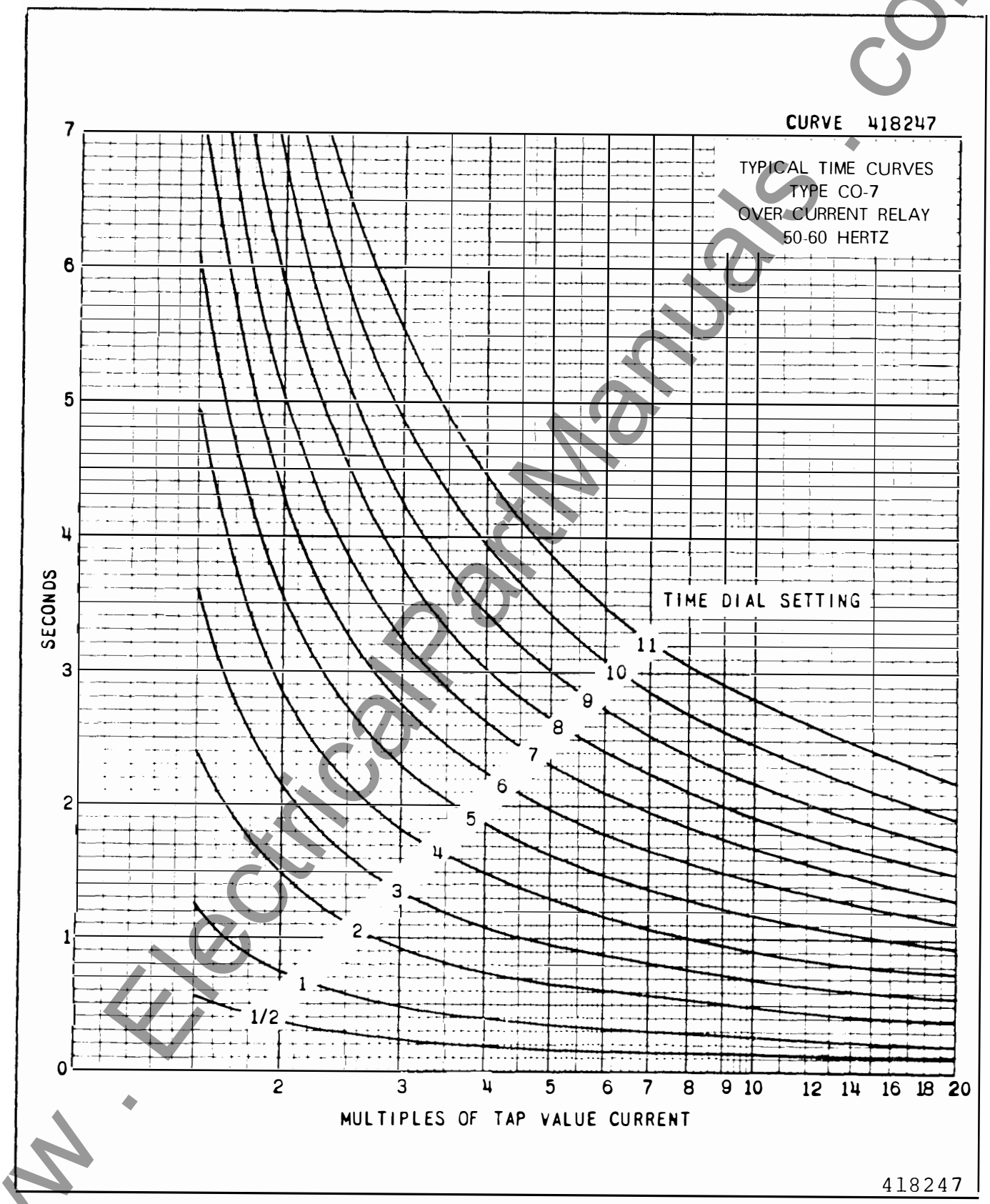


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

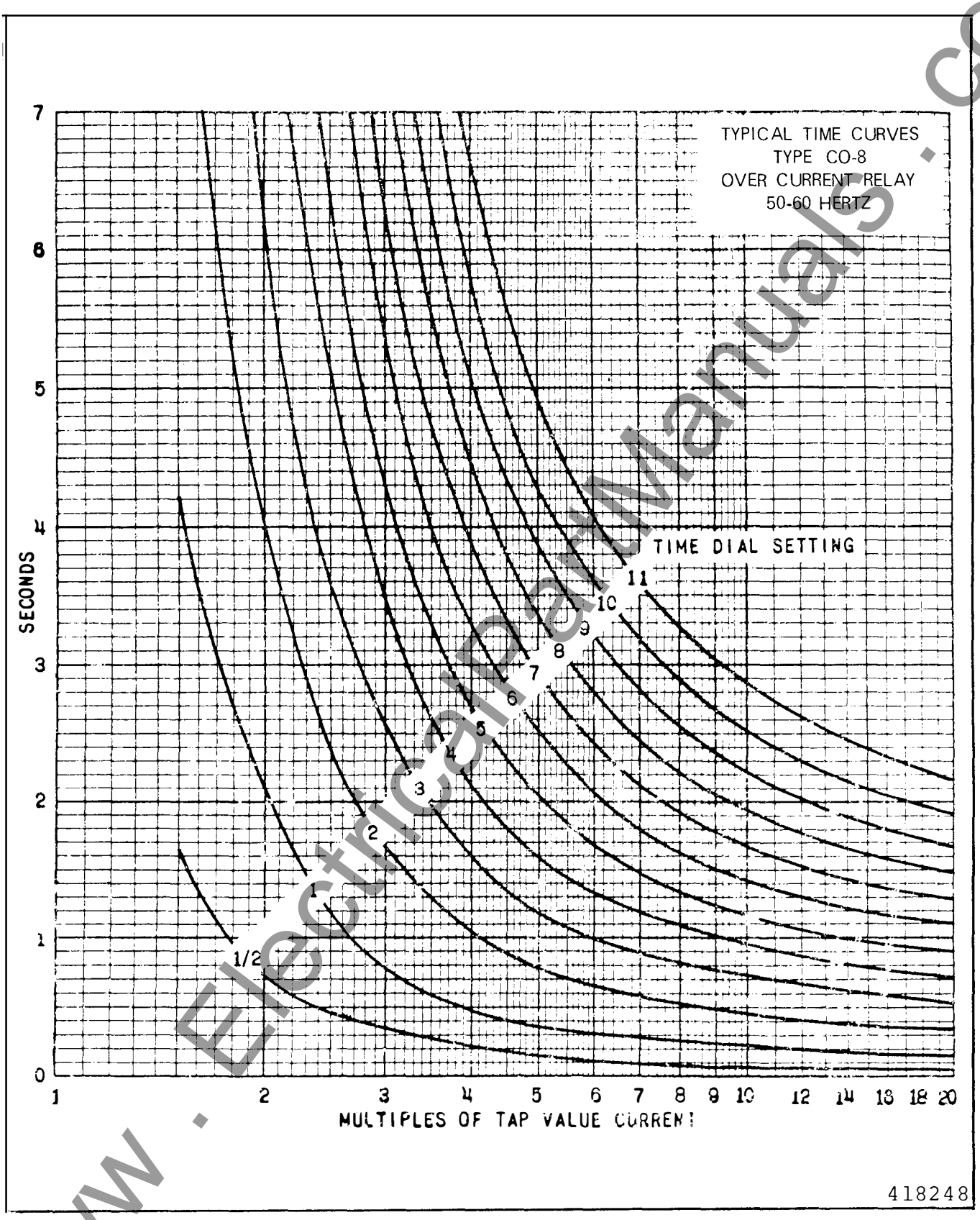


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

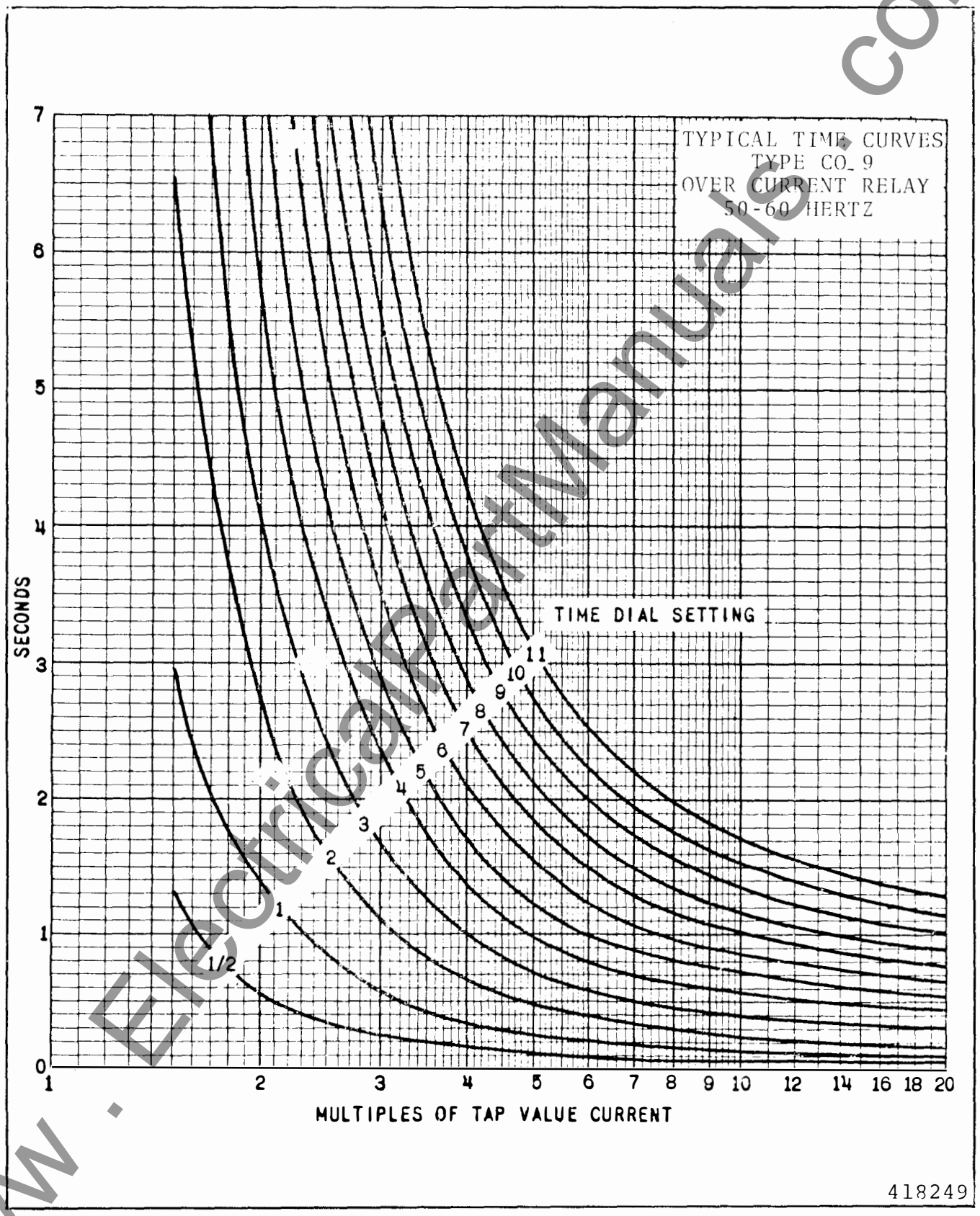


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

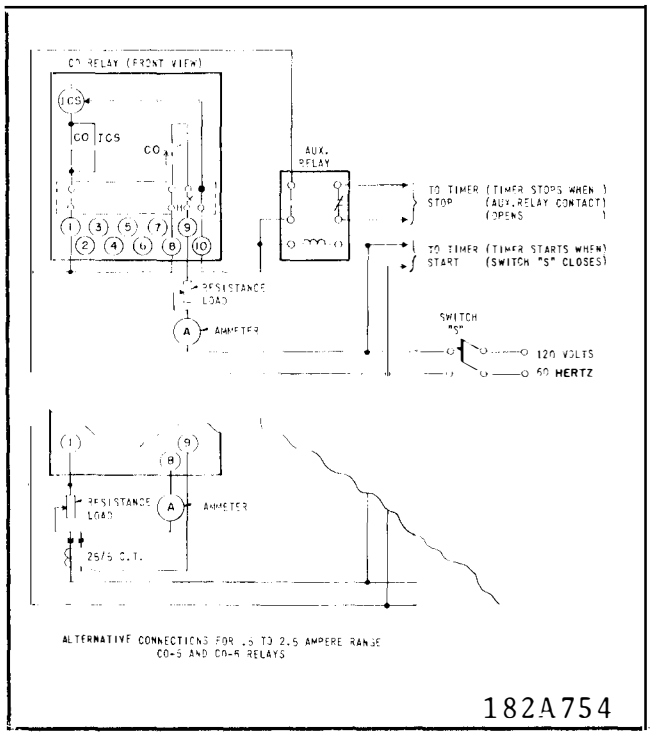


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

may be made directly to the terminals by means of screws for steel panel mounting or to the 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 I.L. 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.

For relays which include an indicating instantaneous trip unit (ITT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

ACCEPTANCE CHECK

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

1. **Contact**

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. **Minimum Trip Current** – Set the time dial to position 6 using the lowest tap setting, 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** – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Table I shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position and the relay set on the lowest tap setting, 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% (Use .5 tap for .1 to .5 range).

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridg-

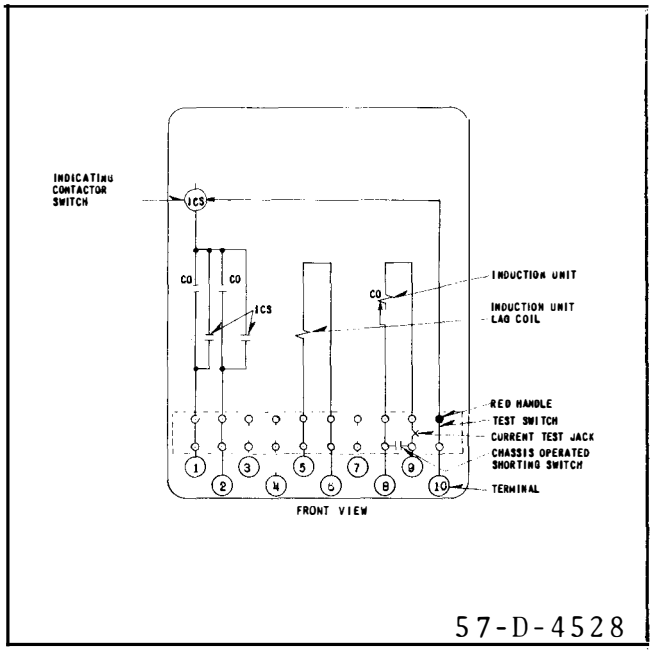


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.

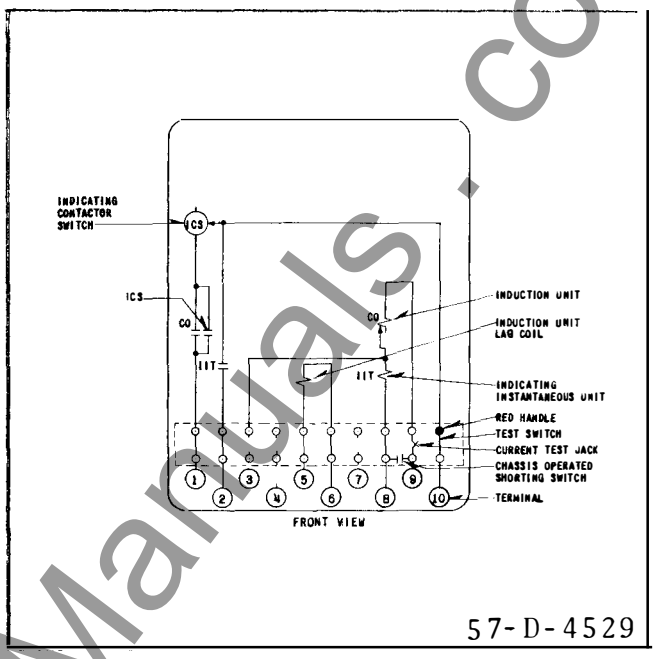


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

ing moving contact should touch both stationary contacts simultaneously.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

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

ROUTINE MAINTENANCE

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. **Contact**

   a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a posi-

tion where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

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 dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

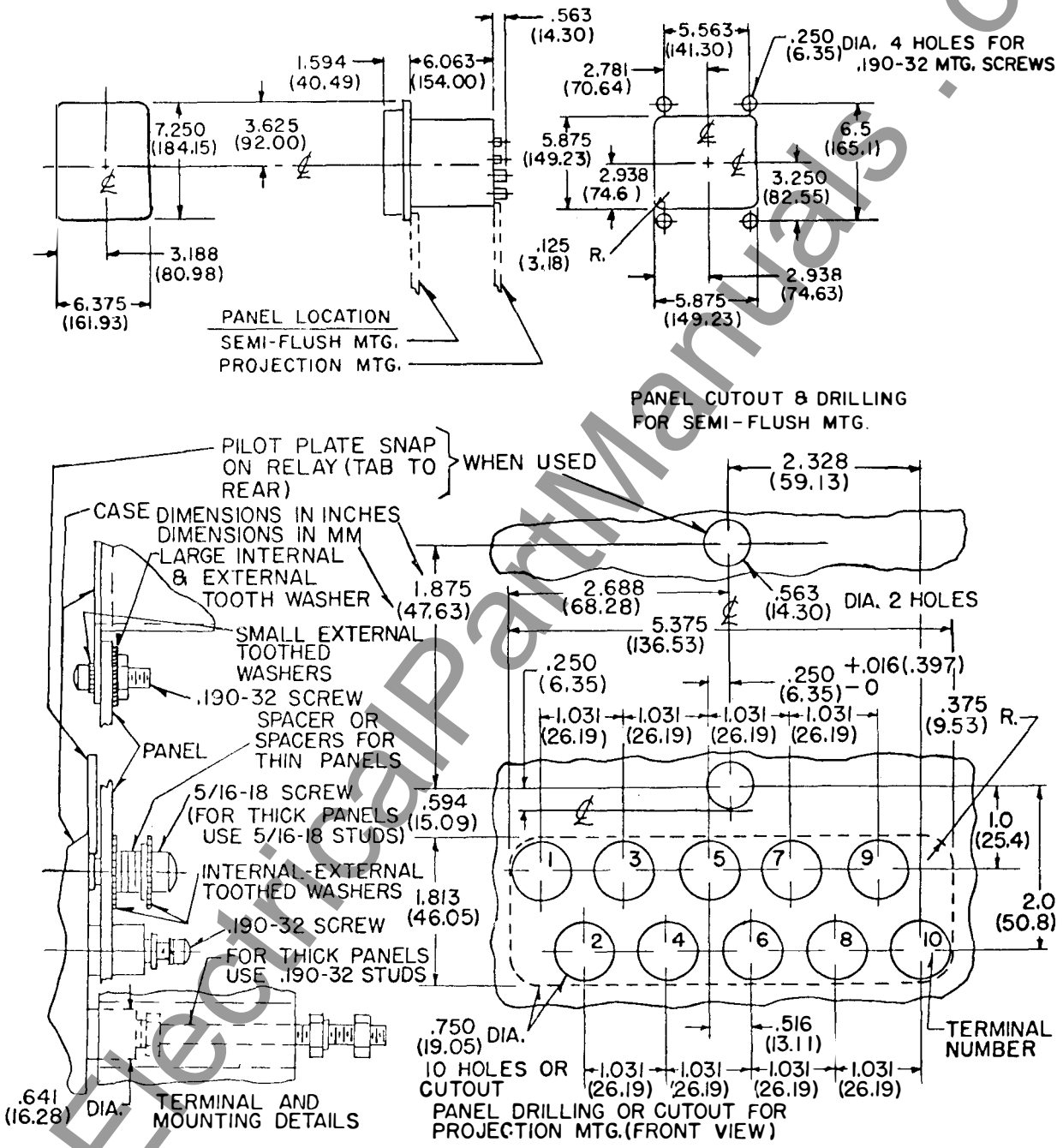
5. **Indicating Instantaneous Trip Unit (IIT)**

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.



Sub 12
57D7901

Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 60 HERTZ

	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 Δ

✪ △For 50 hertz CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

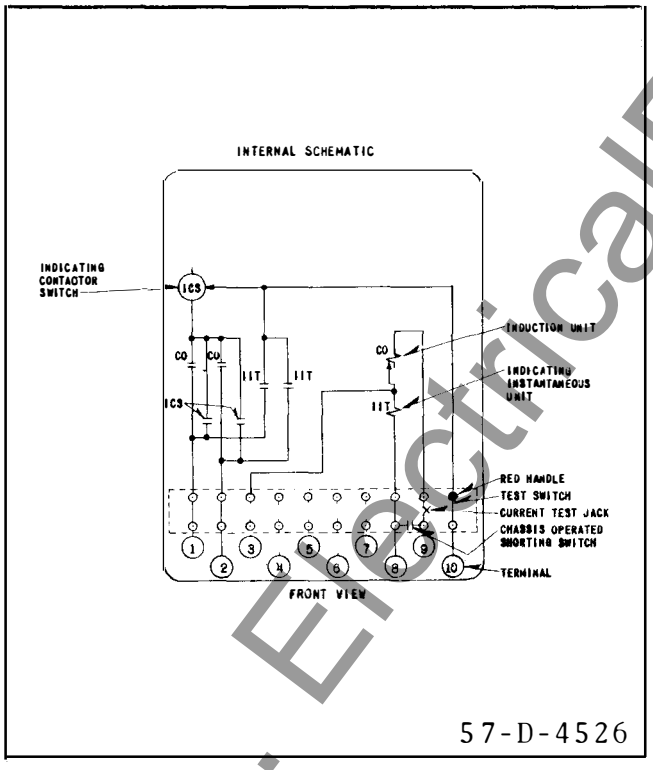


Fig. 20. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

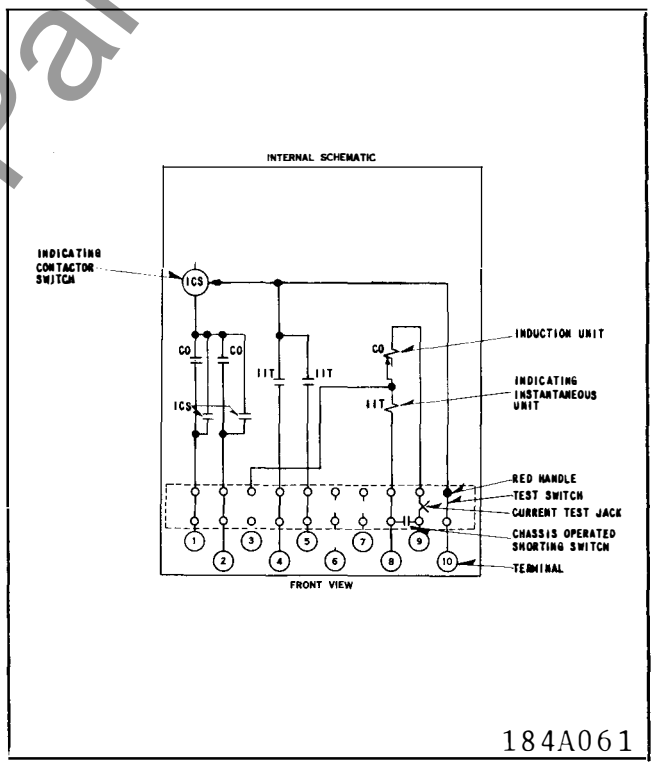


Fig. 21. Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit to Separate Terminals.

