INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE IRV DIRECTIONAL OVERCURRENT RELAY

FOR PHASE PROTECTION

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 relays are phase directional overcurrent relays which are used for the protection of transmission lines and feeder circuits. Both the time-overcurrent and instantaneous overcurrent units are directionally controlled.

CONSTRUCTION AND OPERATION

The Type IRV relay consists of a directional unit (D), an auxiliary switch (CS-1), a time-overcurrent unit (CO), an instantaneous overcurrent 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 and 2.

Time-Overcurrent Unit (CO)

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 units 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 causes a contact closing torque.

The electromagnet for the type CO-2 and CO-11 units 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 Units (ICS/I and ICS/T)

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 pick-up value of the switch.

Directional Unit (D)

The directional unit is a product induction cylinder type unit operating on the interaction between the polarizing circuit flux and the operating circuit flux.

Mechanically, the directional unit is composed of four basic components: A die-cast 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 spring and snap ring. This is an adjustable core which has a .025 inch flat on one side and is held in its adjusted position by the clamping action of two compressed springs. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected operating coils mounted diametrically opposite one another; two magnetic adjusting plugs; upper and lower adjusting plug clips, and two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The elec-

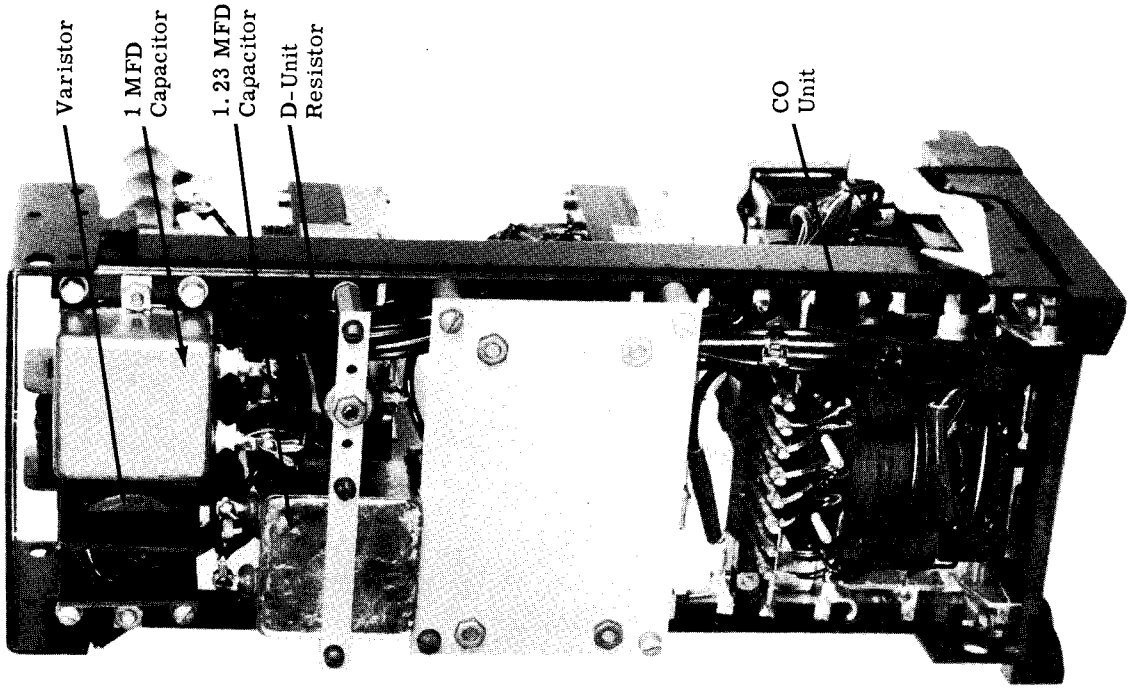


Fig. 2. Type IRV Relay Without Case (Rear View).

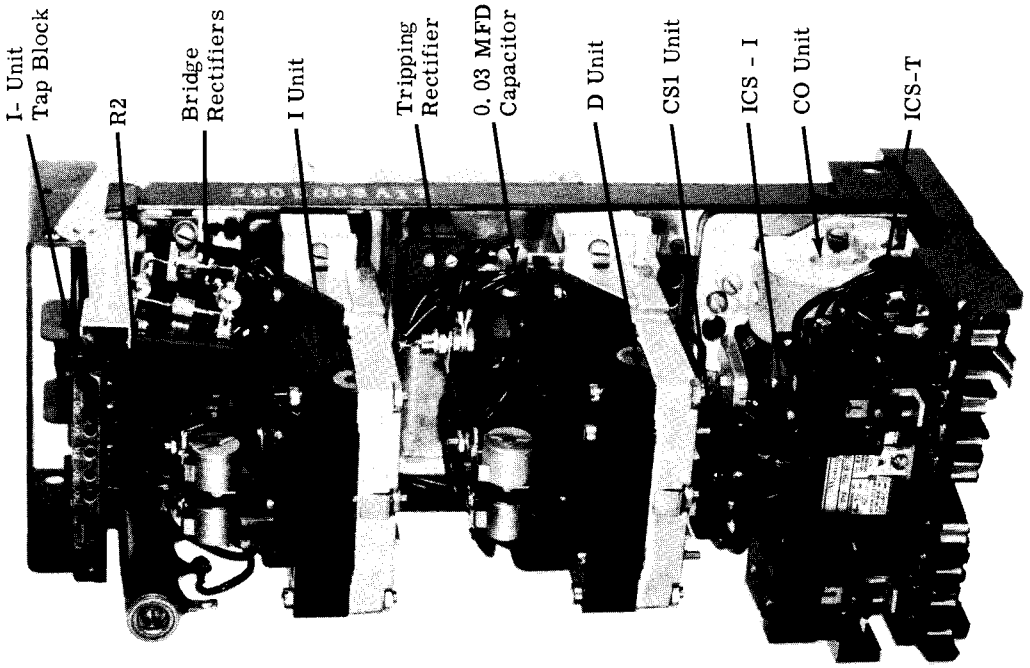


Fig. 1. Type IRV Relay Without Case (Front View).

tromagnet 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 bearing, 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 contacts 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.

Instantaneous Overcurrent Unit (I)

The instantaneous overcurrent unit is similar in construction to the directional unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Instantaneous Overcurrent Unit Transformer

This transformer is of the saturating type for limiting the energy to the instantaneous overcurrent unit at higher values of fault current and to reduce C.T. burden. The primary winding is tapped and these taps are brought out to a tap block for ease in changing the pick-up of the instantaneous overcurrent unit. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

Auxiliary Switch (CS-1)

The auxiliary switch is a small solenoid type d.c. switch. A cylindrical plunger, with a silver disc mounted on its lower end, moves in the core of the solenoid. As the plunger travels upward, the disc bridges the silver stationary contacts. A tapped resistor is used to enable one to use the contactor switch on a 48, 125 or 250 volt d.c. system connected per Fig. 13. The operation of the CS-1 switch is controlled by the directional unit (D) which in turn directionally controls the time-overcurrent unit (CO) as shown in Fig. 15. When sufficient power flows in the tripping direction, the CS-1 switch operates and bridges the lag coil of the time-overcurrent unit (CO) permitting this unit to operate.

Another contact of CS-1 seals in its coil through the break contact of the I unit, in order to relieve the make contact of D from carrying the CS-1 coil current. The break contact of D breaks this seal by short circuiting the CS-1 coil. The break contact of the I unit also breaks the seal of the CS-1 coil to prevent tripping on reversed faults where the directional unit was preclosed on load current.

Instantaneous-Unit Torque Control

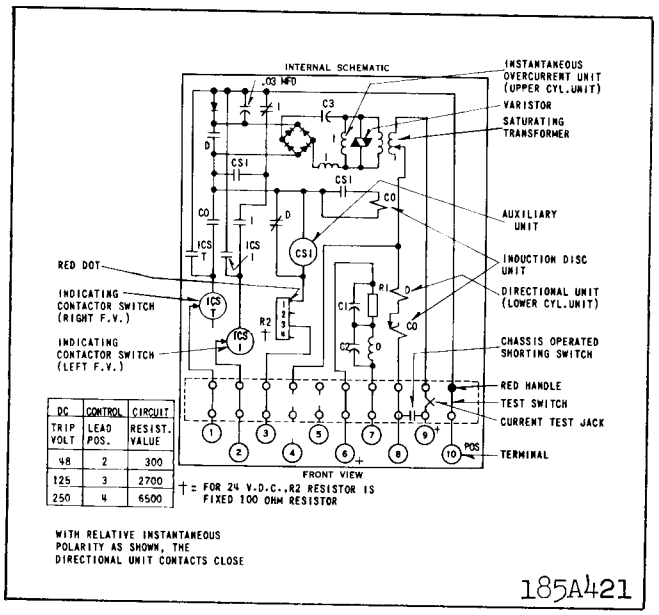
When the make contact of D closes, it permits the I unit to operate. It connects capacitor C3 and one pair of I-unit coils across the output voltage of the saturating transformer I/ST. The full-wave bridge in this connection and the rectifier in series with the D contact serve to isolate the a-c and d-c circuits.

CHARACTERISTICS

The time characteristics of the directional overcurrent relays are designated by specific numbers as indicated below (e.g., IRV-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:



DC TRIP VOLT	CONTROL LEAD POS.	CIRCUIT RESIST. VALUE
48	2	300
125	3	2700
250	4	6500

* *Fig. 3. Internal Schematic of the Type IRV Relay in the Type FT31 Case.*

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

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.

The time vs. current characteristics for the time-overcurrent unit are shown in Figs. 4 to 10. 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.

The time vs. current characteristics for the instantaneous overcurrent unit is shown in Fig. 11.

The time vs. current characteristics for the directional unit is shown in Fig. 12.

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 means of a screw connection.

Cylinder Unit 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.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 ampere tap – 6.5 ohms d-c resistance
2.0 ampere tap – 0.15 ohms d-c resistance

Auxiliary Switch (CS-1)

* The auxiliary switch operating time is approximately 5 milliseconds.

48–250 volt d-c relay
d-c resistance – 1165 ohms

24 volt d-c relay
d-c resistance – 110 ohms (note that series resistor is a fixed 100 ohm resistor).

Directional Unit

The IRV relay is intended for phase fault protection and the directional unit has its maximum torque when the current leads the voltage by approximately 30°. The directional unit minimum pickup is 1.2 volts and 4 amperes at its maximum torque angle for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

The directional unit should be connected using the current in one-phase wire and the potential across the other two phase wires. This connection is commonly referred to as the 90°connection. When utilizing the 90° connection the maximum torque of the relay occurs when the fault current lags its 100% P.F. position by approximately 60°. See Fig. 15.

ENERGY REQUIREMENTS

INSTANTANEOUS OVERCURRENT UNIT OPERATING CURRENT CIRCUIT – 60 CYCLES

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

φ *Degrees current lags voltage.*

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

TYPE IRV-2 TIME OVERCURRENT UNITS

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
0.5/2.5	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
	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
2/6	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
	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
4/12	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
	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

IRV-5, IRV-6, TIME OVERCURRENT UNITS

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
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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

† *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

IRV-7 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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

IRV-8, IRV-9, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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.*

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

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

IRV-11 OVERCURRENT UNITS

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

† *Thermal capacities for short times other than one second may be 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 – 60 CYCLES

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

Range Amps	Continuous Rating (Amperes)	One Second Rating † (Amperes)	Power Factor Angle ϕ	VOLT AMPERES†† At Minimum Tap Value Current	VOLT AMPERES†† At 3 Times Minimum Tap Value Current	VOLT AMPERES†† At 10 Times Minimum Tap Value Current	VOLT AMPERES†† At 20 Times Minimum Tap Value Current
0.5-2.5	10	230	34.5	0.03	0.23	2.8	11.5
2-6	10	230	34.5	0.44	4.08	48.0	182.0
4-12	12	280		0.48	4.62	53.6	216.0

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

† *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.*

†† *Voltages taken with Rectox type voltmeter.*

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

The burden at 120V, 60 cycles, is 12.5 volt-amperes at 15 degrees. (current leading voltage).

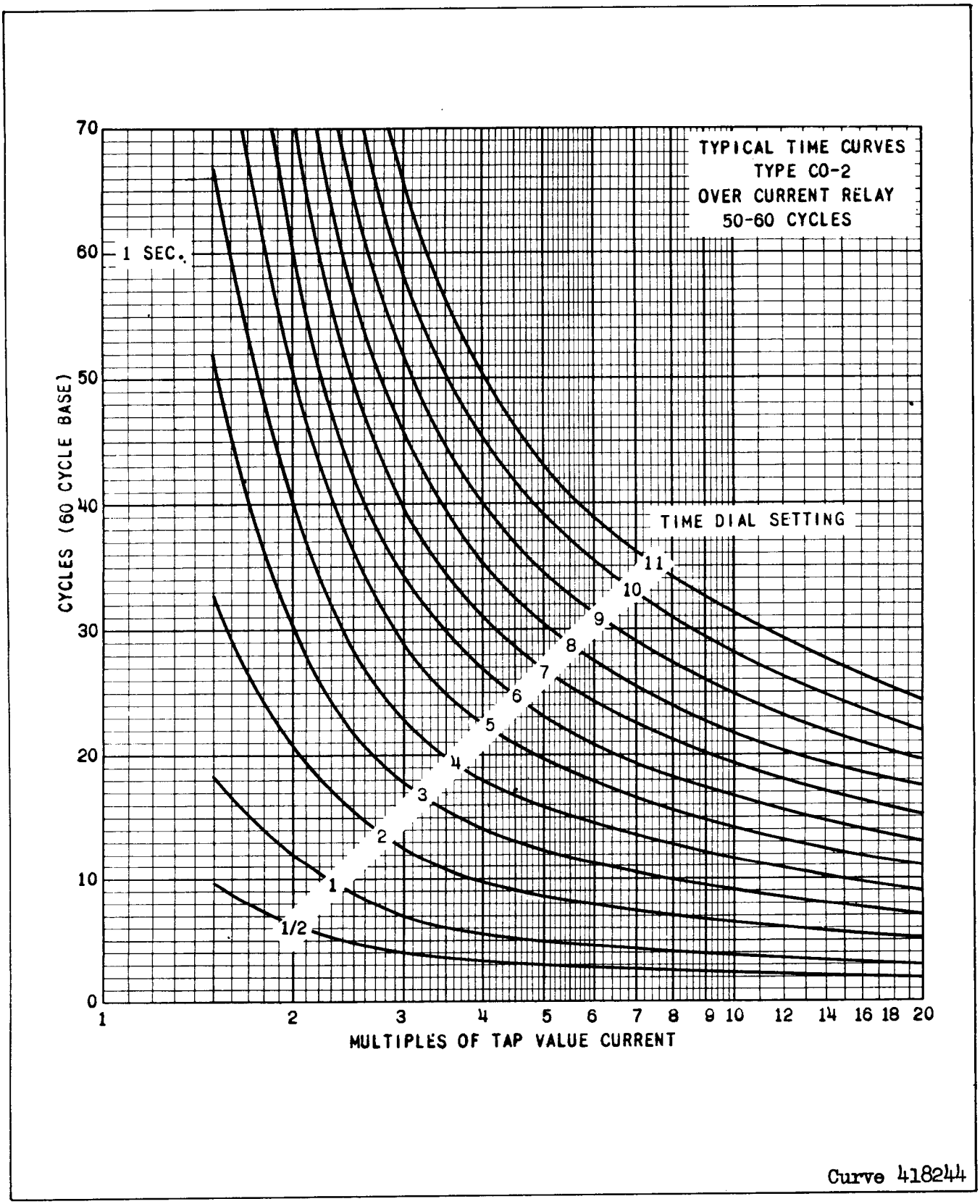


Fig. 4. Typical Time Curves of the Time-Overcurrent Unit of the Short Time (2) Relays.

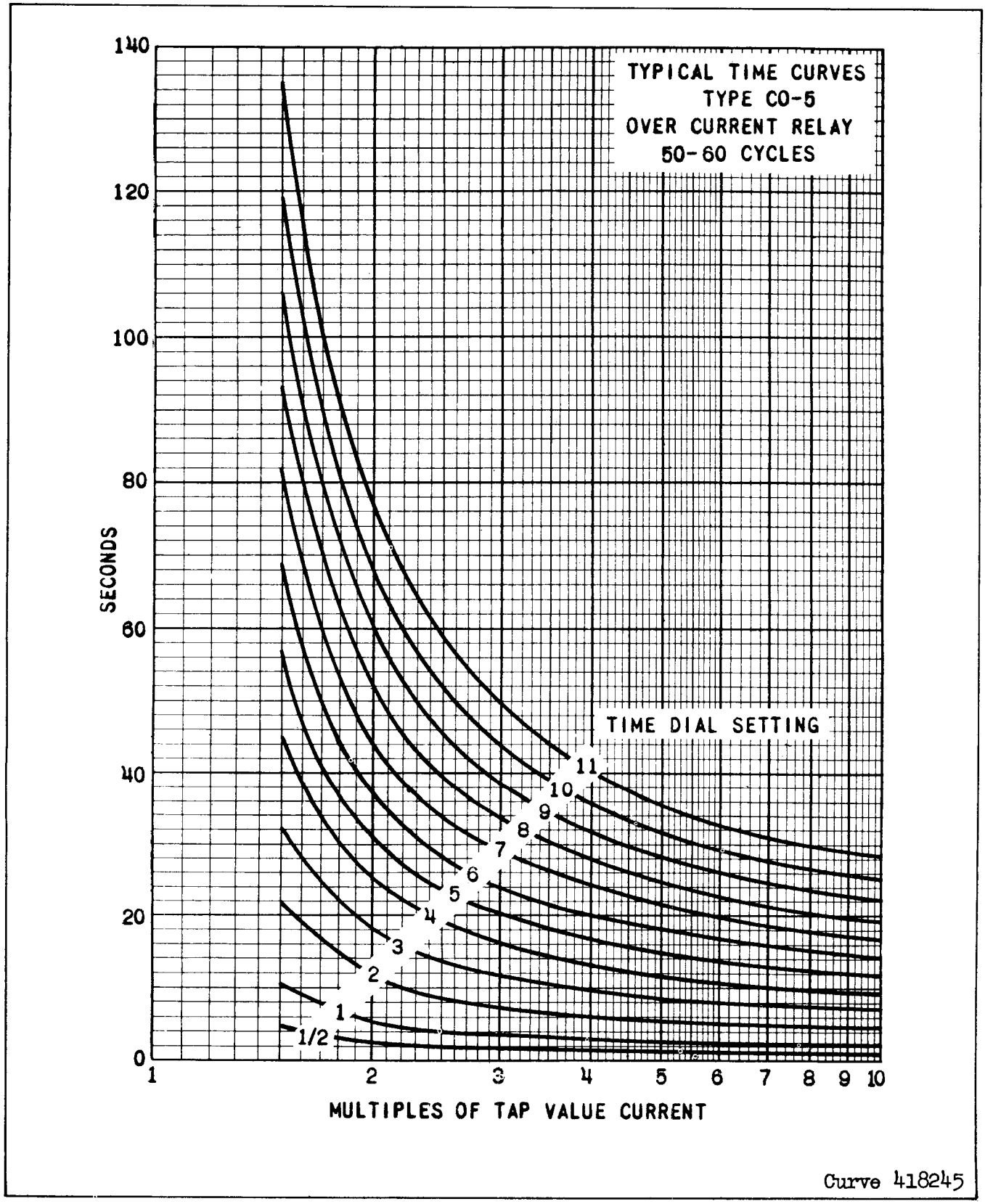


Fig. 5. Typical Time Curve of the Time-Overcurrent Unit of the Long Time (5) Relays.

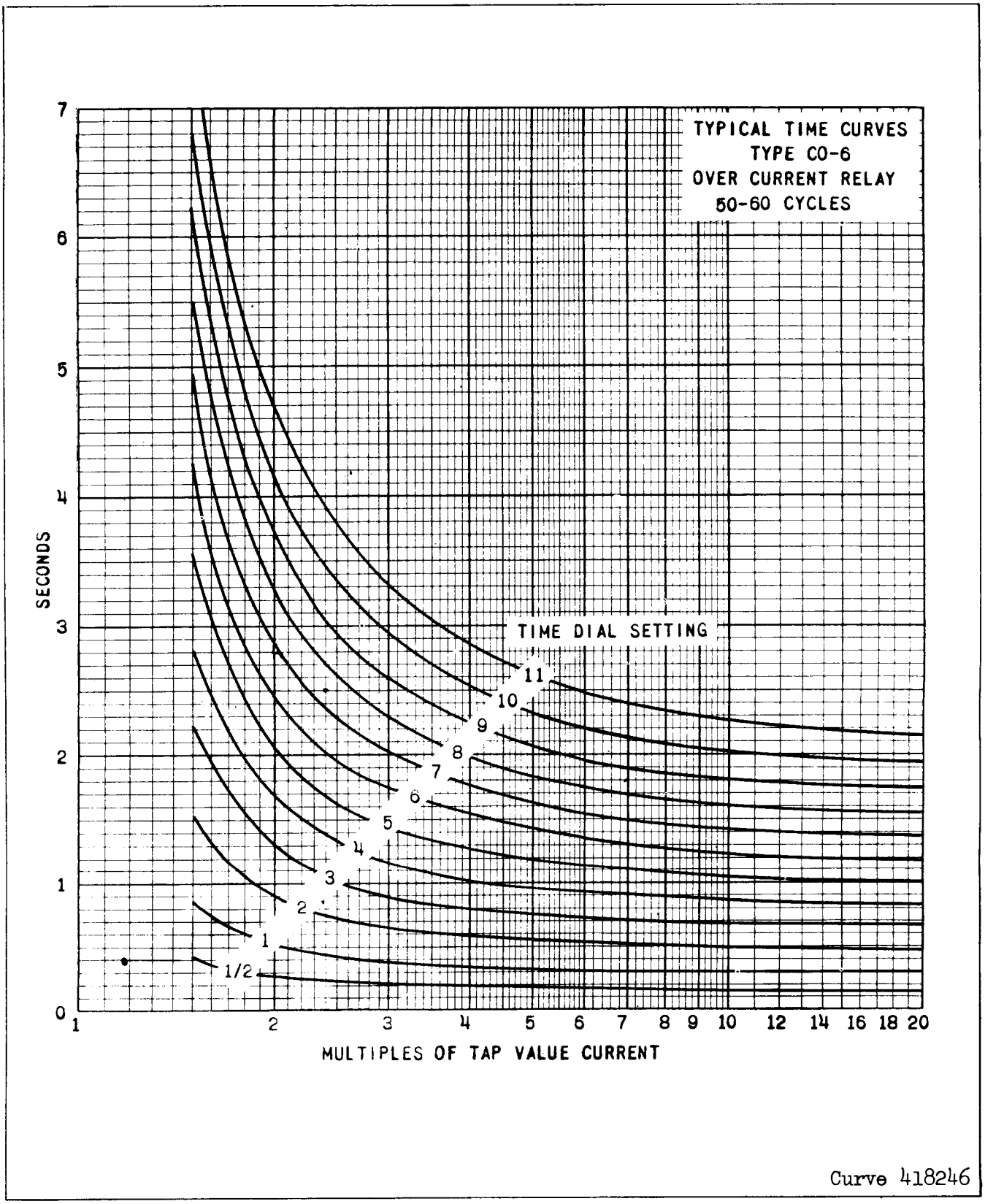


Fig. 6. Typical Time Curve of the Time-Overcurrent Unit of the Definite Time (6) Relays.

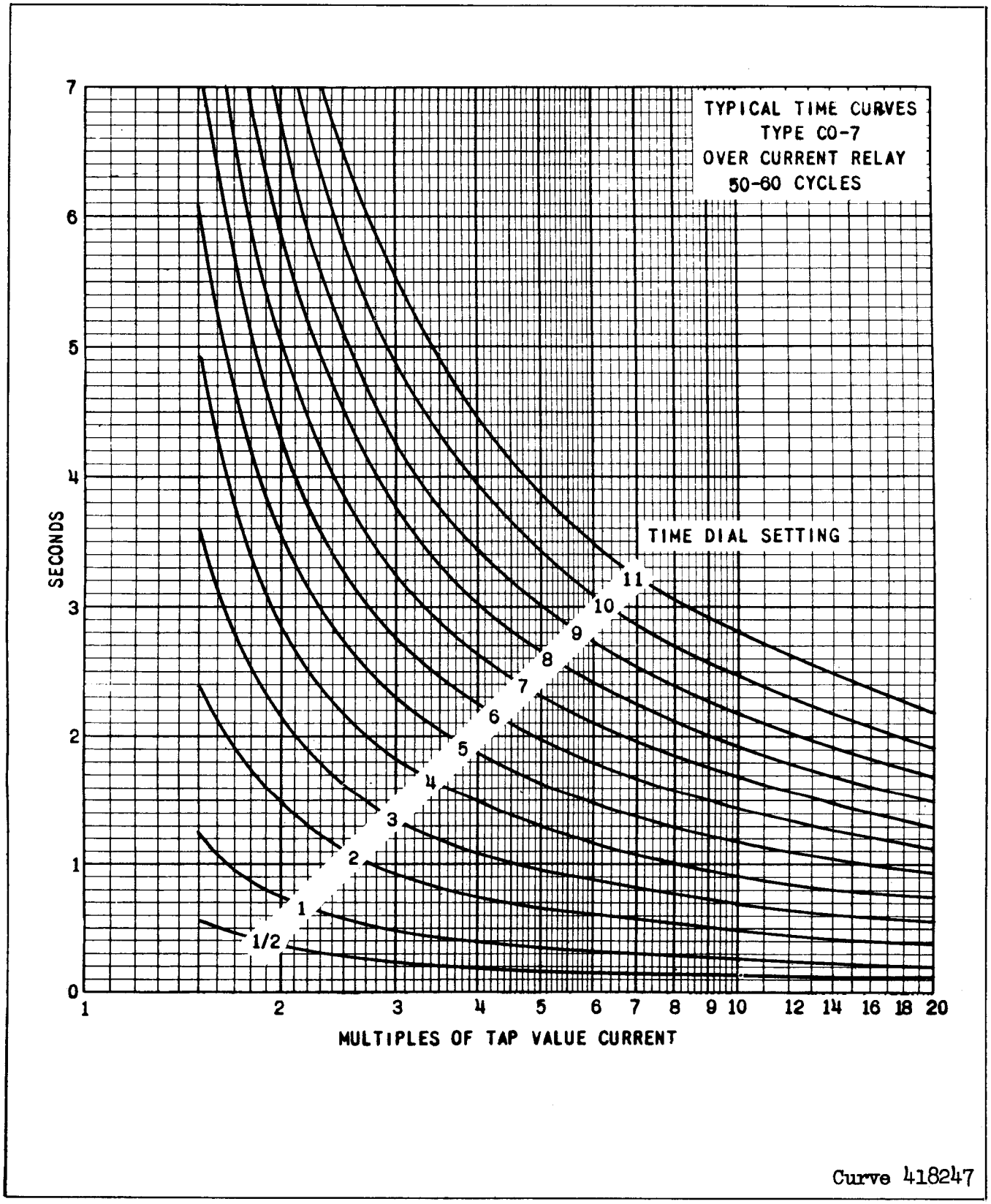


Fig. 7. Typical Time Curve of the Time-Overcurrent Unit of the Moderately Inverse (7) Relays.

