Instruction Leaflet

41-103H

Effective: May 1984

Supersedes I.L. 41-103G, Dated June 1976

(|) Denotes change from superseded issue

Type CO Circuit Opening Overcurrent Relay

CONTENTS

⚠ 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.

1.0 APPLICATION

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. When no suitable station battery is available, the circuit opening type relay in conjunction with ac series trip coil is used to trip the circuit breaker.

2.0 CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), a de-ion contactor switch (CS), an operation indicator (OI) and an indicating instantaneous trip (IIT) when required.

2.1 ELECTROMAGNET

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

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

2.2 DE-ION CONTACTOR SWITCH (CS)

This switch is a small ac solenoid switch whose coil is energized from a small transformer connected in the main current circuit. A cylindrical plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

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

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The overcurrent unit contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

2.3 OPERATION INDICATOR (OI)

The operation indicator is a small clapper type device. A magnetic armature is attracted to the magnetic core upon energization of the switch. When the switch closed two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

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

2.4 INDICATING INSTANTANEOUS TRIP UNIT (IIT)

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

A core screw accessible from the top of the switch provides the adjustable pickup range.

3.0 CHARACTERISTICS

The relays are available in the following current range:

Range	Taps
4 - 12	4 5 6 7 8 10 12

The circuit-opening relay is recommended only in the 4 to 12 ampere range. A lower range is not desirable because the burden of a low-range trip coil is to heavy on the current transformer. One trip coil is required for each relay.

The burden of the auxiliary current transformer at 4 amps. s 4.6 VA with contacts IIT or CO closed and 5.7 VA with contacts open.

The time vs. current characteristics are shown in Figures 3 to 9. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of the tap value current are applied to the relay.

4.0 SETTINGS

4.1 CO UNIT

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

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

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing this screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

⚠ CAUTION

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. IN ORDER TO AVOID OPENING CURRENT TRANSFORMER CIRCUITS WHEN CHANGING TAPS UNDER LOAD, THE RELAY MUST BE FIRST REMOVED FROM THE CASE.

Chassis operating shorting switches on the case will short the secondary of the current transformer. The taps should be changed with the relay outside of the case, then re-inserted into the case.

4.2 INSTANTANEOUS RECLOSING

The factory adjustment of the CO unit contact pro-

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

4.3 DE-ION CONTACTOR SWITCH (CS)

No setting is required on this unit.

4.4 OPERATION INDICATOR (OI)

NO setting is required on this unit.

4.5 INDICATING INSTANTANEOUS TRIP (IIT)

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

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

5.0 INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

6.0 ADJUSTMENTS AND MAINTENANCE

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

6.1 PERFORMANCE CHECK

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

1. Contacts

a. By turning the time dial, move the moving contacts until they reflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the “0” mark on the time dial.

b. For relay identified with a “T”, located at lower left of stationary contact block, the index mark on the movement frame will coincide with the”0” 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 “0” mark by approximately.020”. the placement of the various time dial positions in line wit the index mark will give operating times as shown on the respective time-current curves.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is 53.5 ±5% seconds and should be checked first. *It is important that the 1.30 times tap value current be maintained accurately*. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 9). A slight variation, ±1%, in the 1.30 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effects of different taps can make the total variations appear to the ±15%.

2. Minimum Trip Current

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

3. Time Curve

Table 1 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 1, (i.e., for the CO-2, 3 and 20 times tap value current) and measure the operating time of the relay.

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

4. De-Ion Contactor Switch (CS)

The de-ion contactor switch should operate with a minimum of 4 amperes ac applied.

5. Operation Indicator (OI)

The operation indicator should operate with a minimum of 3 amperes ac applied. The operation indicator target should drop freely.

6. Indicating Instantaneous Trip Unit (IIT)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

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

6.2 ROUTINE MAINTENANCE

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

All contacts should be periodically cleaned. A contact burnisher number 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.

7.0 CALIBRATION

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

7.1 CO UNIT

1. Contacts

a. By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "0" mark on the time dial.

b. For relays identified with a "T", located at the lower left of stationary contact block, the index mark on the movement frame will coincide with the "0" 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, the index mark is offset to the right of the "0" 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 is setting the minimum trip current value of the relay.This adjustment is most conveniently made with the damping magnet removed.

With the time dial set on "0", 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. Set the time dial to position 6.

Adjust the control spring tension so the moving contact will leave the backstop at tap value current +10% and will return to the backstop at tap value current -1.03%.

3. Time Curve Calibration

Install the permanent magnet.

Apply the indicated current per Table 1 for permanent magnet adjustment (i.e., CO-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table 1.

Apply the indicated current per Table 1 for the electromagnet plug adjustment (i.e., 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 determined.

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position of 53.5% ±5% seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Figure 9). A slight variation, ±1%, in the 1.30 times tap value current (including measuring instrument deviation) will change the timing tolerance to ±10% and the effect of different taps can make the total variations appear to be ±15%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

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

4. De-ion Contactor Switch (CS)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes.

5. Operation Indicator (OI)

Pass sufficient current (ac) through the operation indicator to just operate it. This value of current should not be greater than 3 amperes. The operation indicator target should drop freely. To change pickup, adjust the core screw.