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.

CHARACTERISTICS

The relays are generally available in the following current ranges:

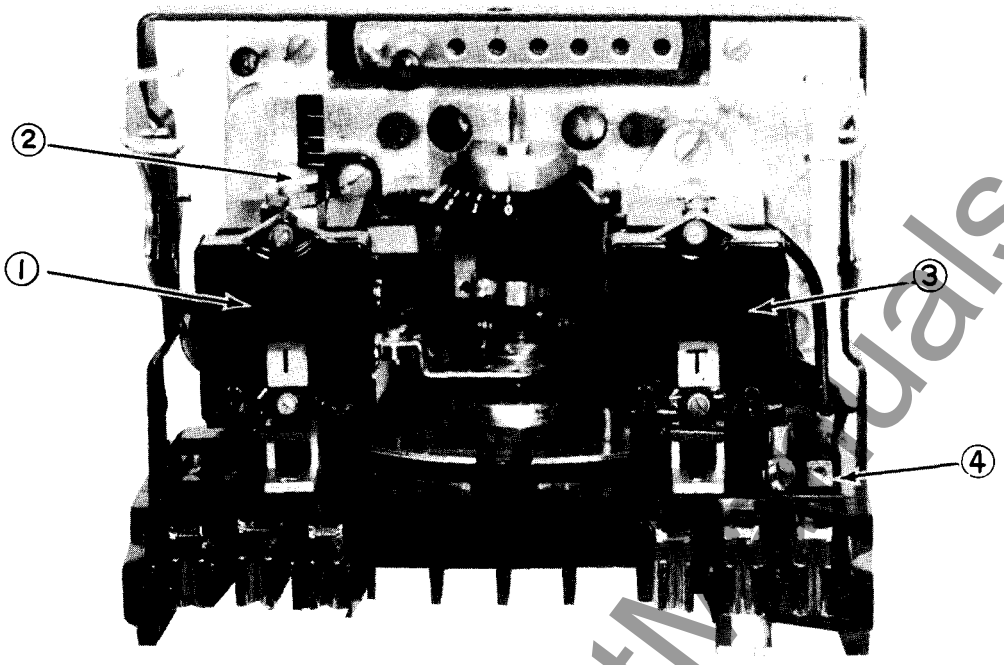


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

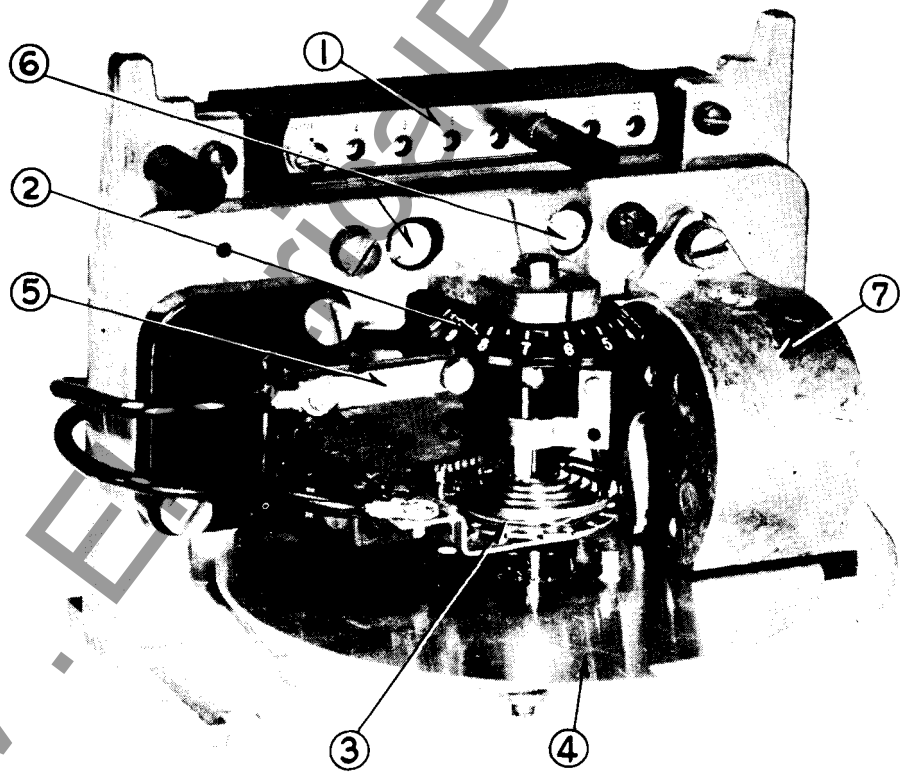


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

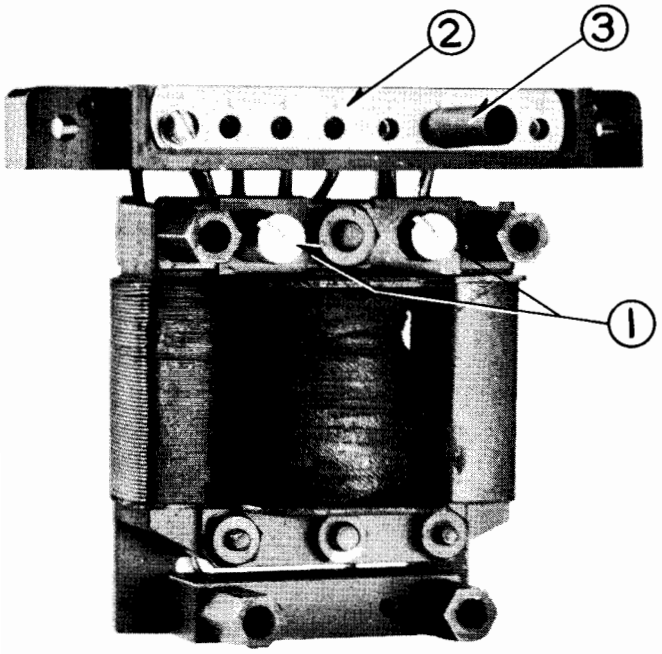


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

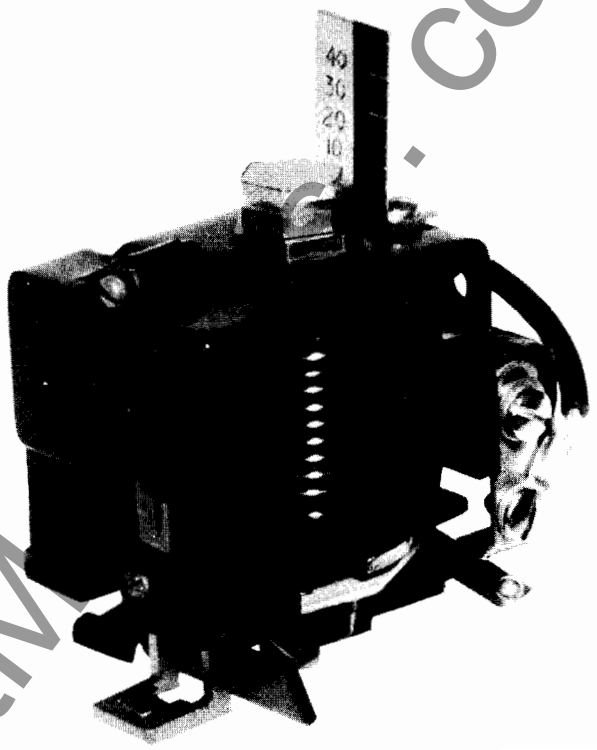


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

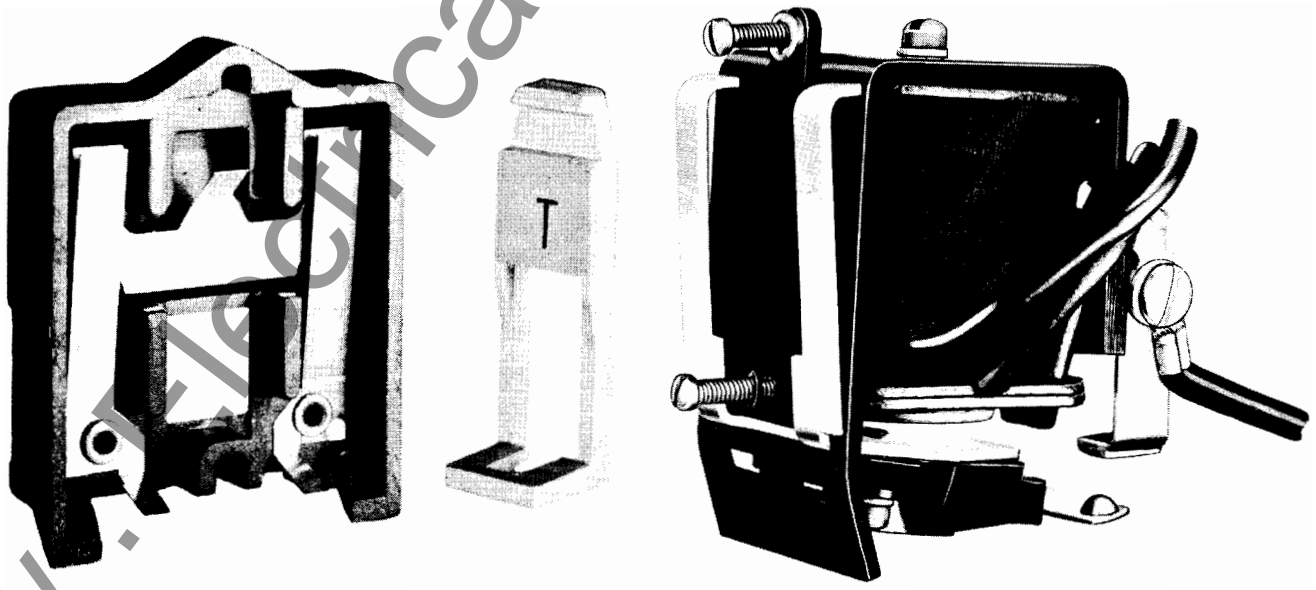


Fig. 5. Indicating Contactor Switch (ICS).

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

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

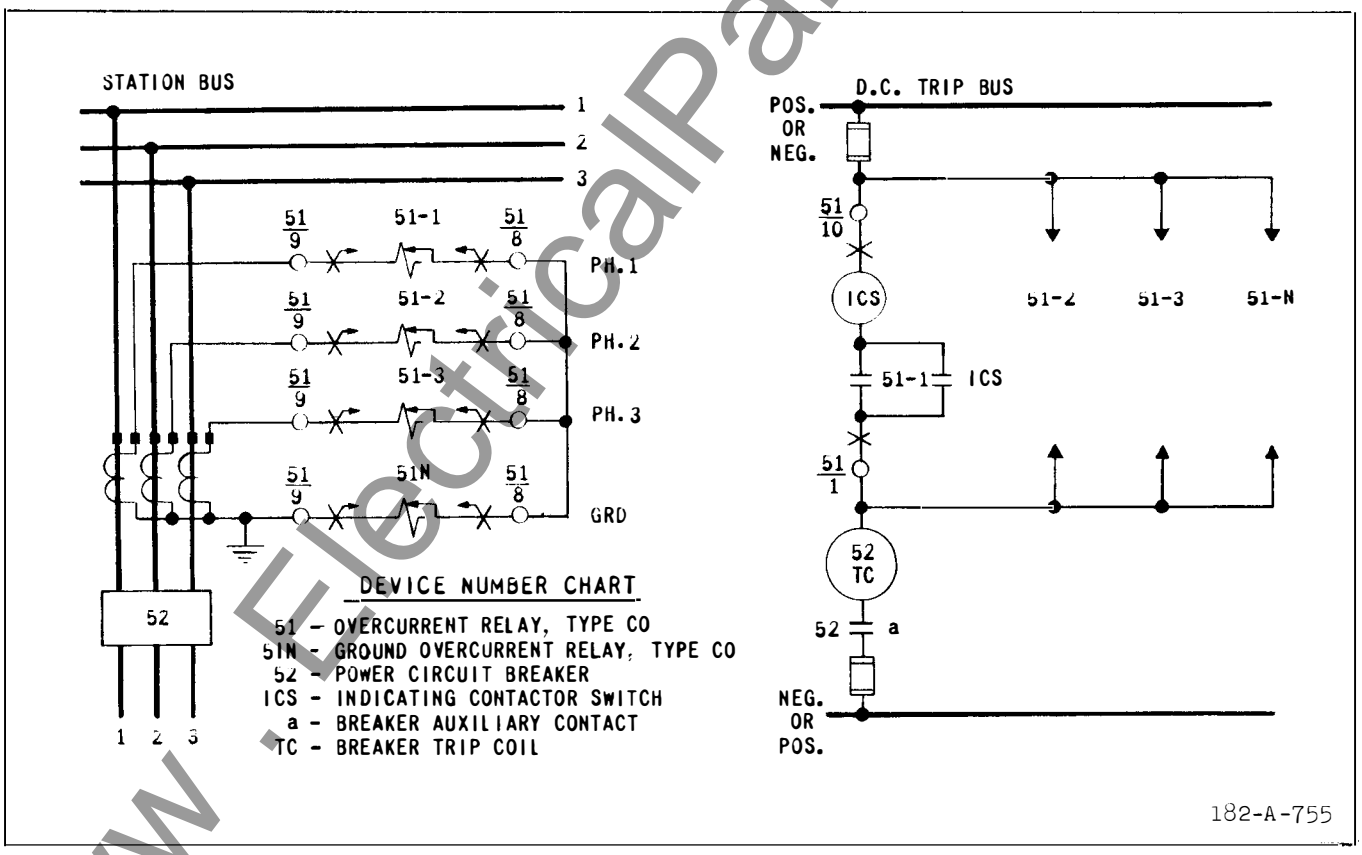


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

* Instantaneous Trip Unit (IIT)

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

TYPE CO-2 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	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	5.53	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.*

ENERGY REQUIREMENTS

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	2.7	88	69	3.92	20.6	103	270
	(0.6	3.1	88	68	3.96	20.7	106	288
	(0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	4.1	88	66	4.07	21.4	122	360
	(1.5	5.7	88	62	4.19	23.2	147	462
	(2.0	6.8	88	60	4.30	24.9	168	548
	(2.5	7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.*

ENERGY REQUIREMENTS

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

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ¢	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	2.7	88	72	2.38	21	132	350
	(0.6	3.1	88	71	2.38	21	134	365
	(0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	4.1	88	67	2.42	21.2	150	440
	(1.5	5.7	88	62	2.51	22	170	530
	(2.0	6.8	88	57	2.65	23.5	200	675
	(2.5	7.7	88	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	2.5	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 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.*