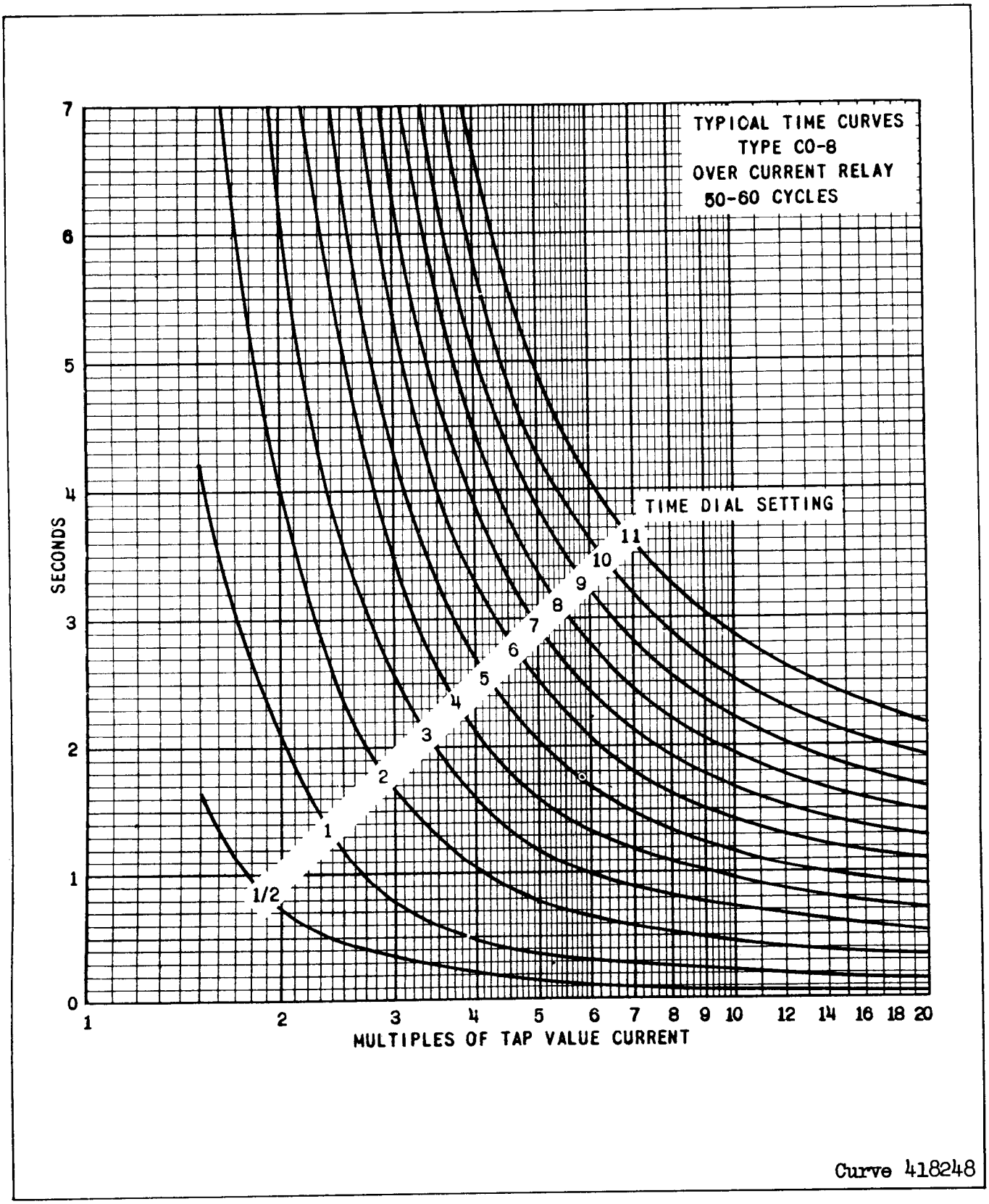


Fig. 8. Typical Time Curve of the Time-Overcurrent Unit of the Inverse (8) Relays.

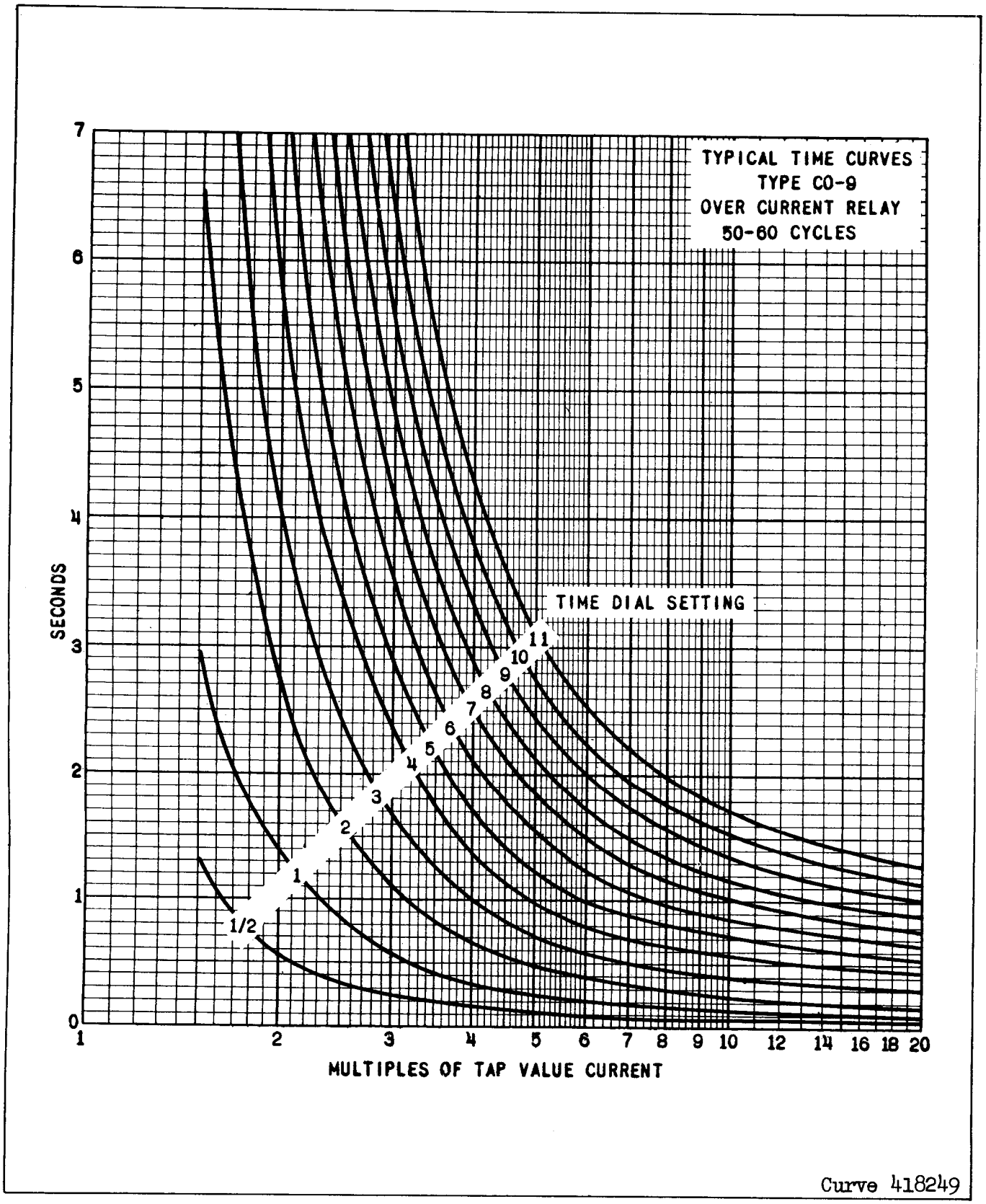


Fig. 9. Typical Time Curve of the Time-Overcurrent Unit of the Very Inverse (9) Relays.

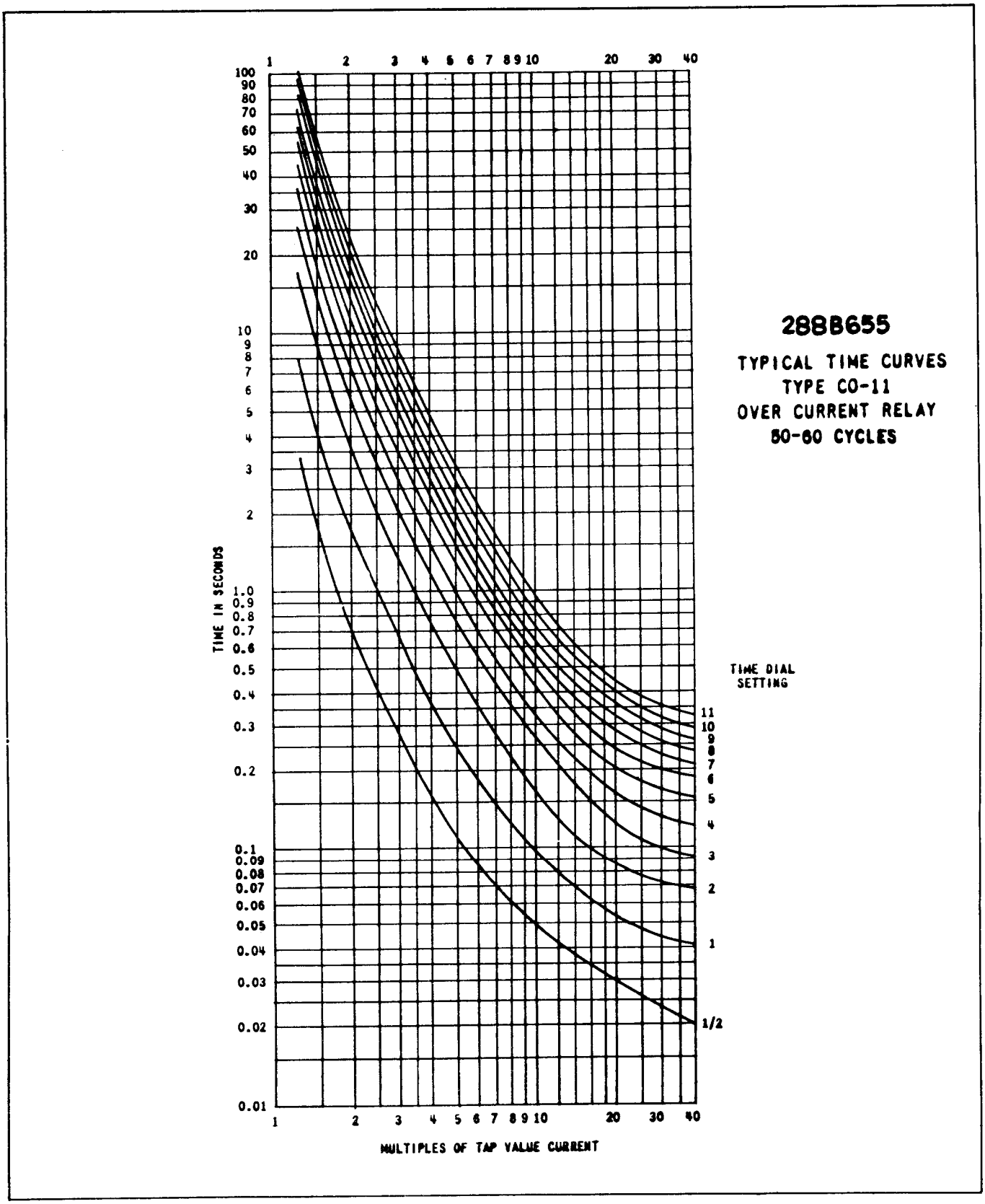


Fig. 10. Typical Time Curve of the Time-Overcurrent Unit of the Extremely Inverse (11) Relays.

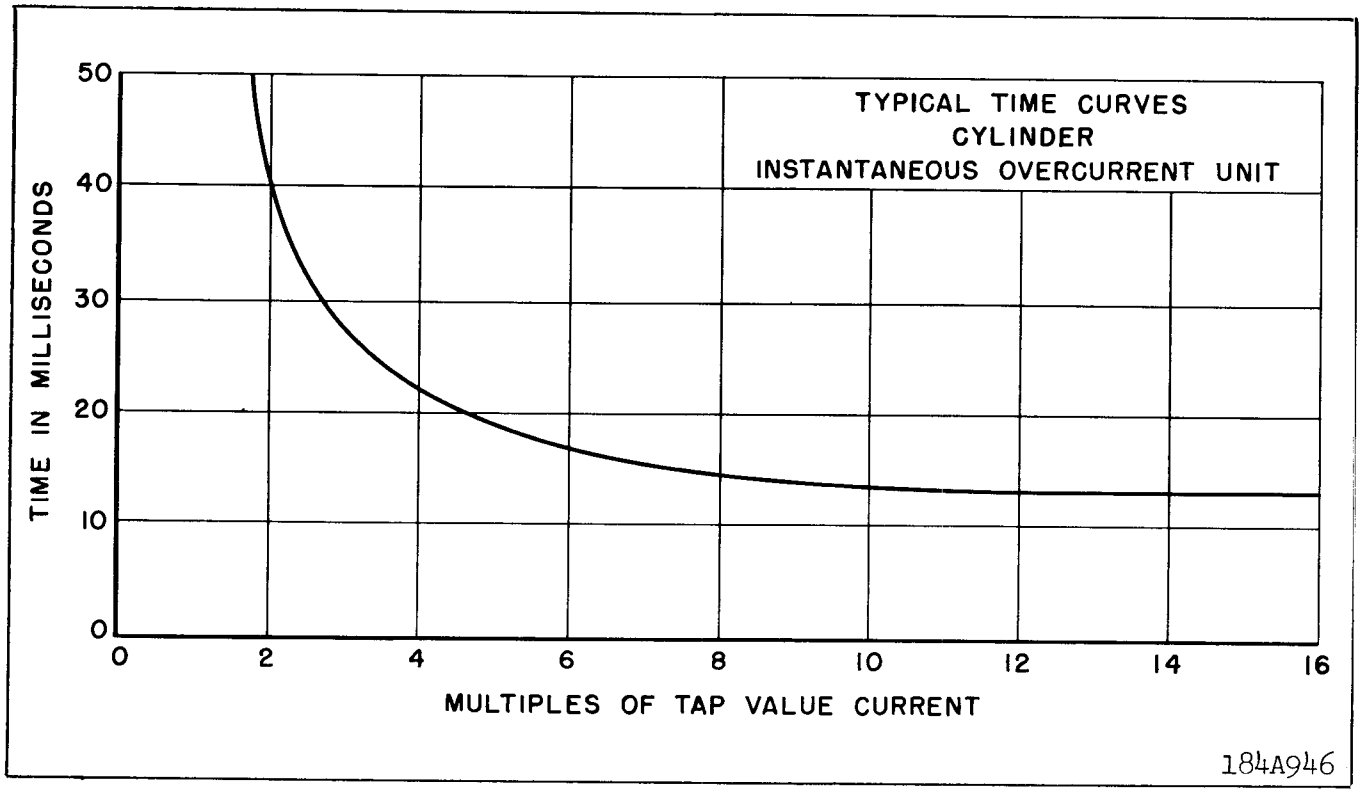


Fig. 11. Typical Time Curve of the Instantaneous Overcurrent Unit.

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 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 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.

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 re-

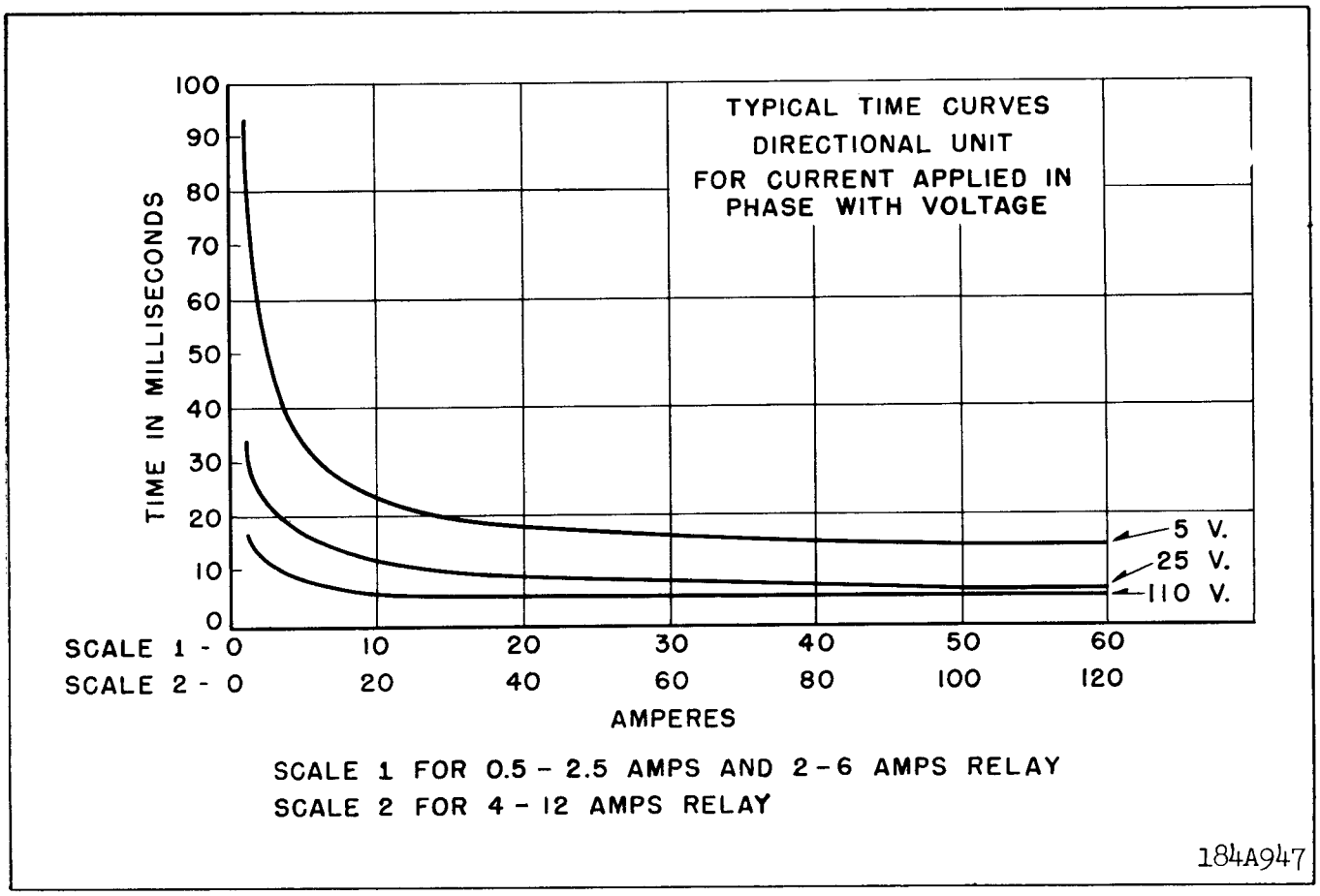


Fig. 12. Typical Time Curves of the Directional Unit.

moving the other tap screw from the original tap position.

Directional Units (D)

No setting is required.

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

No setting is required on the ICS units 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.

Auxiliary Switch (CS-1)

No setting required on the CS-1 unit except for the selection of the required 48, 125 or 250 voltage on the tapped resistor. This connection can be made by referring to Fig. 13.

INSTALLATION

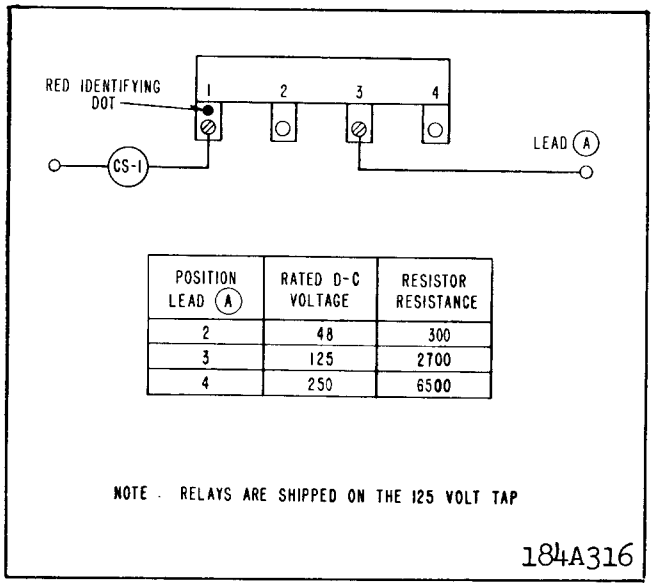
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat Mount the relay vertically by means of the two mounting studs for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting.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

For detail information on the FT Case refer to I.L. 41-076.

The external connection of the directional overcurrent relays is shown in Fig. 15.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon



POSITION LEAD (A)	RATED D-C VOLTAGE	RESISTOR RESISTANCE
2	48	300
3	125	2700
4	250	6500

NOTE - RELAYS ARE SHIPPED ON THE 125 VOLT TAP

Fig. 13. Selection of Proper Voltage Tap for Auxiliary Switch (CS-1) Operation.

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 D contacts should be blocked closed when checking the pick-up of the overcurrent unit.

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.

Directional Unit (D)

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

2. Sensitivity — The directional unit should trip with 1.2 volts and 4 amperes at its maximum torque angle (current leading the voltage by 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

3. Spurious Torque Adjustments — There should be no spurious closing torques when the operating circuits are energized per Table 2 with the polarizing circuit short circuited.

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 with the auxiliary switch (CS-1) contacts blocked closed, 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%.

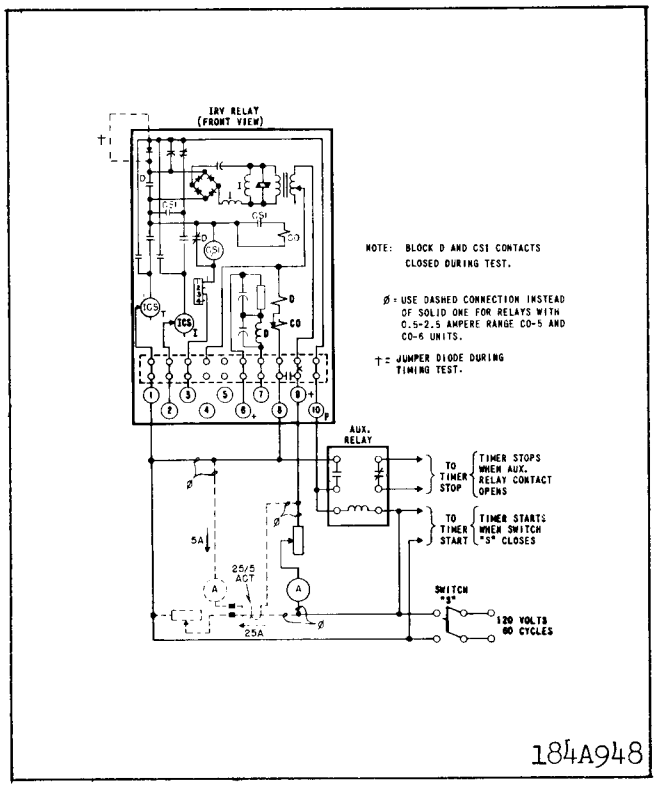
3. Time Curve — Table 1 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 1 (e g. for the IRV-2 3 and 20 times tap value current) And measure the operating time of the relay. The operating times should equal those of Table 1 plus or minus 5 percent.

Indicating Contactor Switches (ICS/1) and (ICS/T)

A) Close the contacts of the CO and the directional unit (D) 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 overcurrent unit (I) and the directional unit (D). Pass sufficient d.c. 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.



* *Fig. 14. Diagram of test connections of the time-overcurrent unit.*

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 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 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 .025" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in postion 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 moving contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in 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.

* Before applying current, block close the contacts of the D unit. 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 pickup of the overcurrent unit with the tap screw is any other tap should be within ± 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.

Directional Unit (D)

The directional unit is the lower cylinder unit.

1. The upper bearing screw should be screwed down until there is approximately .025" clearance between it and the top of the shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut.

2. Contact gap adjustment for the directional 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 moving contact. Then back off the stationary contact 2/3 of one turn for a contact gap * of 0.020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. Insert tap screw of overcurrent unit in highest tap. 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.

The spring is to be adjusted such that the contact will close as indicated by a neon lamp in the contact circuit when energized with 1.2 volts and 4 amps (current leading 30°) for the 4 – 12 ampere range relays and 1.2 volts and 2 amps for the 0.5 to 2.5 and 2 to 6 ampere range relays This can be done approximately using current in phase with voltage by increasing the pickup current to 4.6 and 2.3 amperes respectively.

4. The magnetic plugs and core are used to reverse any unwanted spurious torques that may be present when the relay is energized on current alone.

The reversing of the spurious torques is accomplished by using the adjusting plugs and core in the following manner:

Short circuit the voltage terminals and apply current to the operating circuit terminals as per Table 2.

Plug and core adjustment is then made per Table 2 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment. The core assembly is held in position by the clamping action of two compressed springs. This allows its position to be changed by inserting a non-magnetic tool into the slot on the bottom side of the unit.

The magnetic plug and core adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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 6-3/4 convolutions show.

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

With the auxiliary switch (CS-1) contacts blocked closed, 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. IRV-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. IRV-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/1) and ICS/T)

Adjust the contact gap for approximately .047".