6. Indicating Instantaneous Trip Unit (IIT)

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

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

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

8.0 RENEWAL PARTS

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

Table 1:
TIME CURVE CALIBRATION DATA – 50 and 60 Hertz

Permanent Magnet Adjustment				Electromagnet Plugs	
Relay Type	Time Dial Position	Current (Multiples of Tap Value)	Operating Time Seconds	Current (Multiples of Tap Value)	Operating Time Seconds
CO-2	6	3	0.57	20	0.22
CO-5	6	2	37.80	10	14.30
CO-6	6	2	2.46	20	1.19
CO-7	6	2	4.27	20	1.11
CO-8	6	2	13.35	20	1.11
CO-9	6	2	8.87	20	0.65
CO-11	6	2	11.27	20	0.24$^{\Delta}$

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

ENERGY REQUIREMENTS (Type CO-2 Relay)

					60 Hertz Volt Amperes** (XΔ for 50 Hz)			
Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ϕ	At Tap Value Current (Δ = 0.86)	At 3 Times Tap Value Current (Δ = 0.88)	At 10 Times Tap Value Current (Δ = 0.9)	At 20 Times Tap Value Current (Δ = 0.91)
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	50	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

* *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 high Impedance type voltmeter.*

ENERGY REQUIREMENTS (Type CO-5 Long time and CO-6 Definite Minimum Time Relays)

					60 Hertz Volt Amperes** (XΔ for 50 Hz)			
Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ϕ	At Tap Value Current (Δ = 0.86)	At 3 Times Tap Value Current (Δ = 0.88)	At 10 Times Tap Value Current (Δ = 0.9)	At 20 Times Tap Value Current (Δ = 0.91)
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	21.0	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	26.0	180	630
2/6	2.0	8.0	230	67	3.88	21.0	110	308
	2.5	8.8	230	66	3.87	21.6	118	342
	3.0	9.7	230	64	3.93	22.1	126	381
	3.5	10.4	230	63	4.09	23.1	136	417
	4.0	11.2	230	62	4.08	23.5	14	448
	5.0	12.5	230	59	4.20	24.8	162	540
	6.0	13.7	230	57	4.38	26.5	183	624
.	4.0	16.0	460	65	4.00	22.4	126	376
	5.0	18.8	460	63	4.72	23.7	143	450
	6.0	19.3	460	61	4.32	25.3	162	531
	7.0	20.8	460	59	4.35	26.4	183	611
	8.0	22.5	460	56	4.40	27.8	204	699
	10.0	25.0	460	53	4.60	30.1	247	880
	12.0	28.0	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 high Impedance type voltmeter.*

ENERGY REQUIREMENTS (Type CO-7 Moderately Inverse Time Relay)

					60 Hertz Volt Amperes** (XΔ for 50 Hz)			
Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ϕ	At Tap Value Current (Δ = 0.86)	At 3 Times Tap Value Current (Δ = 0.88)	At 10 Times Tap Value Current (Δ = 0.9)	At 20 Times Tap Value Current (Δ = 0.91)
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	2.0	8.0	230	66	4.06	21.3	111	306
	2.5	8.8	230	63	4.07	21.8	120	342
	3.0	9.7	230	63	4.14	22.5	129	366
	3.5	10.4	230	62	4.34	23.4	141	413
	4.0	11.2	230	61	4.34	23.8	149	448
	5.0	12.5	230	59	4.40	25.2	163	530
	6.0	13.7	230	58	4.62	27.0	183	624
.	4.0	16.0	460	64	4.24	22.8	129	392
	5.0	18.8	460	61	4.30	24.2	149	460
	6.0	19.3	460	60	4.62	25.9	168	540
	7.0	20.8	460	58	4.69	27.3	187	626
	8.0	22.5	460	55	4.80	29.8	211	688
	10.0	25.0	460	51	5.20	33.0	260	860
	12.0	28.0	460	46	5.40	37.5	308	1032

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

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

** *Voltages taken with high Impedance type voltmeter.*

ENERGY REQUIREMENTS (Type CO-8 Inverse Time and CO-9 Very Inverse Time Relays)

					60 Hertz Volt Amperes** (XΔ for 50 Hz)			
Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ϕ	At Tap Value Current (Δ = 0.86)	At 3 Times Tap Value Current (Δ = 0.88)	At 10 Times Tap Value Current (Δ = 0.9)	At 20 Times Tap Value Current (Δ = 0.91)
0.5/2/5	0.5	2.7	88	72	2.38	21.0	132	350
	0.6	3.1	88	71	2.38	21.0	134	265
	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	22.0	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	2.0	8.0	230	70	2.38	21.0	136	30
	2.5	8.8	230	66	2.40	21.1	142	695
	3.0	9.7	230	64	2.42	21.5	149	430
	3.5	10.4	230	62	2.48	22.0	157	470
	4.0	11.2	230	60	2.53	22.7	164	500
	5.0	12.5	230	58	2.64	24.0	180	580
	6.0	13.7	230	56	2.75	25.2	198	
.	4.0	16.0	460	68	2.38	21.3	146	420
	5.0	18.8	460	63	2.46	21.8	458	480
	6.0	19.3	460	60	2.54	22.6	472	550
	7.0	20.8	460	57	2.62	23.6	192	620
	8.0	22.5	460	54	2.73	24.8	207	700
	10.0	25.0	460	48	3.00	27.8	248	850
	12.0	28.0	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 high Impedance type voltmeter.*