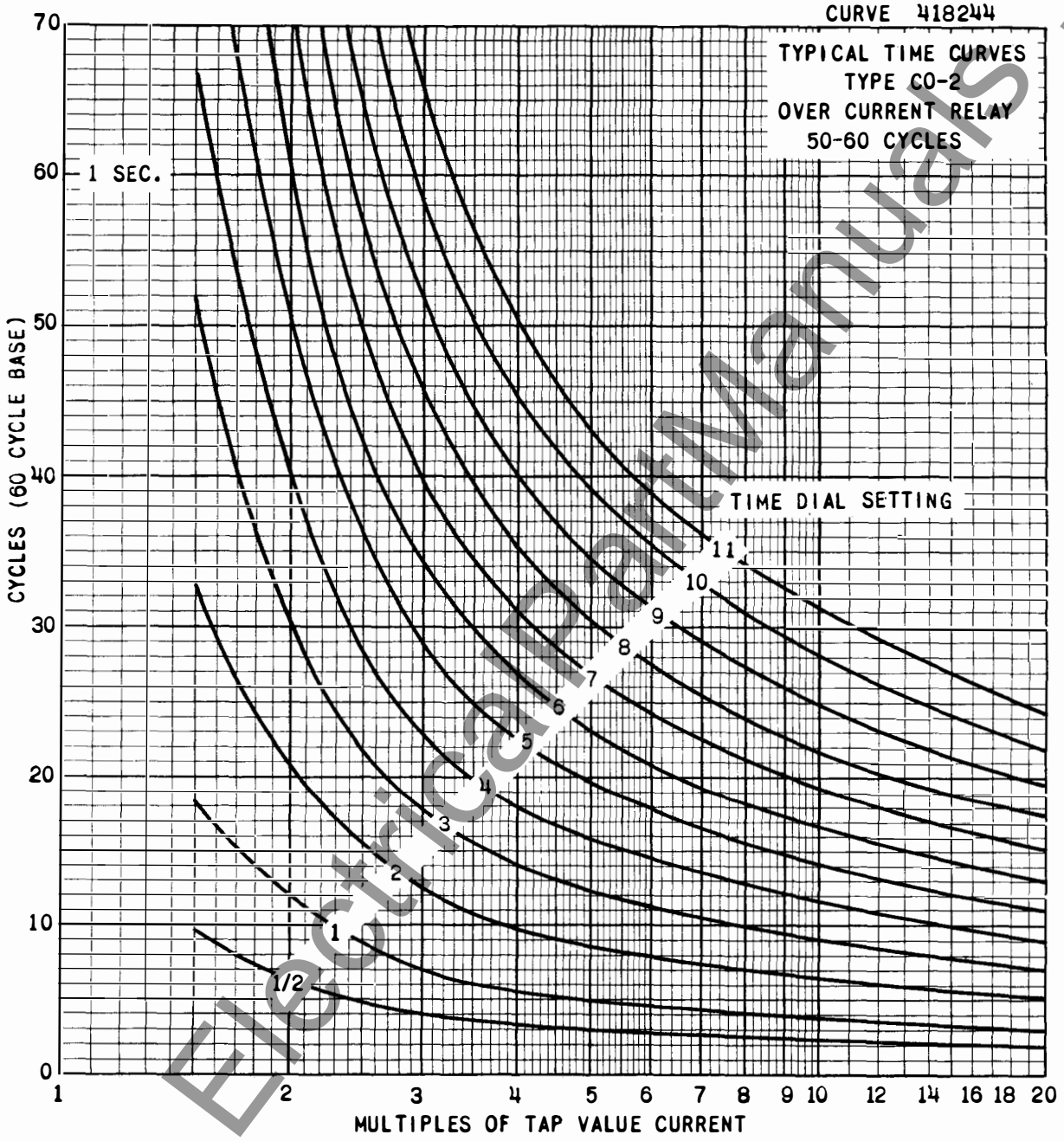


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

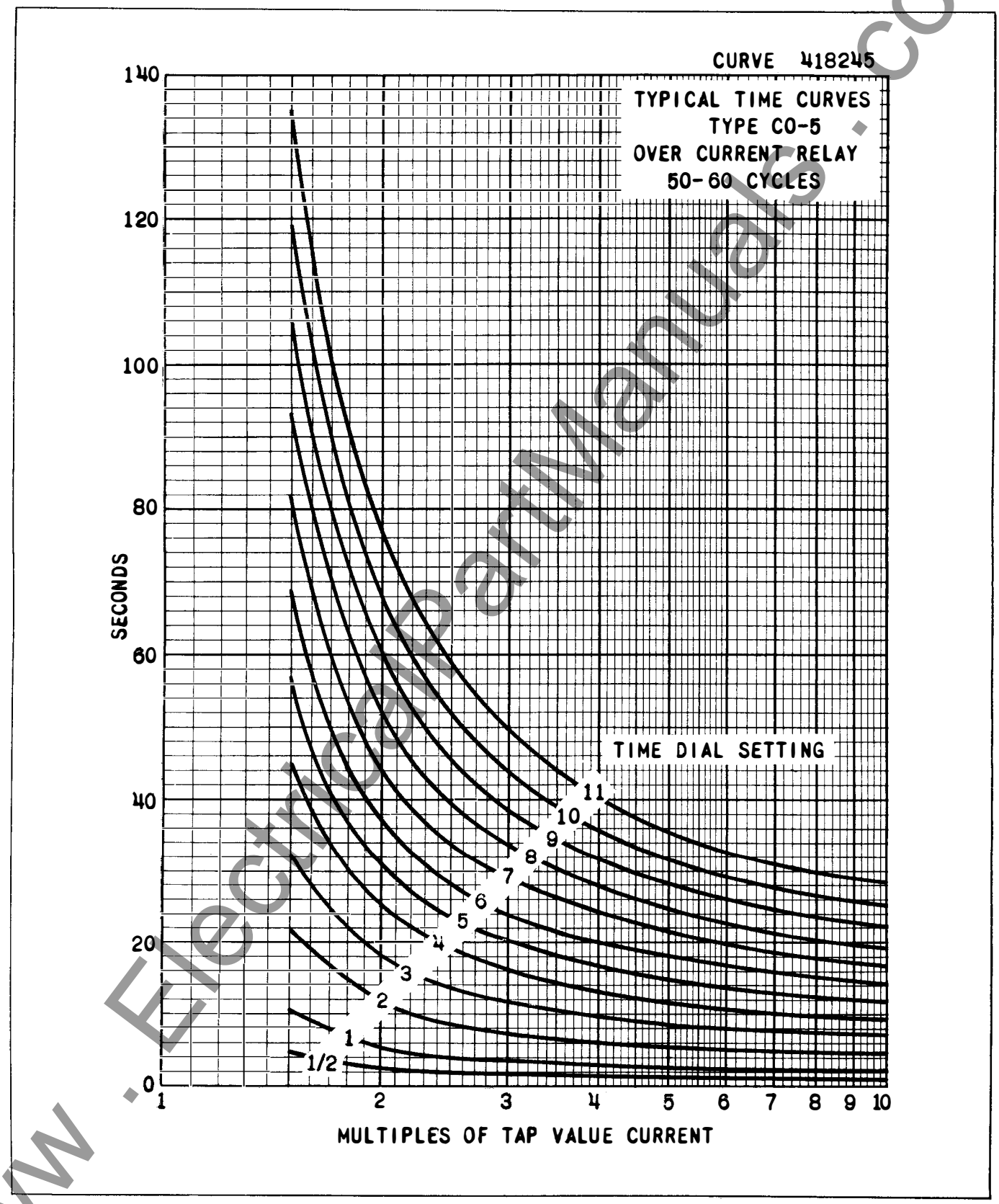


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

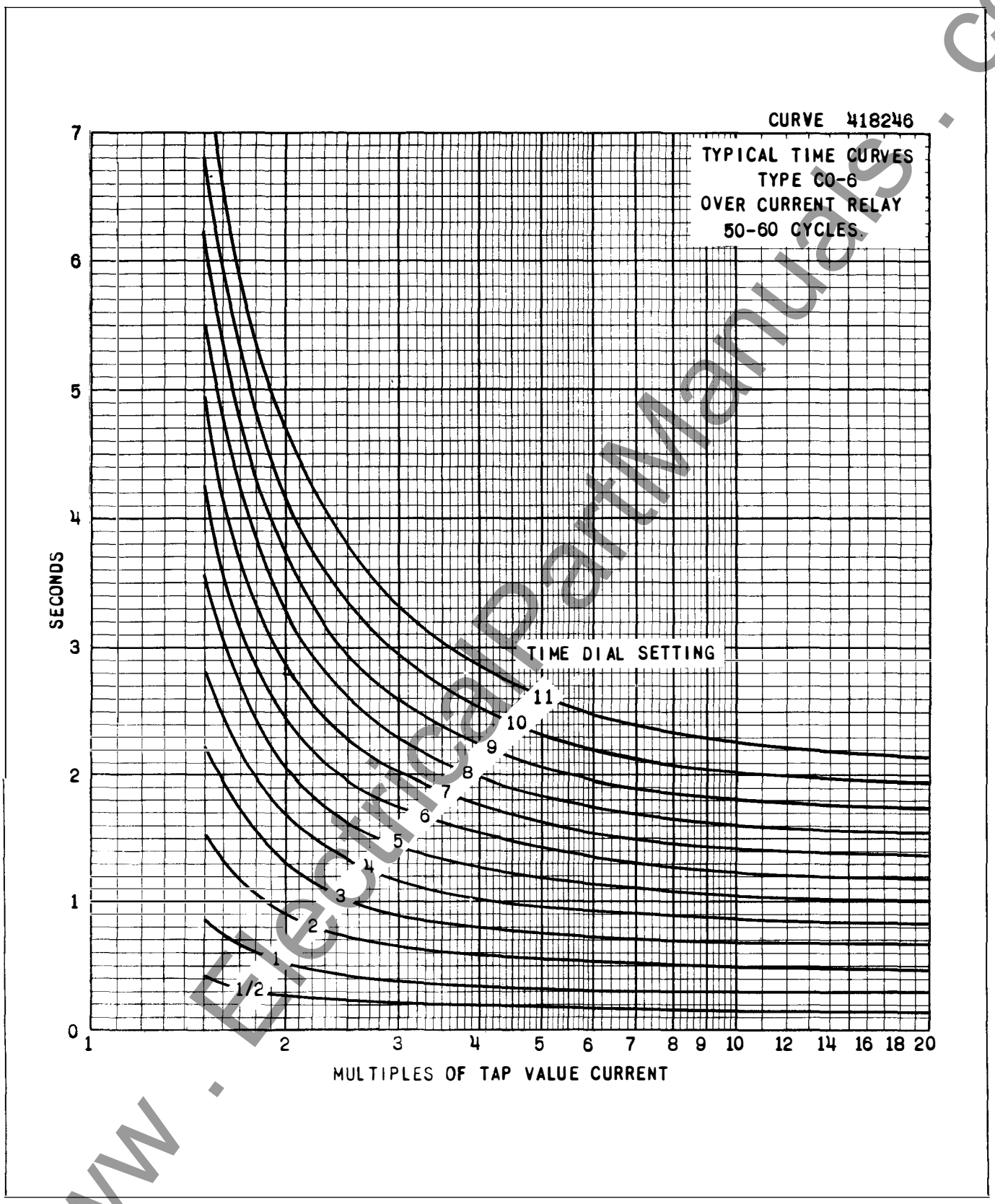


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

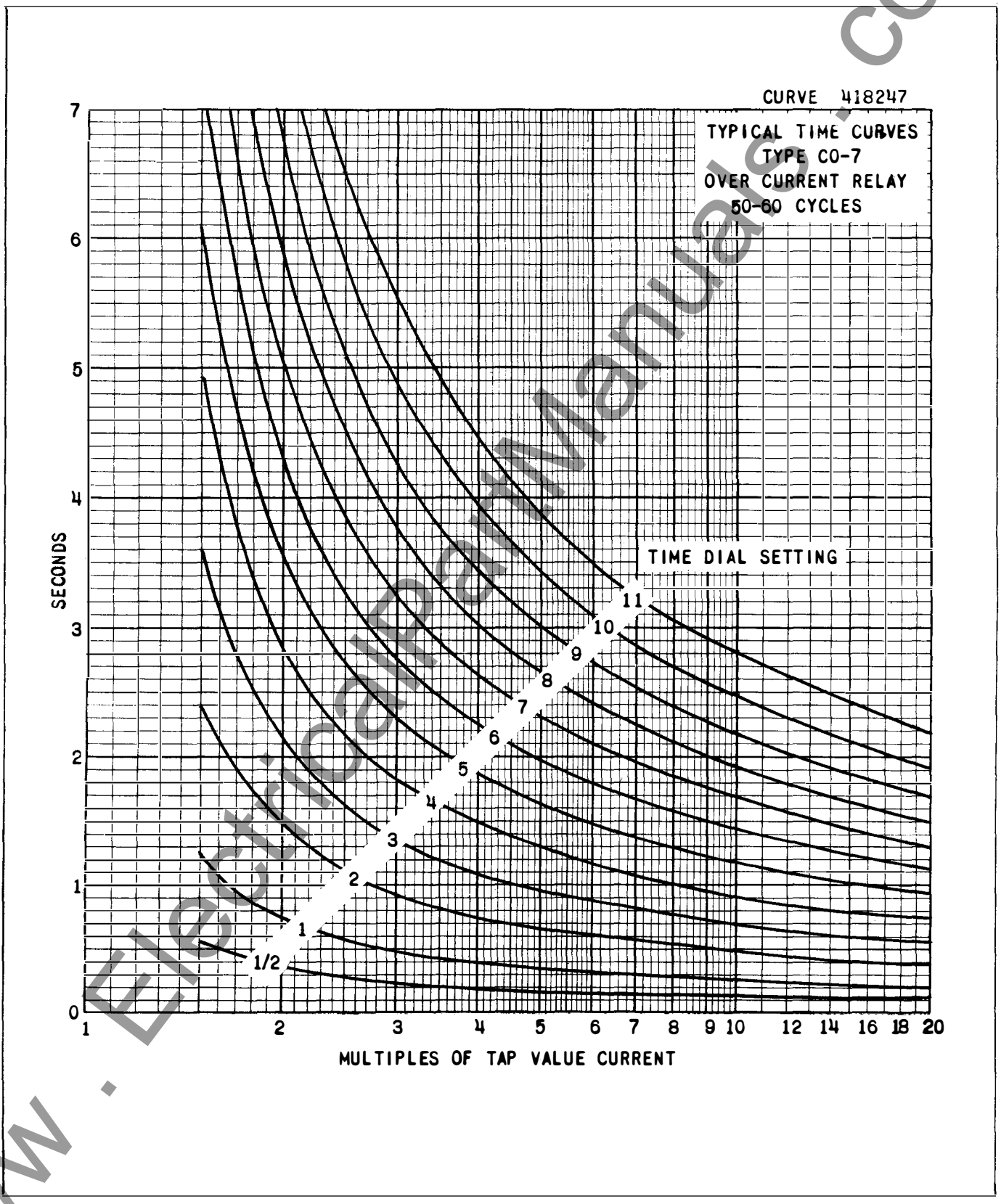


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

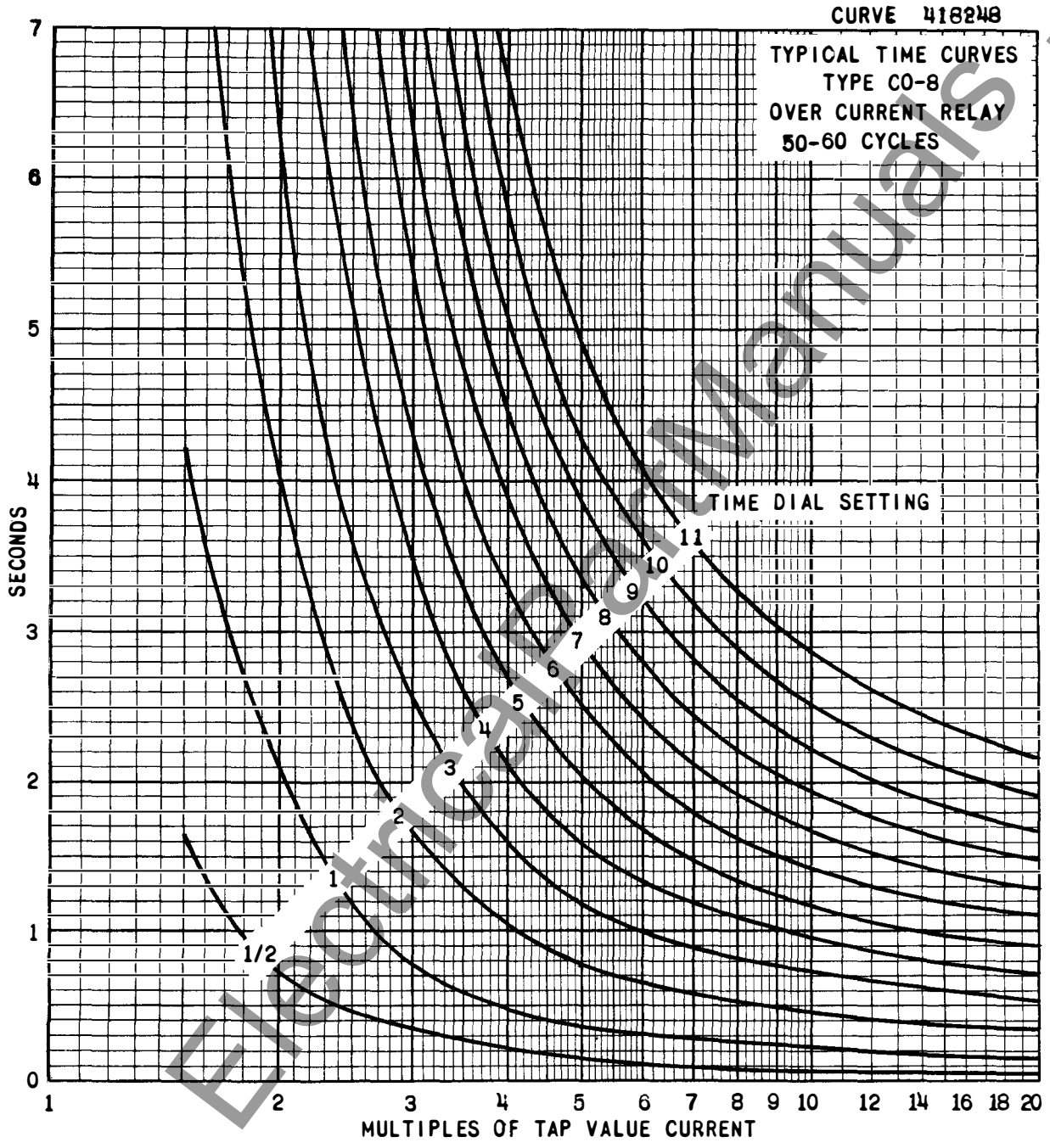


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

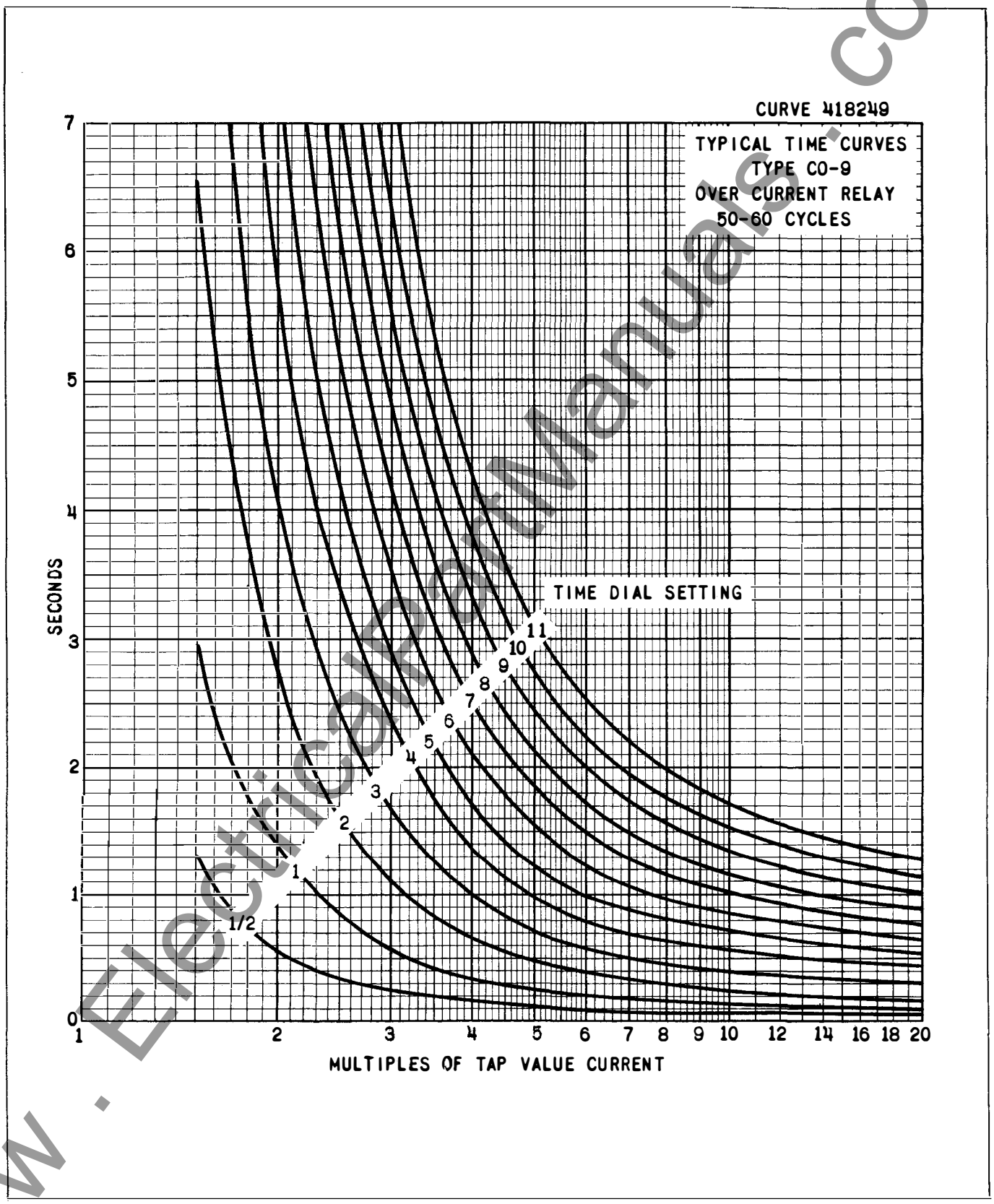


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

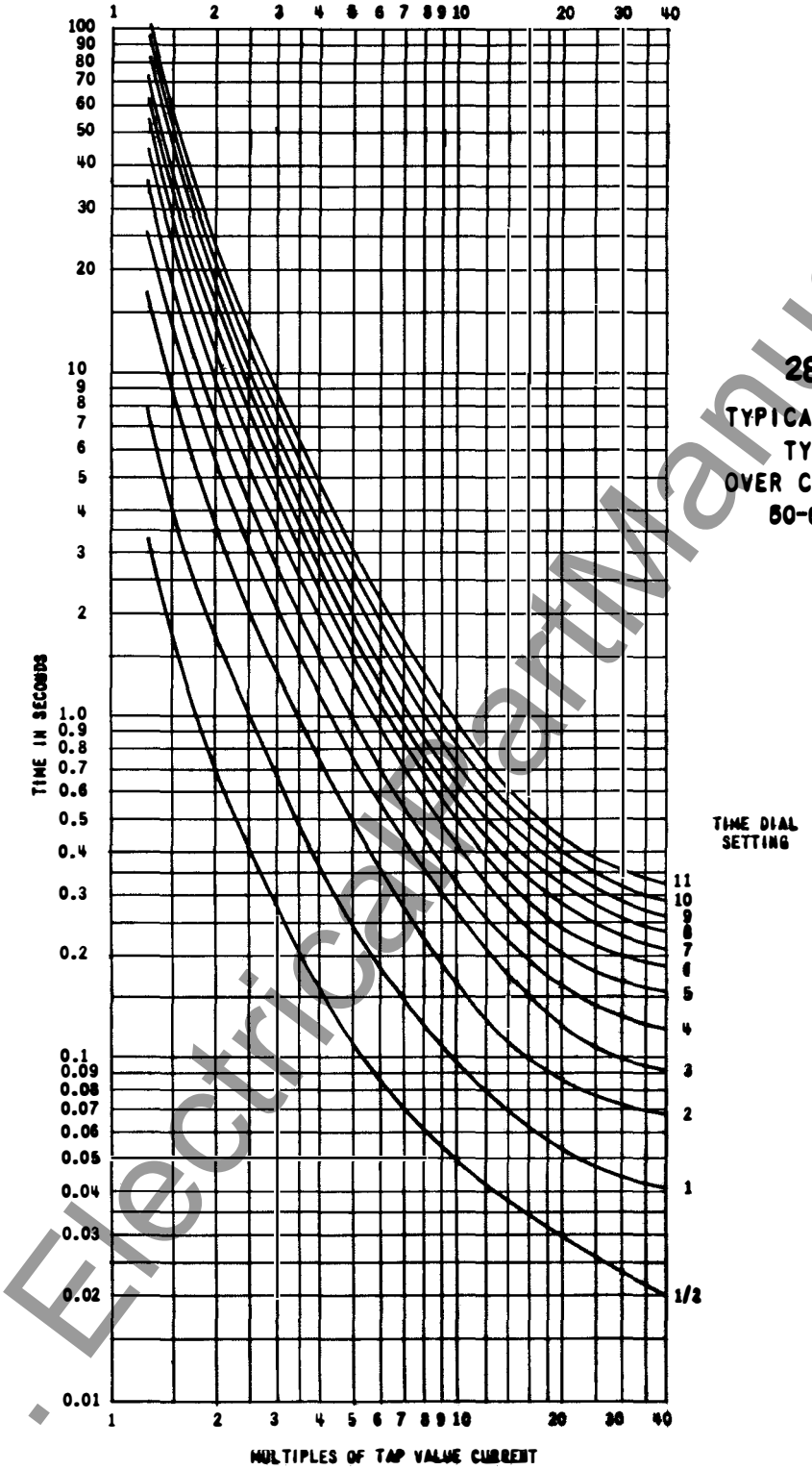


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

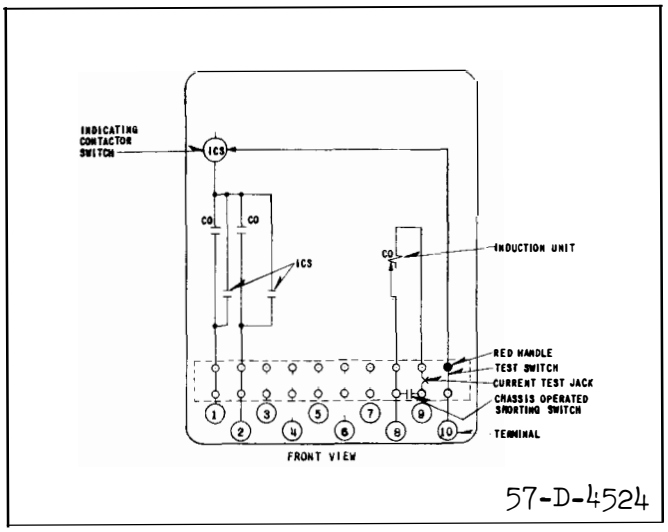


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted.

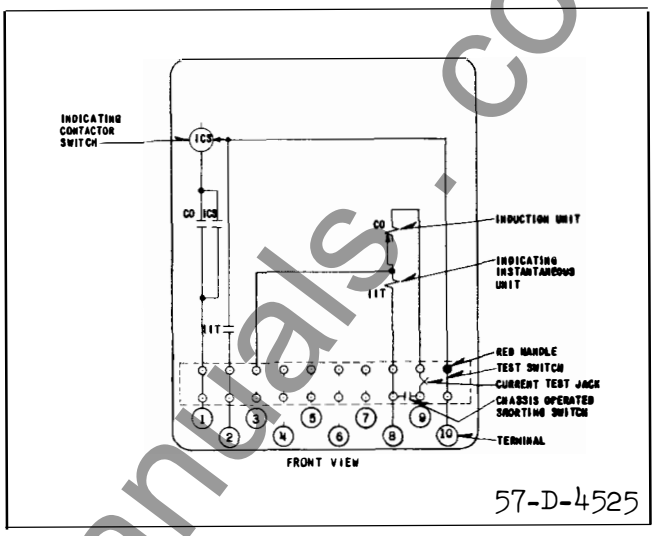


Fig. 15. Internal Schematic of the Single Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is 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)

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.

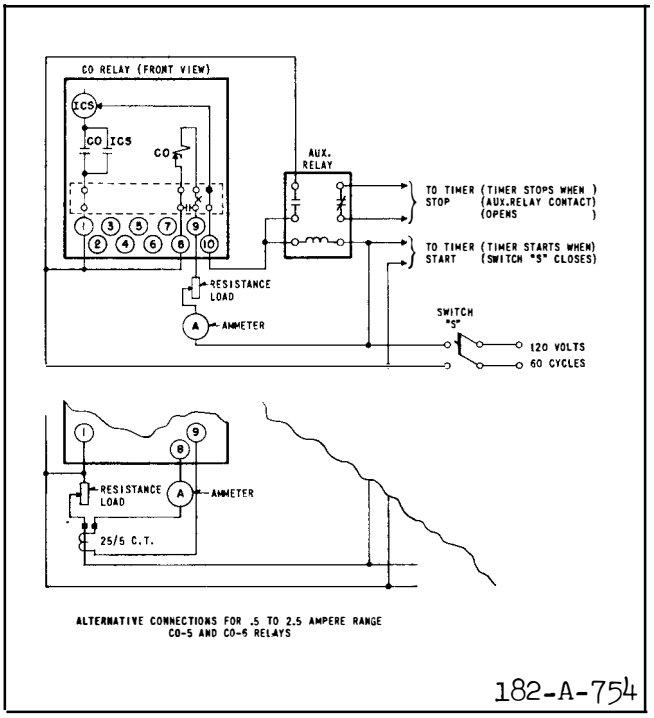


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

Acceptance Check

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

1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current — Set the time dial to position 6 using the lowest tap setting, 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 – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time

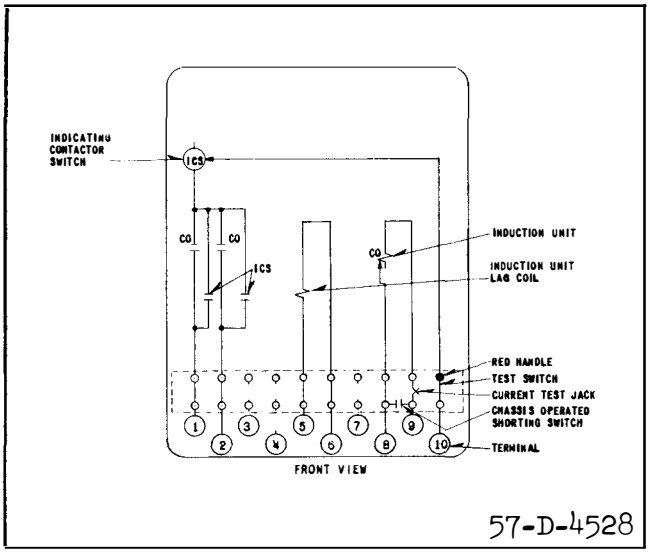


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

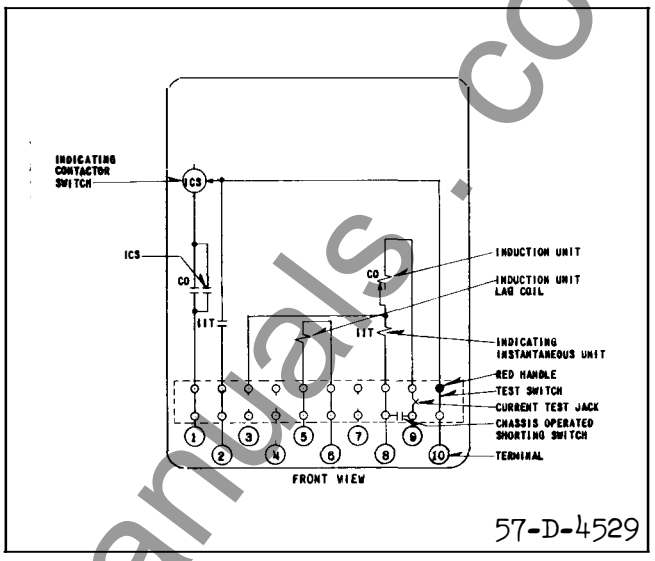


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

dial set to the indicated position and the relay set on the lowest tap setting, 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%

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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.