A) Close the contacts of the CO and the directional unit and pass sufficient d.c. current through

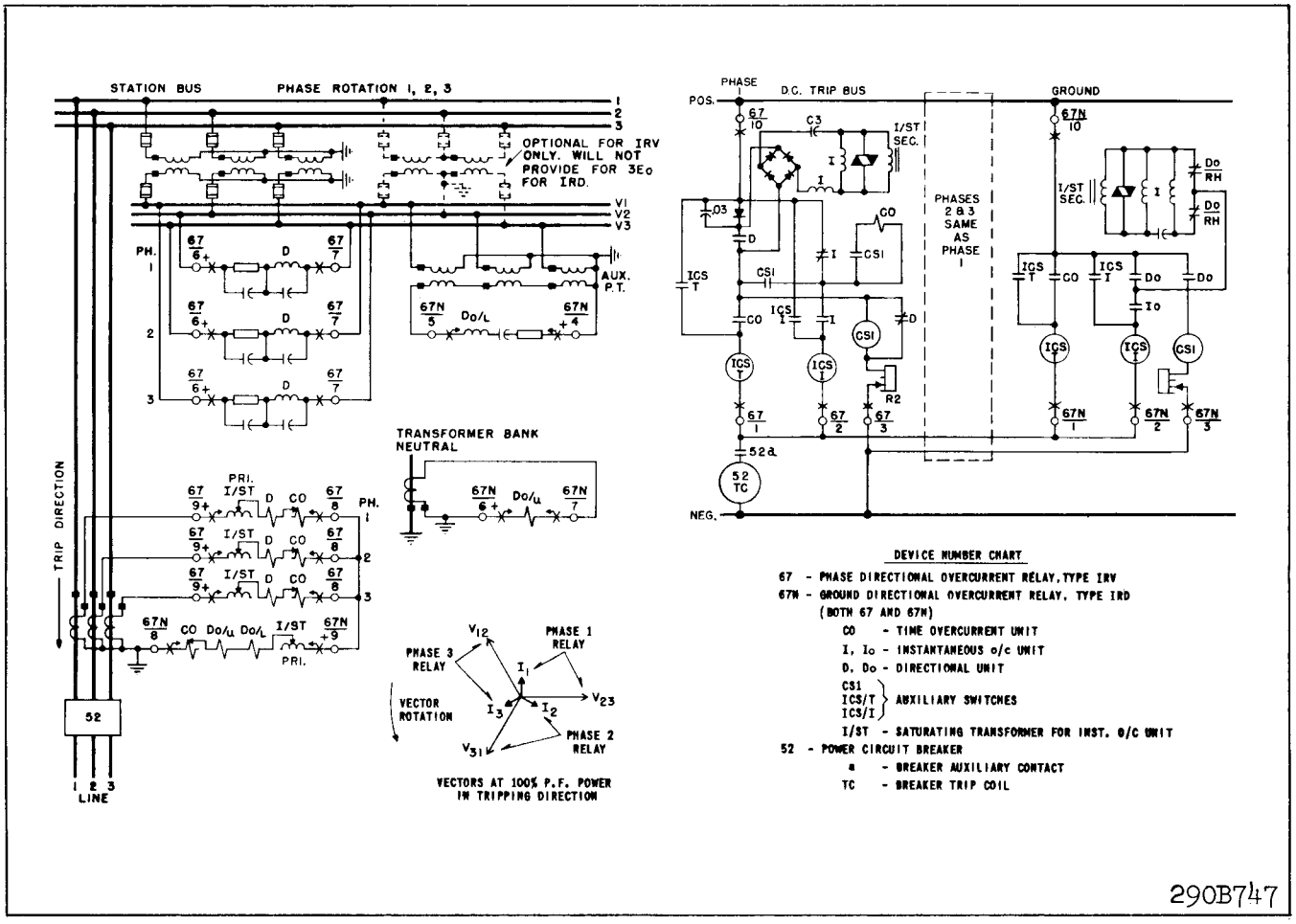


Fig. 15. External Schematic of the IRV Relay for Phase Protection and the IRD Relay for Ground Protection.

the trip circuit to close the contacts of the (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 contacts of instantaneous overcurrent unit (I) and directional unit (D). Pass sufficient d.c. 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.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Connect lead (A) to proper terminal per Fig. 13. Block directional unit (D) contacts close and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make as indicated by a neon lamp in the contact circuit.

RENEWAL PARTS

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

TABLE 1

TIME CURVE CALIBRATION DATA – 60 CYCLES

	PERMANENT MAGNET ADJUSTMENT			ELECTROMAGNET PLUGS	
TIME-OVERCURRENT UNIT TYPE	TIME DIAL POSITION	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

TABLE 2

DIRECTIONAL UNIT CALIBRATION +

Relay Rating	Current	Adjust	Adjustment
.5 to 2.5 Amp and 2-6 amps.	25 Amp	Core ††	Rotate core by means of adjuster located on bottom side of cylinder unit. Adjust core so that a slight contact opening torque is made. Recheck at 15 and 5 amps. to see there is no closing torque for the lower range units and 30 amps and 10 amps for the 4-12 amp range relays.
4-12 amps	50 amps		
.5 to 2.5 amps and 2-6 amps	50 amps	Magnetic Plugs	If spurious torque is in the contact closing direction (left front view) screw out right magnetic plug until direction of spurious torque is reversed. If spurious torque is in the contact opening direction, screw out left plug until spurious torque is slight contact opening. Recheck at 40, 25 and 10 amps for the lower range units and 80, 50 and 20 amps for the 4-12 amp range relays.
4-12	100 amps		

† Short circuit the voltage polarizing circuit at the relay terminals before making the above adjustments.
†† Plugs should be at fully in position prior to adjustment of core.

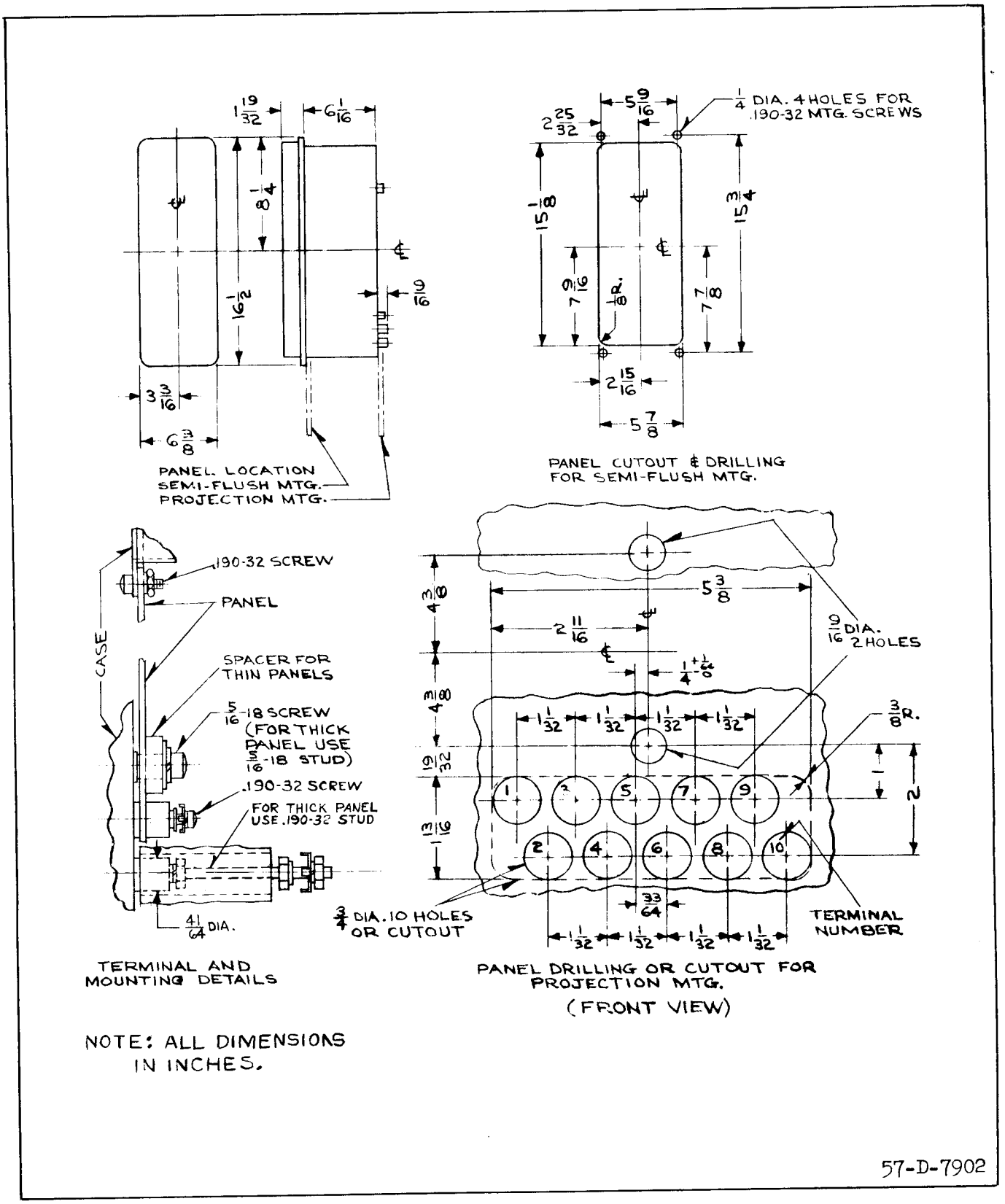


Fig. 16. Outline and Drilling Plan for the Type IRV Relay in the Type FT31 Case.

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

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE IRV DIRECTIONAL OVERCURRENT RELAY

FOR PHASE PROTECTION

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 relays are phase directional overcurrent relays which are used for the protection of transmission lines and feeder circuits. Both the time-overcurrent and instantaneous overcurrent units are directionally controlled.

CONSTRUCTION AND OPERATION

The Type IRV relay consists of a directional unit (D), an auxiliary switch (CS-1), a time-overcurrent unit (CO), an instantaneous overcurrent 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 and 2.

Time-Overcurrent Unit (CO)

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 units 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 causes a contact closing torque.

The electromagnet for the type CO-2 and CO-11 units 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 Units (ICS/I and ICS/T)

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 pick-up value of the switch.

Directional Unit (D)

The directional unit is a product induction cylinder type unit operating on the interaction between the polarizing circuit flux and the operating circuit flux.

Mechanically, the directional unit is composed of four basic components: A die-cast 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 spring and snap ring. This is an adjustable core which has a .025 inch flat on one side and is held in its adjusted position by the clamping action of two compressed springs. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected operating coils mounted diametrically opposite one another; two magnetic adjusting plugs; upper and lower adjusting plug clips, and two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The elec-

ENERGY REQUIREMENTS

TYPE IRV-2 TIME OVERCURRENT UNITS

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

IRV-5, IRV-6, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	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	3.87	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

† *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

IRV-7 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	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

IRV-8, IRV-9, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	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.*

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

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

IRV-11 OVERCURRENT UNITS

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

† *Thermal capacities for short times other than one second may be 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 – 60 CYCLES

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

Range Amps	Continuous Rating (Amperes)	One Second Rating † (Amperes)	Power Factor Angle ϕ	VOLT AMPERES†† At Minimum Tap Value Current	VOLT AMPERES†† At 3 Times Minimum Tap Value Current	VOLT AMPERES†† At 10 Times Minimum Tap Value Current	VOLT AMPERES†† At 20 Times Minimum Tap Value Current
0.5-2.5	10	230	34.5	0.03	0.23	2.8	11.5
2-6	10	230	34.5	0.44	4.08	48.0	182.0
4-12	12	280		0.48	4.62	53.6	216.0

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

† *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.*

†† *Voltages taken with Rectox type voltmeter.*

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

The burden at 120V, 60 cycles, is 12.5 volt-amperes at 15 degrees. (current leading voltage).

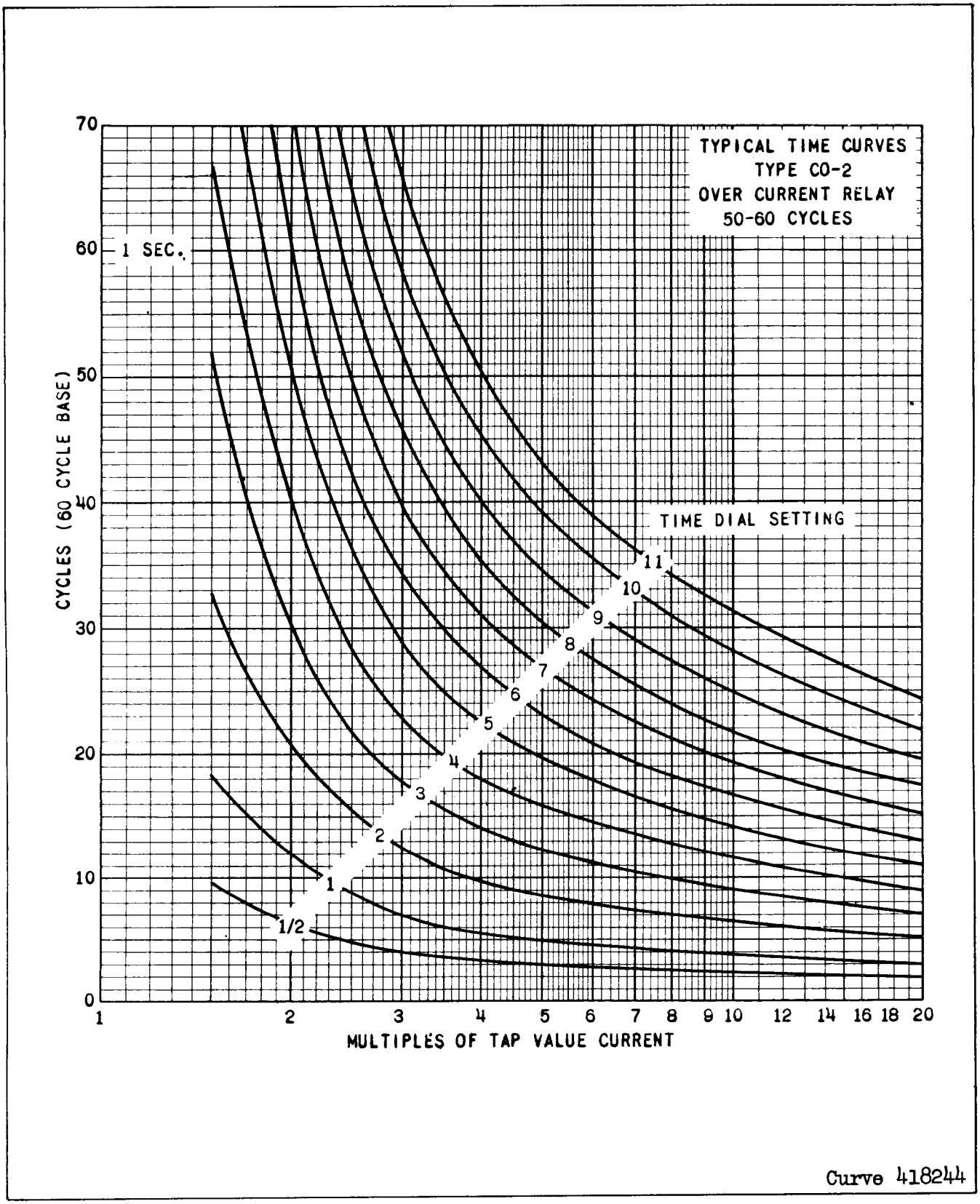


Fig. 4. Typical Time Curves of the Time-Overcurrent Unit of the Short Time (2) Relays.

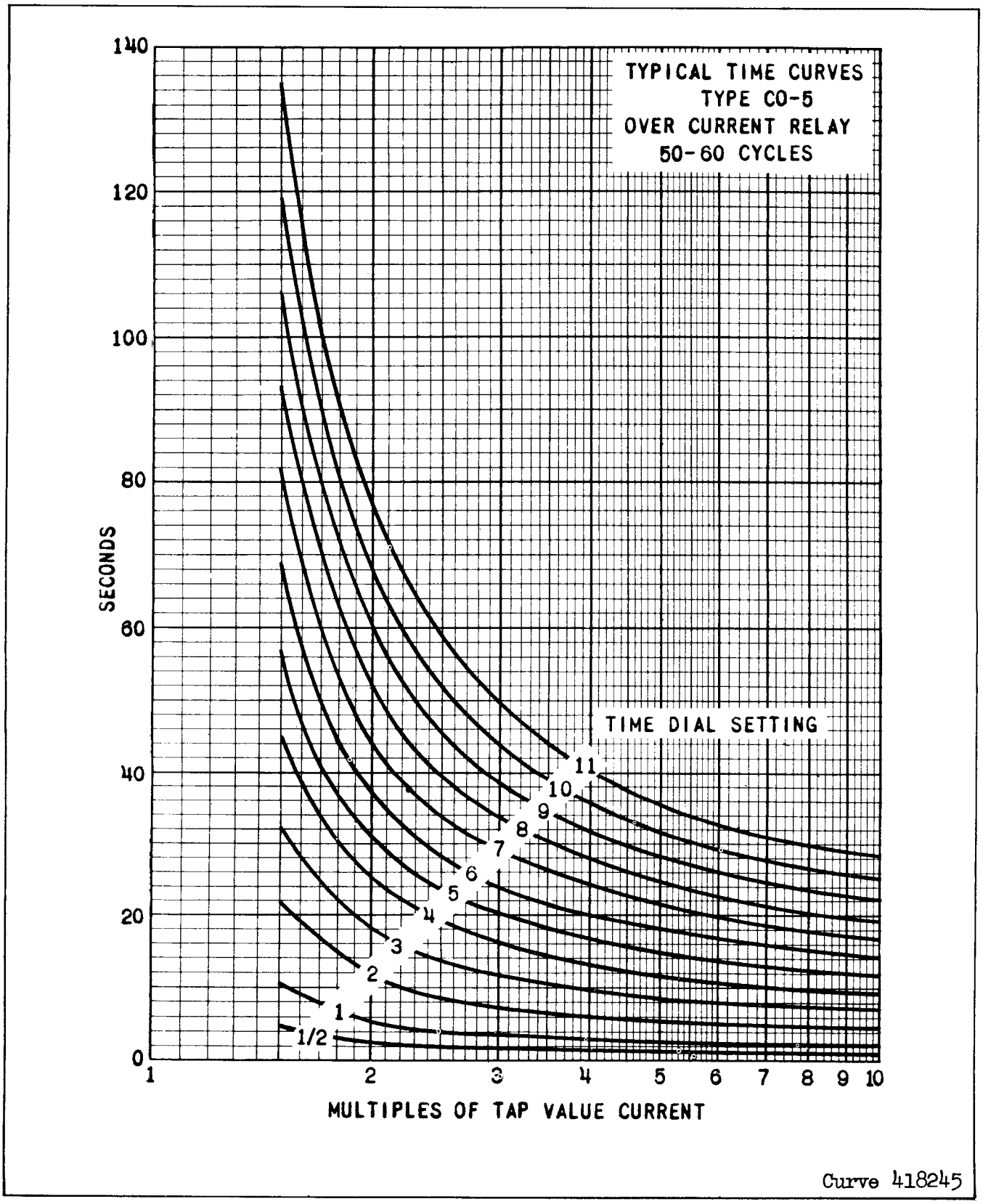


Fig. 5. Typical Time Curve of the Time-Overcurrent Unit of the Long Time (5) Relays.

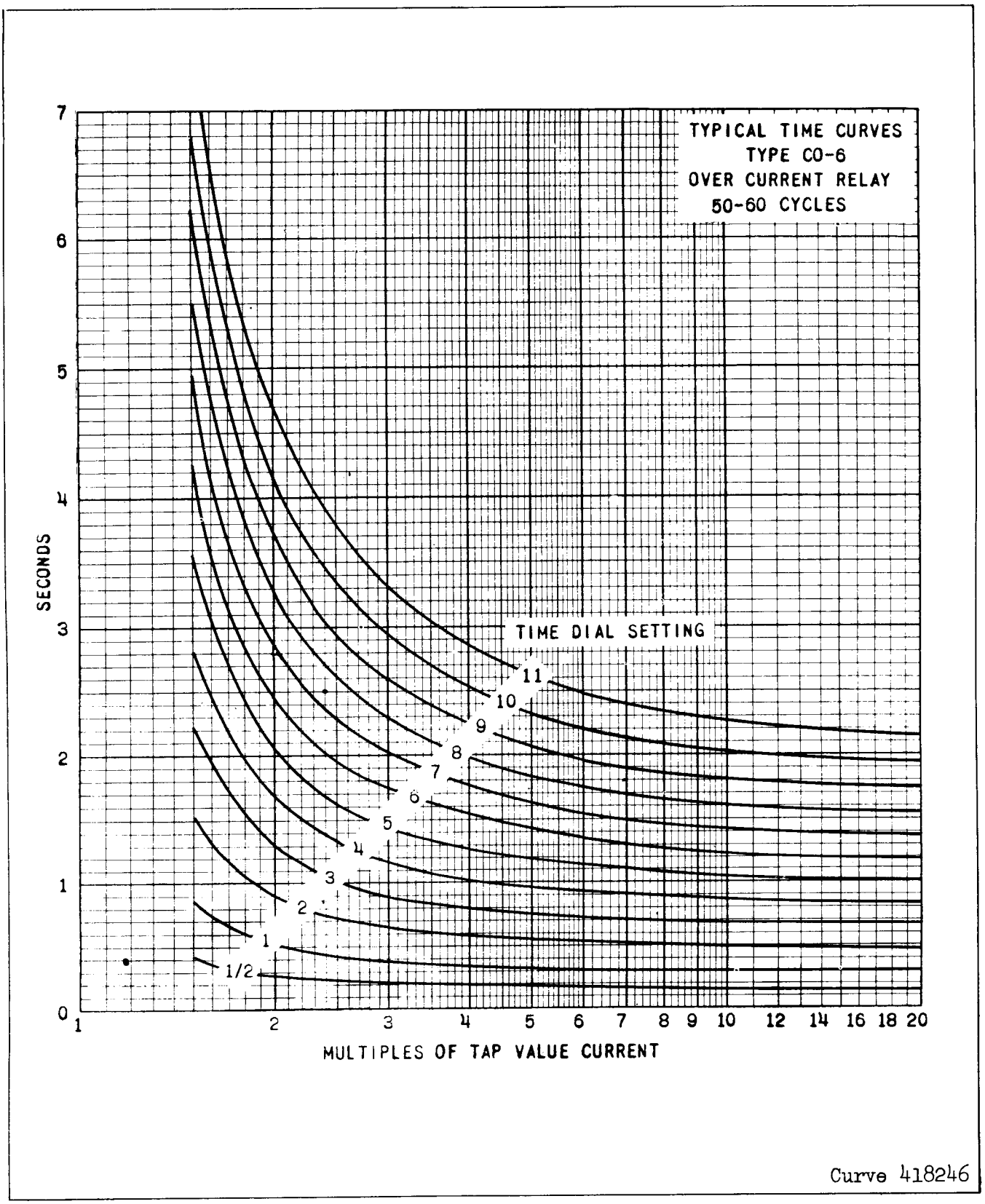


Fig. 6. Typical Time Curve of the Time-Overcurrent Unit of the Definite Time (6) Relays.

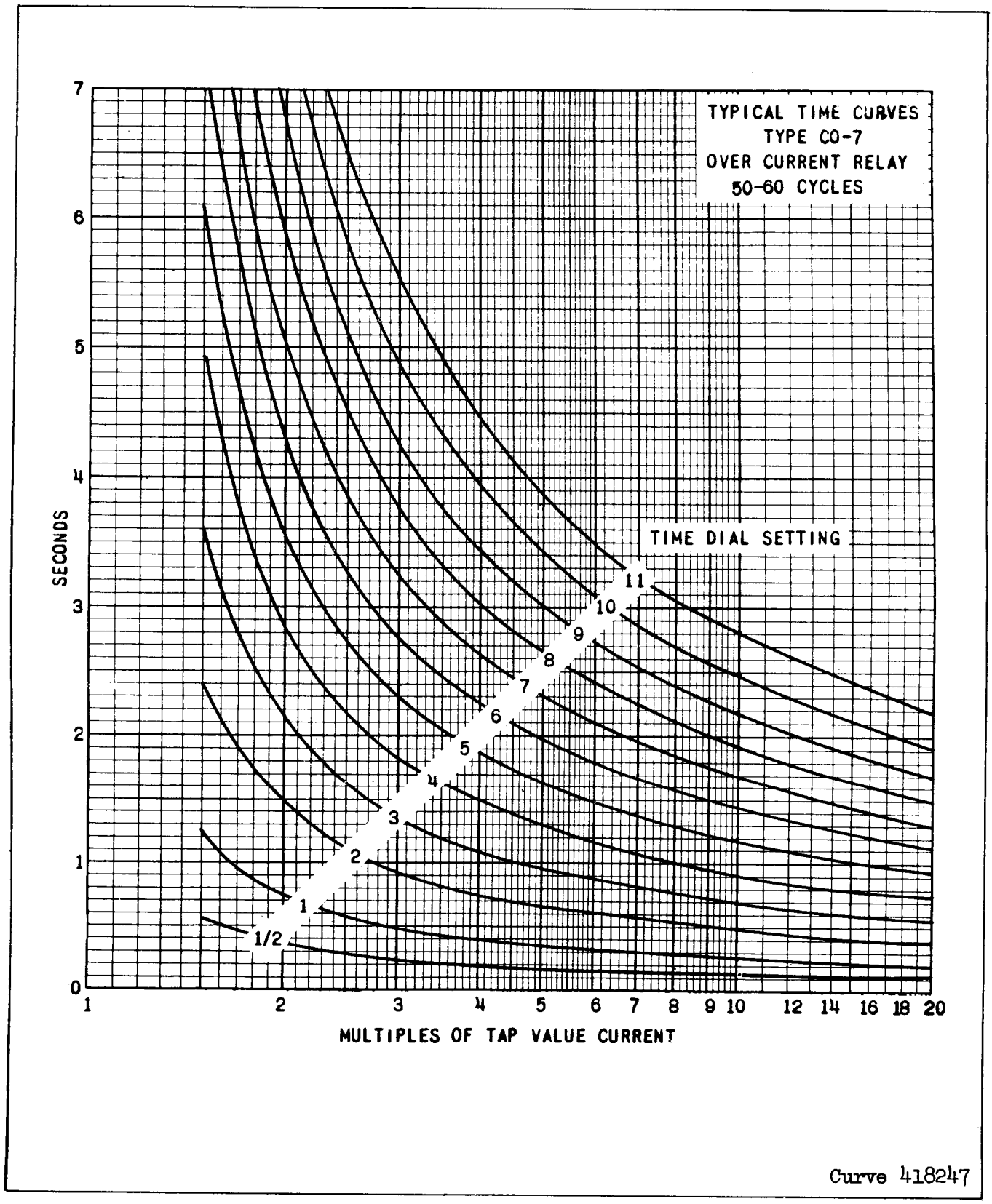


Fig. 7. Typical Time Curve of the Time-Overcurrent Unit of the Moderately Inverse (7) Relays.