ENERGY REQUIREMENTS (Type CO-11 Relay)

					60 Hertz Volt Amperes** (XΔ for 50 Hz)			
Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle ϕ	At Tap Value Current (Δ = 0.86)	At 3 Times Tap Value Current (Δ = 0.88)	At 10 Times Tap Value Current (Δ = 0.9)	At 20 Times Tap Value Current (Δ = 0.91)
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
.	4.0	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	440.0	454
	8.0	20	460	18	1.23	11.10	124.8	480
	10.0	22	460	17	1.32	14.90	131.6	600
	12.0	26	460	16	1.80	16.30	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 high Impedance type voltmeter.*

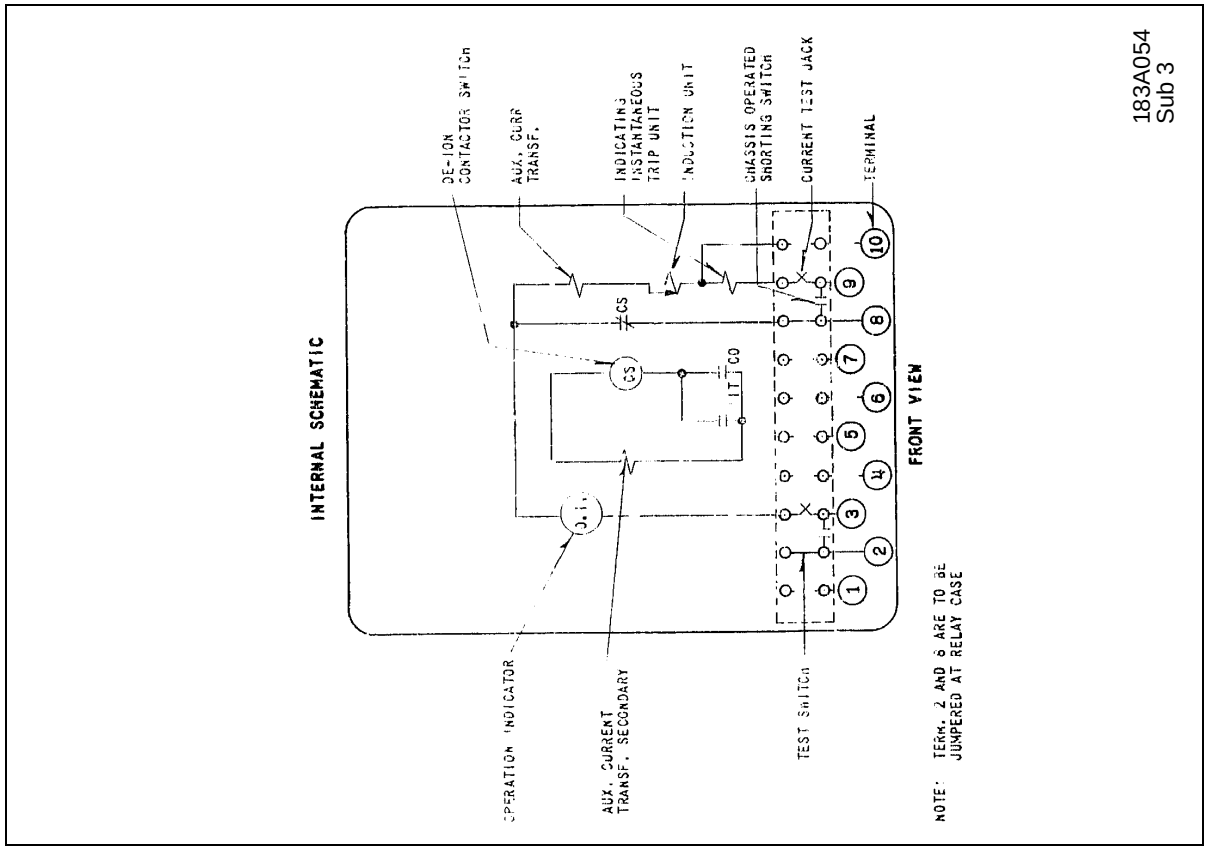

Figure 2: Internal Schematic of the Circuit Opening Type CO Relay in Type FT-21 Case