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

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

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)

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.

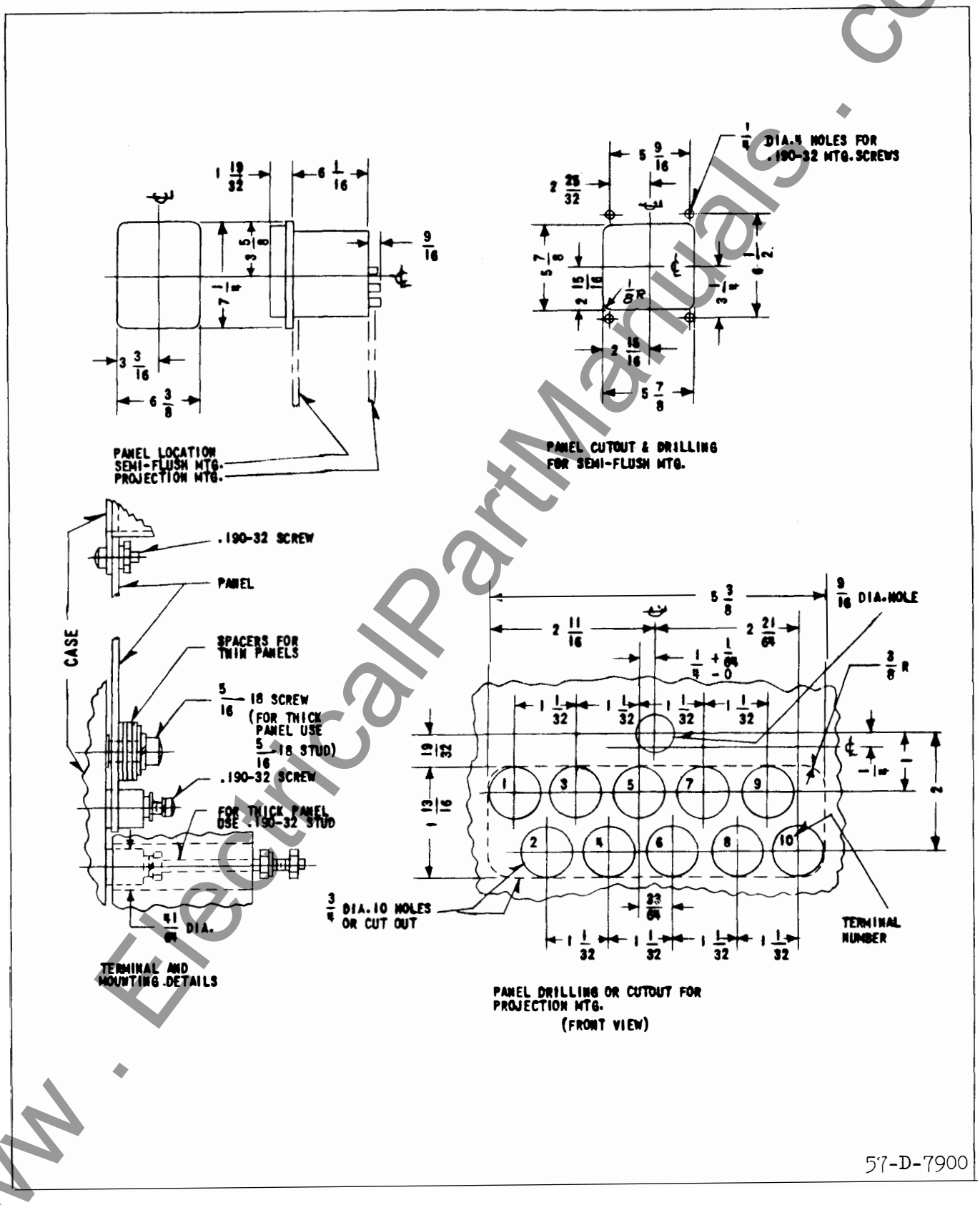


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 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 Δ

Δ For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

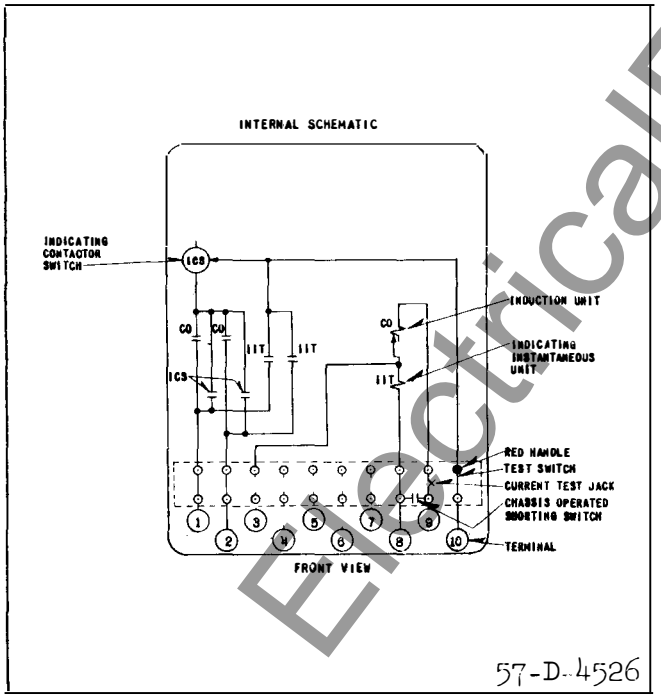


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

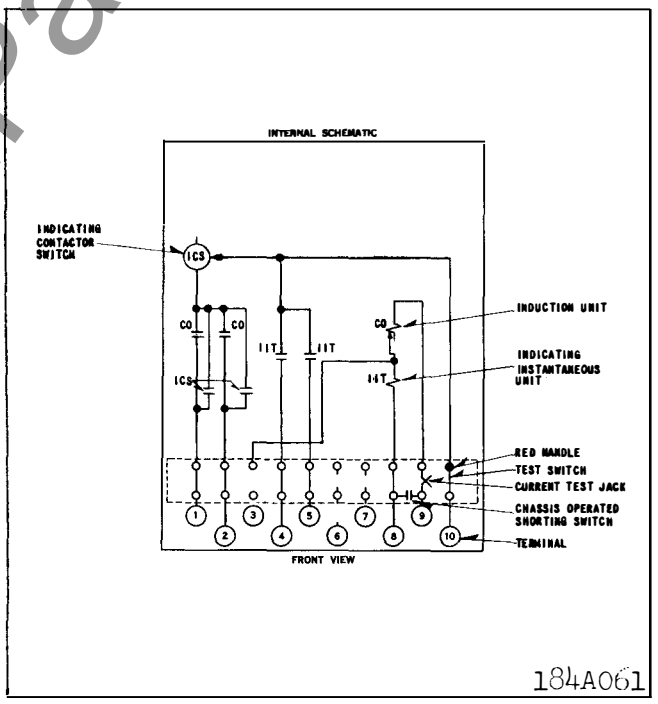


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

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

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.

CHARACTERISTICS

The relays are generally available in the following current ranges:

SUPERSEDES I.L. 41-101L
* Denotes change from superseded issue.

EFFECTIVE MAY 1967

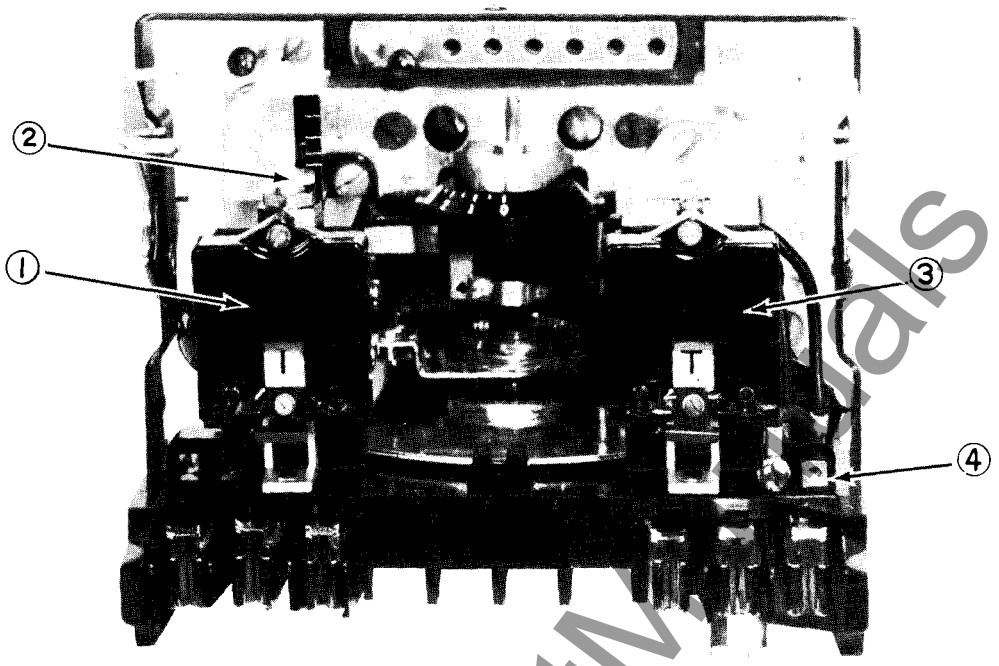


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

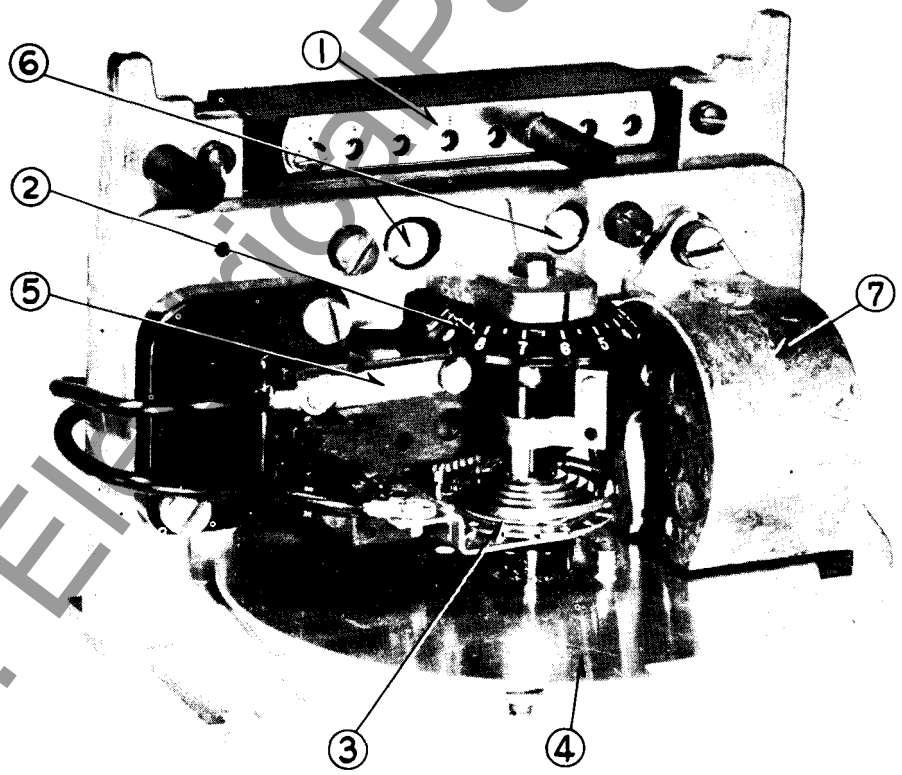


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

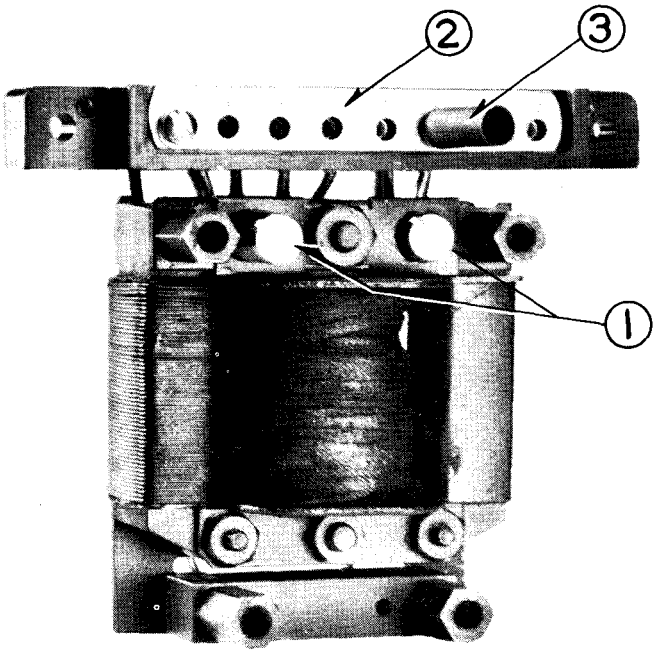


Fig. 3. "E" Type Electromagnet. 1-Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

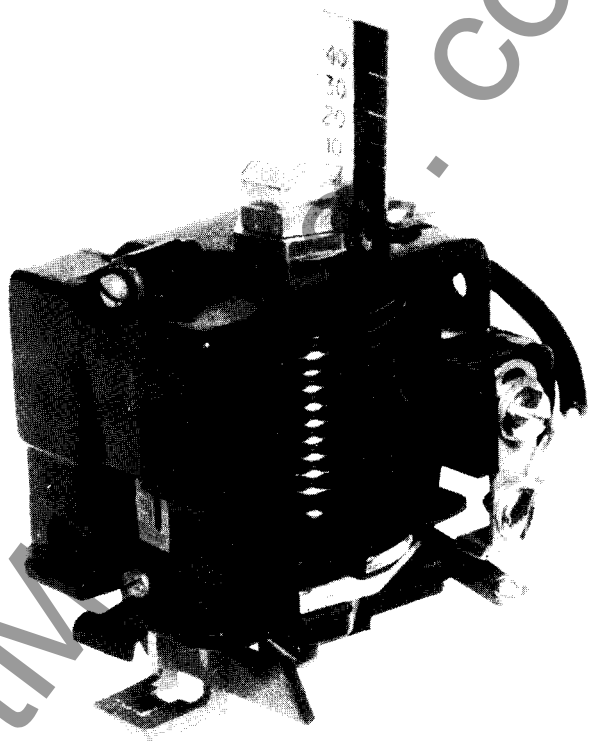


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

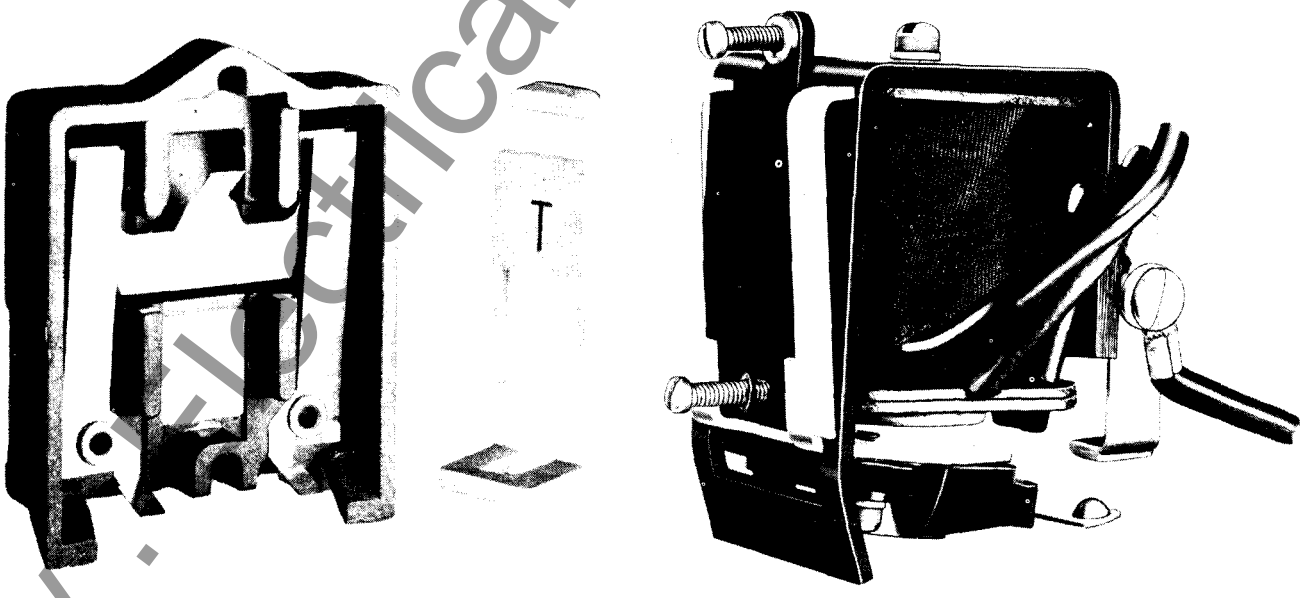


Fig. 5. Indicating Contactor Switch (ICS).

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

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

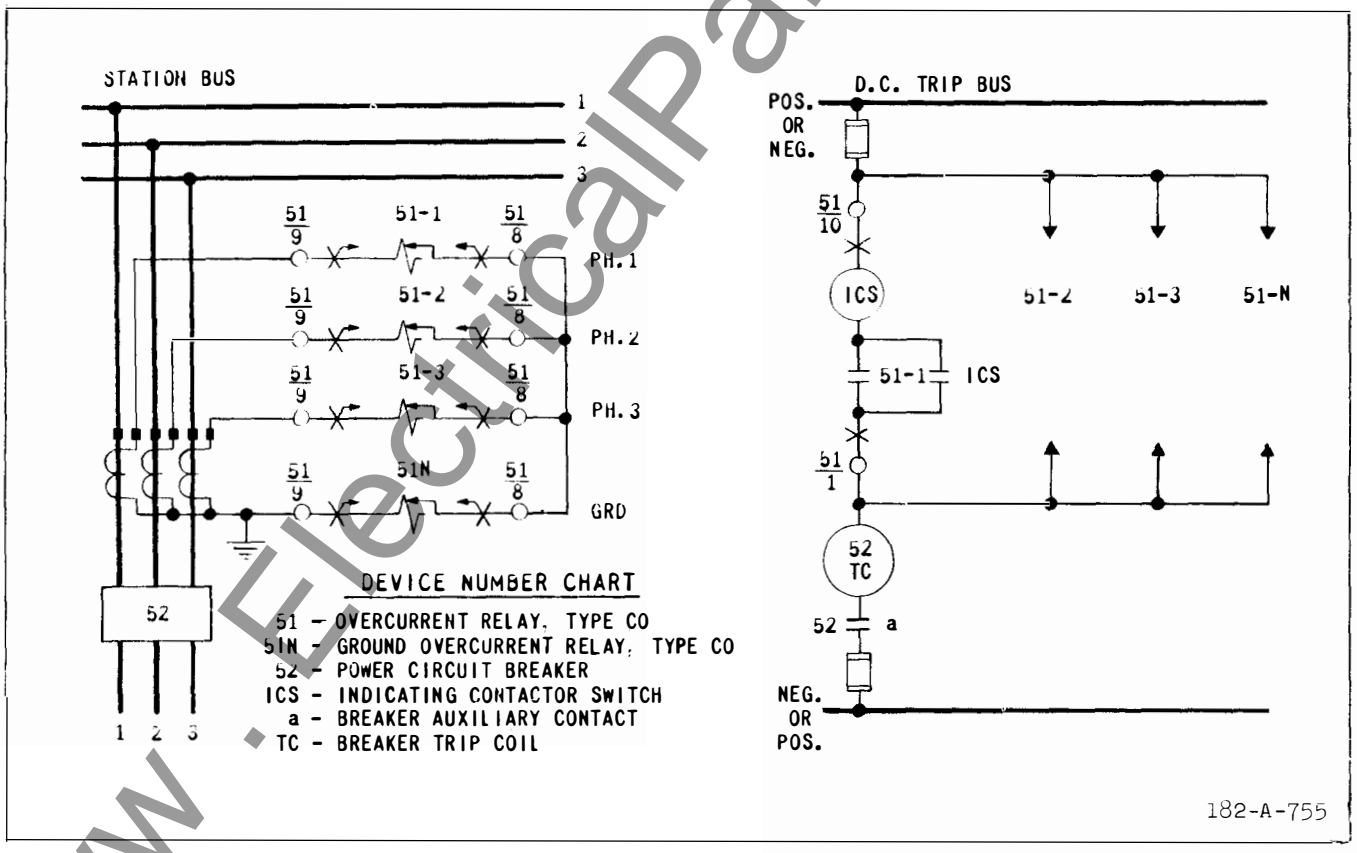


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

ENERGY REQUIREMENTS

*** Instantaneous Trip Unit (IIT)**

RANGE IN AMPERES	BURDEN IN VOLT-AMPS. AT	
	MINIMUM SETTING	MAXIMUM SETTING
2 - 8	4.5	32
4 - 16	4.5	32
10 - 40	4.5	40
20 - 80	6.5	70
40 - 160	9.0	144

TYPE CO-2 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	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	5.53	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.*

ENERGY REQUIREMENTS

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	2.7	88	69	3.92	20.6	103	270
	(0.6	3.1	88	68	3.96	20.7	106	288
	(0.8	3.7	88	67	3.96	21	114	325
0.5/2.5	(1.0	4.1	88	66	4.07	21.4	122	360
	(1.5	5.7	88	62	4.19	23.2	147	462
	(2.0	6.8	88	60	4.30	24.9	168	548
	(2.5	7.7	88	58	4.37	26.2	180	630
	(2	8	230	67	3.88	21	110	308
	(2.5	8.8	230	66	3.90	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	4.12	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	4.35	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	2.7	88	68	3.88	20.7	103	278
	(0.6	3.1	88	67	3.93	20.9	107	288
	(0.8	3.7	88	66	3.93	21.1	114	320
0.5/2.5	(1.0	4.1	88	64	4.00	21.6	122	356
	(1.5	5.7	88	61	4.08	22.9	148	459
	(2.0	6.8	88	58	4.24	24.8	174	552
	(2.5	7.7	88	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.*

ENERGY REQUIREMENTS

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

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ¢	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	2.7	88	72	2.38	21	132	350
	(0.6	3.1	88	71	2.38	21	134	365
	(0.8	3.7	88	69	2.40	21.1	142	400
0.5/2.5	(1.0	4.1	88	67	2.42	21.2	150	440
	(1.5	5.7	88	62	2.51	22	170	530
	(2.0	6.8	88	57	2.65	23.5	200	675
	(2.5	7.7	88	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	2.5	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 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.*