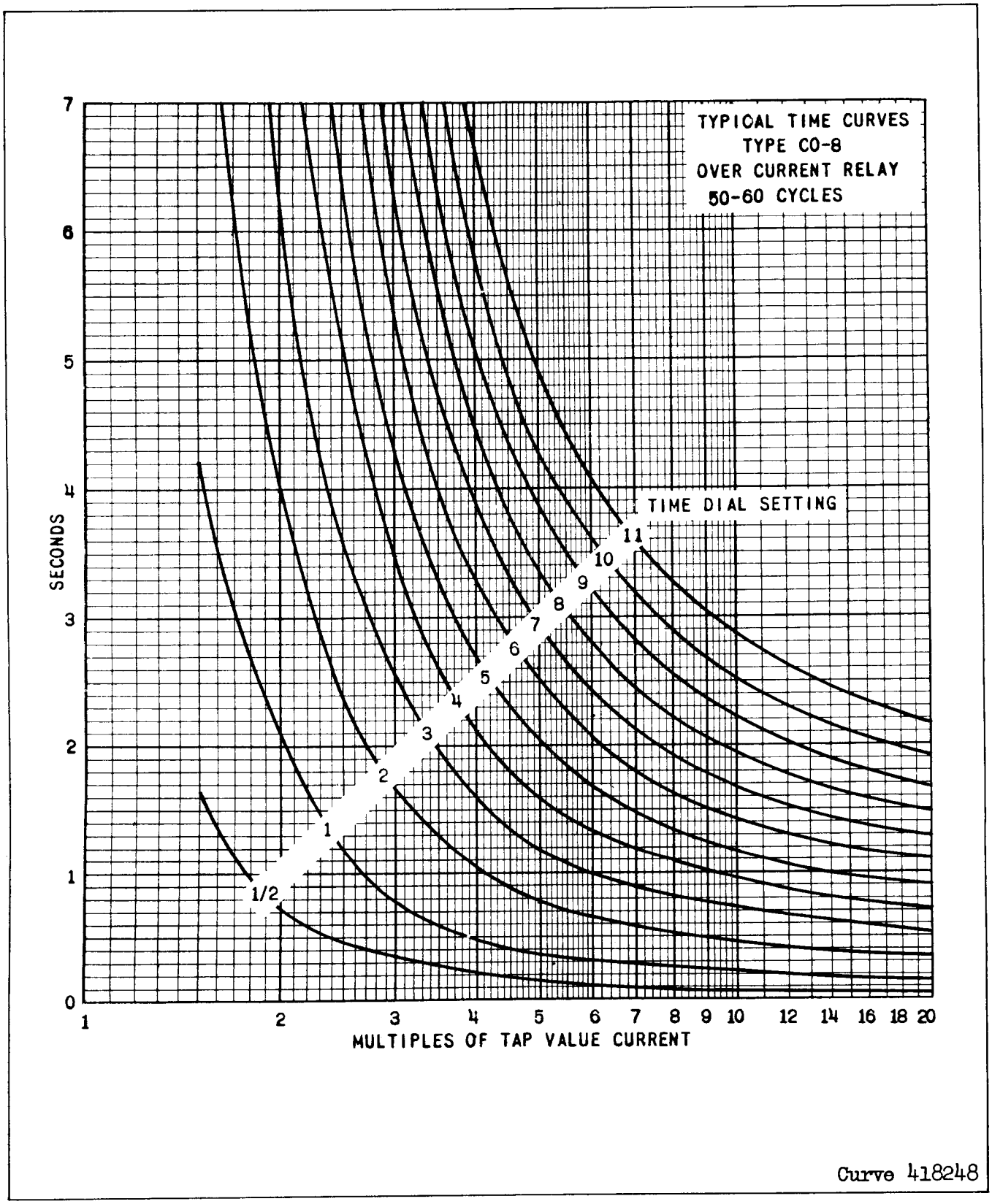


Fig. 8. Typical Time Curve of the Time-Overcurrent Unit of the Inverse (8) Relays.

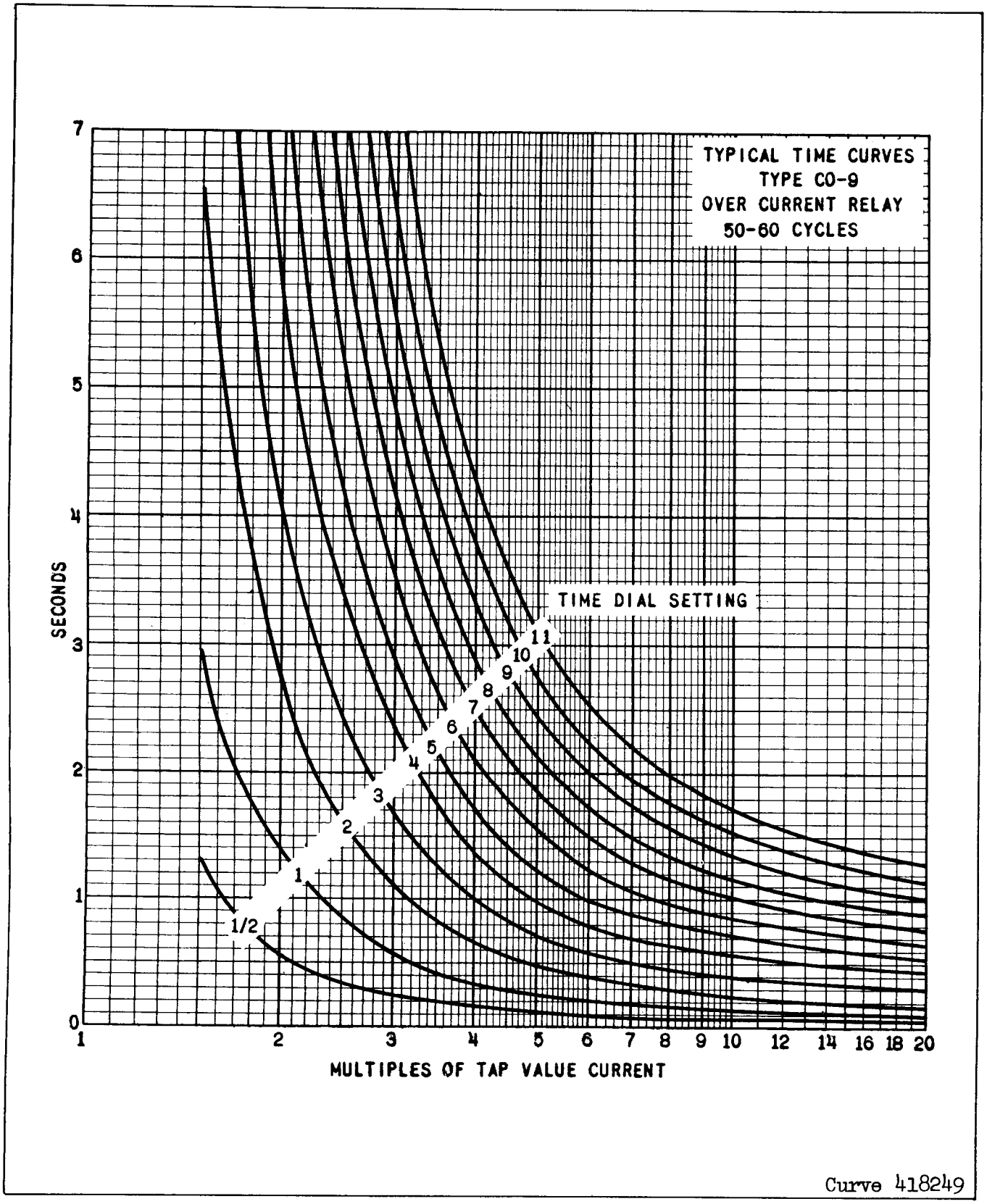


Fig. 9. Typical Time Curve of the Time-Overcurrent Unit of the Very Inverse (9) Relays.

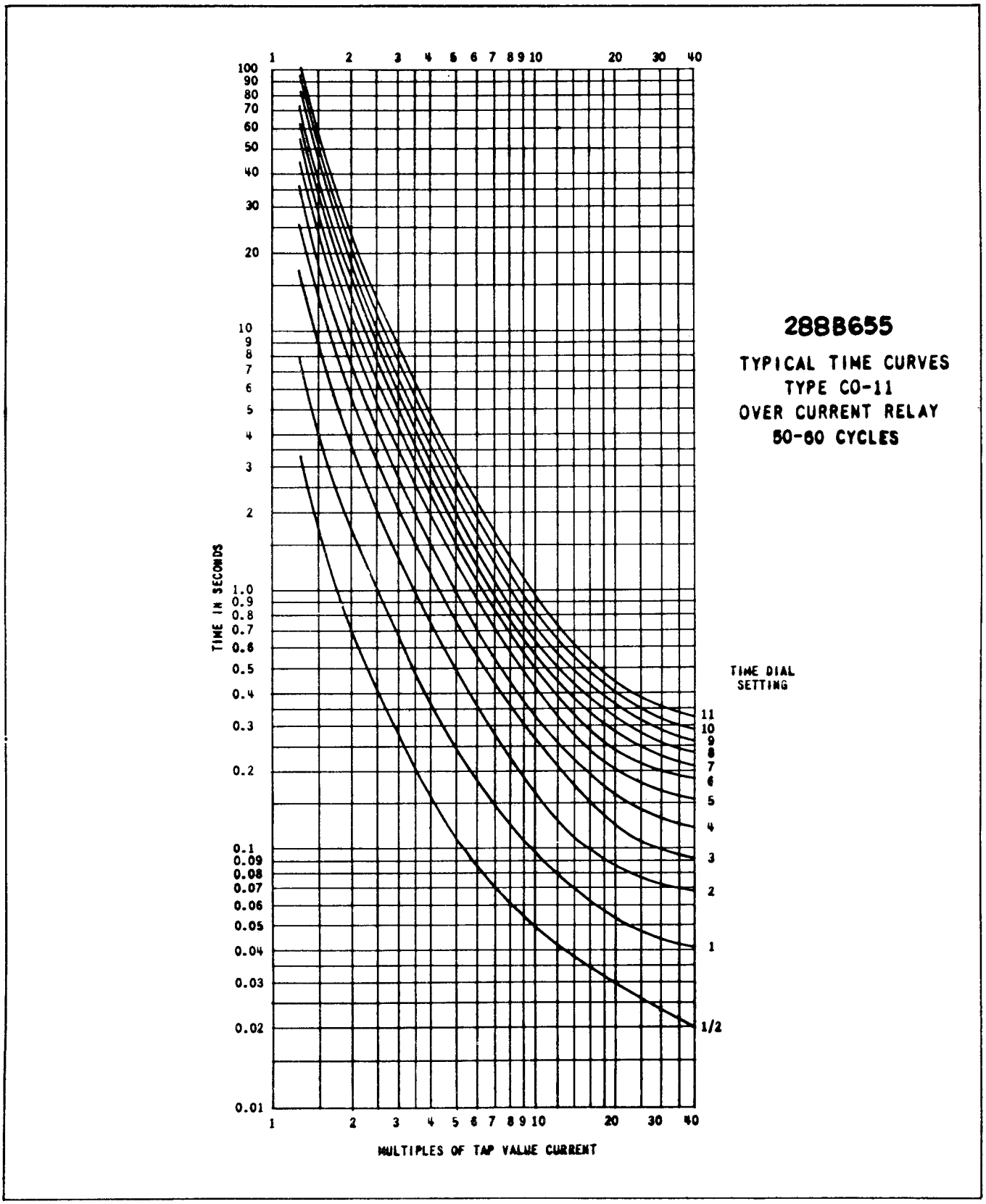


Fig. 10. Typical Time Curve of the Time-Overcurrent Unit of the Extremely Inverse (11) Relays.

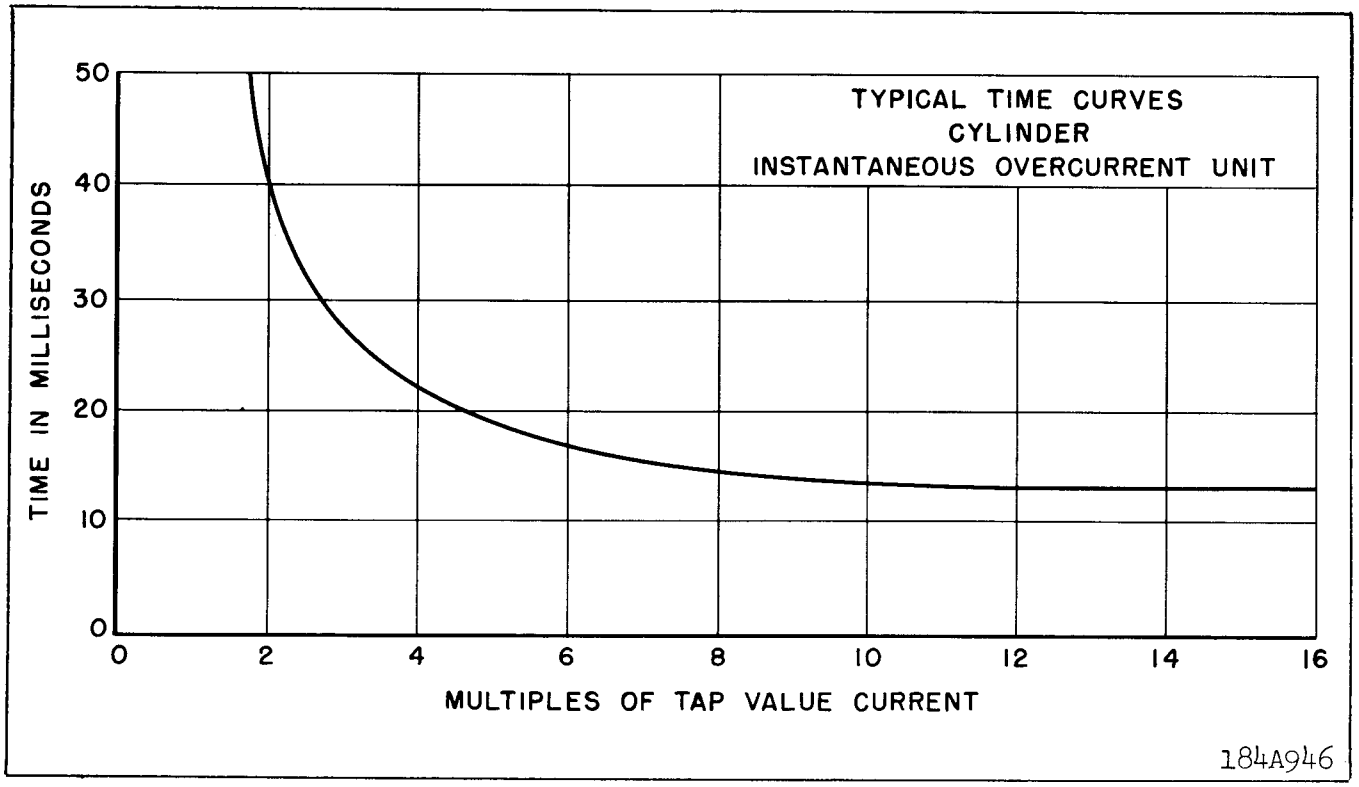


Fig. 11. Typical Time Curve of the Instantaneous Overcurrent Unit.

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 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 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.

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 re-

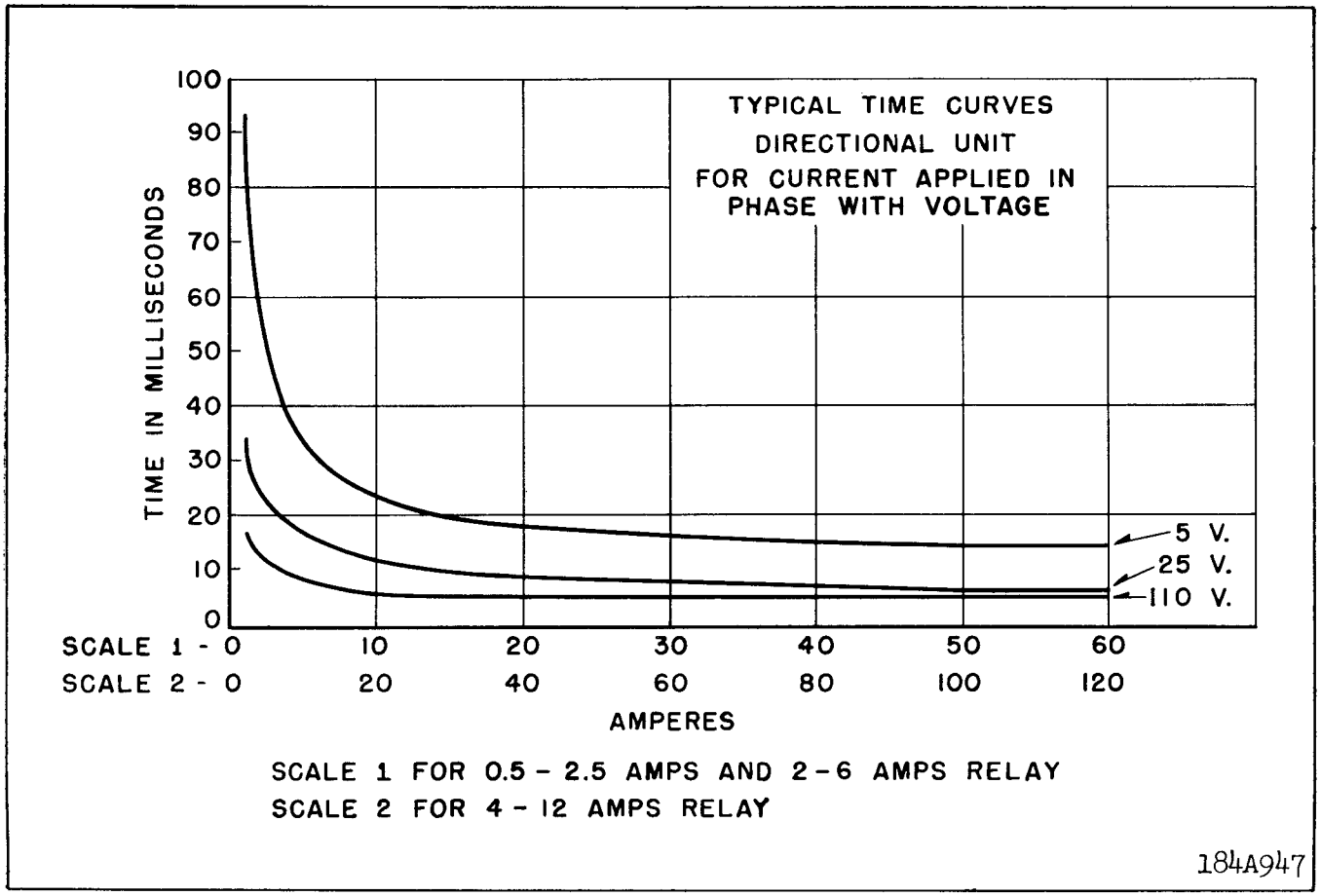


Fig. 12. Typical Time Curves of the Directional Unit.

moving the other tap screw from the original tap position.

Directional Units (D)

No setting is required.

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

The only 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.

Auxiliary Switch (CS-1)

No setting required on the CS-1 unit except for the selection of the required 48, 125 or 250 voltage on the tapped resistor. This connection can be made by referring to Fig. 13.

INSTALLATION

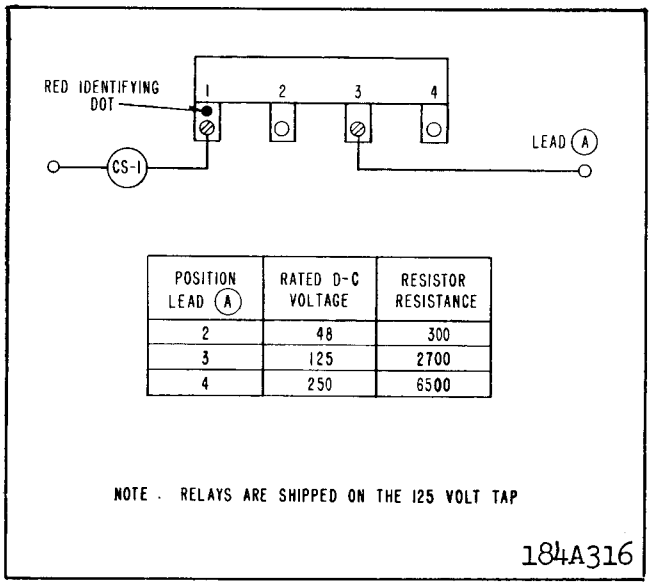
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat Mount the relay vertically by means of the two mounting studs for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting.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

For detail information on the FT Case refer to I.L. 41-076.

The external connection of the directional overcurrent relays is shown in Fig. 15.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon



POSITION LEAD (A)	RATED D-C VOLTAGE	RESISTOR RESISTANCE
2	48	300
3	125	2700
4	250	6500

NOTE . RELAYS ARE SHIPPED ON THE 125 VOLT TAP

184A316

Fig. 13. Selection of Proper Voltage Tap for Auxiliary Switch (CS-1) Operation.

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 D contacts should be blocked closed when checking the pick-up of the overcurrent unit.

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.

Directional Unit (D)

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

2. Sensitivity — The directional unit should trip with 1.2 volts and 4 amperes at its maximum torque angle (current leading the voltage by 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

3. Spurious Torque Adjustments — There should be no spurious closing torques when the operating circuits are energized per Table 2 with the polarizing circuit short circuited.

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 with the auxiliary switch (CS-1) contacts blocked closed, 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 IRV-2 3 and 20 times tap value current) And measure the operating time of the relay. The operating times should equal those of Table 1 plus or minus 5 percent.

For type IRV-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 (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Indicating Contactor Switches (ICS/1) and (ICS/T)

A) Close the contacts of the CO and the directional unit (D) 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 overcurrent unit (I) and the directional unit (D). Pass suf-

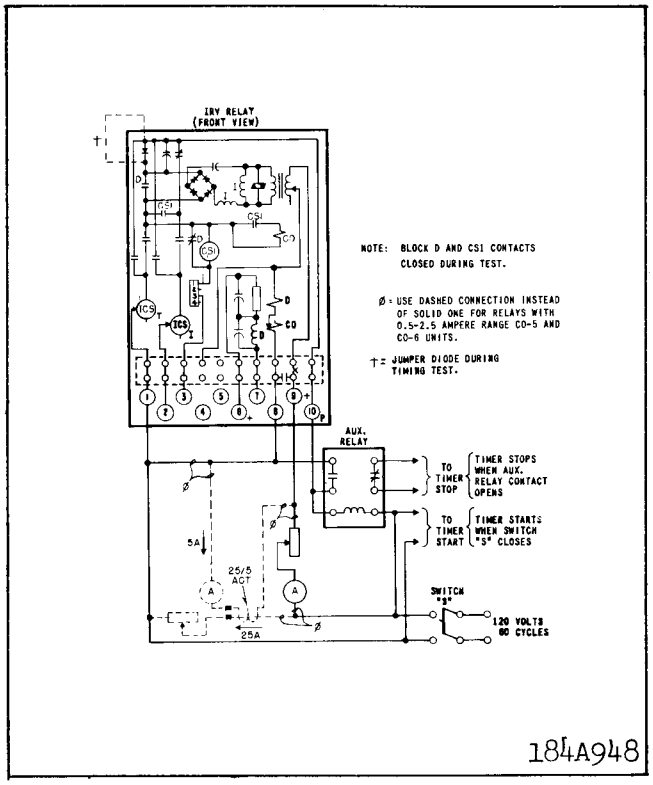


Fig. 14. Diagram of test connections of the time-overcurrent unit.

ficient d.c. 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 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 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 (1)

1. The upper pin bearing should be screwed down until there is approximately .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 moving contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in 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.

Before applying current, block close the con-

tacts of the D unit. 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 pickup of the overcurrent unit with the tap screw is any other tap should be within ± 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.

Directional Unit (D)

The directional unit is the lower cylinder unit.

1. The upper bearing screw should be screwed down until there is approximately .025" clearance between it and the top of the shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut.

2. Contact gap adjustment for the directional unit is made with the moving contact in the reset position, i.e., against the right side of the bridge. Advance the right hand stationary contact until the contacts just close. Then advance the stationary contact an additional one-half turn.

Now move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact 2/3 of one turn for a contact gap of .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. Insert tap screw of overcurrent unit in highest tap. 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.

The spring is to be adjusted such that the contact will close as indicated by a neon lamp in the contact circuit when energized with 1.2 volts and 4 amps (current leading 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amps for the 0.5 to 2.5 and 2 to 6 ampere range relays. This can be done approximately using current in phase with voltage by increasing the pickup current to 4.6 and 2.3 amperes respectively.

* 4. The magnetic plugs and core are used to reverse any unwanted spurious torques that may be present when the relay is energized respectively on current or voltage alone.

The reversing of the spurious torques is accomplished by using the adjusting plugs and core in the following manner: ††

Apply 120 VAC 60 Hz to terminals 6 and 7. Relay contacts should stay open. If the contacts are closed rotate core by means of adjustor located on the bottom side of the cylinder unit until contacts stay open. The core assembly is held in position by the clamping action of two compressed springs. This allows its position to be changed by inserting a non-magnetic tool into the slot on the bottom side of the unit.

Short circuit the voltage terminals and apply current to the operating circuit terminals as per Table 2.

Plug adjustment is then made per Table 2 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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 6-3/4 convolutions show.

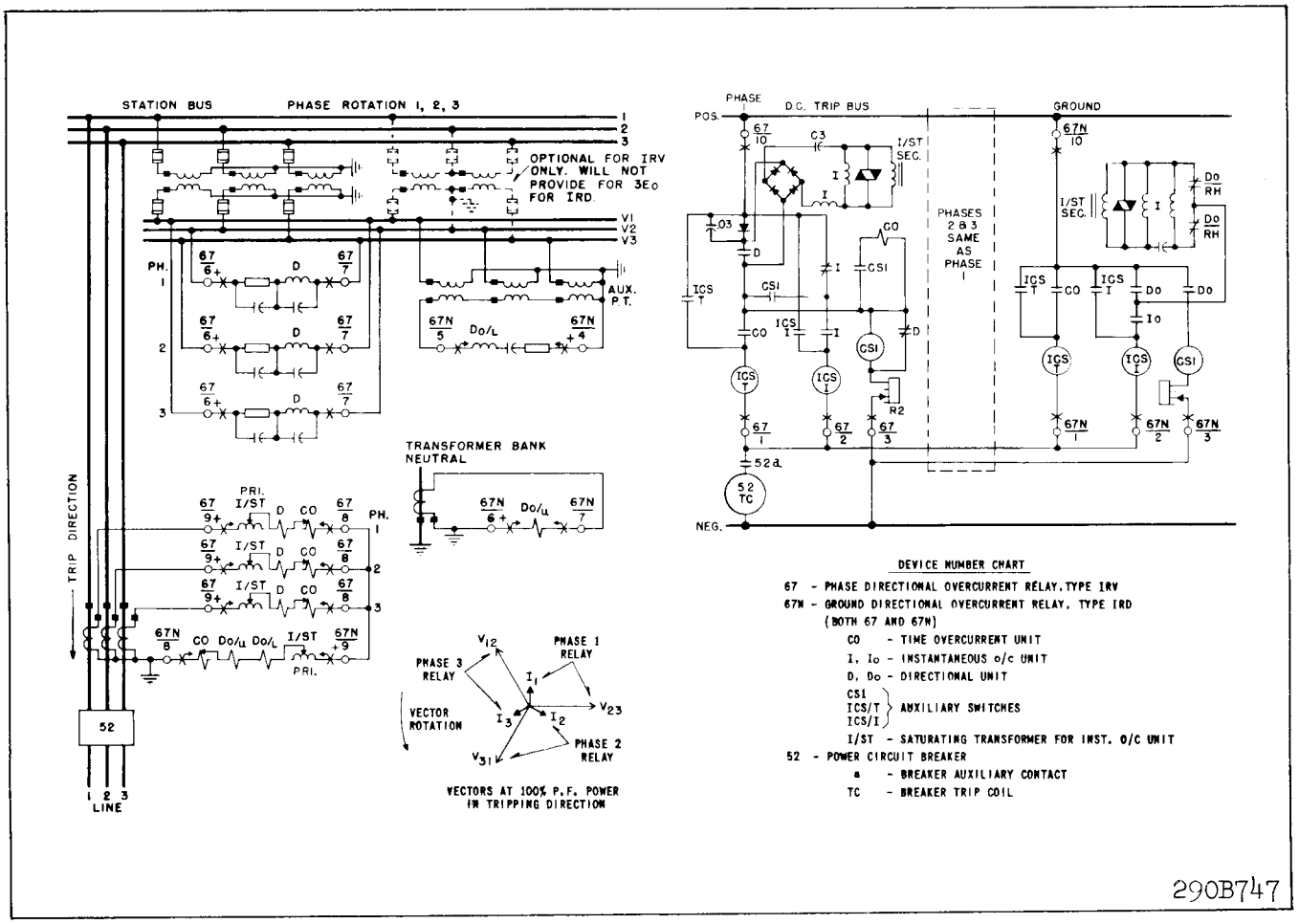


Fig. 15. External Schematic of the IRV Relay for Phase Protection and the IRD Relay for Ground Protection.