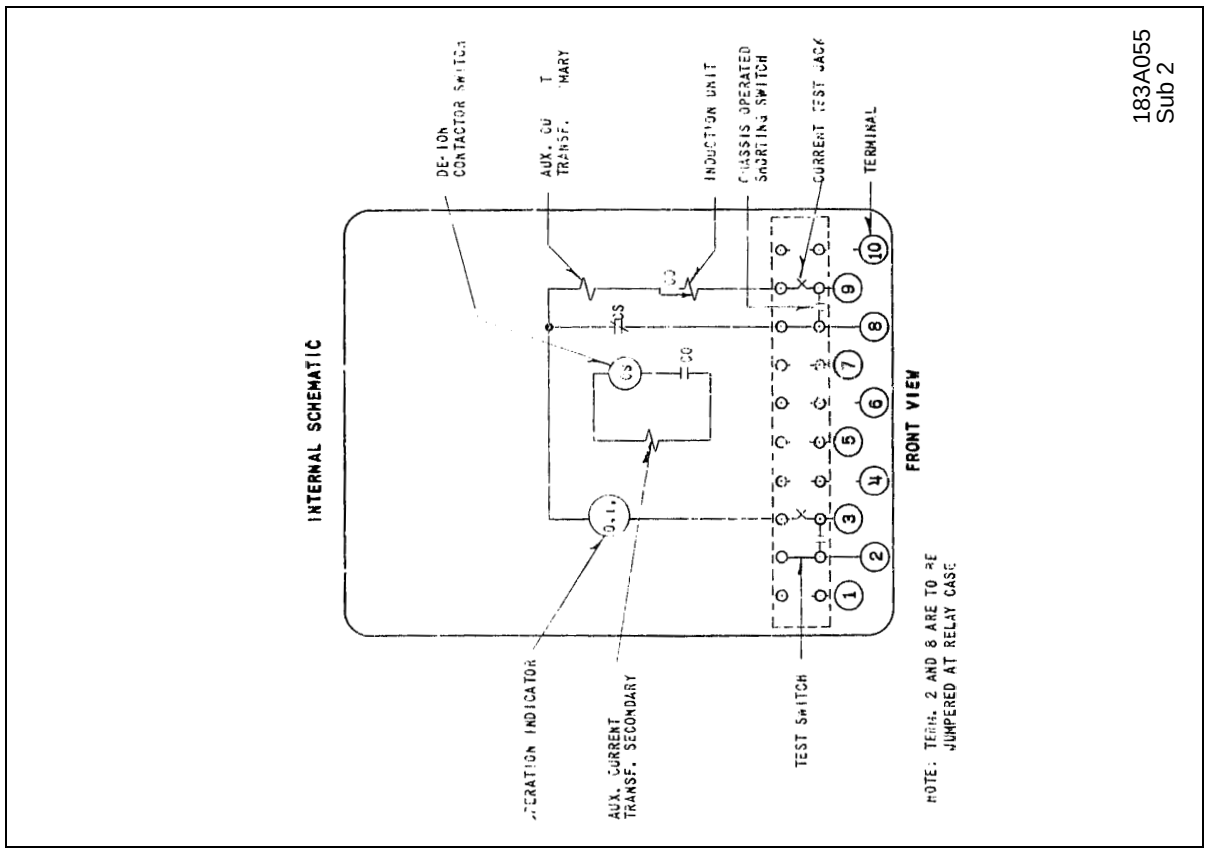

Figure 1: Internal Schematic of the Circuit Opening Type CO-Relay, with Indicating Instantaneous Trip, in Type FT-21 Case