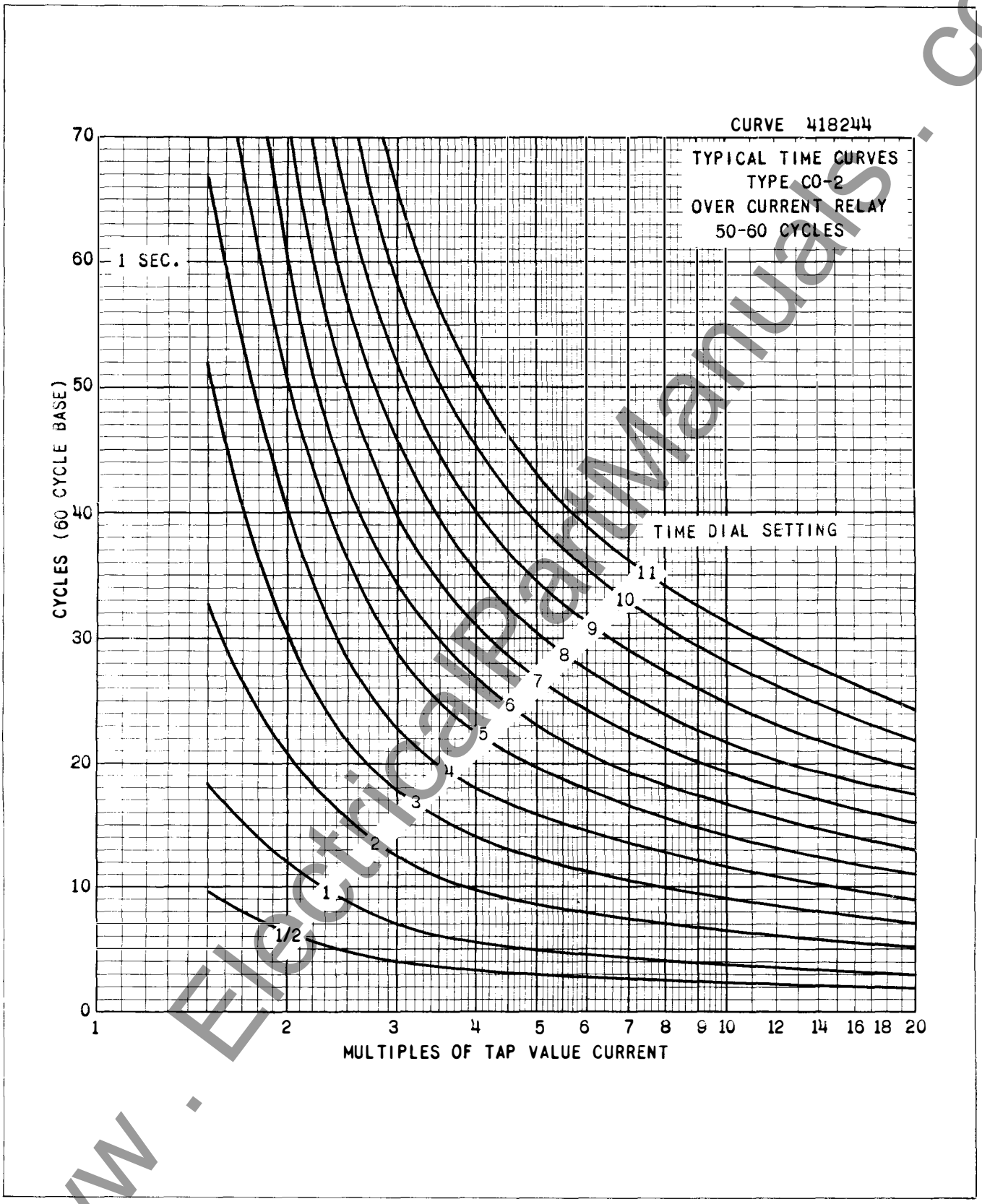


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

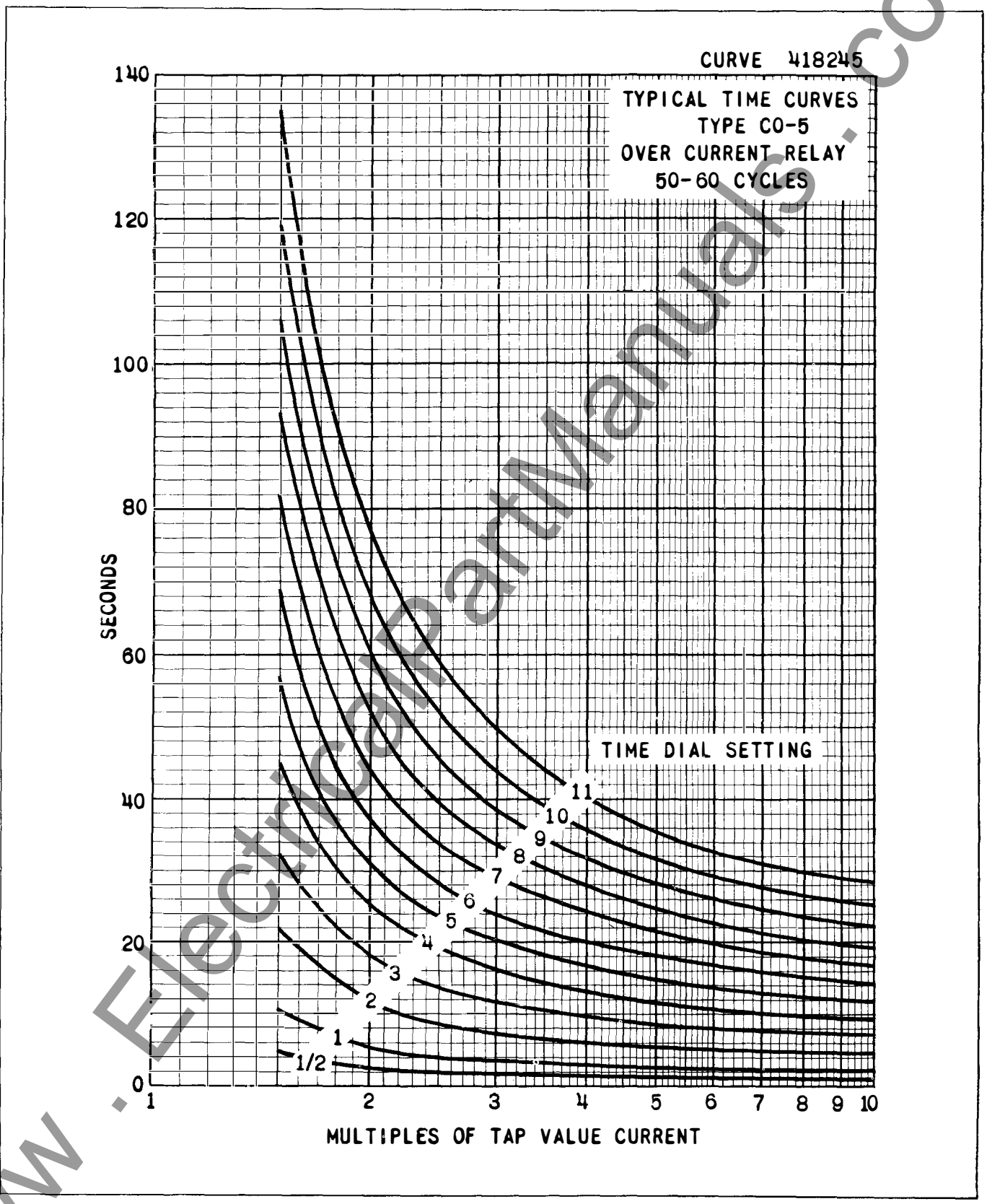


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

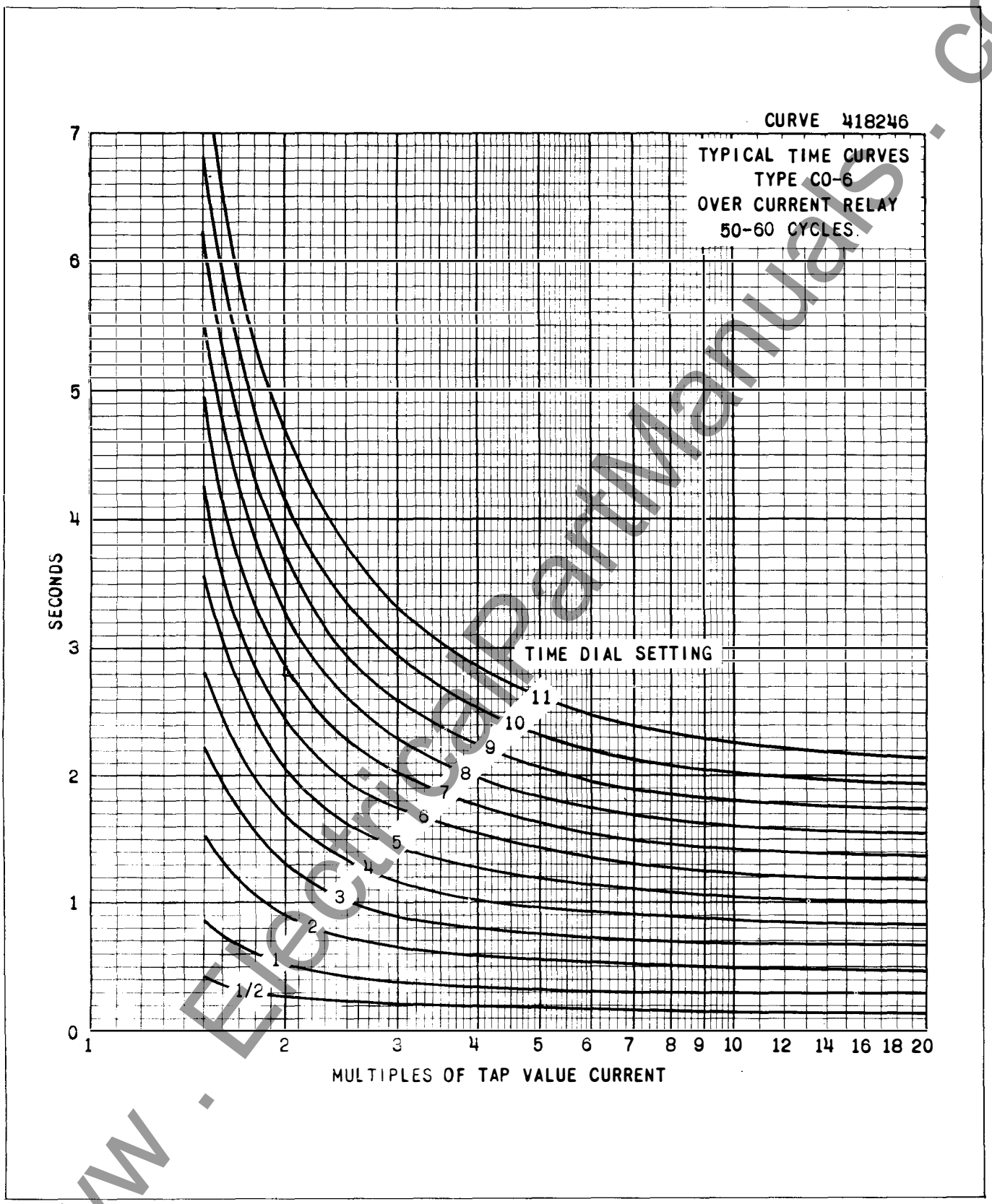


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

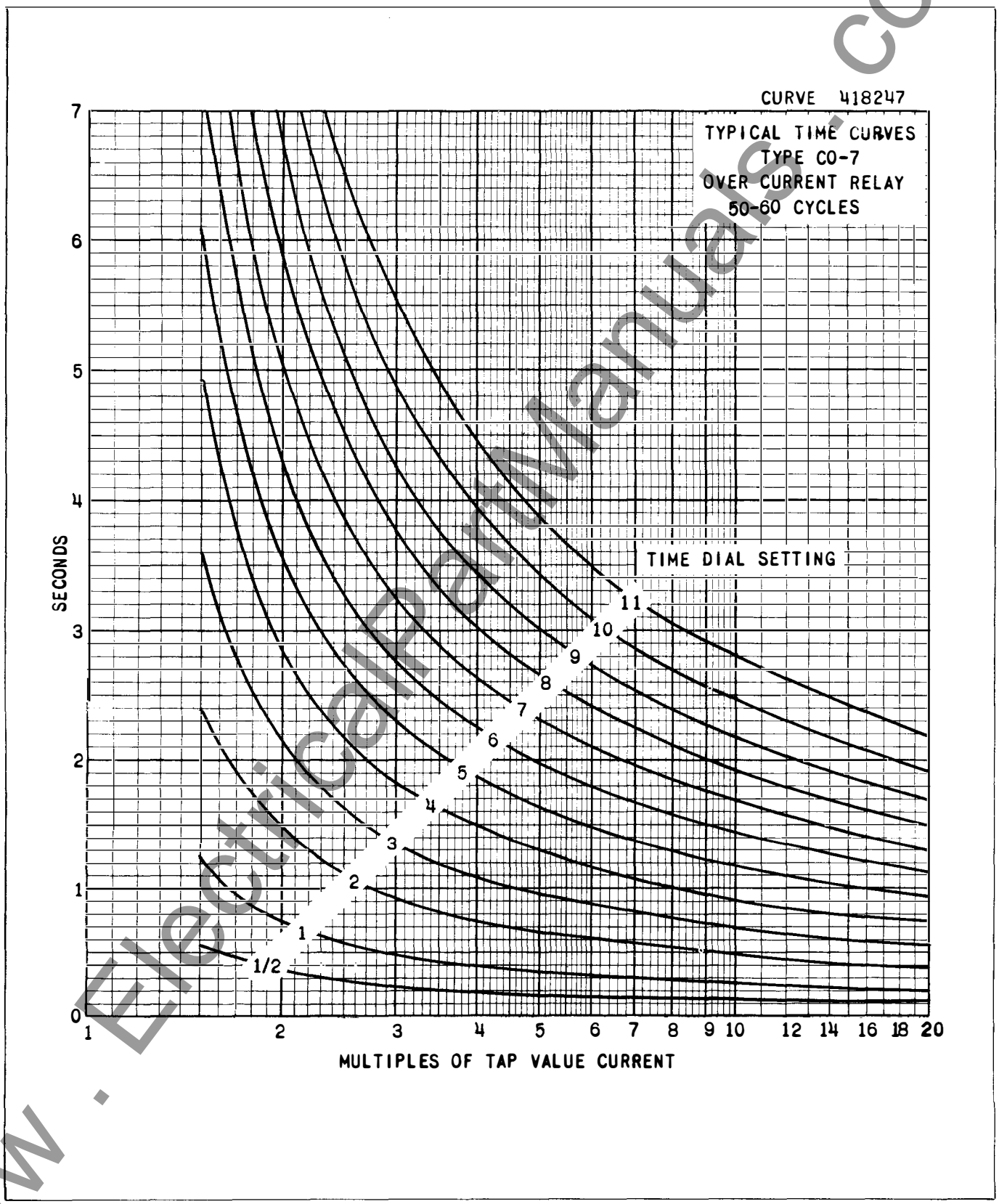


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

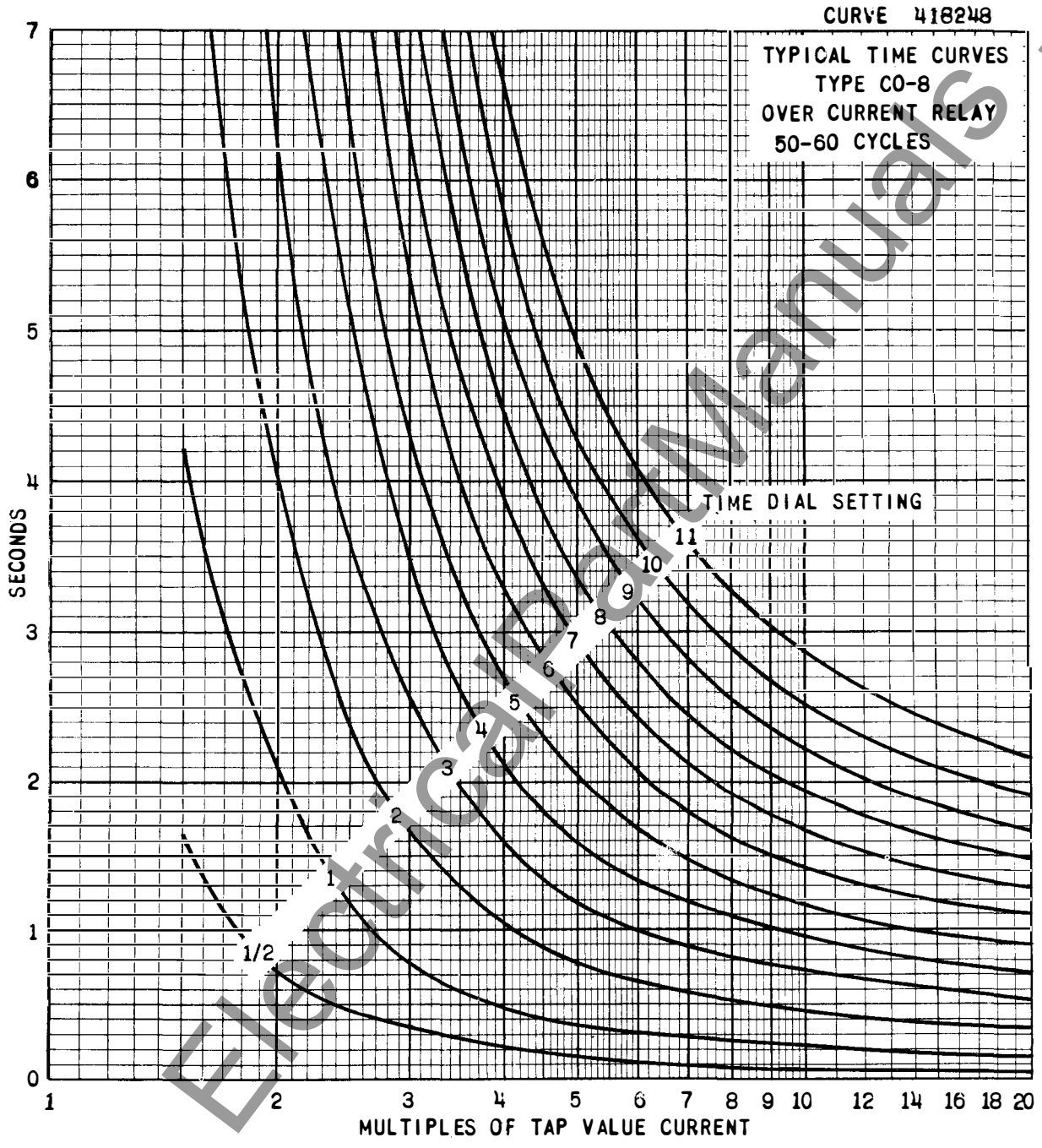


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

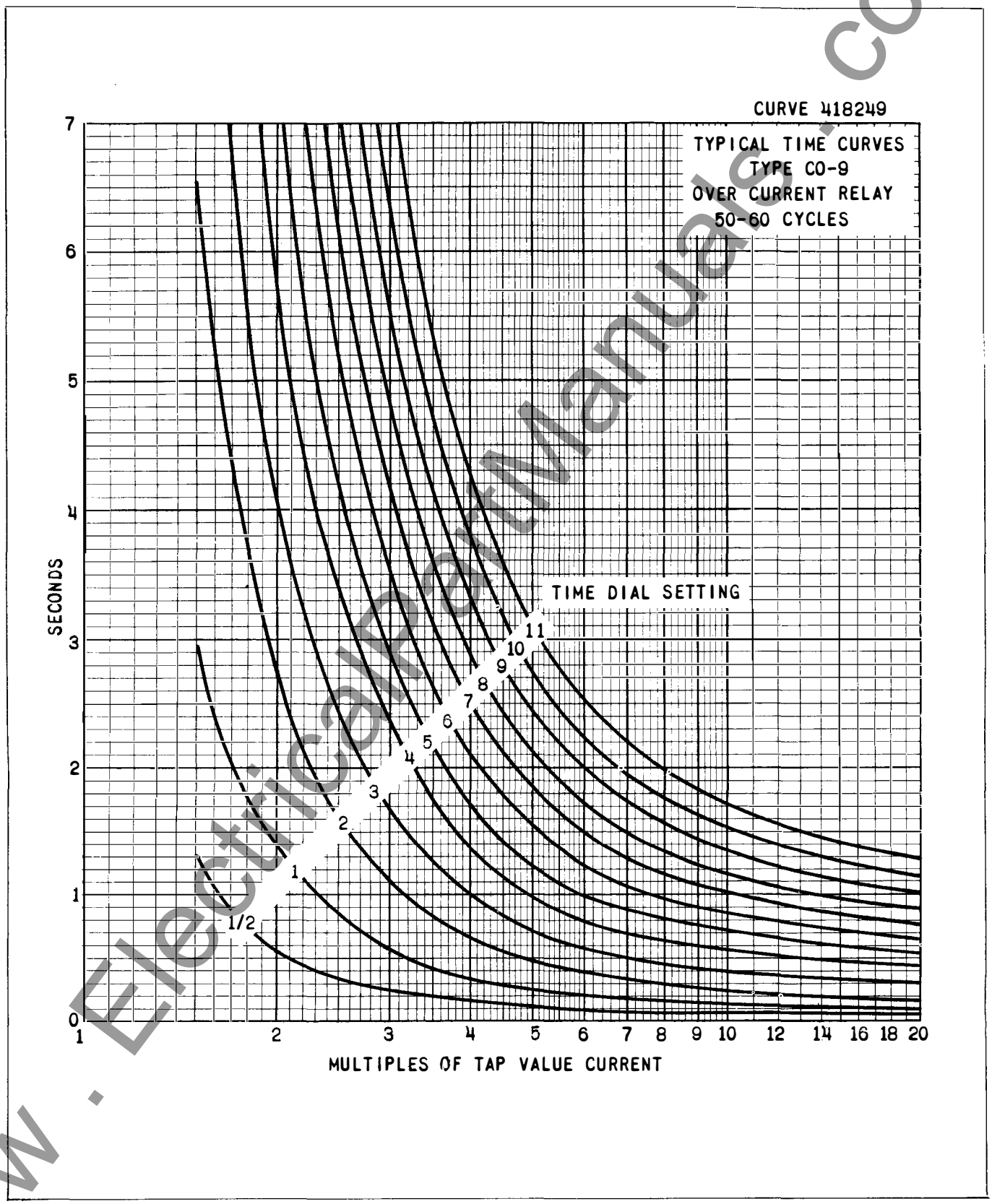


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

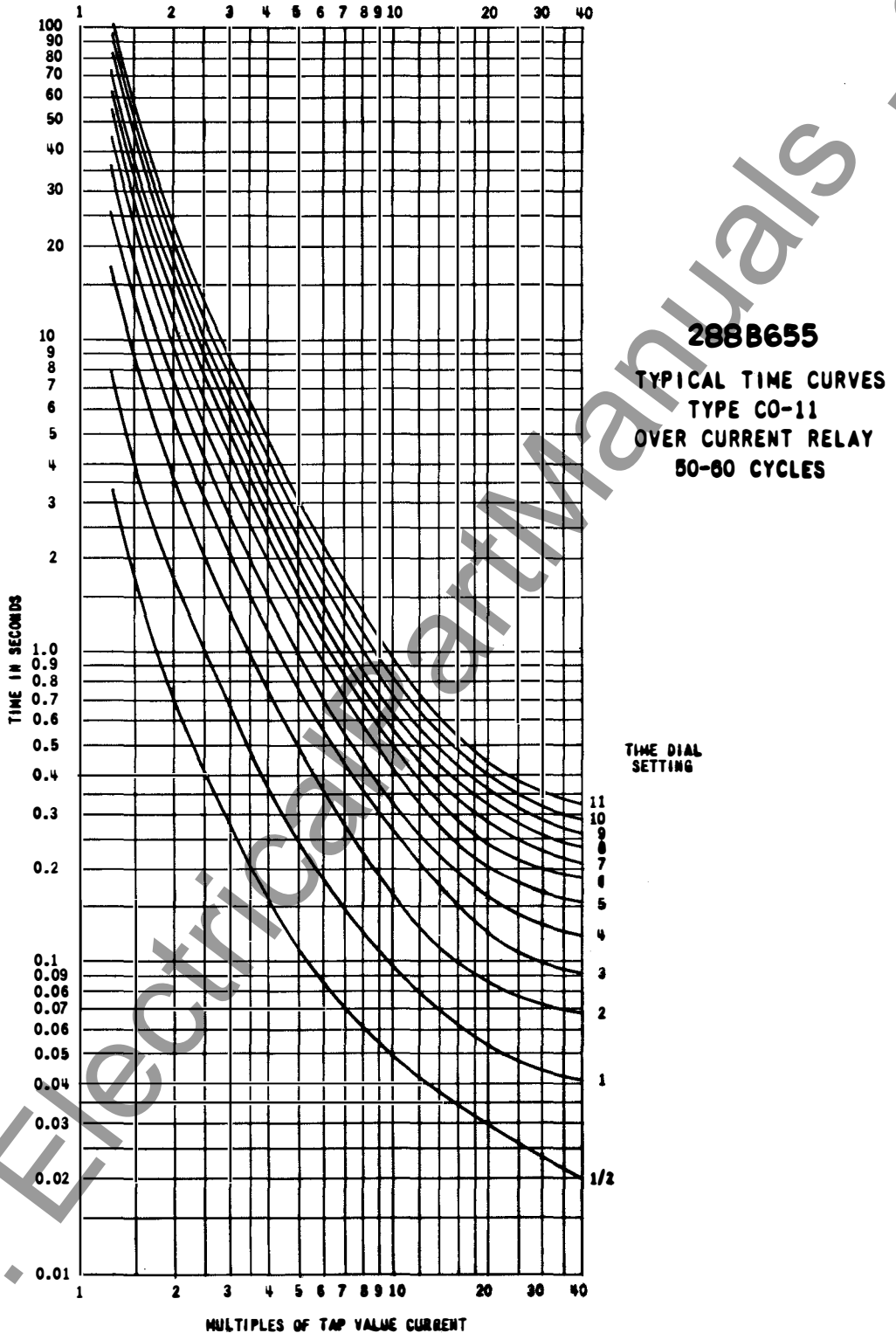
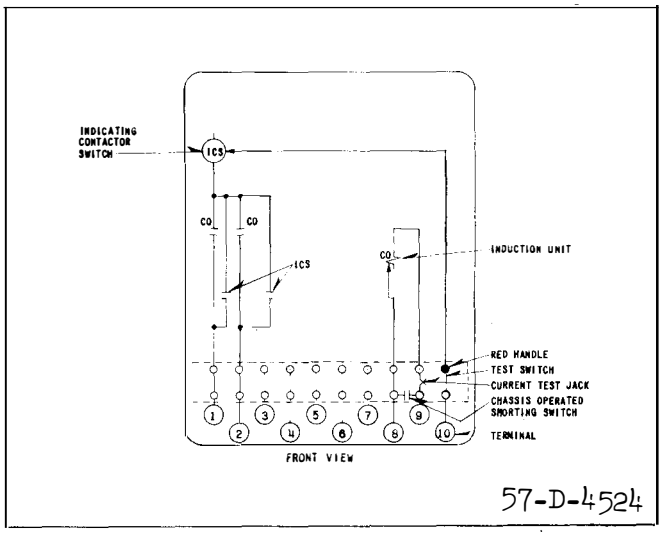


Fig. 13. Typical Time Curves of the Type CO-11 Relay.



* *Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4523.*

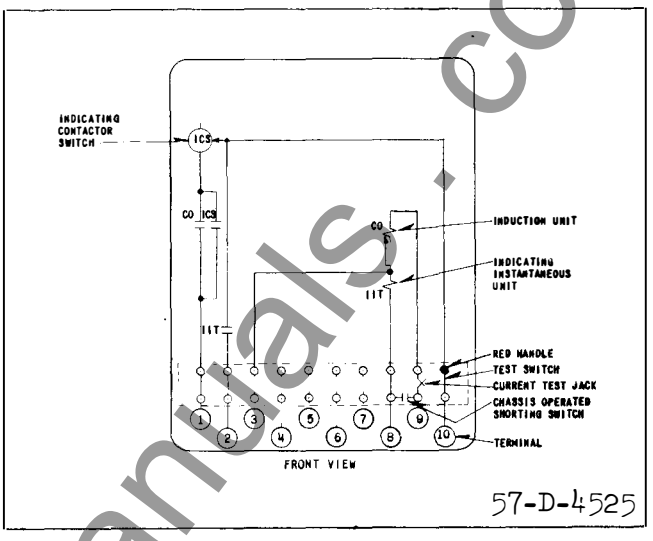


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

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 respond to multiples of tap value currents in accordance with the various typical time-current curves.

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 contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained 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.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is 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)

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.

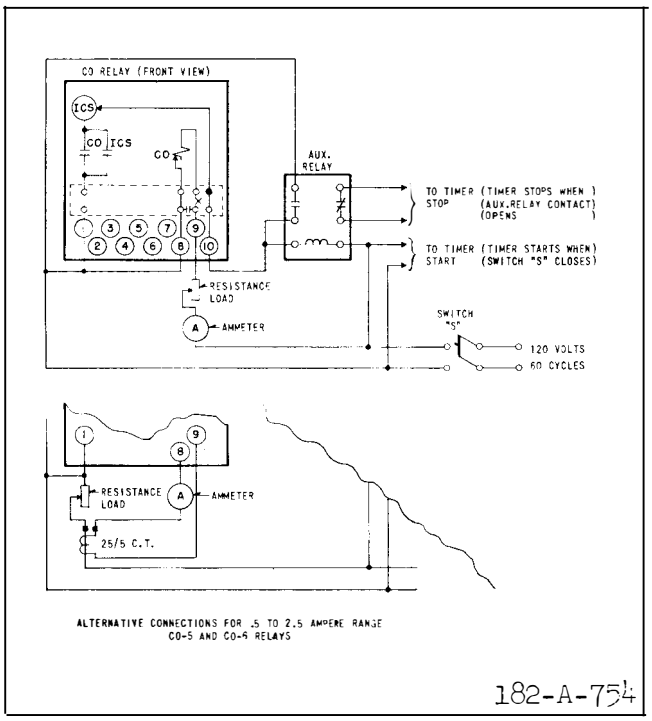


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

Acceptance Check

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

1. Contact

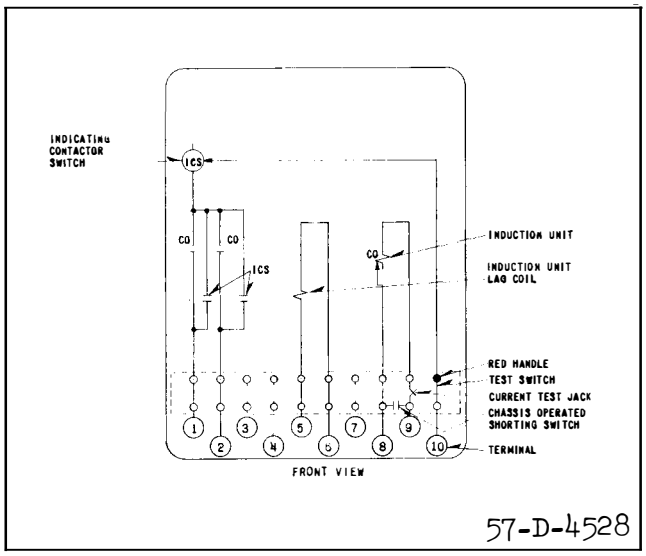
a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current – Set the time dial to position 6 using the lowest tap setting, 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 – For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds and should be checked first. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%

Table I shows the time curve calibration points for the various types of relays. With the time



* *Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted. Dwg. 57-D-4527.*

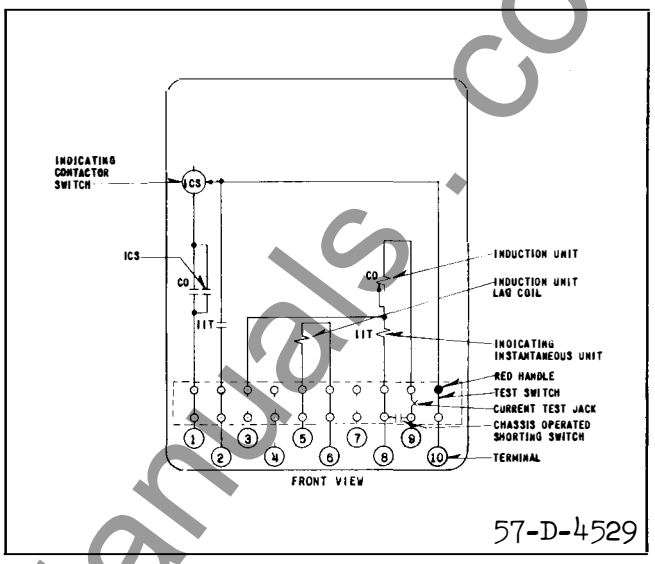


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