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

With the auxiliary switch (CS-1) contacts blocked closed, 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%.

†† Plugs should be at "fully screwed in" position prior to adjustment of core.

3) Time Curve Calibration — Install the permanent magnet.

Apply the indicated current per Table 1 for permanent magnet adjustment (e.g. IRV-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.

For type IRV-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 (Fig. 19). 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 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 1 for the electromagnet plug adjustment (e.g. IRV-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 the directional unit and pass sufficient d.c. current through the trip circuit to close the contacts of the (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 contacts of instantaneous overcurrent unit (I) and directional unit (D). Pass sufficient d.c. 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.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Connect lead (A) to proper terminal per Fig. 13. Block directional unit (D) contacts close and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make as indicated by a neon lamp in the contact circuit.

RENEWAL PARTS

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

TABLE 1

TIME CURVE CALIBRATION DATA – 60 CYCLES

	PERMANENT MAGNET ADJUSTMENT			ELECTROMAGNET PLUGS	
TIME-OVERCURRENT UNIT TYPE	TIME DIAL POSITION	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

* TABLE 2

DIRECTIONAL UNIT CALIBRATION +

Relay Rating	Current	Adjust	Adjustment
.5 to 2.5 amps and 2-6 amps	50 amps	Magnetic Plugs	If spurious torque is in the contact closing direction (left front view) screw out right magnetic plug until direction of spurious torque is reversed. If spurious torque is in the contact opening direction, screw out left plug until spurious torque is slight contact opening. Recheck at 40, 25 and 10 amps for the lower range units and 80, 50 and 20 amps for the 4-12 amp range relays.
4-12	100 amps		

† Short circuit the voltage polarizing circuit at the relay terminals before making the above adjustments.

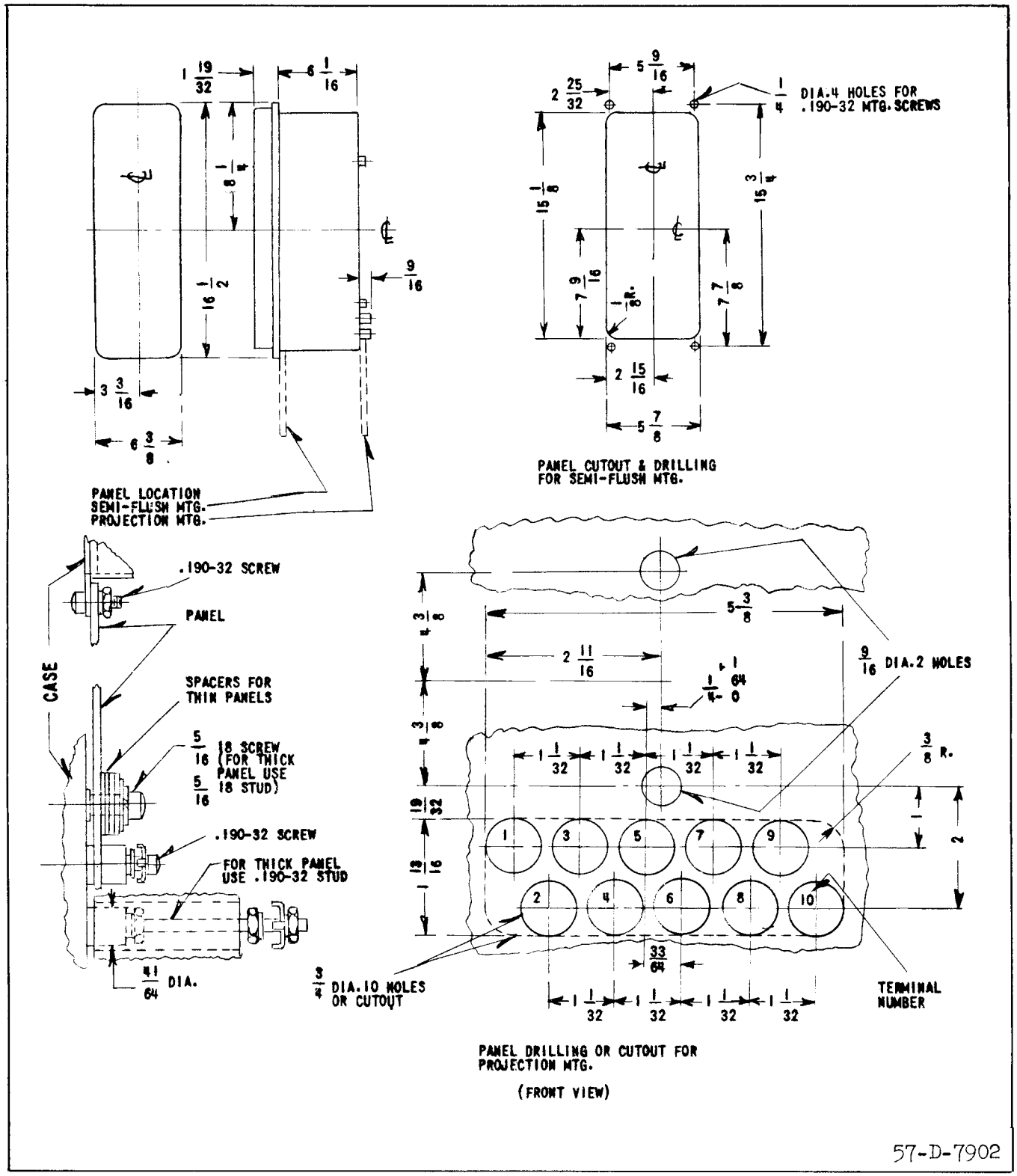


Fig. 16. Outline and Drilling Plan for the Type IRV Relay in the Type FT31 Case.

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

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE IRV DIRECTIONAL OVERCURRENT RELAY

FOR PHASE PROTECTION

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 relays are phase directional overcurrent relays which are used for the protection of transmission lines and feeder circuits. Both the time-overcurrent and instantaneous overcurrent units are directionally controlled.

CONSTRUCTION AND OPERATION

The Type IRV relay consists of a directional unit (D), an auxiliary switch (CS-1), a time-overcurrent unit (CO), an instantaneous overcurrent 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 and 2.

Time-Overcurrent Unit (CO)

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 units 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 causes a contact closing torque.

The electromagnet for the type CO-2 and CO-11 units 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 Units (ICS/I and ICS/T)

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 pick-up value of the switch.

Directional Unit (D)

The directional unit is a product induction cylinder type unit operating on the interaction between the polarizing circuit flux and the operating circuit flux.

Mechanically, the directional unit is composed of four basic components: A die-cast 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 spring and snap ring. This is an adjustable core which has a .025 inch flat on one side and is held in its adjusted position by the clamping action of two compressed springs. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected operating coils mounted diametrically opposite one another; two magnetic adjusting plugs; upper and lower adjusting plug clips, and two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The elec-

ENERGY REQUIREMENTS

TYPE IRV-2 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	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
	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
2/6	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
	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
4/12	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
	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

IRV-5, IRV-6, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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

† *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

IRV-7 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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

IRV-8, IRV-9, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
0.5/2.5	(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
	(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
2/6	(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
	(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
4/12	(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
	(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.*

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

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

IRV-11 OVERCURRENT UNITS

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
0.5/2.5	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
	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
2/6	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
	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
4/12	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
	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.*

ENERGY REQUIREMENTS – 60 CYCLES

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

Range Amps	Continuous Rating (Amperes)	One Second Rating † (Amperes)	Power Factor Angle ϕ	VOLT AMPERES†† At Minimum Tap Value Current	At 3 Times Minimum Tap Value Current	At 10 Times Minimum Tap Value Current	At 20 Times Minimum Tap Value Current
0.5-2.5	10	230	34.5	0.03	0.23	2.8	11.5
2-6	10	230	34.5	0.44	4.08	48.0	182.0
4-12	12	280		0.48	4.62	53.6	216.0

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

† *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.*

†† *Voltages taken with Rectox type voltmeter.*

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

The burden at 120V, 60 cycles, is 12.5 volt-amperes at 15 degrees. (current leading voltage).

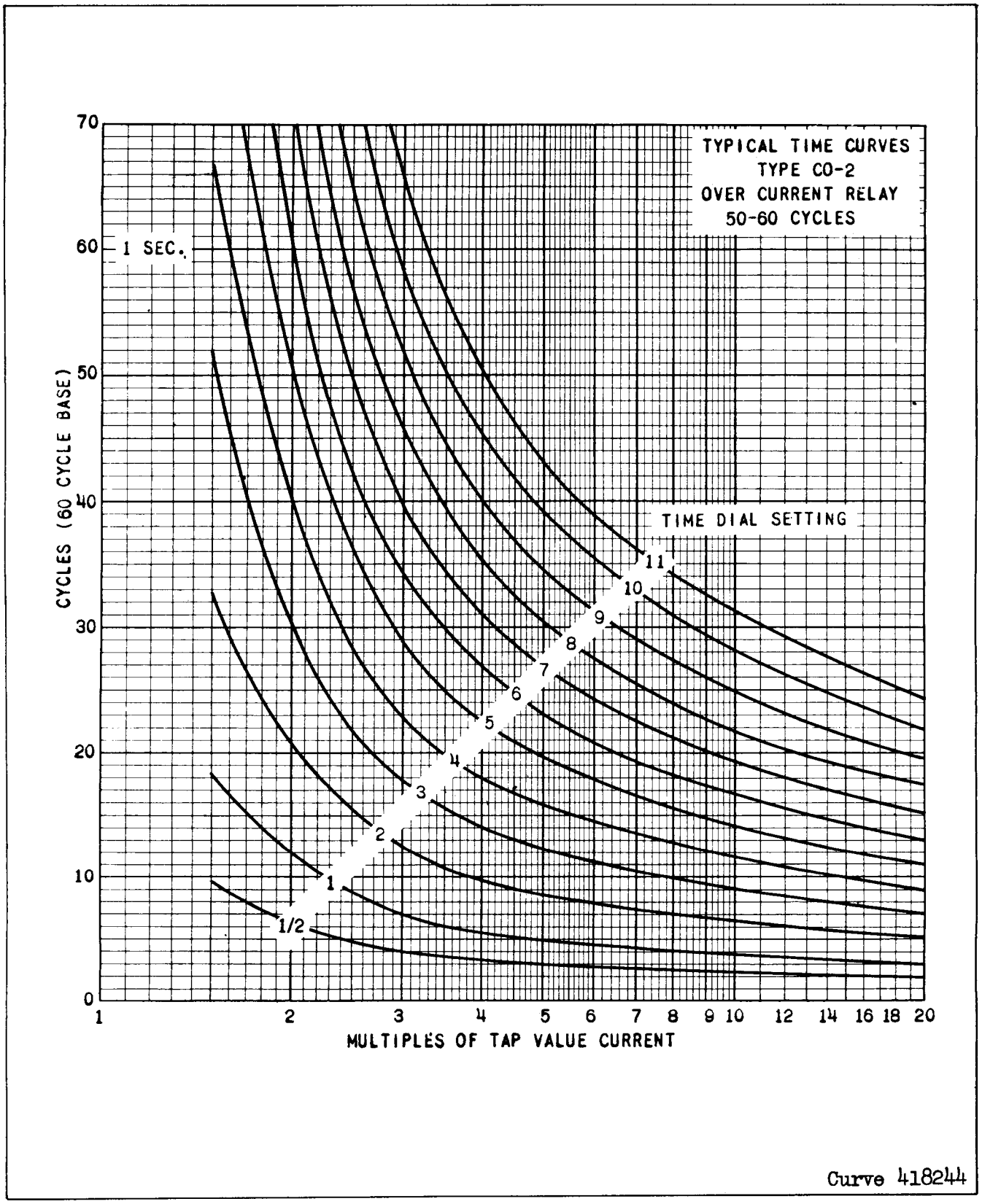


Fig. 4. Typical Time Curves of the Time-Overcurrent Unit of the Short Time (2) Relays.

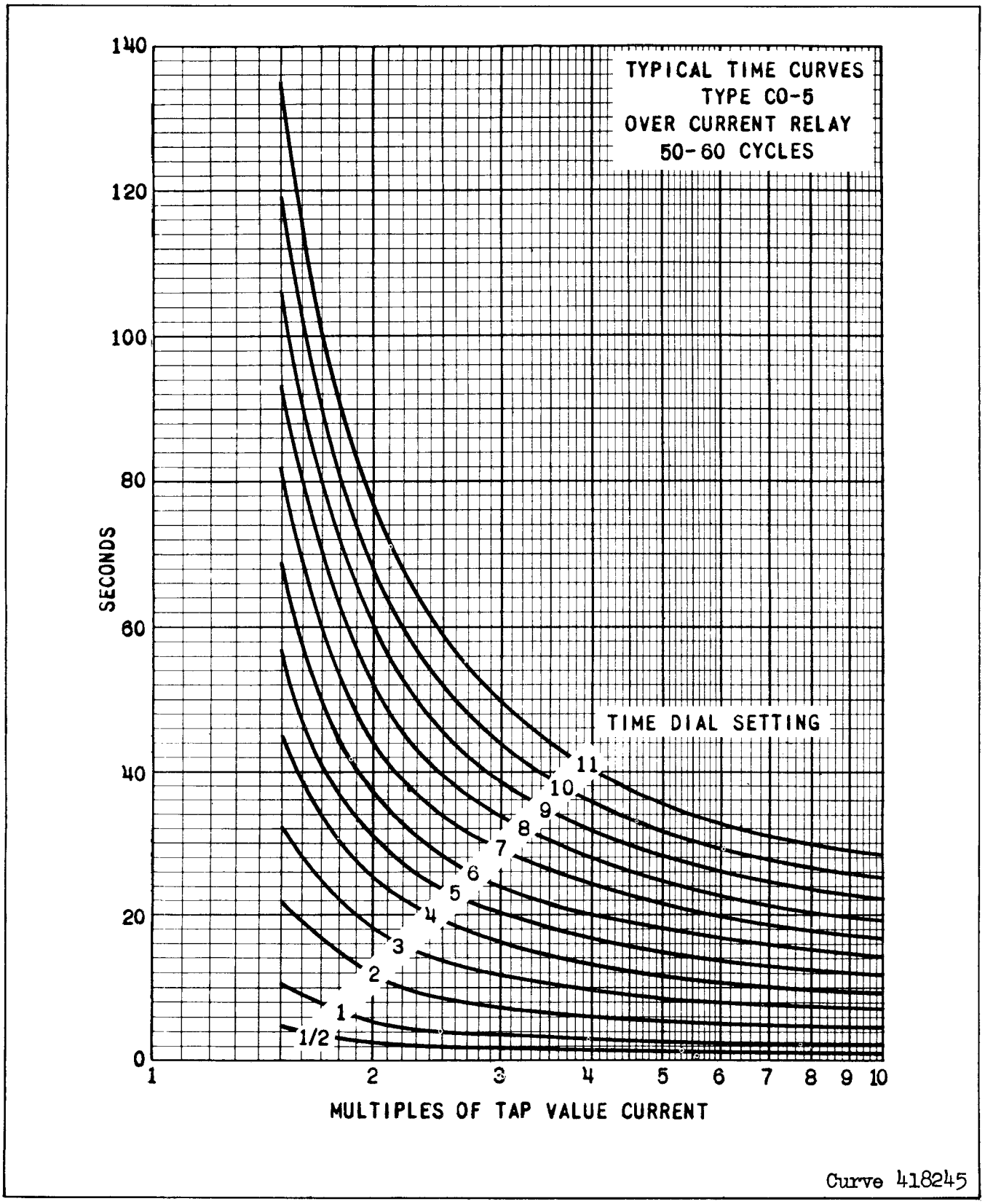


Fig. 5. Typical Time Curve of the Time-Overcurrent Unit of the Long Time (5) Relays.

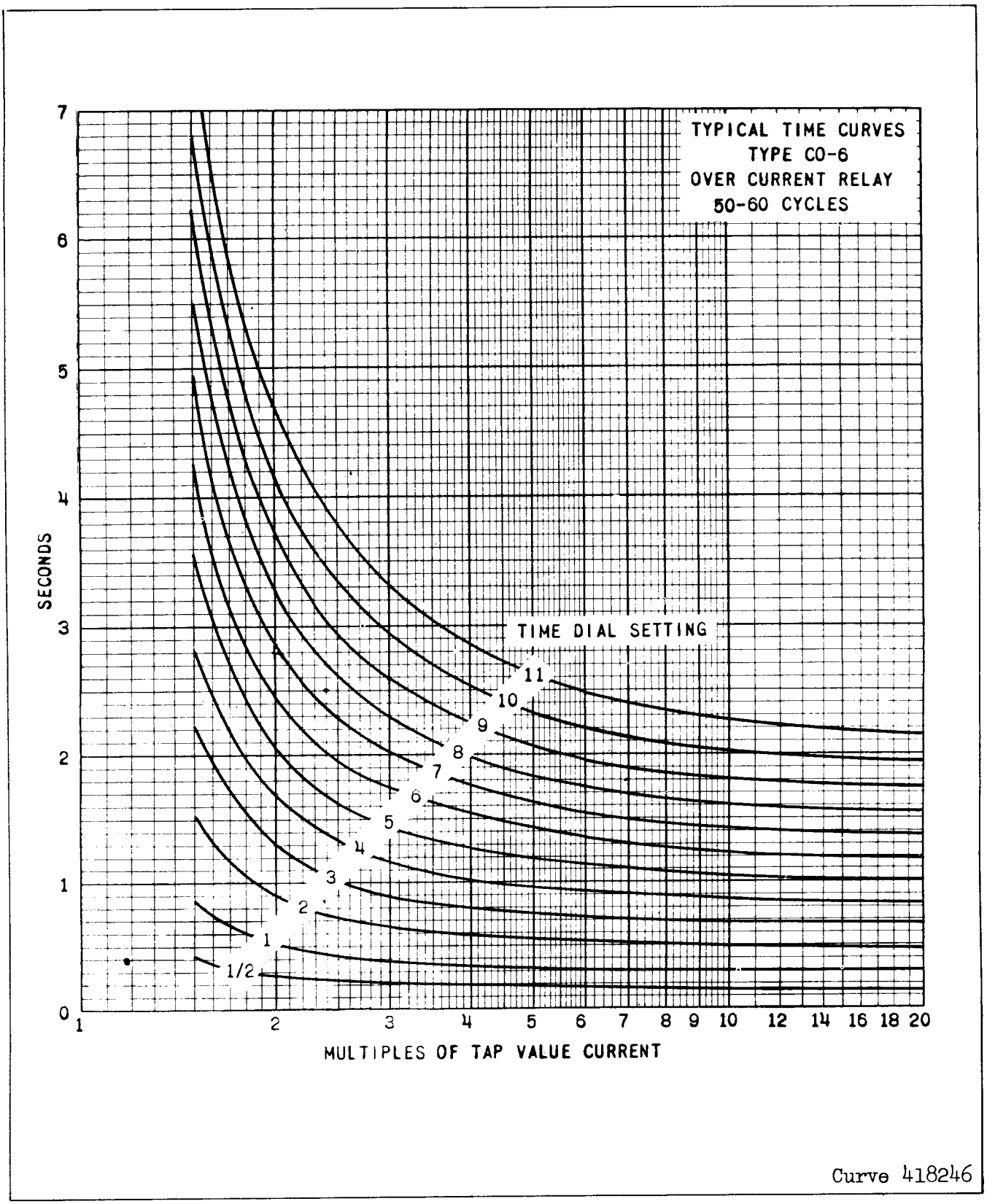


Fig. 6. Typical Time Curve of the Time-Overcurrent Unit of the Definite Time (6) Relays.

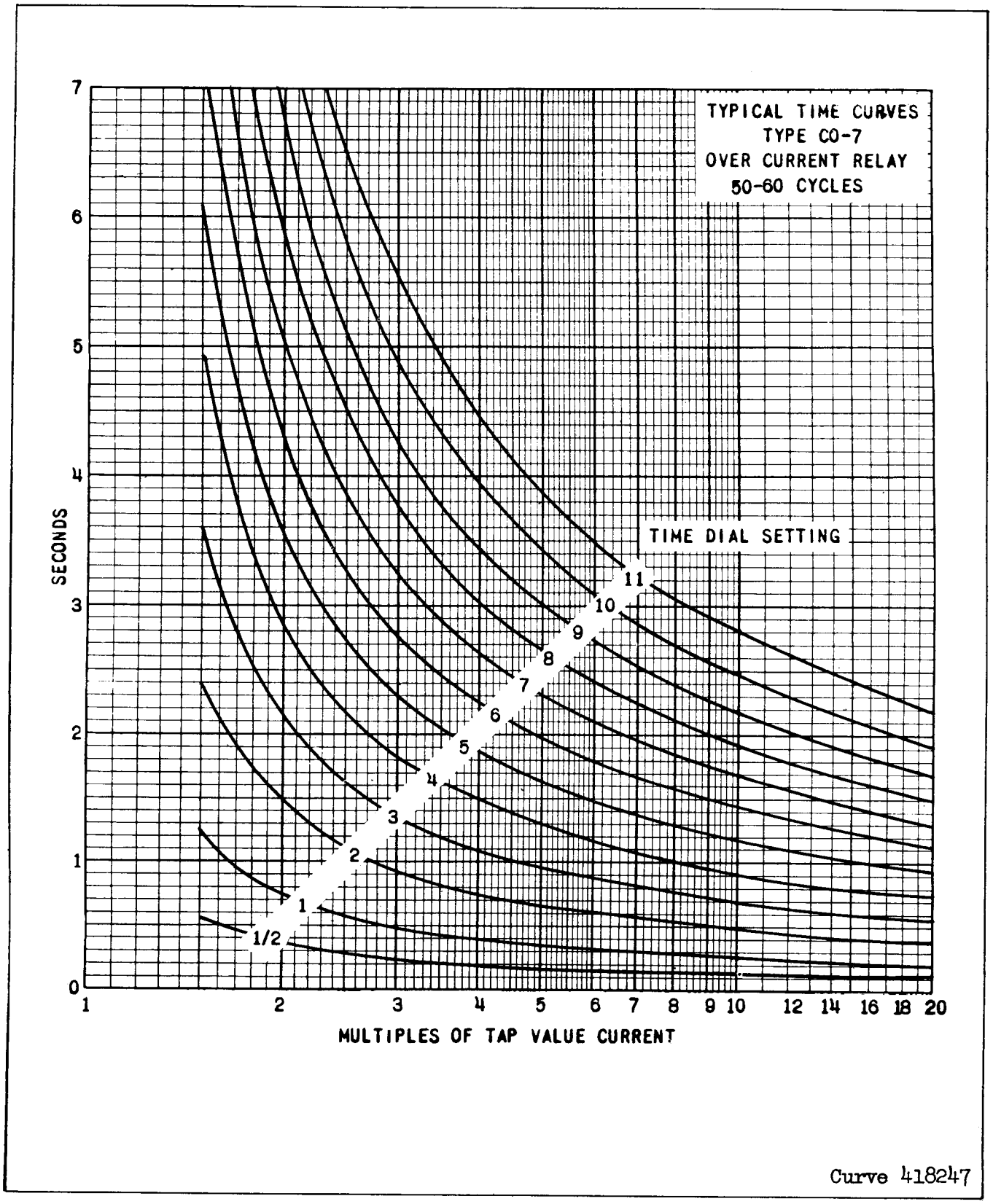


Fig. 7. Typical Time Curve of the Time-Overcurrent Unit of the Moderately Inverse (7) Relays.

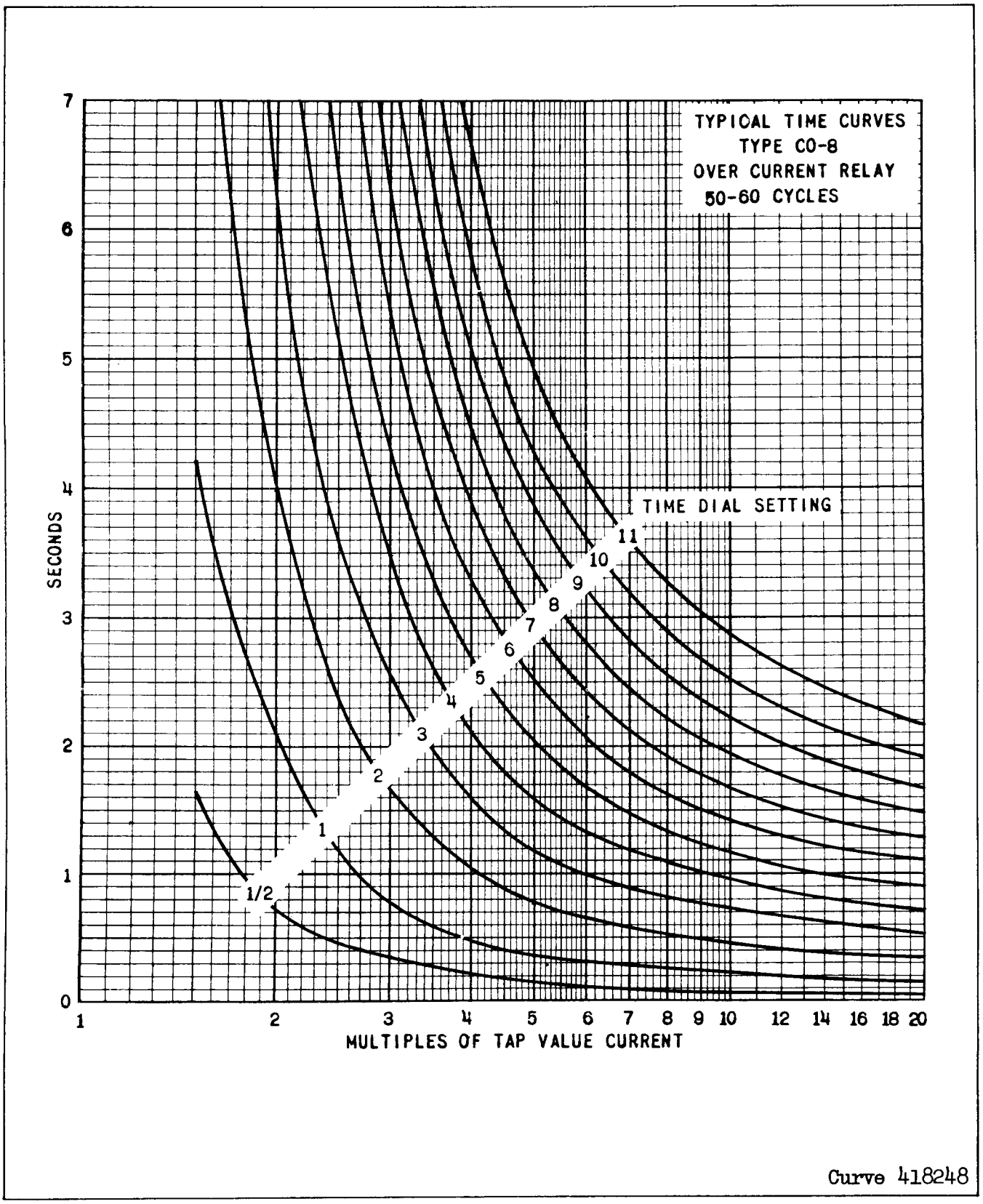


Fig. 8. Typical Time Curve of the Time-Overcurrent Unit of the Inverse (8) Relays.