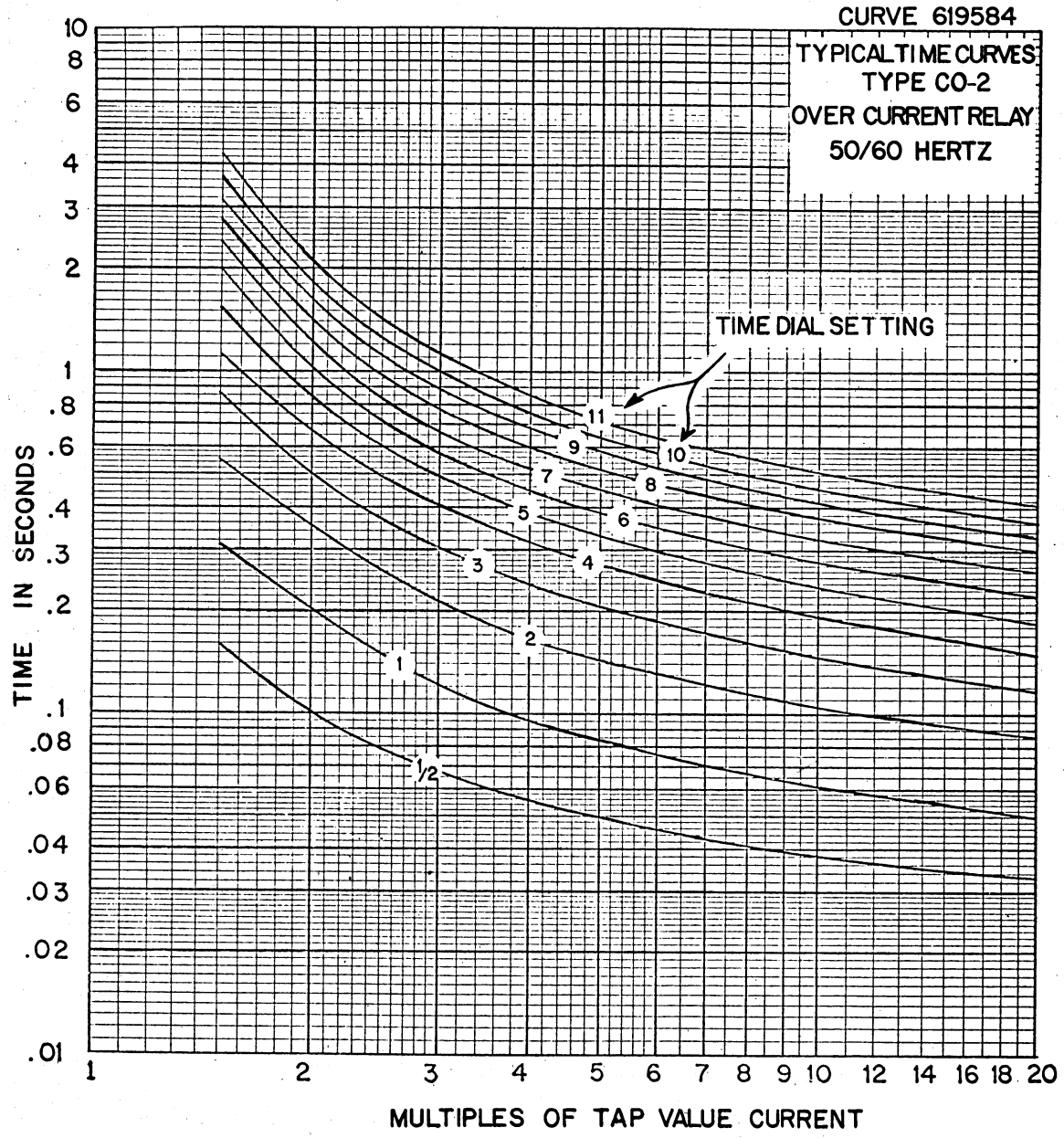

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Figure 3: Typical Time Curve of the Type CO-2 Relay