dial set to the indicated position and the relay set on the lowest tap setting, 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%

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%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

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.

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

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass secondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 16 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e. use 10L50 or better).

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. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

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 for permanent magnet adjustment (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.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 54.9 ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 13). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

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)

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.

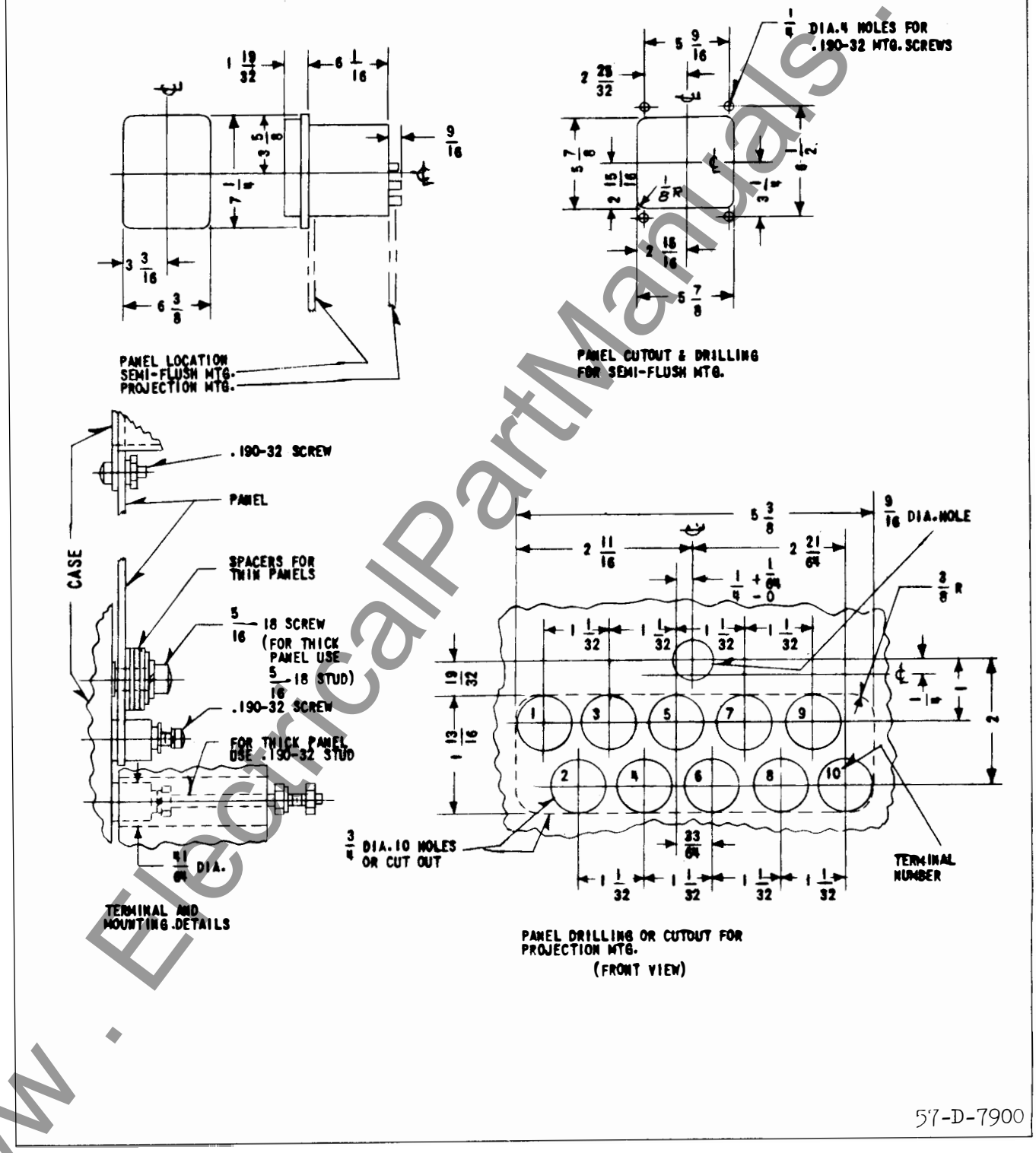


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

TABLE 1

TIME CURVE CALIBRATION DATA – 50 & 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 △

△ For 50 cycle CO-11 relay 20 times operating time limits are 0.24 + 10%, −5%.

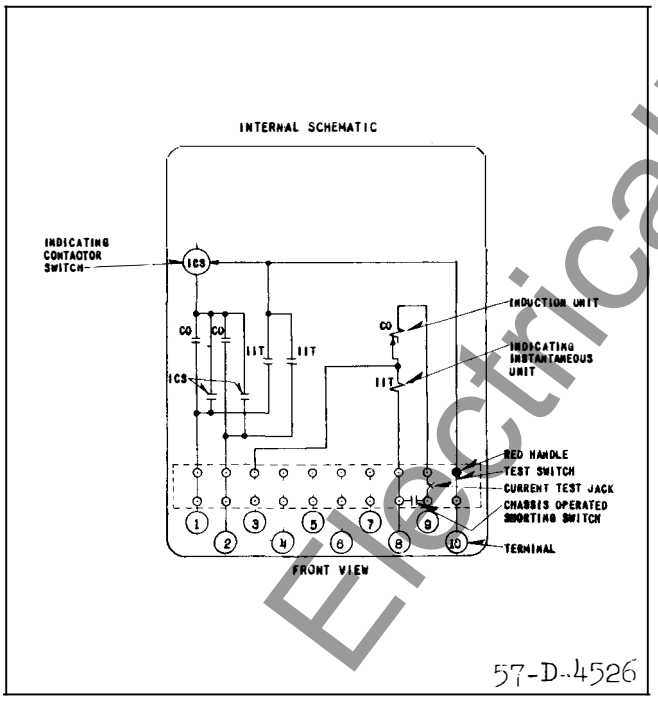


Fig. 20 Internal Schematic of the Double Trip Circuit Closing Relay with Indicating Instantaneous Trip Unit.

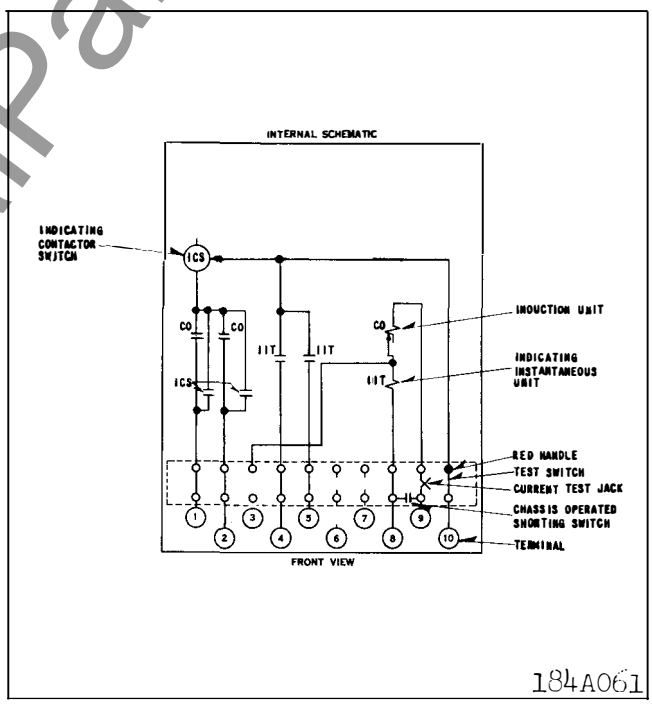


Fig. 21 Internal Schematic of the Double Trip Circuit Closing Realy with Indicating Instantaneous Trip Unit to Separate Terminals.

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

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:

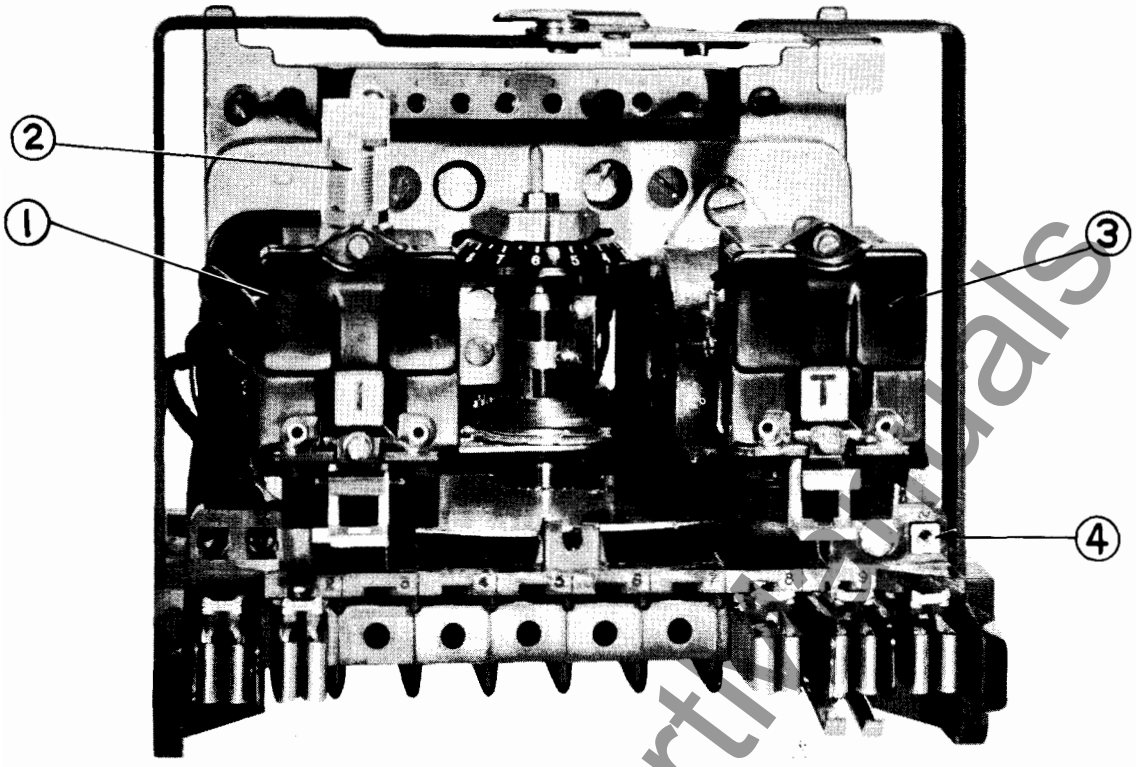


Fig. 1. Type CO Relay Without Case. 1-Indicating Instantaneous trip (IIT). 2-IIT Adjusting Screw. 3-Indicating Contactor Switch (ICS). 4-Indicating Contactor Switch Tap Block.

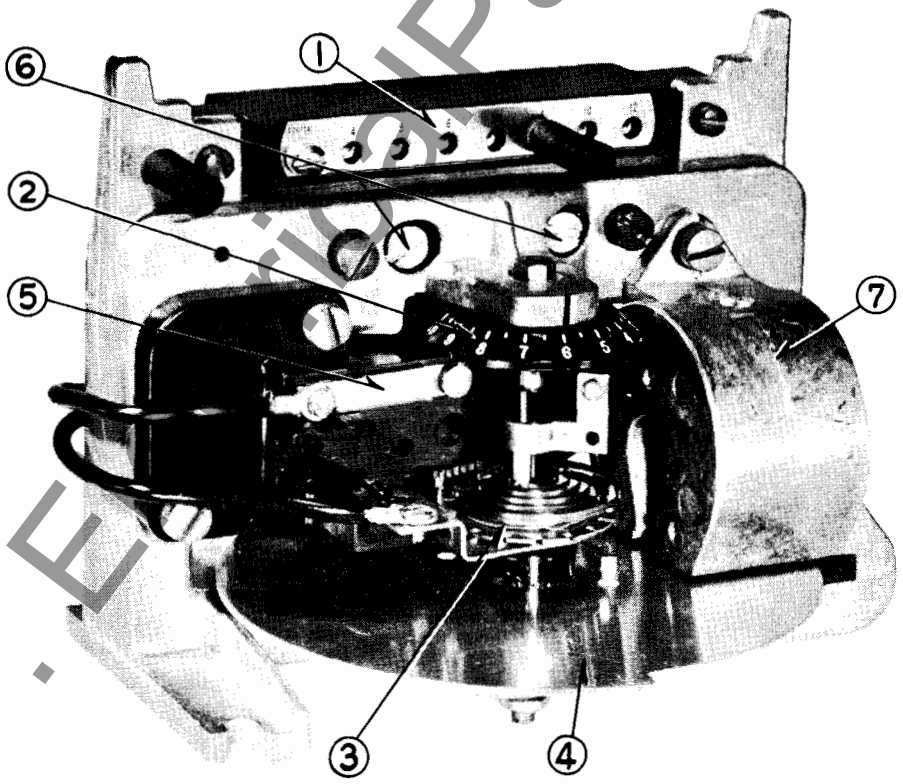


Fig. 2. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

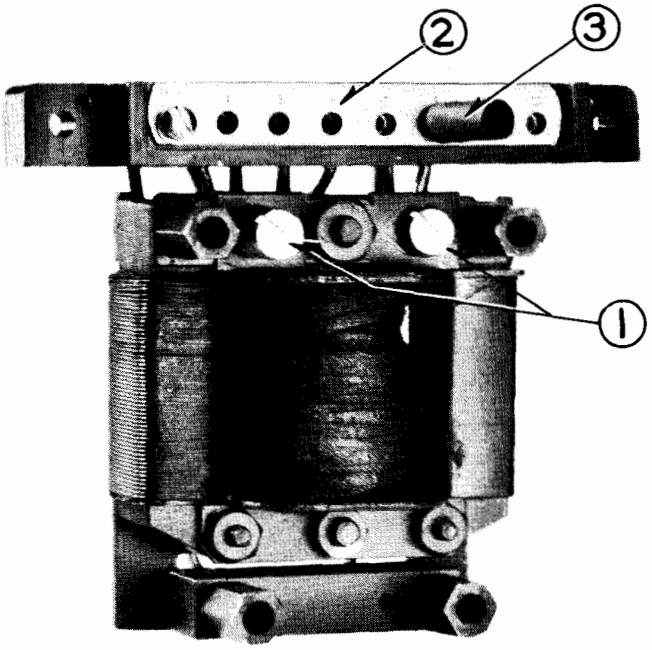


Fig. 3. "E" Type Electromagnet. 1- Magnetic Plugs. 2-Tap Block. 3-Tap Screw.