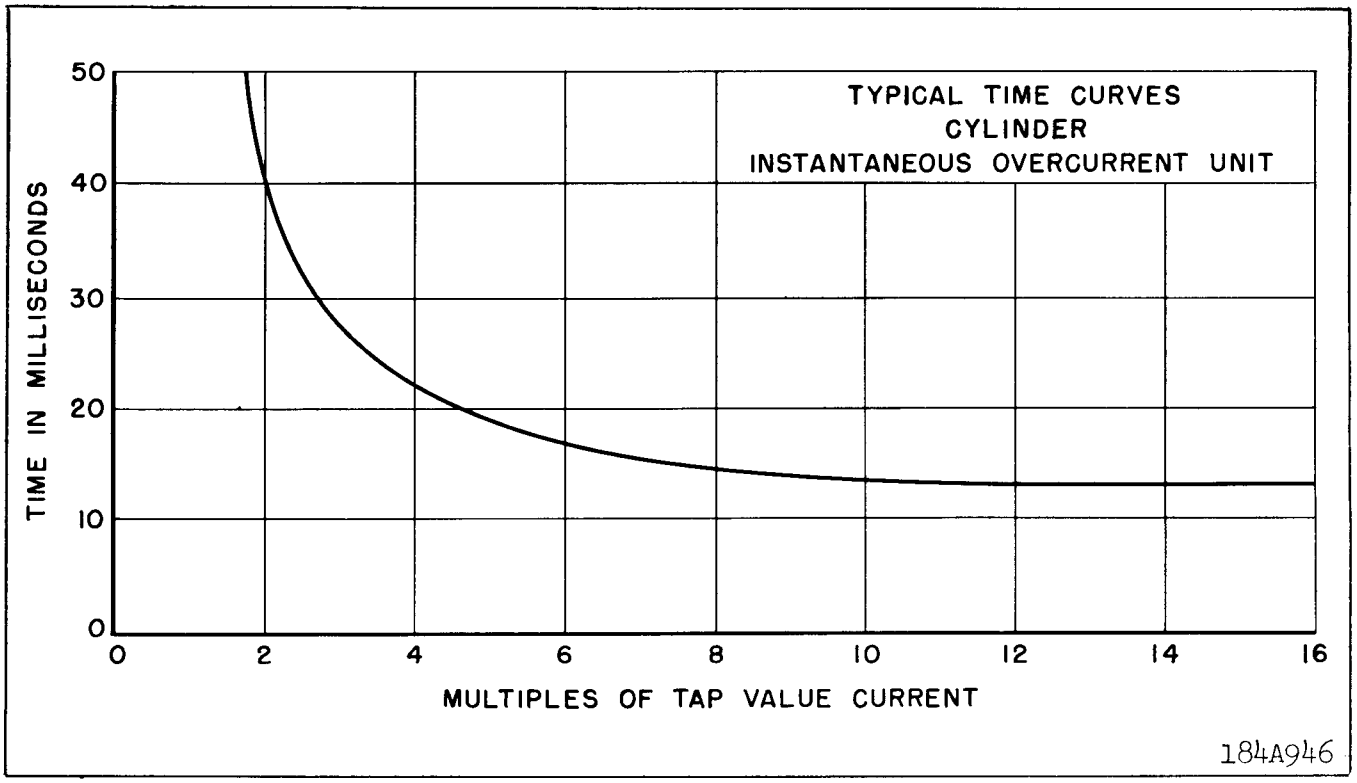


Fig. 11. Typical Time Curve of the Instantaneous Overcurrent Unit.

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 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 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.

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 re-

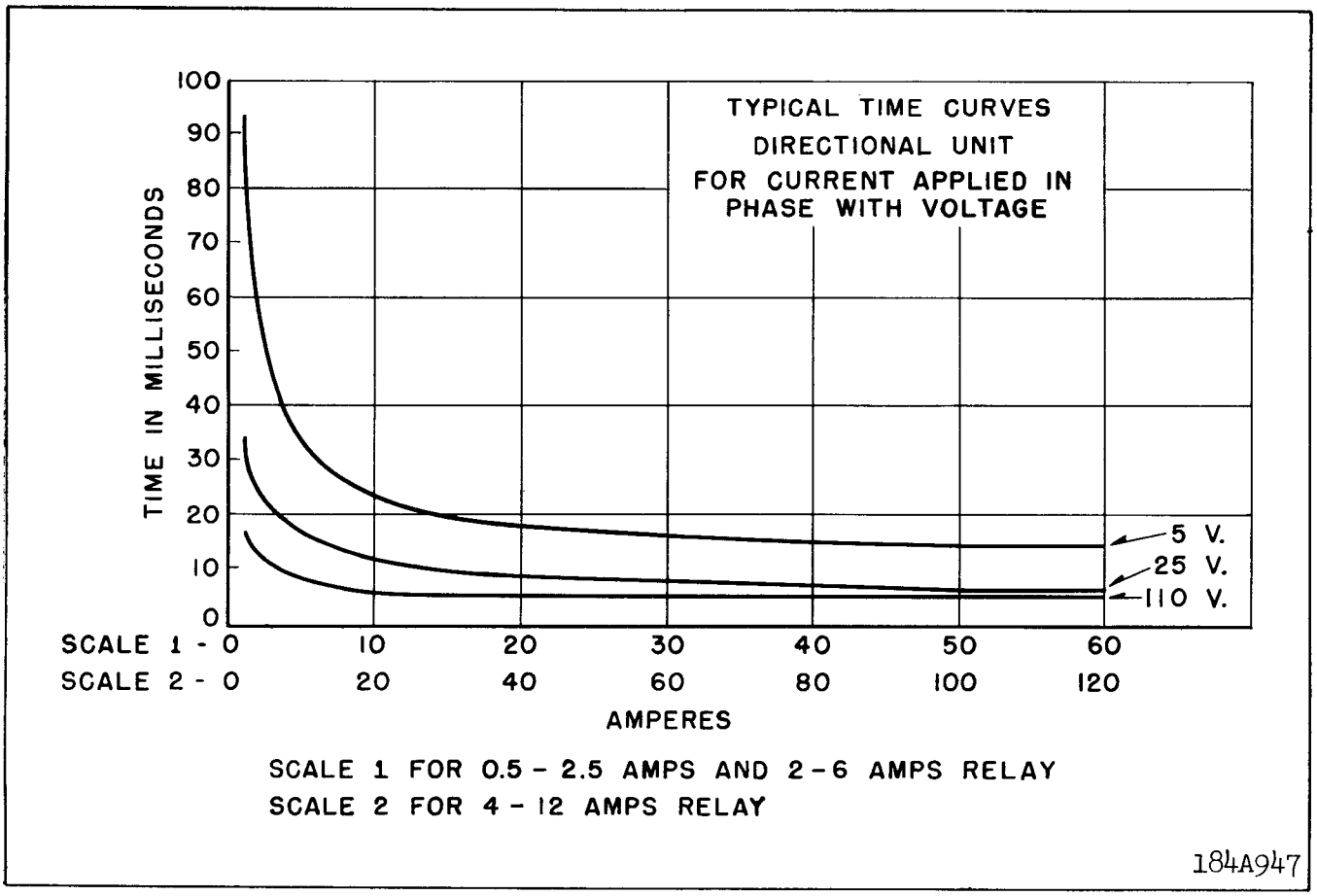


Fig. 12. Typical Time Curves of the Directional Unit.

moving the other tap screw from the original tap position.

Directional Units (D)

No setting is required.

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

The only 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.

Auxiliary Switch (CS-1)

No setting required on the CS-1 unit except for the selection of the required 48, 125 or 250 voltage on the tapped resistor. This connection can be made by referring to Fig. 13.

INSTALLATION

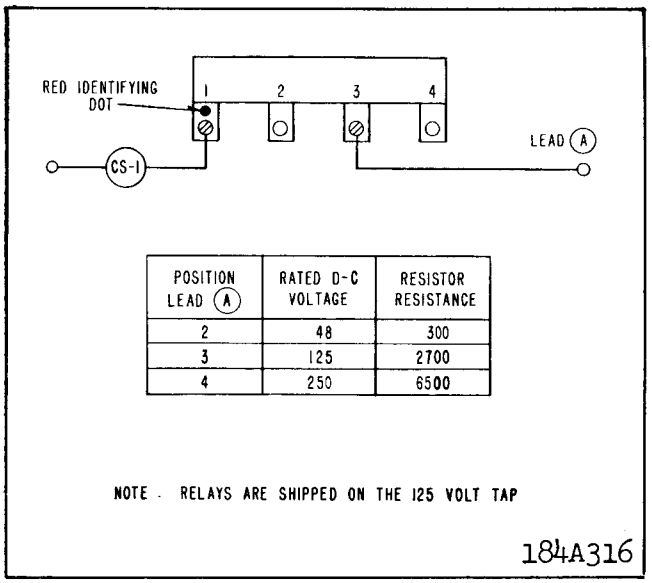
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat Mount the relay vertically by means of the two mounting studs for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting.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

For detail information on the FT Case refer to I.L. 41-076.

The external connection of the directional overcurrent relays is shown in Fig. 15.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon



POSITION LEAD (A)	RATED D-C VOLTAGE	RESISTOR RESISTANCE
2	48	300
3	125	2700
4	250	6500

NOTE . RELAYS ARE SHIPPED ON THE 125 VOLT TAP

184A316

Fig. 13. Selection of Proper Voltage Tap for Auxiliary Switch (CS-1) Operation.

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 D contacts should be blocked closed when checking the pick-up of the overcurrent unit.

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.

Directional Unit (D)

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

2. Sensitivity – The directional unit should trip with 1.2 volts and 4 amperes at its maximum torque angle (current leading the voltage by 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

3. Spurious Torque Adjustments – There should be no spurious closing torques when the operating circuits are energized per Table 2 with the polarizing circuit short circuited.

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 with the auxiliary switch (CS-1) contacts blocked closed, 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 IRV-2 3 and 20 times tap value current) And measure the operating time of the relay. The operating times should equal those of Table 1 plus or minus 5 percent.

For type IRV-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 (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Indicating Contactor Switches (ICS/1) and (ICS/T)

A) Close the contacts of the CO and the directional unit (D) 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 overcurrent unit (I) and the directional unit (D). Pass suf-

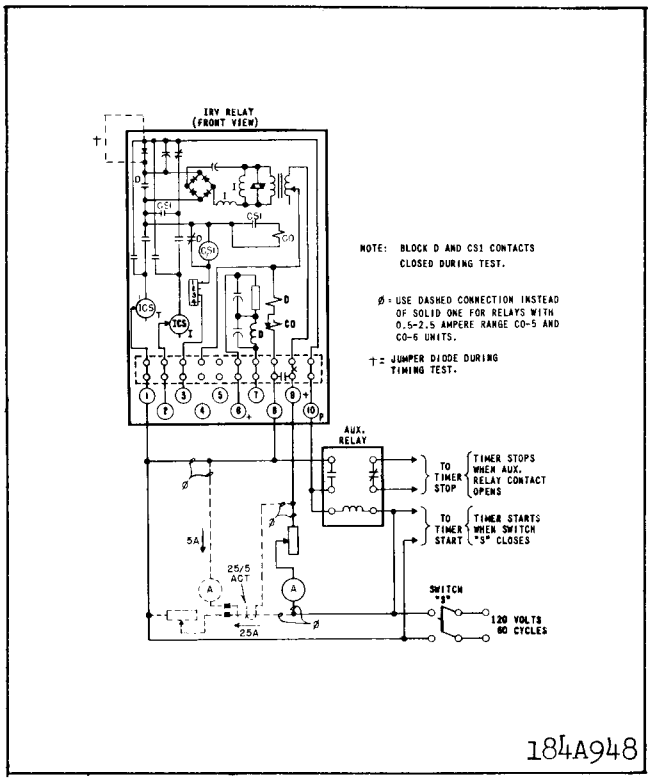


Fig. 14. Diagram of test connections of the time-overcurrent unit.

ficient d.c. 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 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 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 (1)

1. The upper pin bearing should be screwed down until there is approximately .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 moving contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in 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.

Before applying current, block close the con-

tacts of the D unit. 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 pickup of the overcurrent unit with the tap screw is any other tap should be within ± 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.

Directional Unit (D)

The directional unit is the lower cylinder unit.

1. The upper bearing screw should be screwed down until there is approximately .025" clearance between it and the top of the shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut.

2. Contact gap adjustment for the directional unit is made with the moving contact in the reset position, i.e., against the right side of the bridge. Advance the right hand stationary contact until the contacts just close. Then advance the stationary contact an additional one-half turn.

Now move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact 2/3 of one turn for a contact gap of .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. Insert tap screw of overcurrent unit in highest tap. 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.

The spring is to be adjusted such that the contact will close as indicated by a neon lamp in the contact circuit when energized with 1.2 volts and 4 amps (current leading 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amps for the 0.5 to 2.5 and 2 to 6 ampere range relays. This can be done approximately using current in phase with voltage by increasing the pickup current to 4.6 and 2.3 amperes respectively.

* 4. The magnetic plugs and core are used to reverse any unwanted spurious torques that may be present when the relay is energized respectively on current or voltage alone.

The reversing of the spurious torques is accomplished by using the adjusting plugs and core in the following manner: ††

Apply 120 VAC 60 Hz to terminals 6 and 7. Relay contacts should stay open. If the contacts are closed rotate core by means of adjustor located on the bottom side of the cylinder unit until contacts stay open. The core assembly is held in position by the clamping action of two compressed springs. This allows its position to be changed by inserting a non-magnetic tool into the slot on the bottom side of the unit.

Short circuit the voltage terminals and apply current to the operating circuit terminals as per Table 2.

Plug adjustment is then made per Table 2 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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 6-3/4 convolutions show.

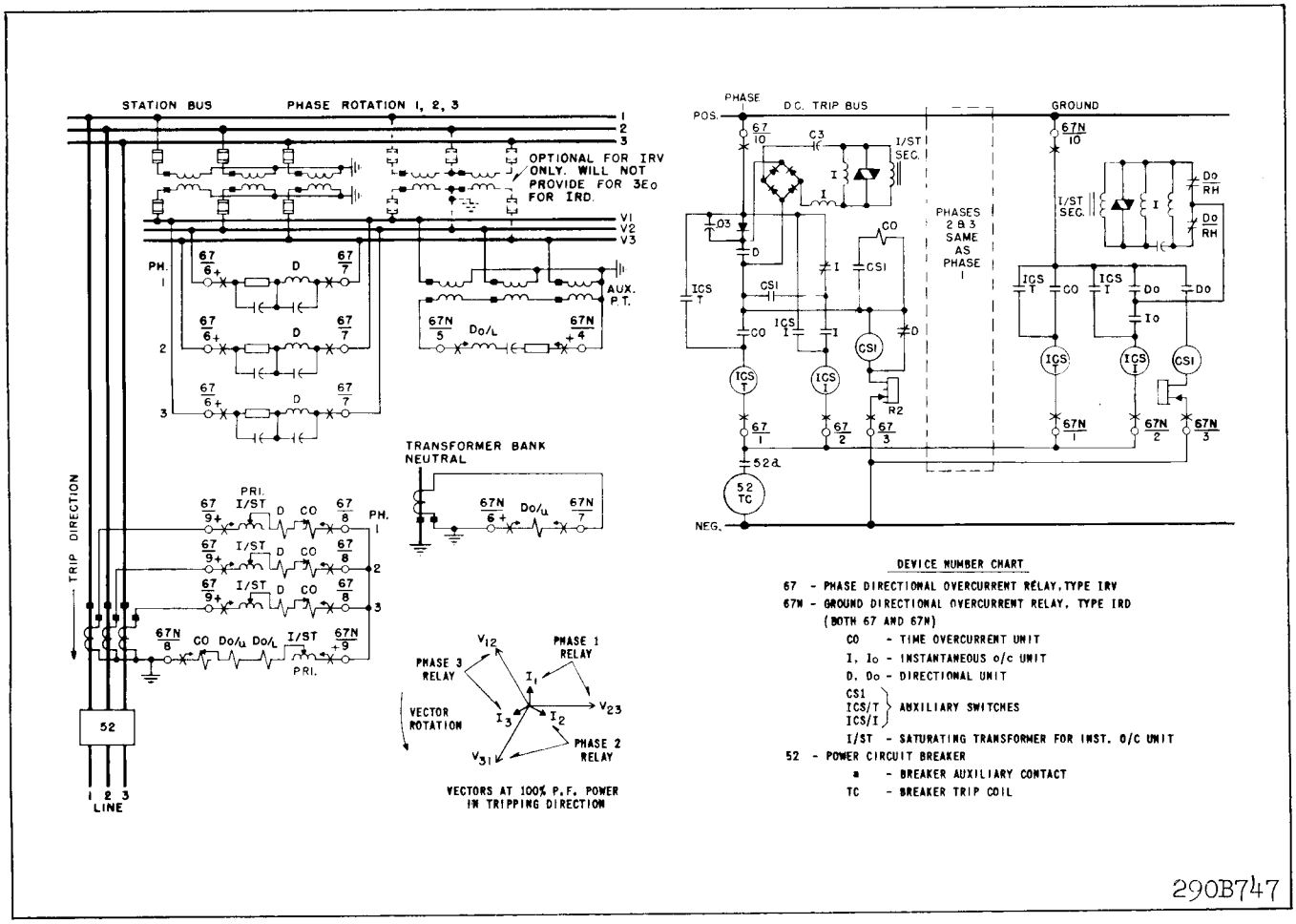


Fig. 15. External Schematic of the IRV Relay for Phase Protection and the IRD Relay for Ground Protection.

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

With the auxiliary switch (CS-1) contacts blocked closed, 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%.

†† Plugs should be at "fully screwed in" position prior to adjustment of core.

3) Time Curve Calibration — Install the permanent magnet.

Apply the indicated current per Table 1 for permanent magnet adjustment (e.g. IRV-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.

For type IRV-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 (Fig. 19). 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 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 1 for the electromagnet plug adjustment (e.g. IRV-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 the directional unit and pass sufficient d.c. current through the trip circuit to close the contacts of the (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 contacts of instantaneous overcurrent unit (I) and directional unit (D). Pass sufficient d.c. 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.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Connect lead (A) to proper terminal per Fig. 13. Block directional unit (D) contacts close and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make as indicated by a neon lamp in the contact circuit.

RENEWAL PARTS

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

TABLE 1

TIME CURVE CALIBRATION DATA - 60 CYCLES

	PERMANENT MAGNET ADJUSTMENT			ELECTROMAGNET PLUGS	
TIME-OVERCURRENT UNIT TYPE	TIME DIAL POSITION	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

* TABLE 2

DIRECTIONAL UNIT CALIBRATION +

Relay Rating	Current	Adjust	Adjustment
.5 to 2.5 amps and 2-6 amps	50 amps	Magnetic Plugs	If spurious torque is in the contact closing direction (left front view) screw out right magnetic plug until direction of spurious torque is reversed. If spurious torque is in the contact opening direction, screw out left plug until spurious torque is slight contact opening. Recheck at 40, 25 and 10 amps for the lower range units and 80, 50 and 20 amps for the 4-12 amp range relays.
4-12	100 amps		

† Short circuit the voltage polarizing circuit at the relay terminals before making the above adjustments.

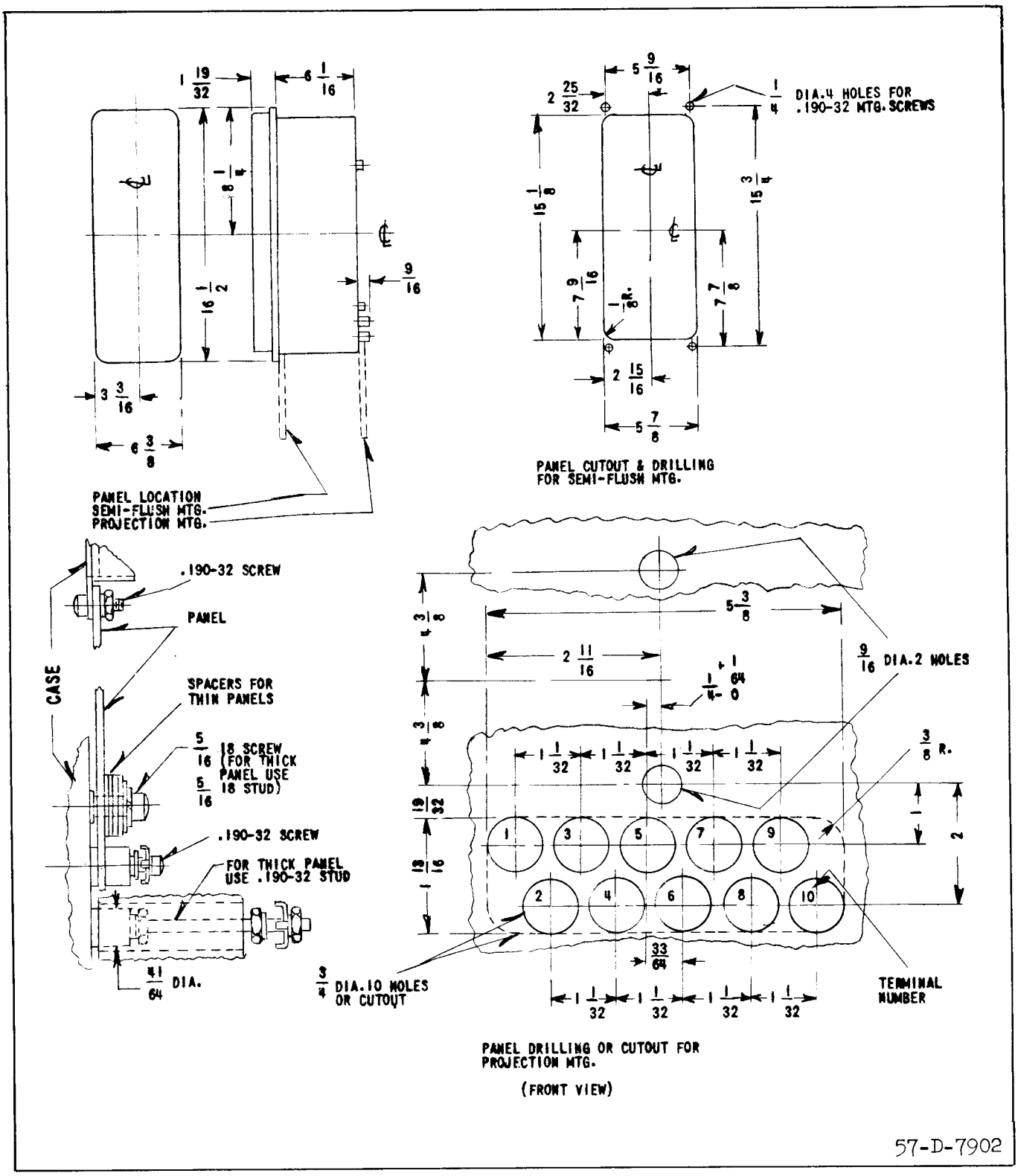


Fig. 16. Outline and Drilling Plan for the Type IRV Relay in the Type FT31 Case.

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

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE IRV DIRECTIONAL OVERCURRENT RELAY

FOR PHASE PROTECTION

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 relays are phase directional overcurrent relays which are used for the protection of transmission lines and feeder circuits. Both the time-overcurrent and instantaneous overcurrent units are directionally controlled.

CONSTRUCTION AND OPERATION

The Type IRV relay consists of a directional unit (D), an auxiliary switch (CS-1), a time-overcurrent unit (CO), an instantaneous overcurrent 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 and 2.

Time-Overcurrent Unit (CO)

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 units 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 causes a contact closing torque.

The electromagnet for the type CO-2 and CO-11 units 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 Units (ICS/I and ICS/T)

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 pick-up value of the switch.

Directional Unit (D)

The directional unit is a product induction cylinder type unit operating on the interaction between the polarizing circuit flux and the operating circuit flux.

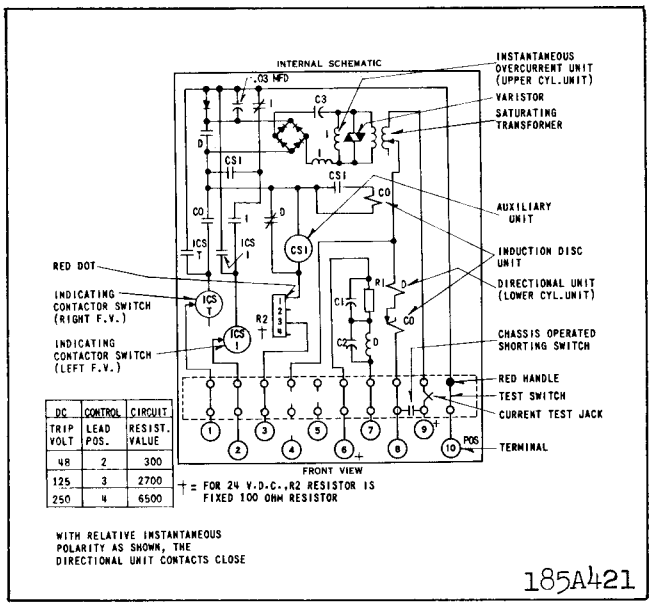
Mechanically, the directional unit is composed of four basic components: A die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

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 spring and snap ring. This is an adjustable core which has a .025 inch flat on one side and is held in its adjusted position by the clamping action of two compressed springs. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected operating coils mounted diametrically opposite one another; two magnetic adjusting plugs; upper and lower adjusting plug clips, and two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The elec-

SUPERSEDES I.L. 41-133.3E, dated May 1971
*Denotes change from superseded issue.