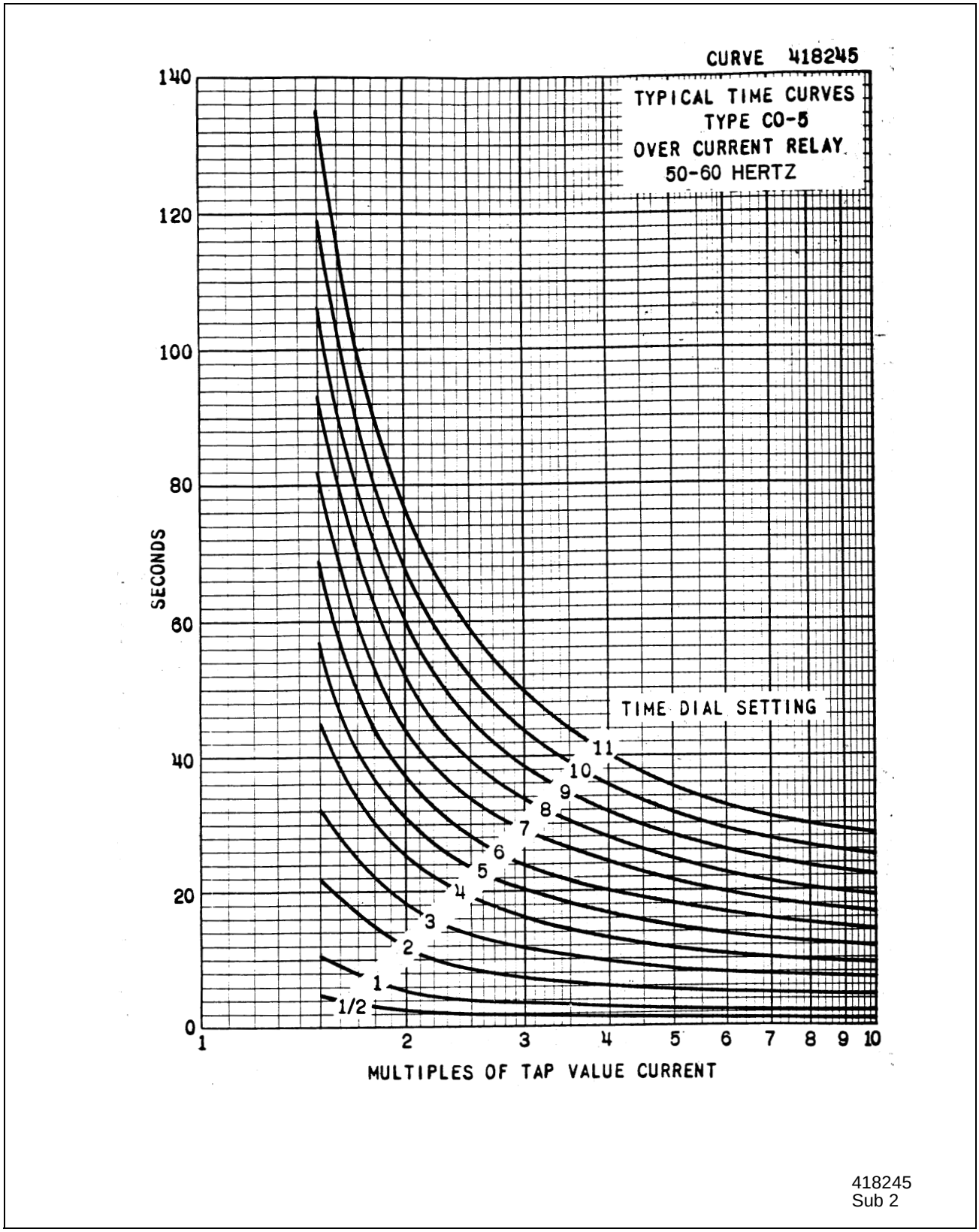

Figure 4: Typical Time Curve of the Type CO-5 Relay

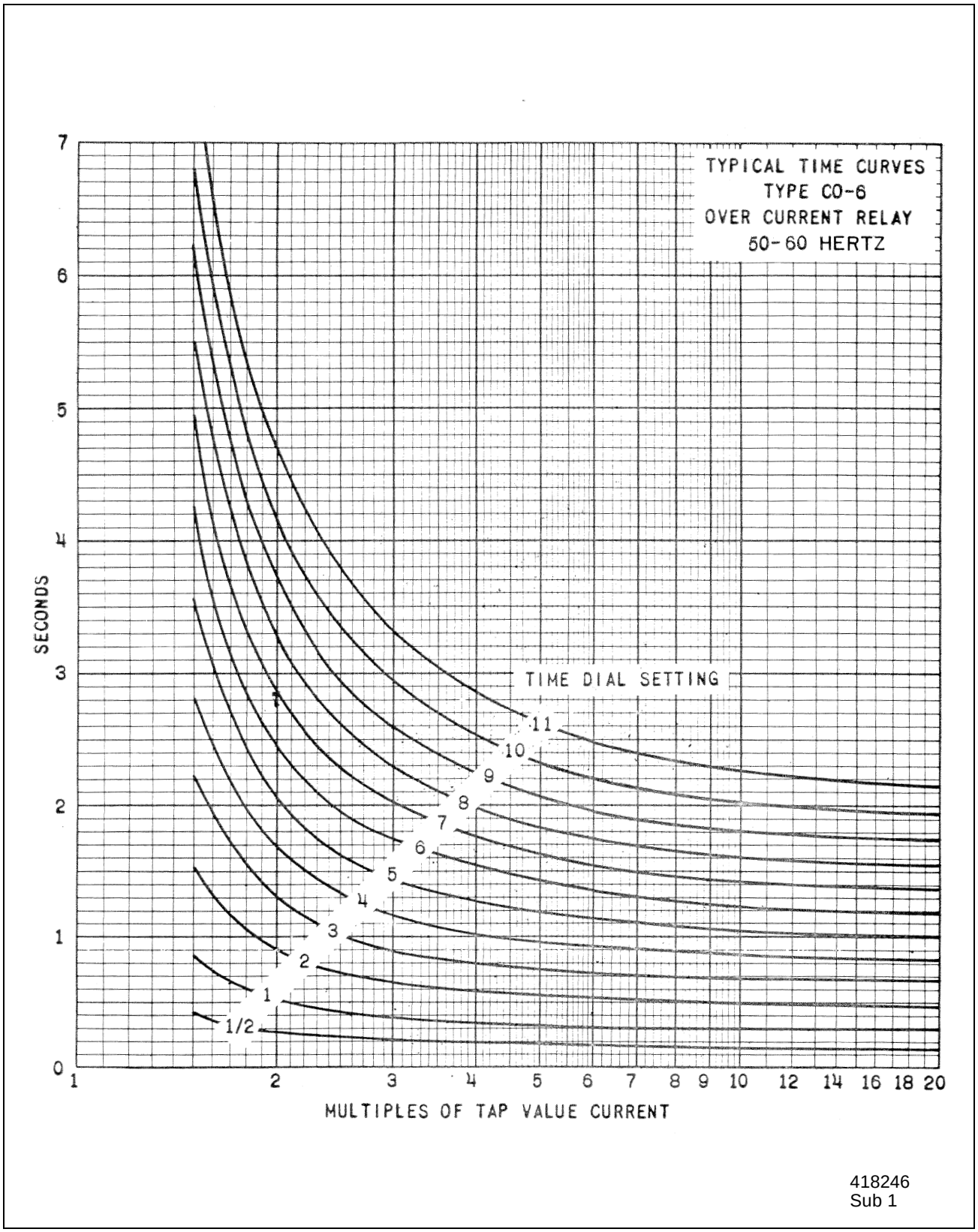