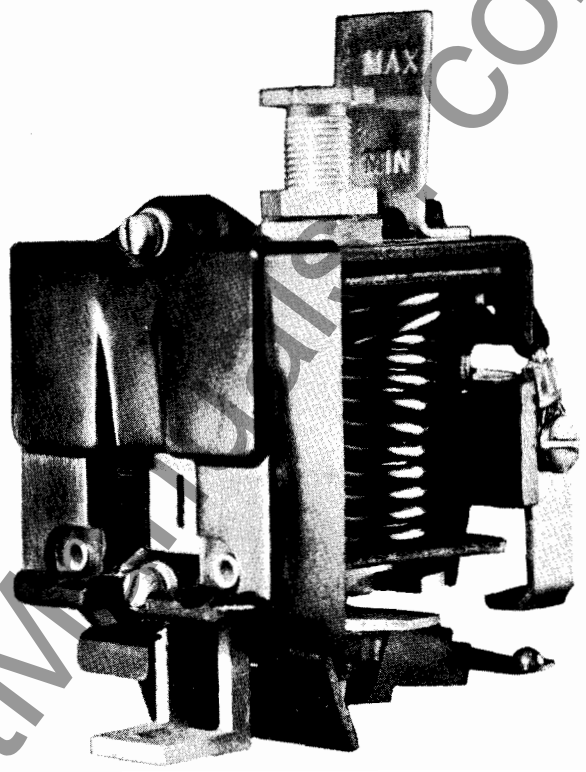


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

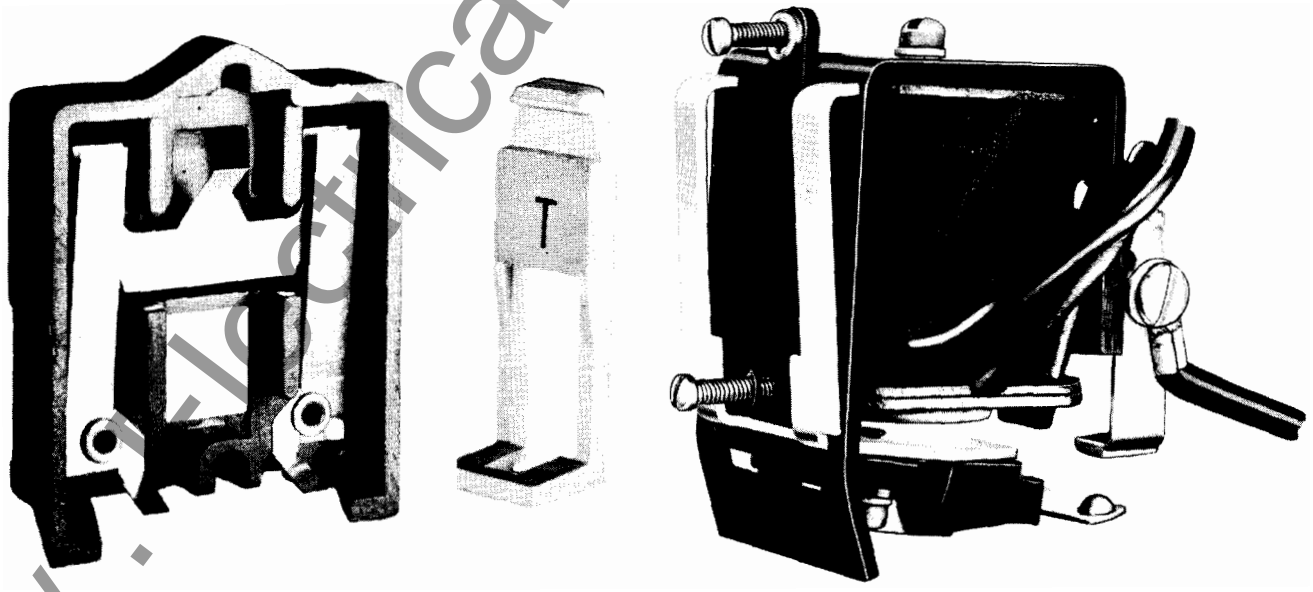


Fig. 5. Indicating Contactor Switch (ICS).

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

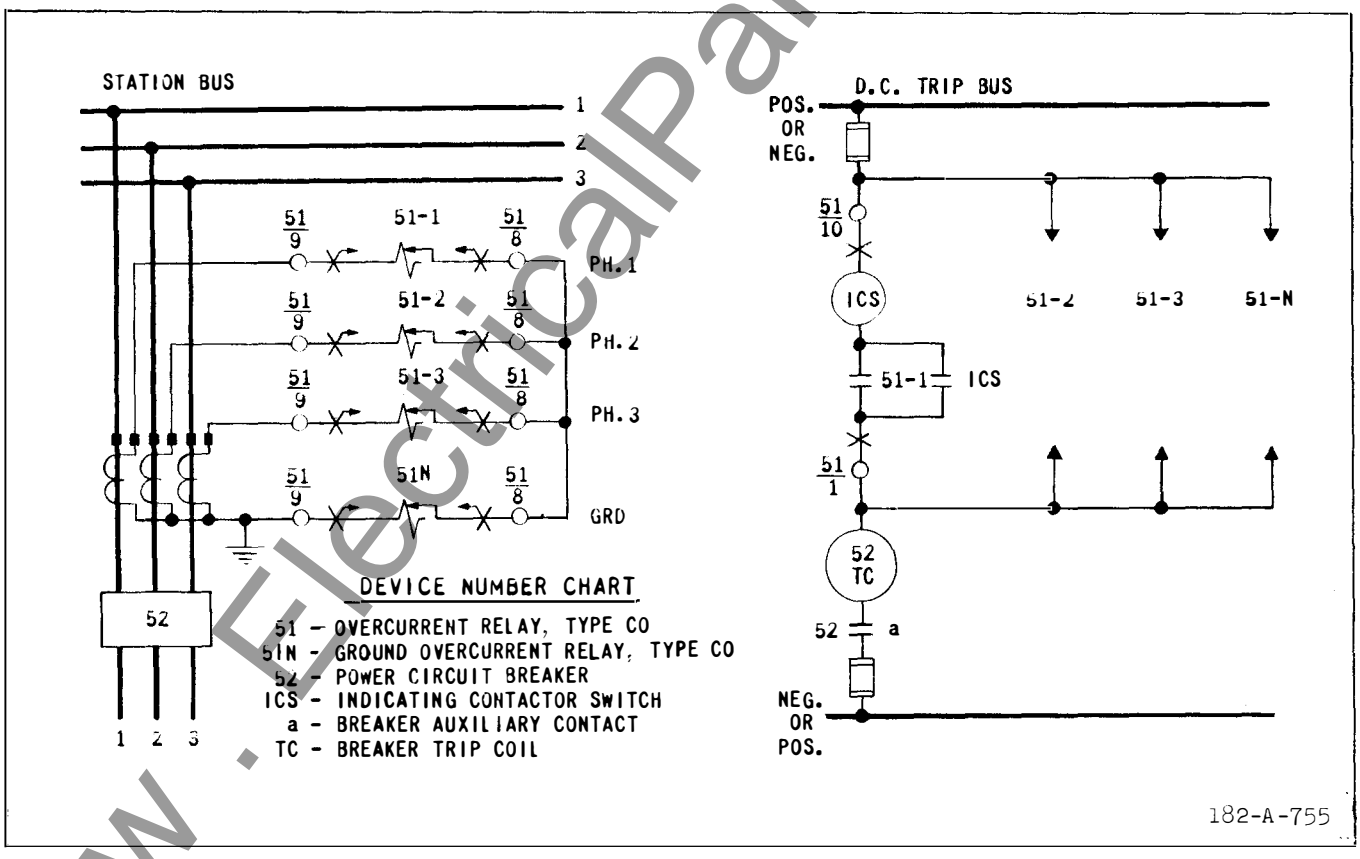


Fig. 6. External Schematic of the Circuit-Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

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.*

ENERGY REQUIREMENTS

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.*

ENERGY REQUIREMENTS

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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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	AT 3 TIMES TAP VALUE CURRENT	AT 10 TIMES TAP VALUE CURRENT	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 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.*

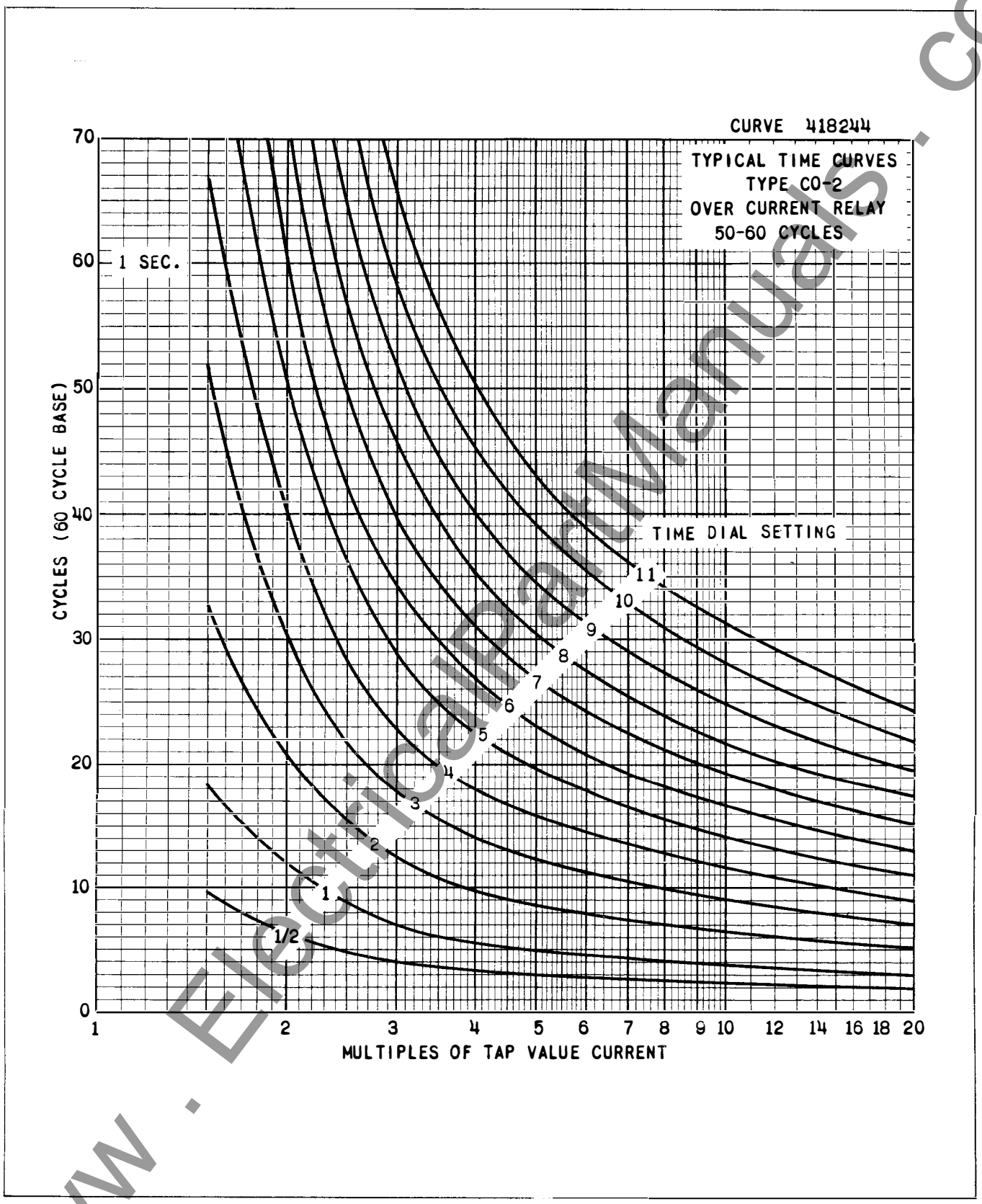


Fig. 7. Typical Time Curves of the Type CO-2 Relay.

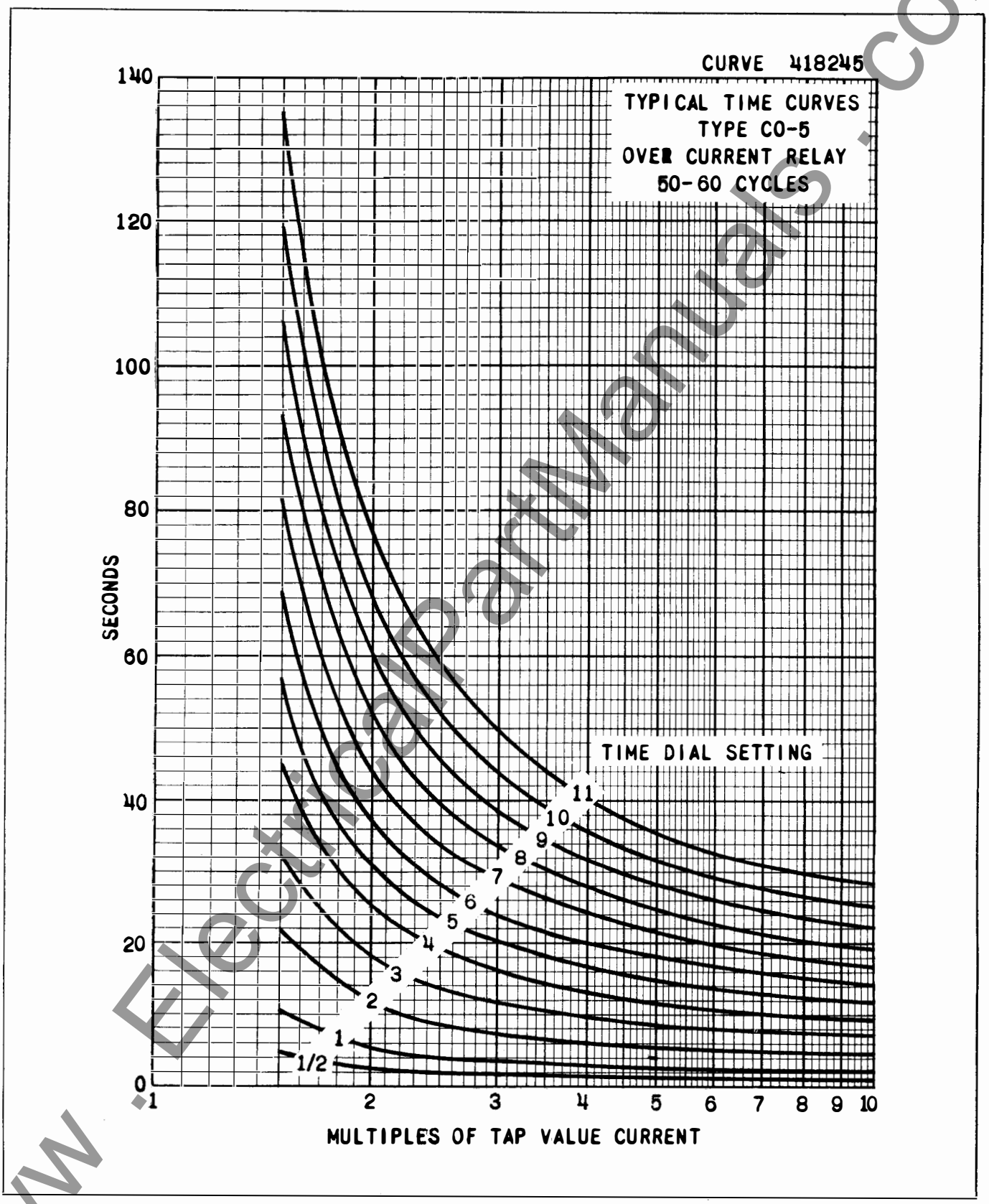


Fig. 8. Typical Time Curves of the Type CO-5 Relay.

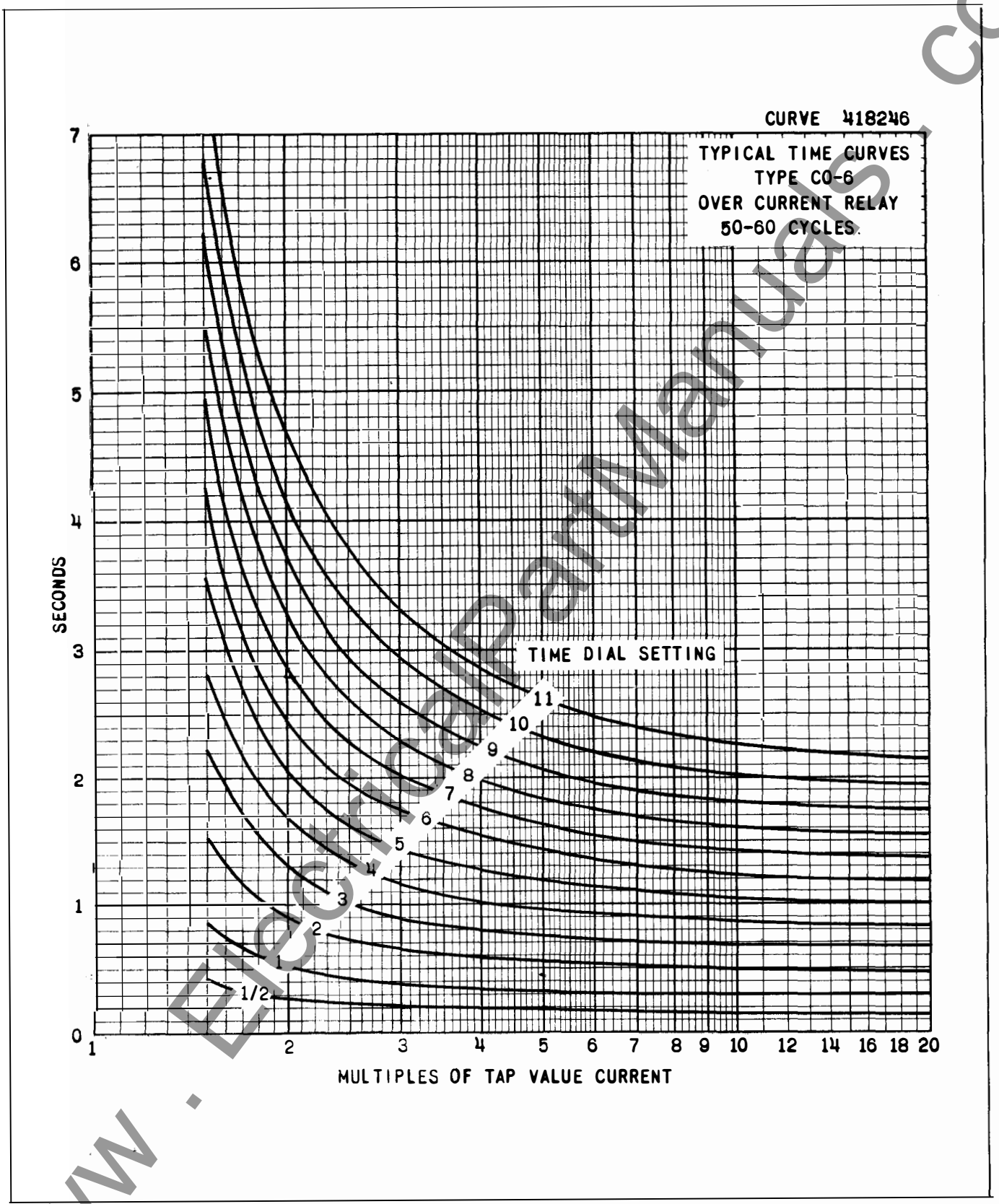


Fig. 9. Typical Time Curves of the Type CO-6 Relay.

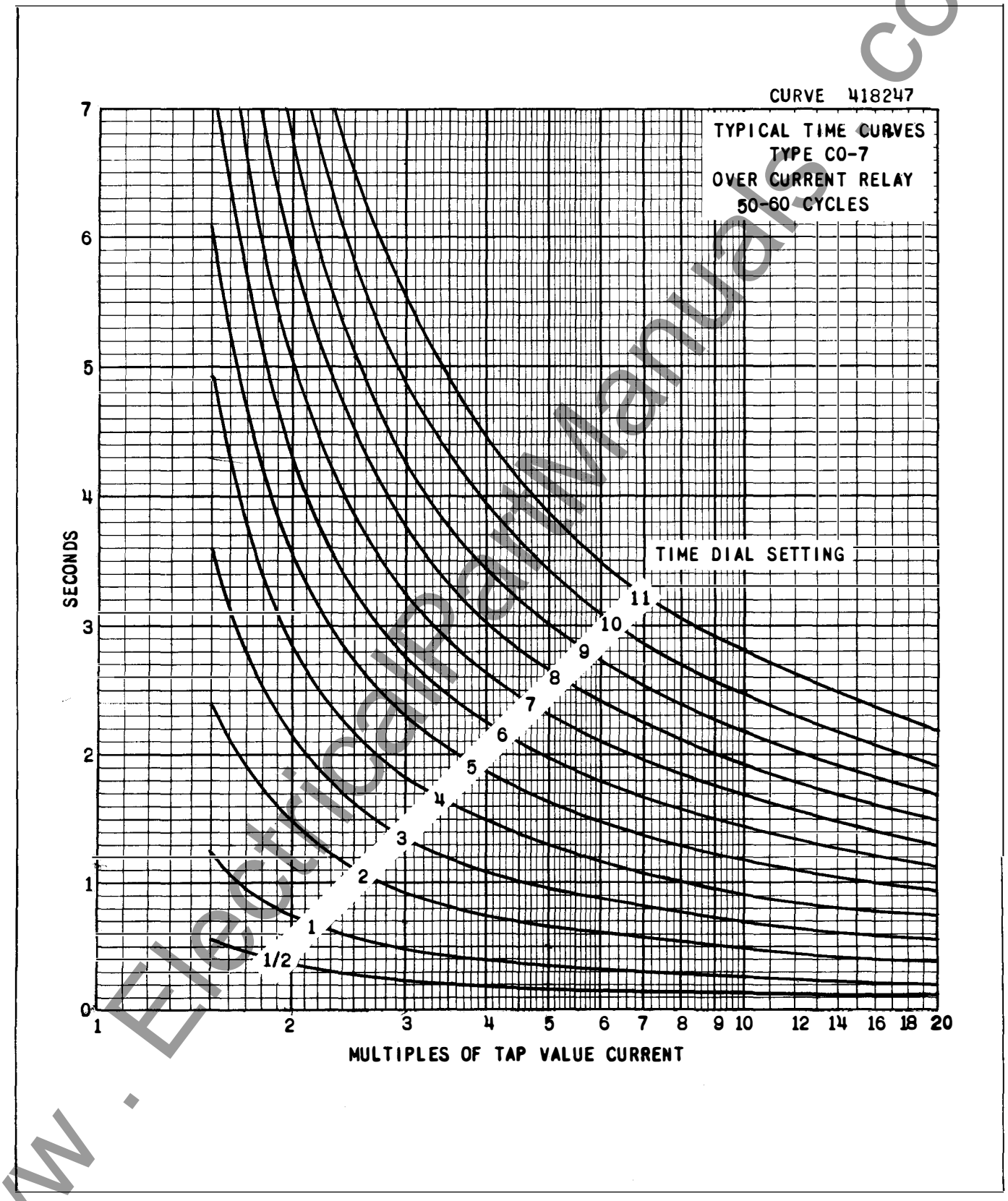


Fig. 10. Typical Time Curves of the Type CO-7 Relay.