EFFECTIVE JUNE 1975



DC TRIP VOLT	CONTROL LEAD POS.	CIRCUIT RESIST. VALUE
48	2	300
125	3	2700
250	4	6500

Fig. 3. Internal Schematic of the Type IRV Relay in the Type FT31 Case.

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

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.

The time vs. current characteristics for the time-overcurrent unit are shown in Figs. 4 to 10. 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.

The time vs. current characteristics for the instantaneous overcurrent unit is shown in Fig. 11.

The time vs. current characteristics for the directional unit is shown in Fig. 12.

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 means of a screw connection.

Cylinder Unit 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.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 ampere tap – 6.5 ohms d-c resistance
2.0 ampere tap – 0.15 ohms d-c resistance

Auxiliary Switch (CS-1)

The auxiliary switch operating time is approximately 5 milliseconds.

48–250 volt d-c relay

d-c resistance – 1165 ohms

24 volt d-c relay

d-c resistance – 110 ohms (note that series resistor is a fixed 100 ohm resistor).

Directional Unit

The IRV relay is intended for phase fault protection and the directional unit has its maximum torque when the current leads the voltage by approximately 30°. The directional unit minimum pickup is 1.2 volts and 4 amperes at its maximum torque angle for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

The directional unit should be connected using the current in one-phase wire and the potential across the other two phase wires. This connection is commonly referred to as the 90°connection. When utilizing the 90° connection the maximum torque of the relay occurs when the fault current lags its 100% P.F. position by approximately 60°. See Fig. 15.

ENERGY REQUIREMENTS

* INSTANTANEOUS OVERCURRENT UNIT OPERATING CURRENT CIRCUIT – 60 HERTZ

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

ϕ *Degrees current lags voltage.*

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

TYPE IRV-2 TIME OVERCURRENT UNITS

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	5.35	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

IRV-5, IRV-6, TIME OVERCURRENT UNITS

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	3.87	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

† *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

IRV-7 TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING† (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	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

IRV-8, IRV-9, TIME OVERCURRENT UNITS

AMPERE RANGE	TAP	CONTINUOUS RATING (AMPERES)	ONE SECOND RATING* (AMPERES)	POWER FACTOR ANGLE ϕ	VOLT AMPERES†† AT TAP VALUE CURRENT	VOLT AMPERES†† AT 3 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 10 TIMES TAP VALUE CURRENT	VOLT AMPERES†† AT 20 TIMES TAP VALUE CURRENT
	(0.5	2.7	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.*

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

†† *Voltages taken with Rectox type voltmeter.*

ENERGY REQUIREMENTS

IRV-11 OVERCURRENT UNITS

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.*

* ENERGY REQUIREMENTS – 60 HERTZ

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

Range Amps	Continuous Rating (Amperes)	One Second Rating † (Amperes)	Power Factor Angle ϕ	VOLT AMPERES †† At Minimum Tap Value Current	At 3 Times Minimum Tap Value Current	At 10 Times Minimum Tap Value Current	At 20 Times Minimum Tap Value Current
0.5-2.5	10	230	34.5	0.03	0.23	2.8	11.5
2-6	10	230	34.5	0.44	4.08	48.0	182.0
4-12	12	280		0.48	4.62	53.6	216.0

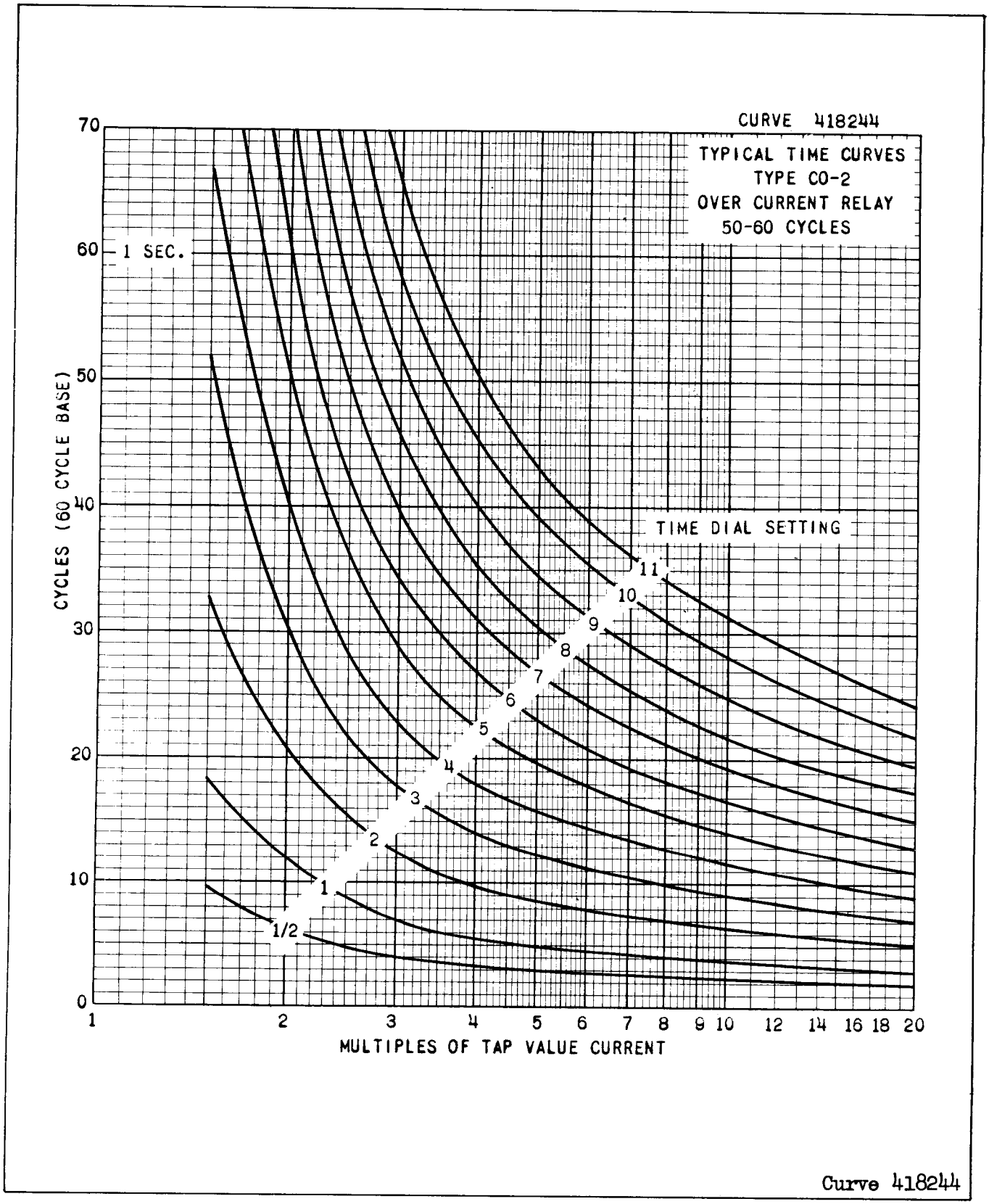
ϕ *Degrees current lags voltage at tap value current.*

† *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.*

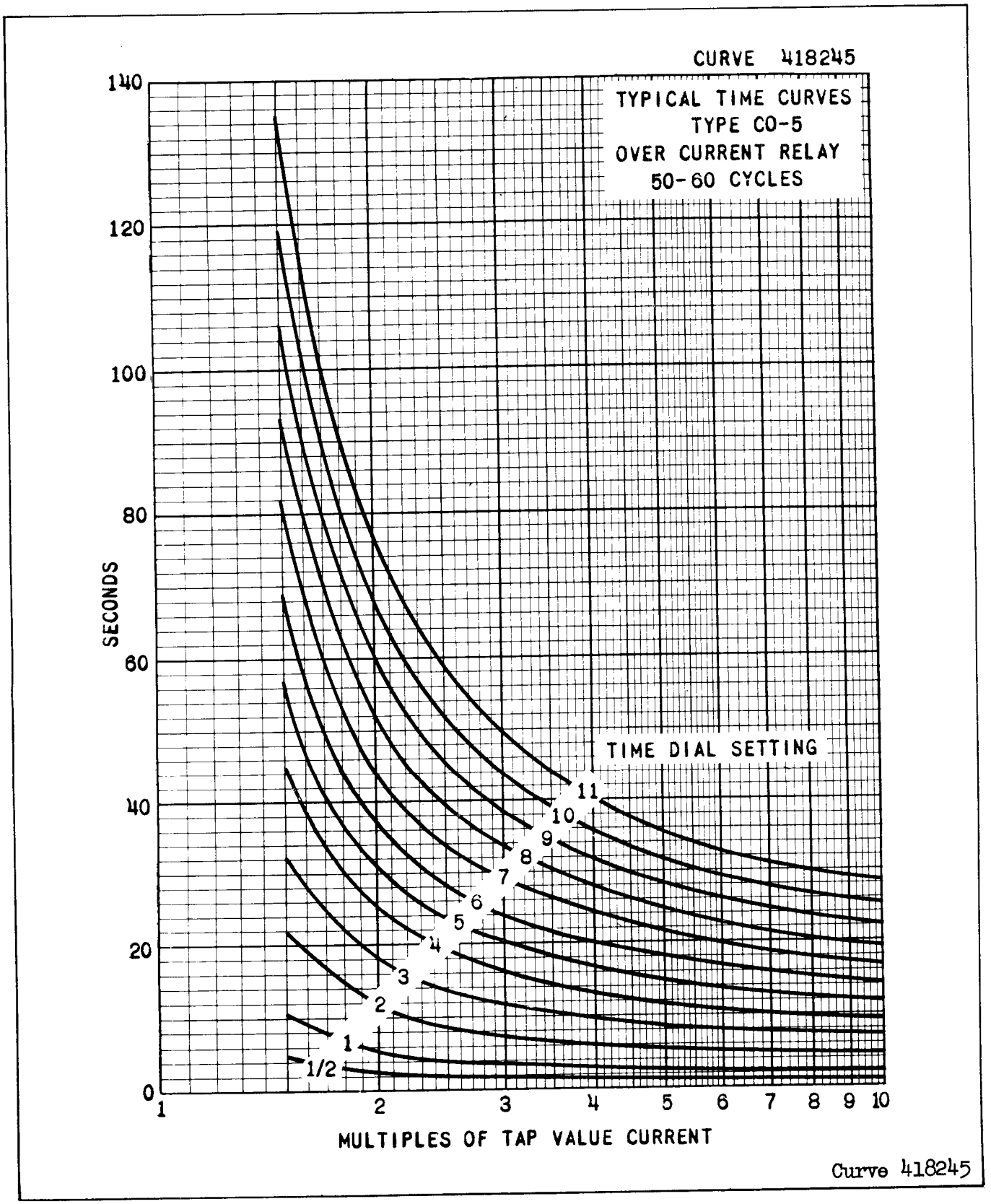
†† *Voltages taken with Rectox type voltmeter.*

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

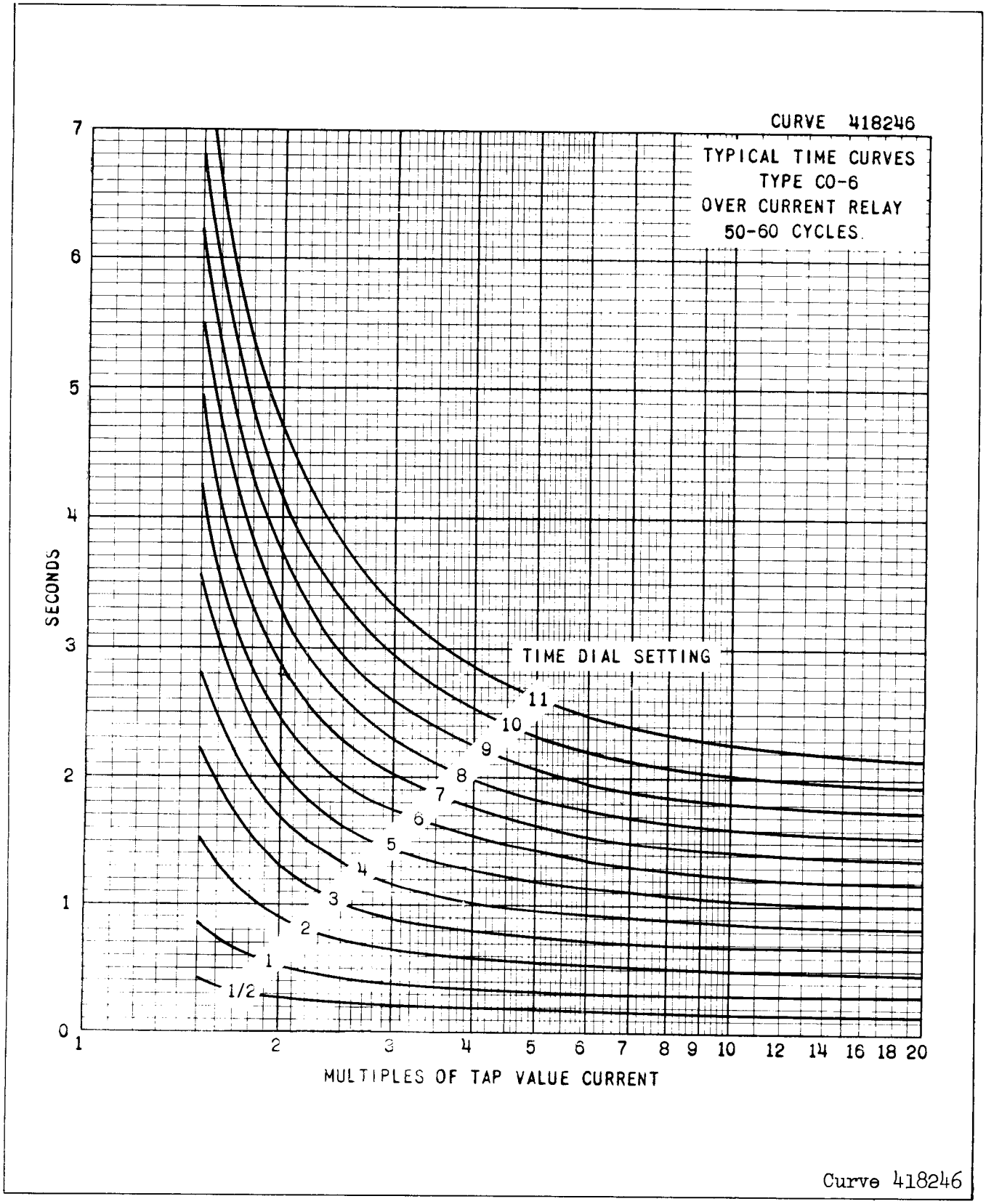
The burden at 120V, 60 cycles, is 12.5 volt-amperes at 15 degrees. (current leading voltage).



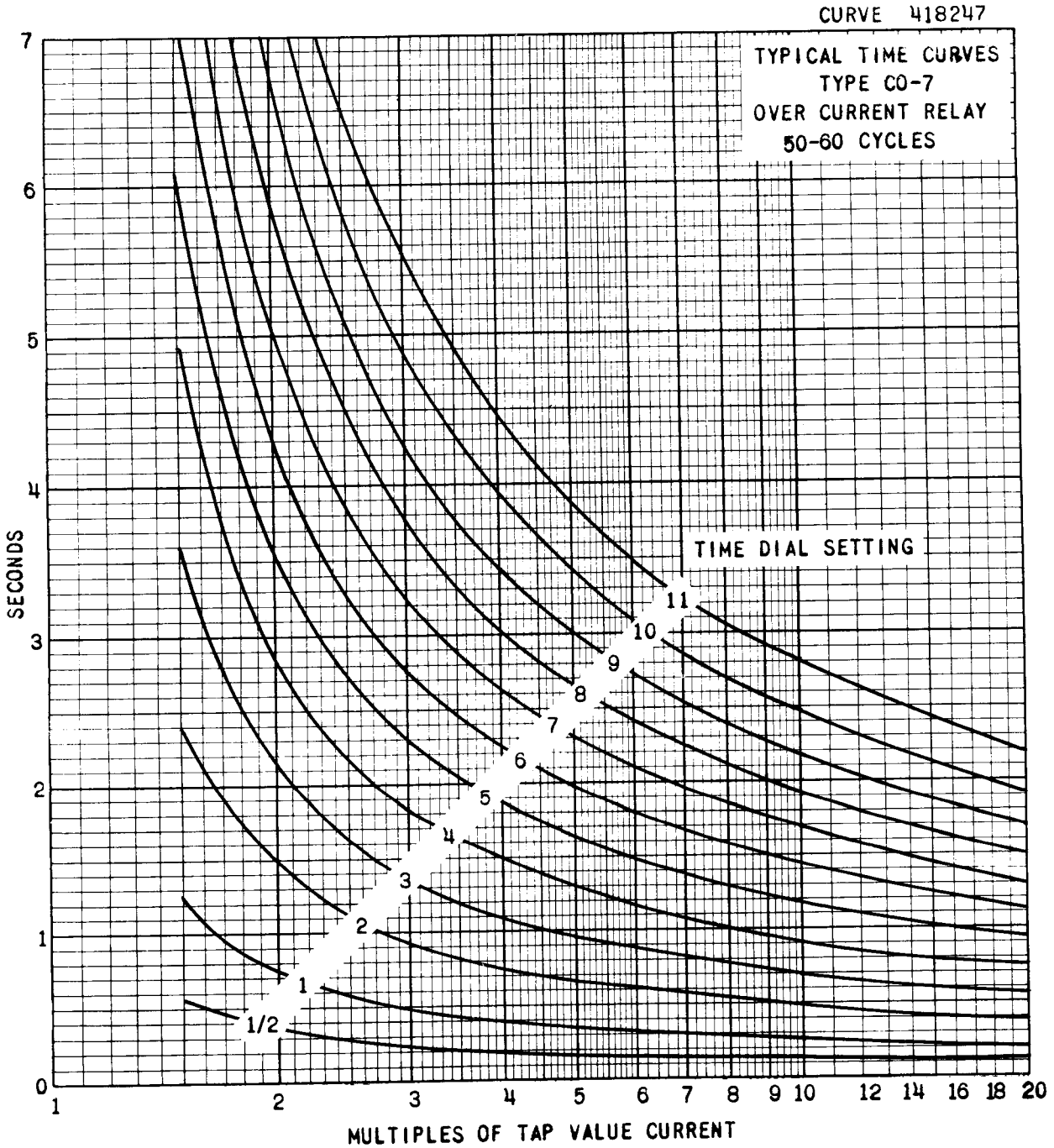
* *Fig. 4. Typical Time Curves of the Time-Overcurrent Unit of the Short Time (2) Relays.*



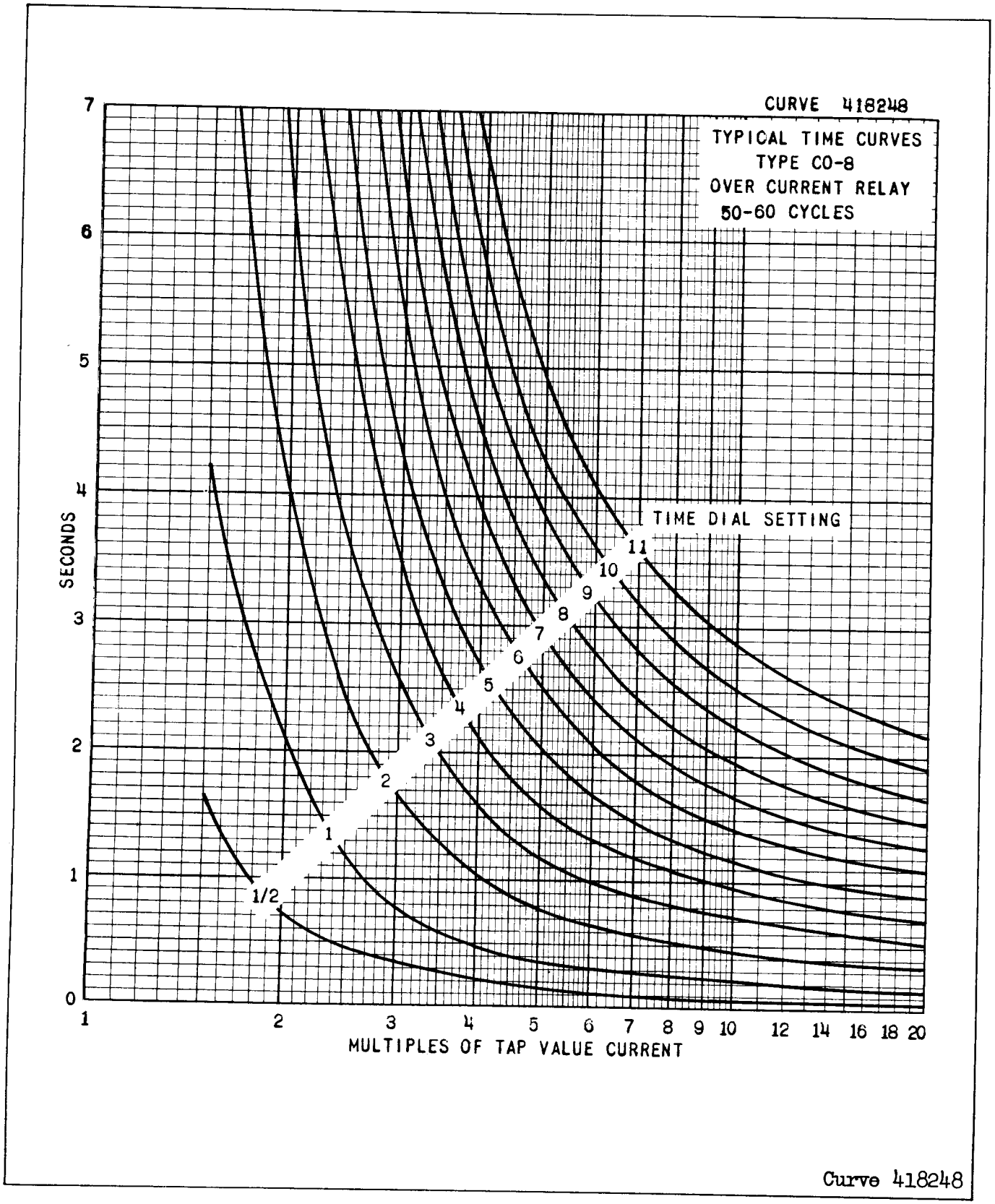
* *Fig. 5. Typical Time Curve of the Time-Overcurrent Unit of the Long Time (5) Relays.*



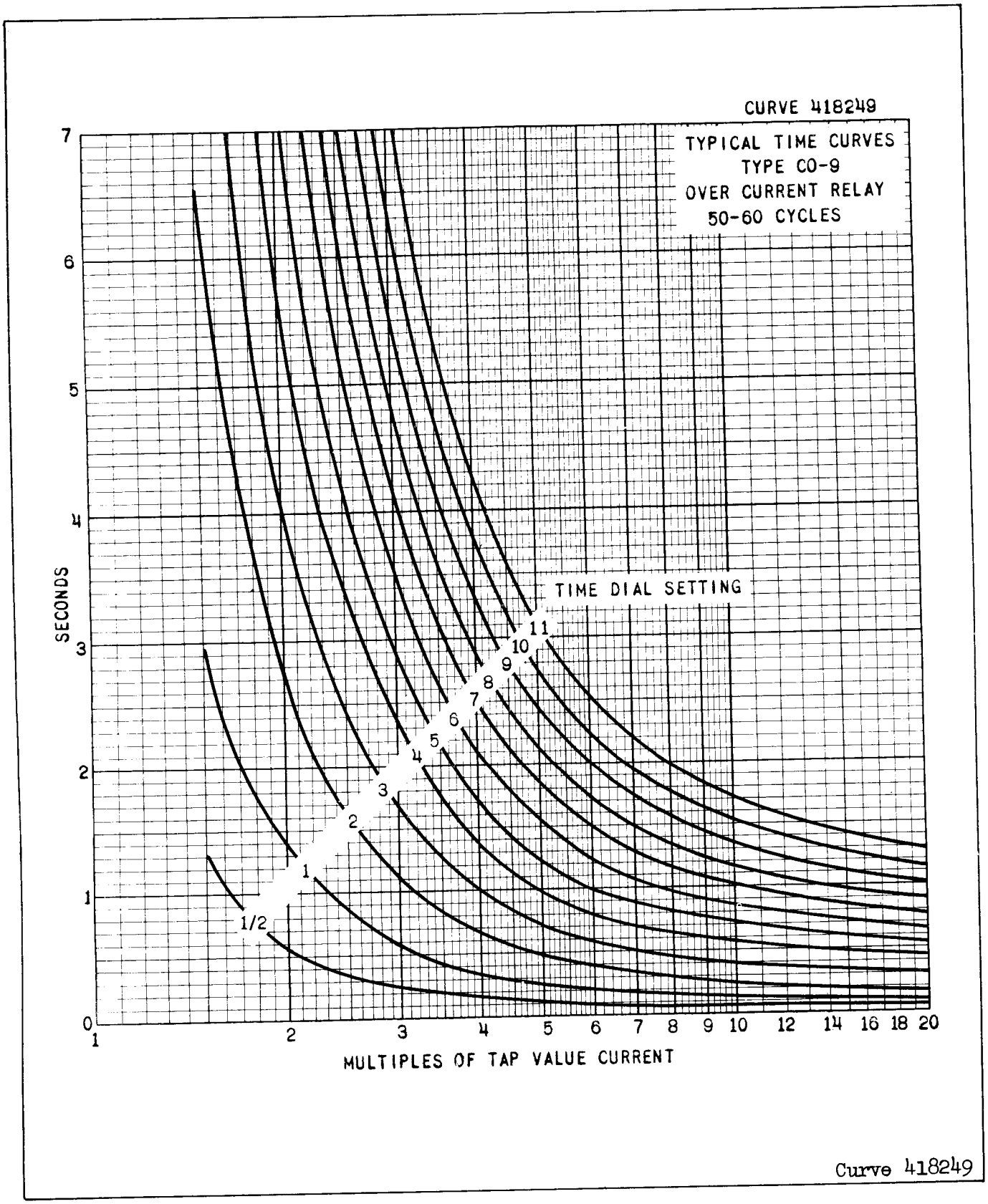
* *Fig. 6. Typical Time Curve of the Time-Overcurrent Unit of the Definite Time (6) Relays.*