Figure 5: Typical Time Curve of the Type CO-6 Relay

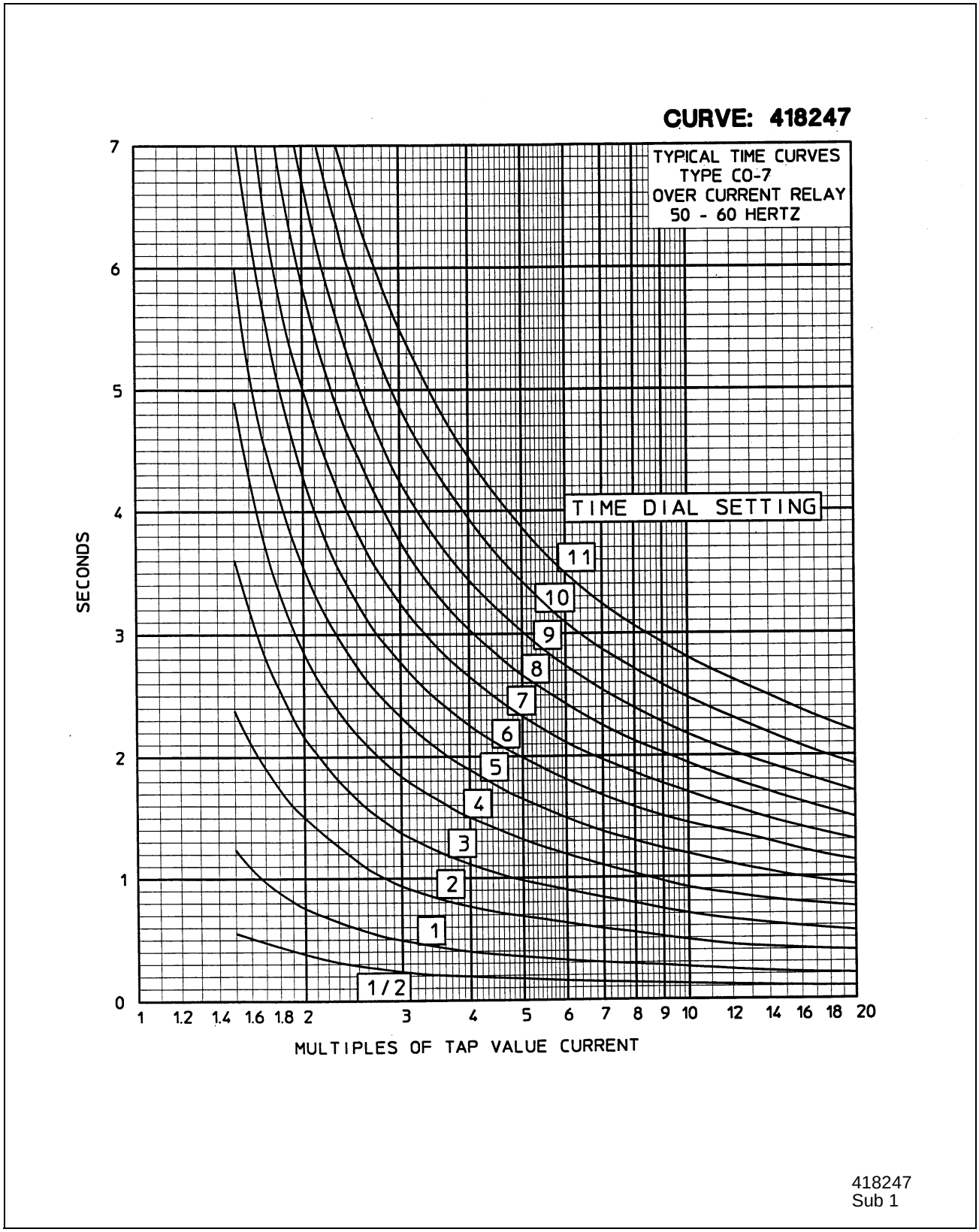

Figure 6: Typical Time Curve of the Type CO-7 Relay

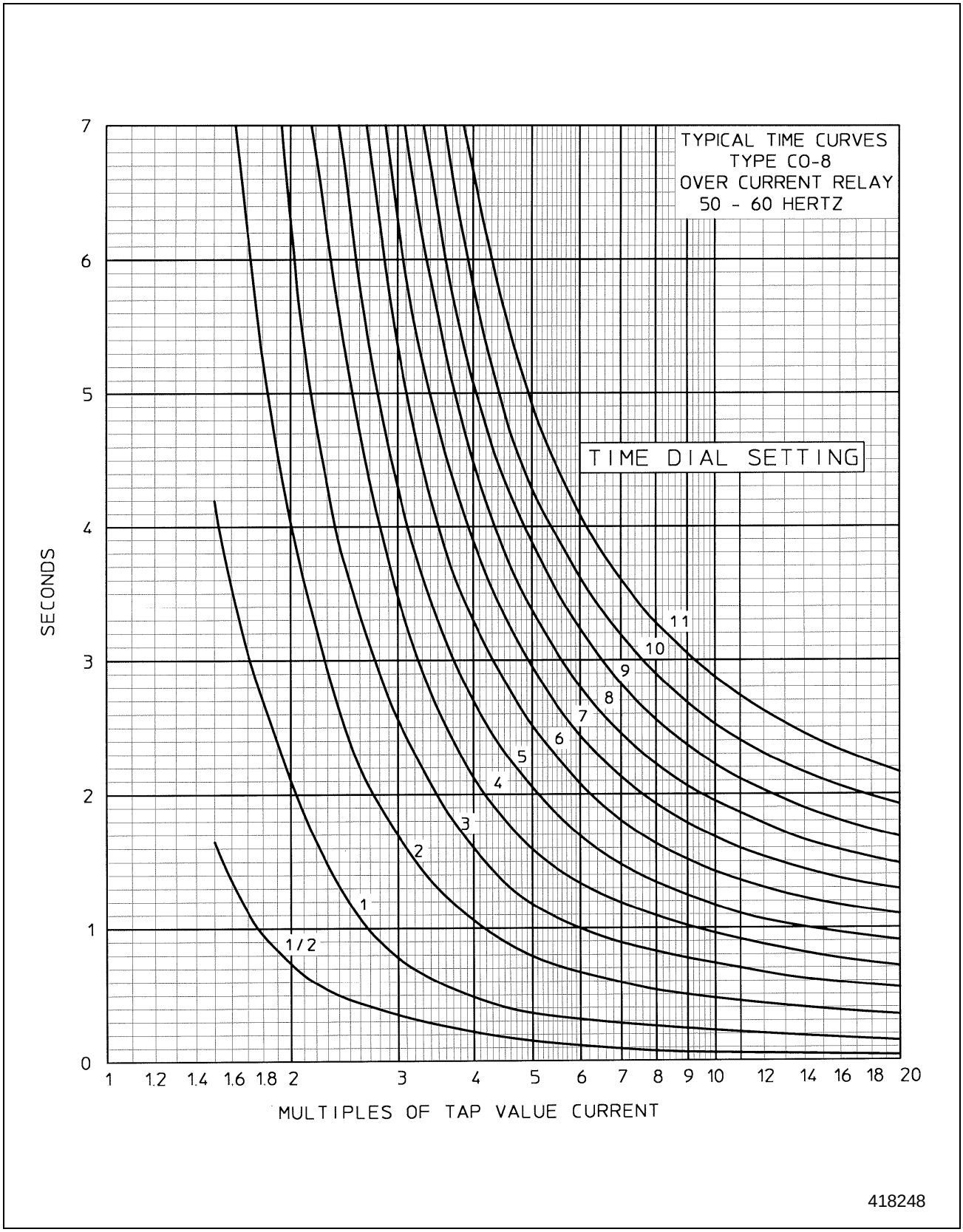