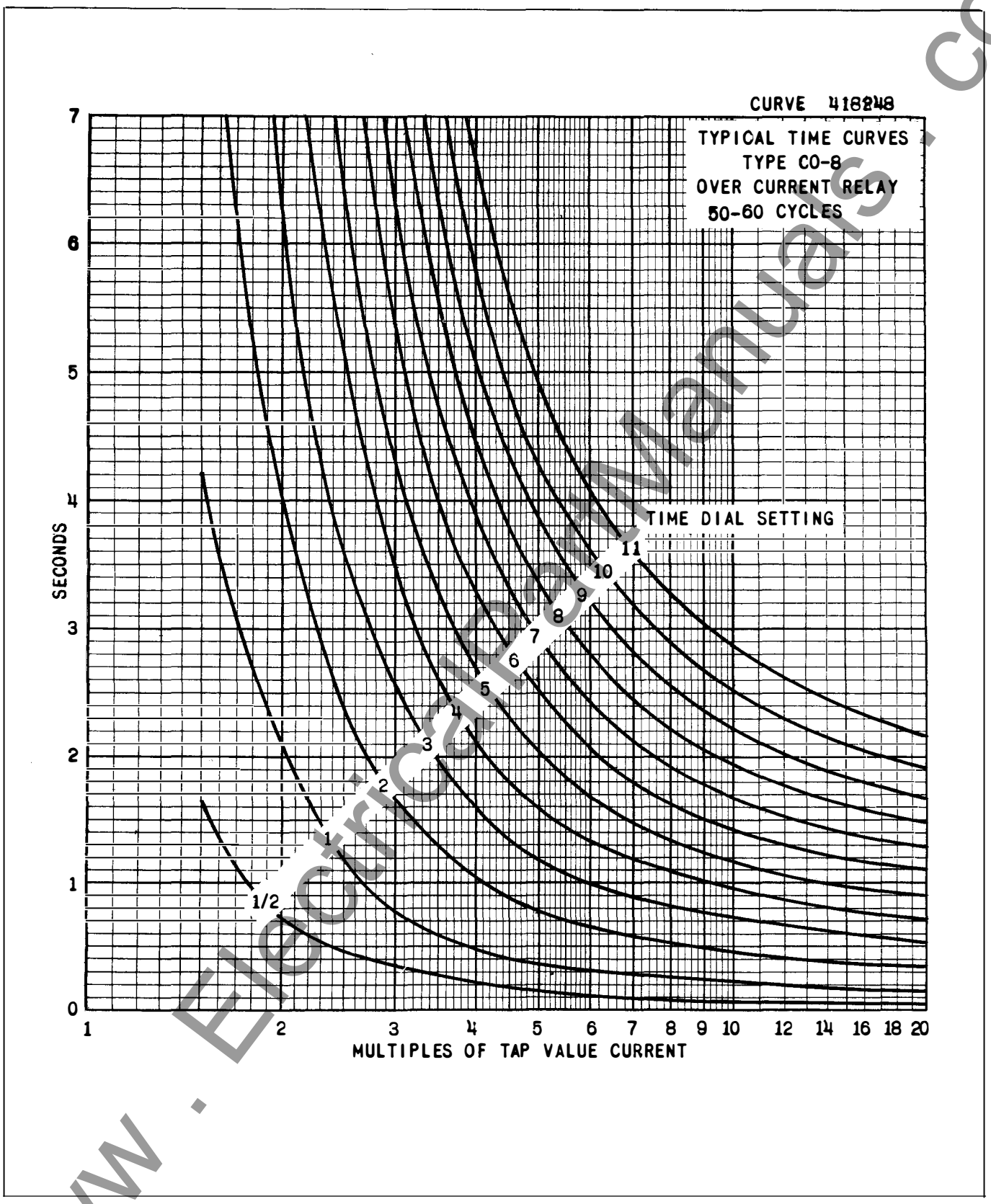


Fig. 11. Typical Time Curves of the Type CO-8 Relay.

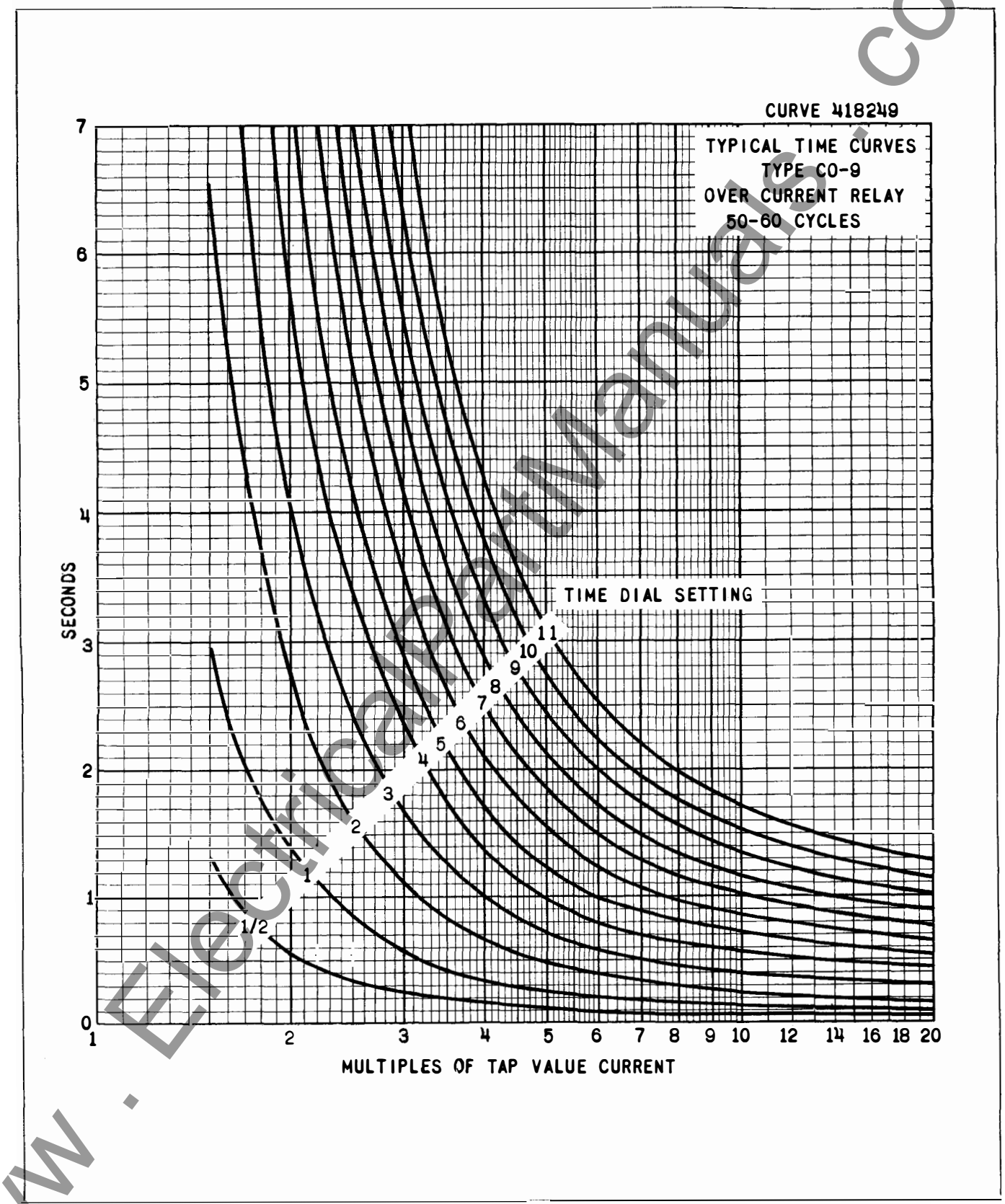


Fig. 12. Typical Time Curves of the Type CO-9 Relay.

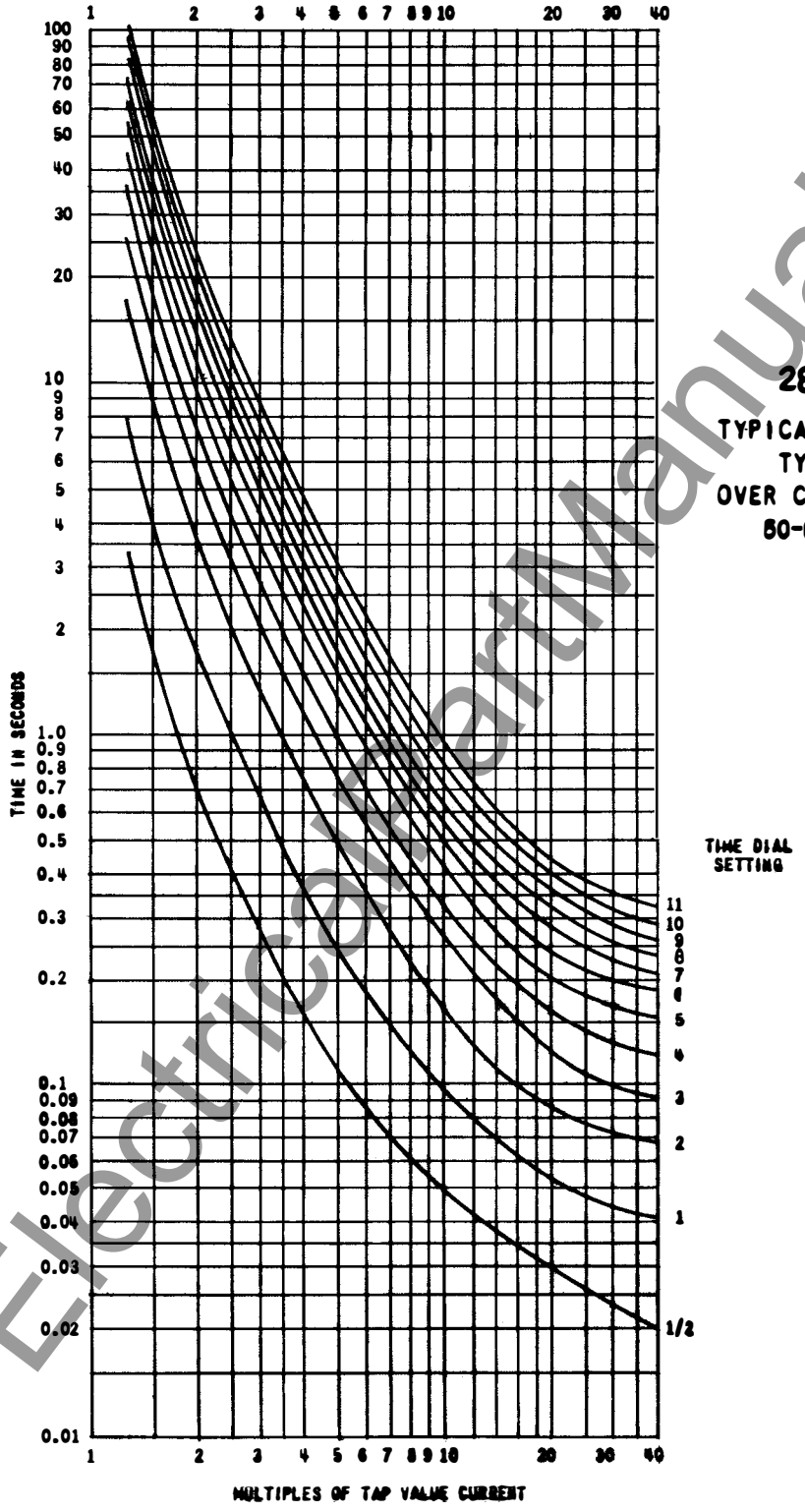


Fig. 13. Typical Time Curves of the Type CO-11 Relay.

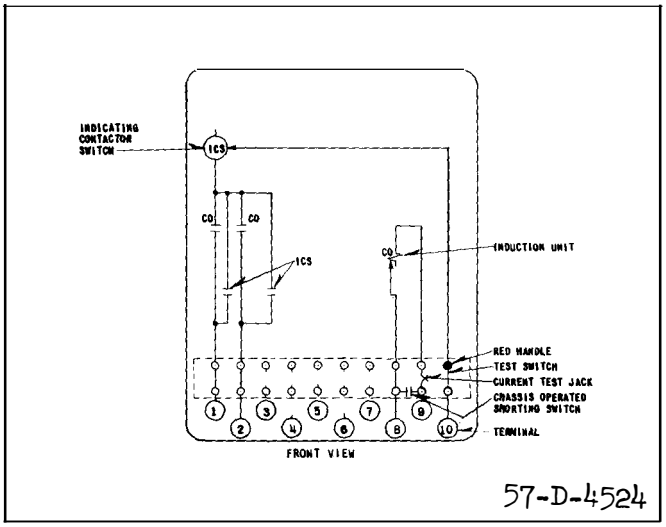


Fig. 14. Internal Schematic of the Double Trip Circuit Closing Relay. For the Single Trip Relay the Circuits Associated with Terminal 2 are Omitted.

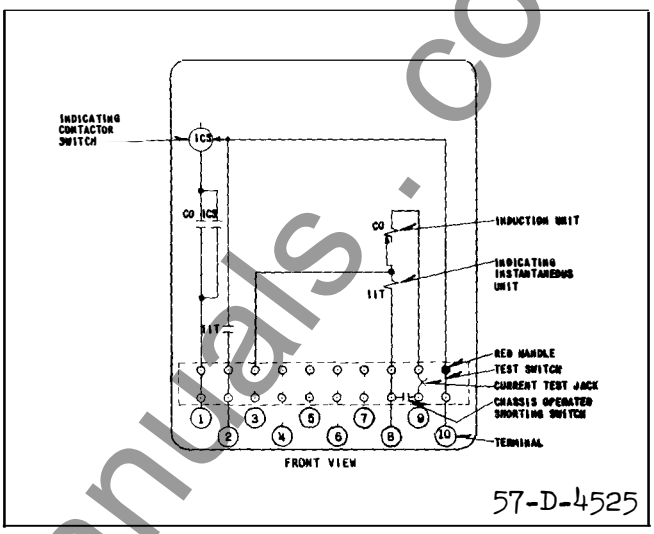


Fig. 15. Internal Schematic of the Single Trip Circuit-Closing Relay with Indicating Instantaneous Trip Unit.

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.

For double trip relays, the upper stationary contact is adjusted such that the contact rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

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. un

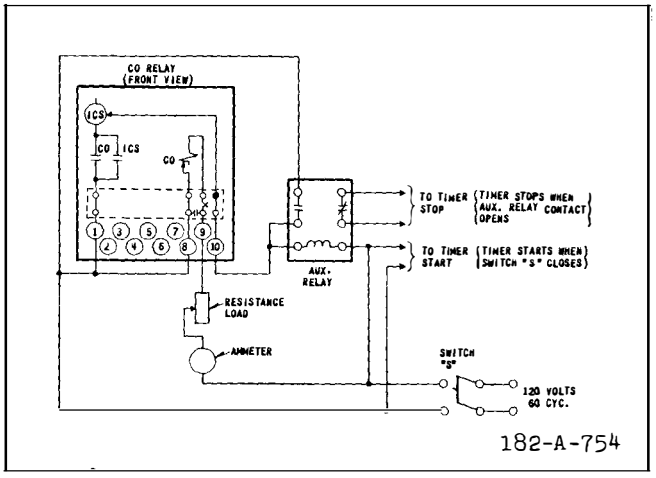


Fig. 16. Diagram of Test Connections for the Circuit-Closing Type CO Relay.

INSTALLATION

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

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

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. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

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.

* For Type CO-11 Relay only, the 1.3 times tap value operating time from the number 6 time dial position is 54.9 ± 5% seconds.

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

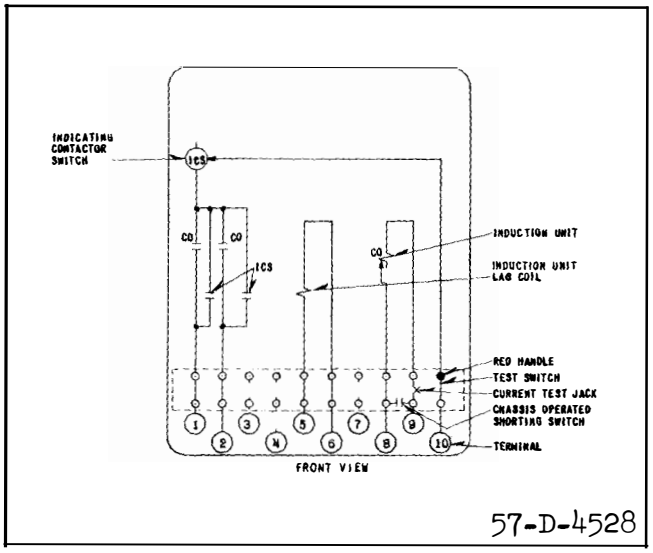


Fig. 17. Internal Schematic of the Double Trip Circuit Closing Relay with Torque Control Terminals. For the Single Trip Relay, the Circuits Associated with Terminal 2 are Omitted.

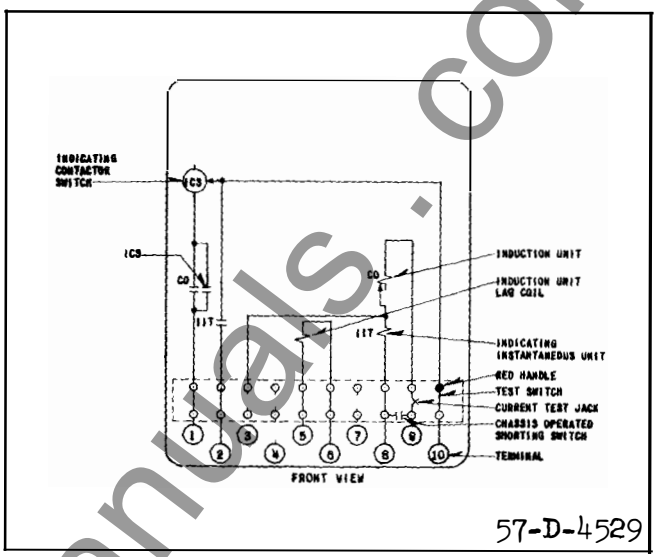


Fig. 18. Internal Schematic of the Single Trip Circuit Closing Relay with Torque Control Terminals and Indicating Instantaneous Trip Unit.

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 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.

For double trip relays only, the follow on the stationary contacts is obtained through the use of the stationary contact adjusting screw. The upper stationary contact is adjusted first such that there is approximately 1/64" follow. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

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 for permanent magnet adjustment (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.

* For Type CO-11 Relay only, the 1.3 times tap value operating time from the number 6 time dial position is 54.9 ± 5% seconds. If the operating time at 1.3 times tap value is not within these limits, minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has has been completed.

Apply the indicated current per Table I for

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 – 50 & 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

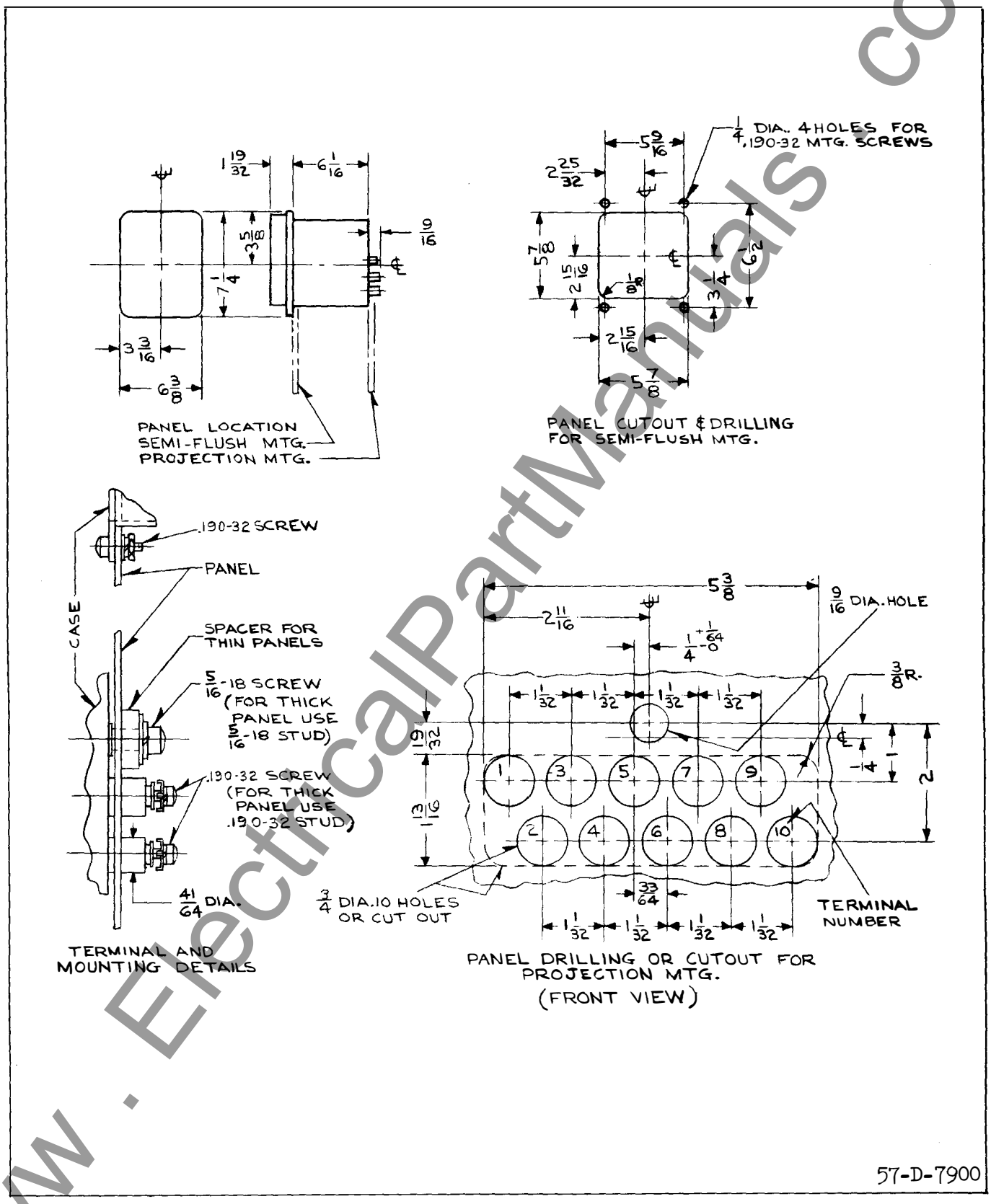


Fig. 19. Outline and Drilling Plan for the Type CO Relay.

WESTINGHOUSE ELECTRIC CORPORATION

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