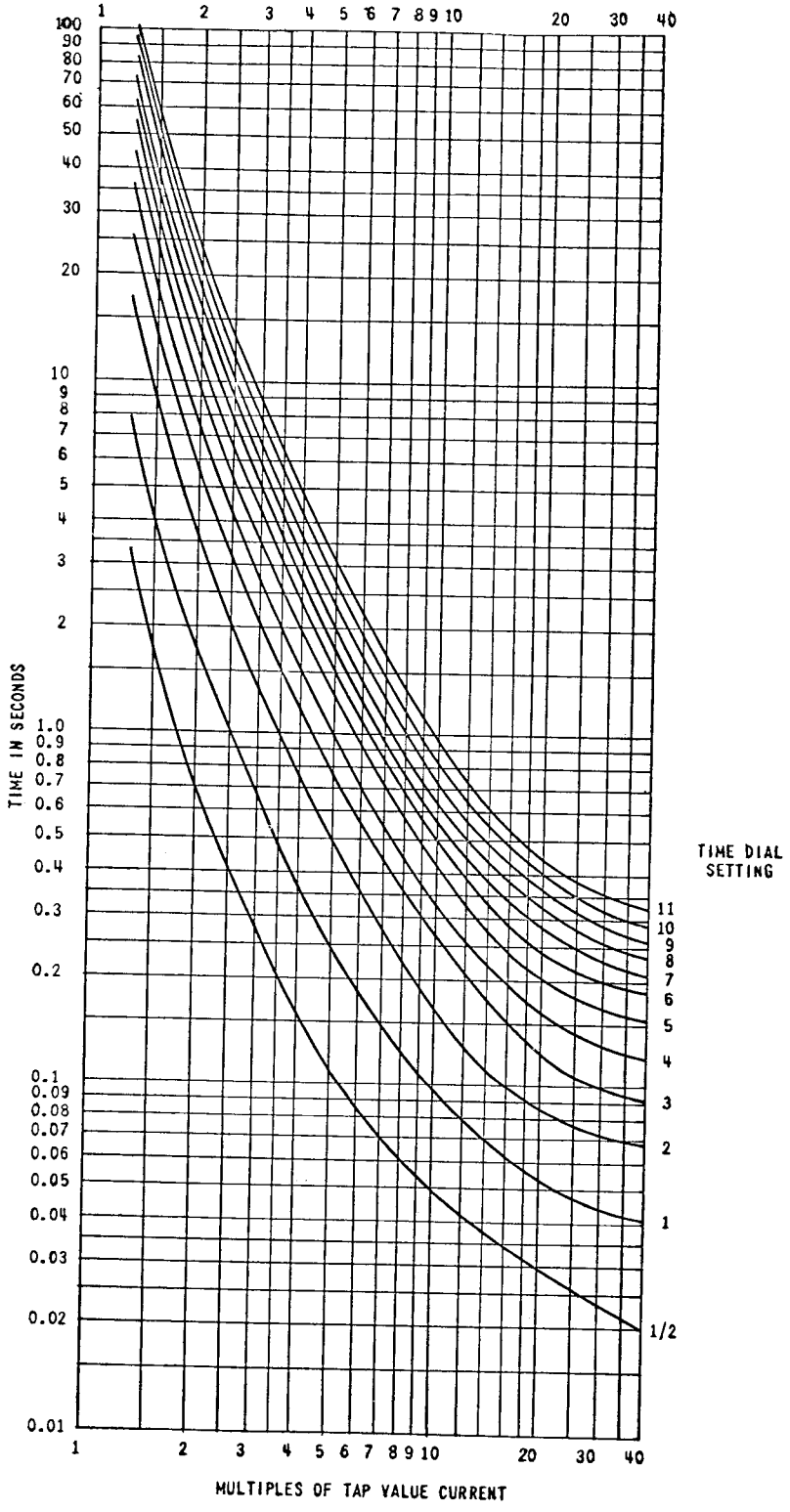
* *Fig. 7. Typical Time Curve of the Time-Overcurrent Unit of the Moderately Inverse (7) Relays.*



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



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



* *Fig. 10. Typical Time Curve of the Time-Overcurrent Unit of the Extremely Inverse (11) Relays.*

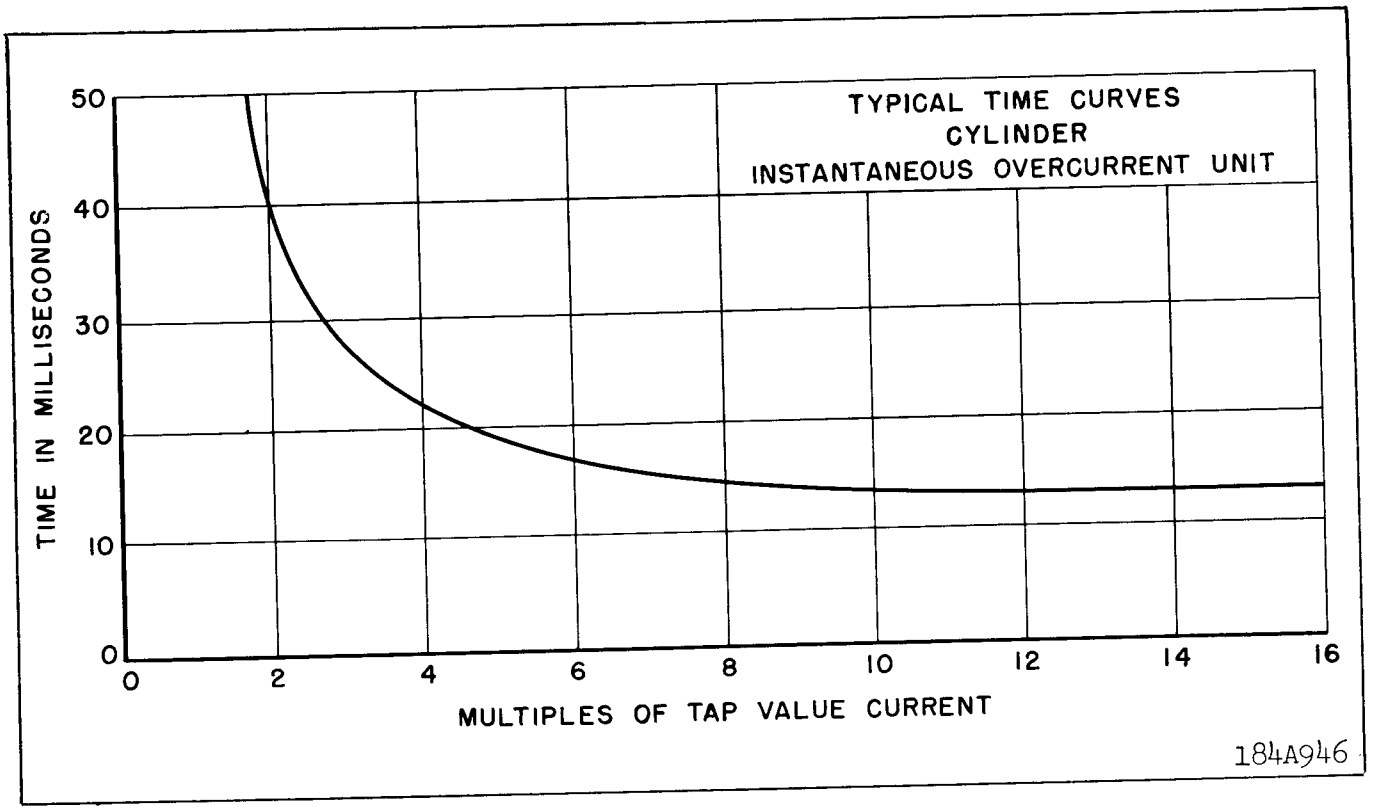


Fig. 11. Typical Time Curve of the Instantaneous Overcurrent Unit.

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 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 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.

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 re-

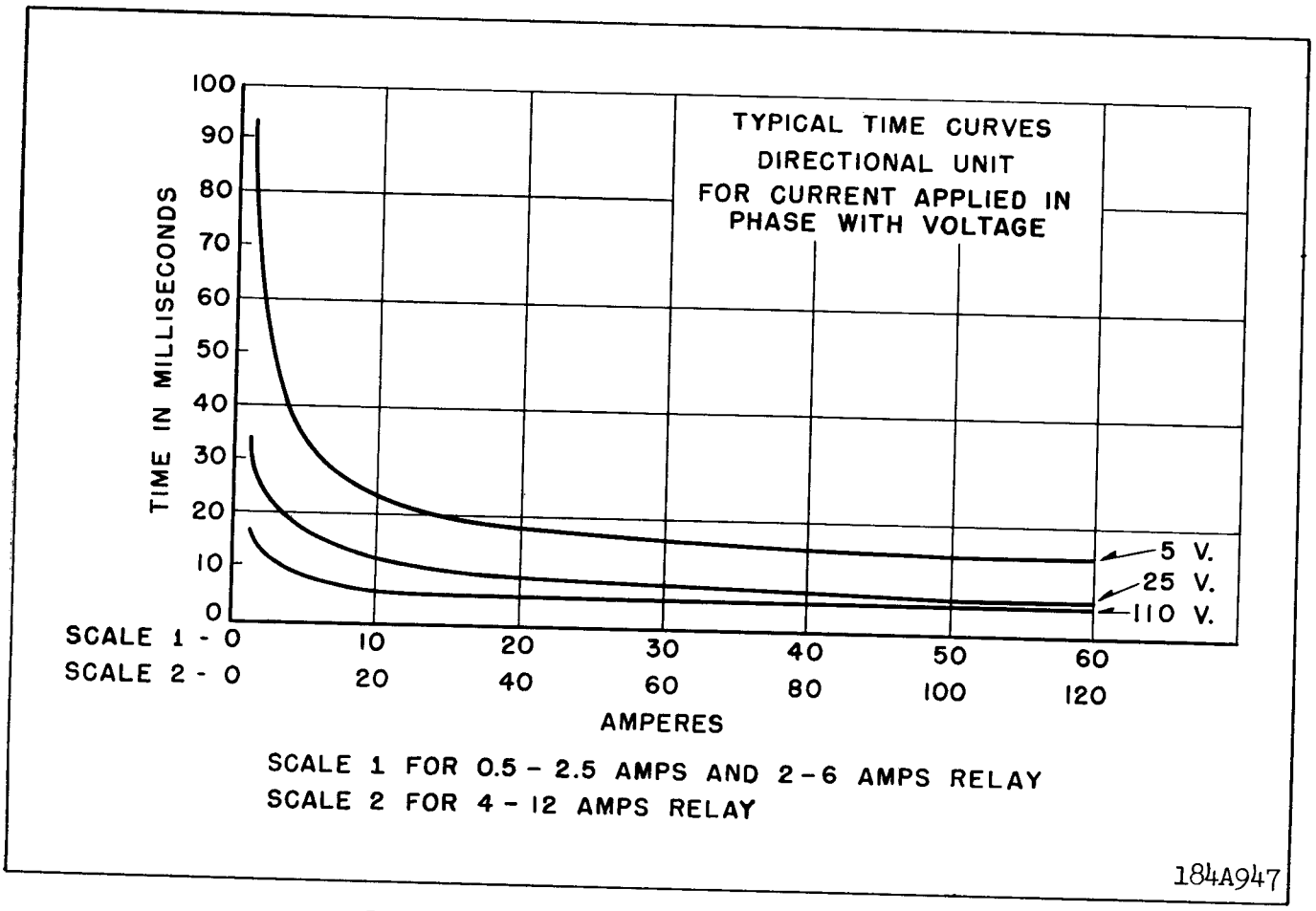


Fig. 12. Typical Time Curves of the Directional Unit.

moving the other tap screw from the original tap position.

Directional Units (D)

No setting is required.

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

The only 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.

Auxiliary Switch (CS-1)

No setting required on the CS-1 unit except for the selection of the required 48, 125 or 250 voltage on the tapped resistor. This connection can be made by referring to Fig. 13.

INSTALLATION

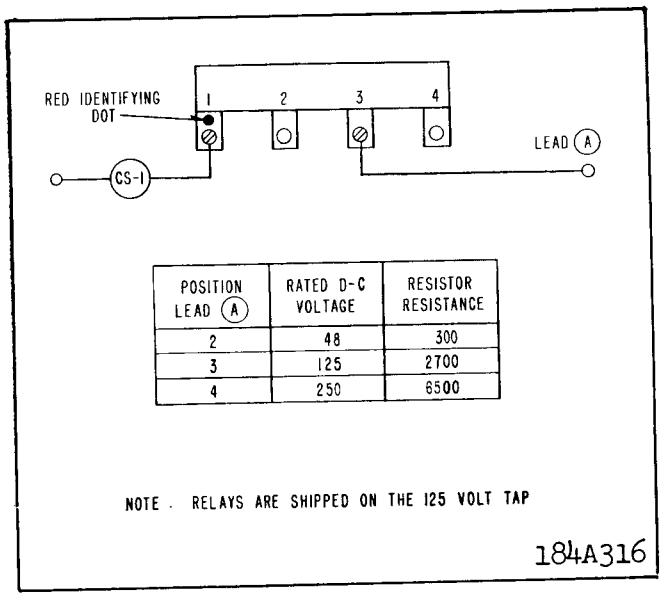
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat Mount the relay vertically by means of the two mounting studs for projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting.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

For detail information on the FT Case refer to I.L. 41-076.

The external connection of the directional overcurrent relays is shown in Fig. 15.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon



POSITION LEAD (A)	RATED D-C VOLTAGE	RESISTOR RESISTANCE
2	48	300
3	125	2700
4	250	6500

NOTE . RELAYS ARE SHIPPED ON THE 125 VOLT TAP

184A316

Fig. 13. Selection of Proper Voltage Tap for Auxiliary Switch (CS-1) Operation.

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 D contacts should be blocked closed when checking the pick-up of the overcurrent unit.

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.

Directional Unit (D)

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

2. Sensitivity — The directional unit should trip with 1.2 volts and 4 amperes at its maximum torque angle (current leading the voltage by 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amperes for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

3. Spurious Torque Adjustments — There should be no spurious closing torques when the operating circuits are energized per Table 2 with the polarizing circuit short circuited.

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 with the auxiliary switch (CS-1) contacts blocked closed, 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%.

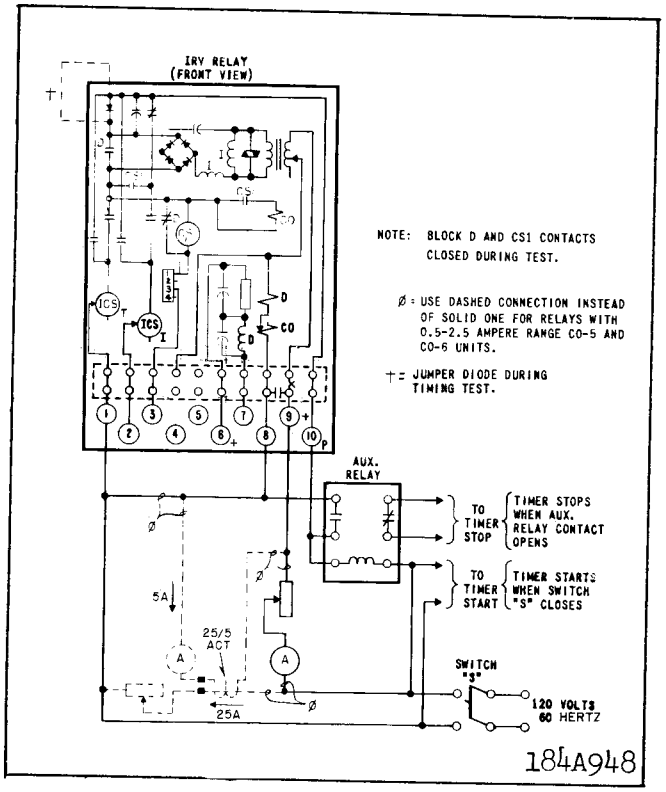
3. Time Curve — Table 1 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 1 (e g. for the IRV-2 3 and 20 times tap value current) And measure the operating time of the relay. The operating times should equal those of Table 1 plus or minus 5 percent.

For type IRV-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 (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Indicating Contactor Switches (ICS/1) and (ICS/T)

A) Close the contacts of the CO and the directional unit (D) 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 overcurrent unit (I) and the directional unit (D). Pass suf-



* *Fig. 14. Diagram of test connections of the time-overcurrent unit.*

ficient d.c. 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 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 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 (1)

1. The upper pin bearing should be screwed down until there is approximately .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 moving contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in 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.

Before applying current, block close the con-

tacts of the D unit. 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 pickup of the overcurrent unit with the tap screw is any other tap should be within ± 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.

Directional Unit (D)

The directional unit is the lower cylinder unit.

1. The upper bearing screw should be screwed down until there is approximately .025" clearance between it and the top of the shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut.

2. Contact gap adjustment for the directional unit is made with the moving contact in the reset position, i.e., against the right side of the bridge. Advance the right hand stationary contact until the contacts just close. Then advance the stationary contact an additional one-half turn.

Now move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact 2/3 of one turn for a contact gap of .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. Insert tap screw of overcurrent unit in highest tap. 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.

The spring is to be adjusted such that the contact will close as indicated by a neon lamp in the contact circuit when energized with 1.2 volts and 4 amps (current leading 30°) for the 4 to 12 ampere range relays and 1.2 volts and 2 amps for the 0.5 to 2.5 and 2 to 6 ampere range relays. This can be done approximately using current in phase with voltage by increasing the pickup current to 4.6 and 2.3 amperes respectively.

* 4. The magnetic plugs and core are used to reverse any unwanted spurious torques that may be present when the relay is energized respectively on current or voltage alone.

The reversing of the spurious torques is accomplished by using the adjusting plugs and core in the following manner: ††

Apply 120 VAC 60 Hz to terminals 6 and 7. Relay contacts should stay open. If the contacts are closed rotate core by means of adjustor located on the bottom side of the cylinder unit until contacts stay open. The core assembly is held in position by the clamping action of two compressed springs. This allows its position to be changed by inserting a non-magnetic tool into the slot on the bottom side of the unit.

Short circuit the voltage terminals and apply current to the operating circuit terminals as per Table 2.

Plug adjustment is then made per Table 2 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

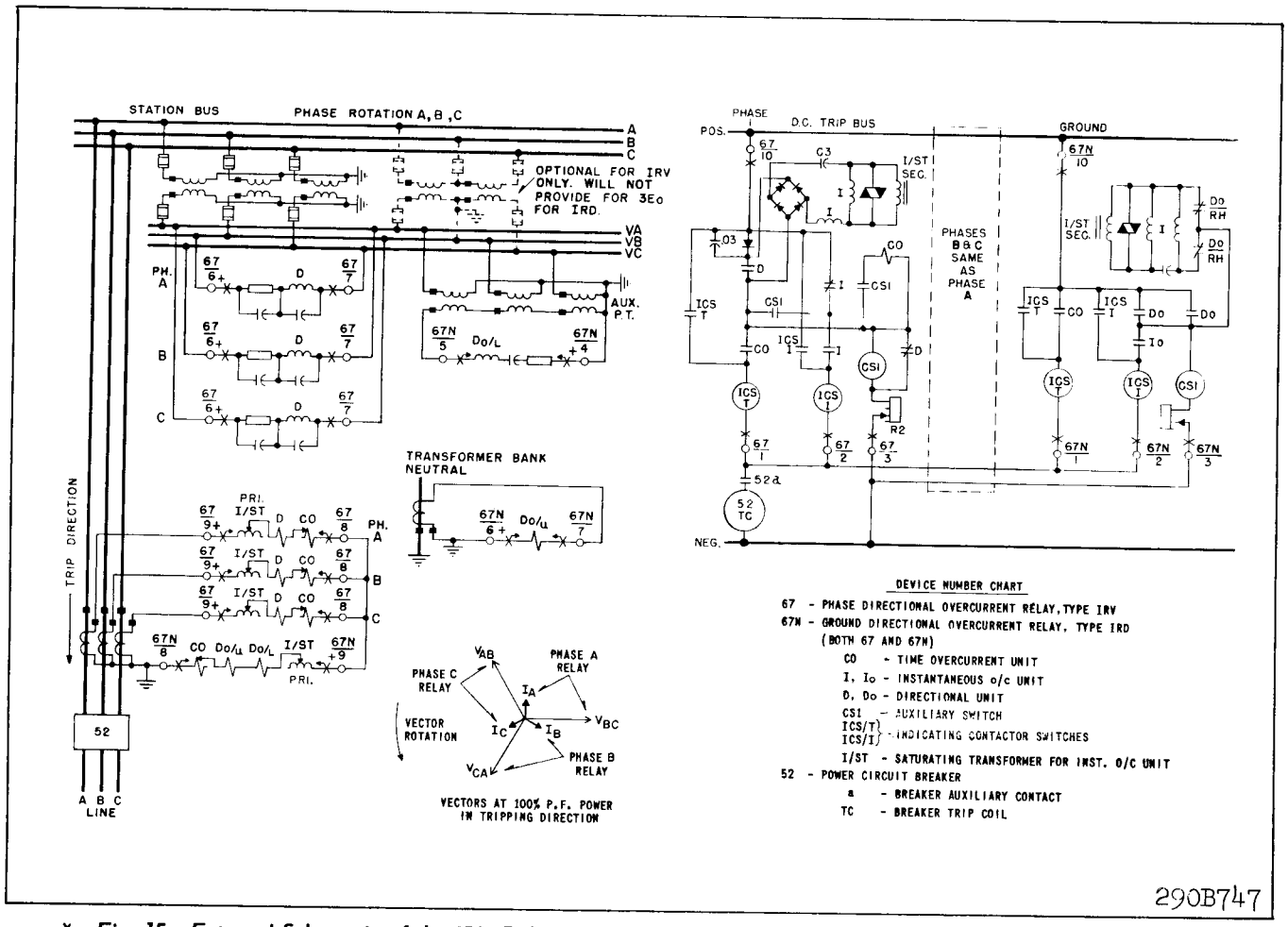
The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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 6-3/4 convolutions show.



* *Fig. 15. External Schematic of the IRV Relay for Phase Protection and the IRD Relay for Ground Protection.*

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

With the auxiliary switch (CS-1) contacts blocked closed, 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%.

†† Plugs should be at "fully screwed in" position prior to adjustment of core.

3) Time Curve Calibration — Install the permanent magnet.

Apply the indicated current per Table 1 for permanent magnet adjustment (e.g. IRV-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.

For type IRV-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 (Fig. 19). 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 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 1 for the electromagnet plug adjustment (e.g. IRV-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 the directional unit and pass sufficient d.c. current through the trip circuit to close the contacts of the (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 contacts of instantaneous overcurrent unit (I) and directional unit (D). Pass sufficient d.c. 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.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Connect lead (A) to proper terminal per Fig. 13. Block directional unit (D) contacts close and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make as indicated by a neon lamp in the contact circuit.

RENEWAL PARTS

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

TABLE 1

* TIME CURVE CALIBRATION DATA – 60 HERTZ

	PERMANENT MAGNET ADJUSTMENT			ELECTROMAGNET PLUGS	
TIME-OVERCURRENT UNIT TYPE	TIME DIAL POSITION	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

TABLE 2

DIRECTIONAL UNIT CALIBRATION +

Relay Rating	Current	Adjust	Adjustment
.5 to 2.5 amps and 2-6 amps	50 amps	Magnetic Plugs	If spurious torque is in the contact closing direction (left front view) screw out right magnetic plug until direction of spurious torque is reversed.
4-12	100 amps		If spurious torque is in the contact opening direction, screw out left plug until spurious torque is slight contact opening. Recheck at 40, 25 and 10 amps for the lower range units and 80, 50 and 20 amps for the 4-12 amp range relays.

† Short circuit the voltage polarizing circuit at the relay terminals before making the above adjustments.

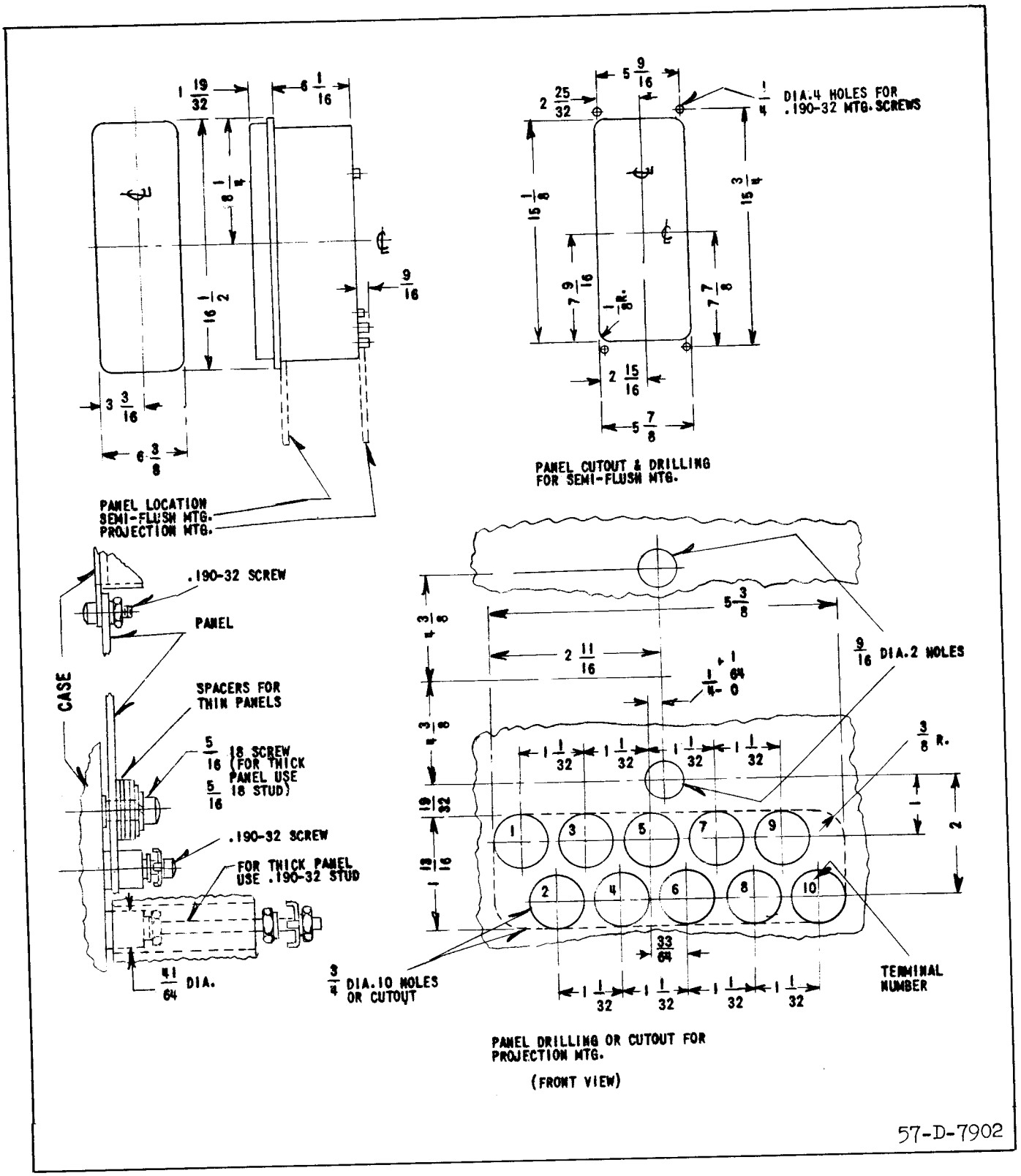


Fig. 16. Outline and Drilling Plan for the Type IRV Relay in the Type FT31 Case.

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