Figure 7: Typical Time Curve of the Type CO-8 Relay

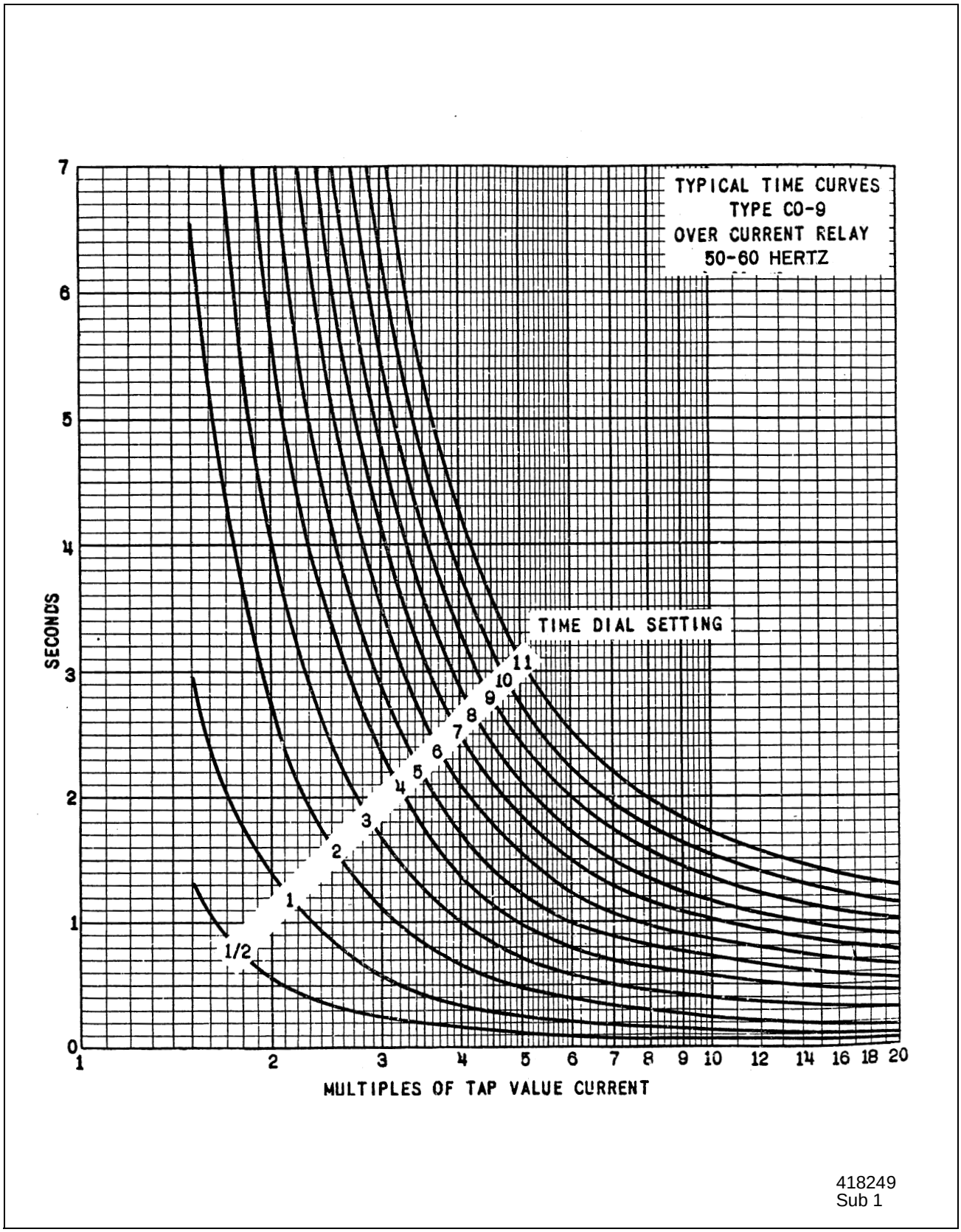

Figure 8: Typical Time Curve of the Type CO-9 Relay

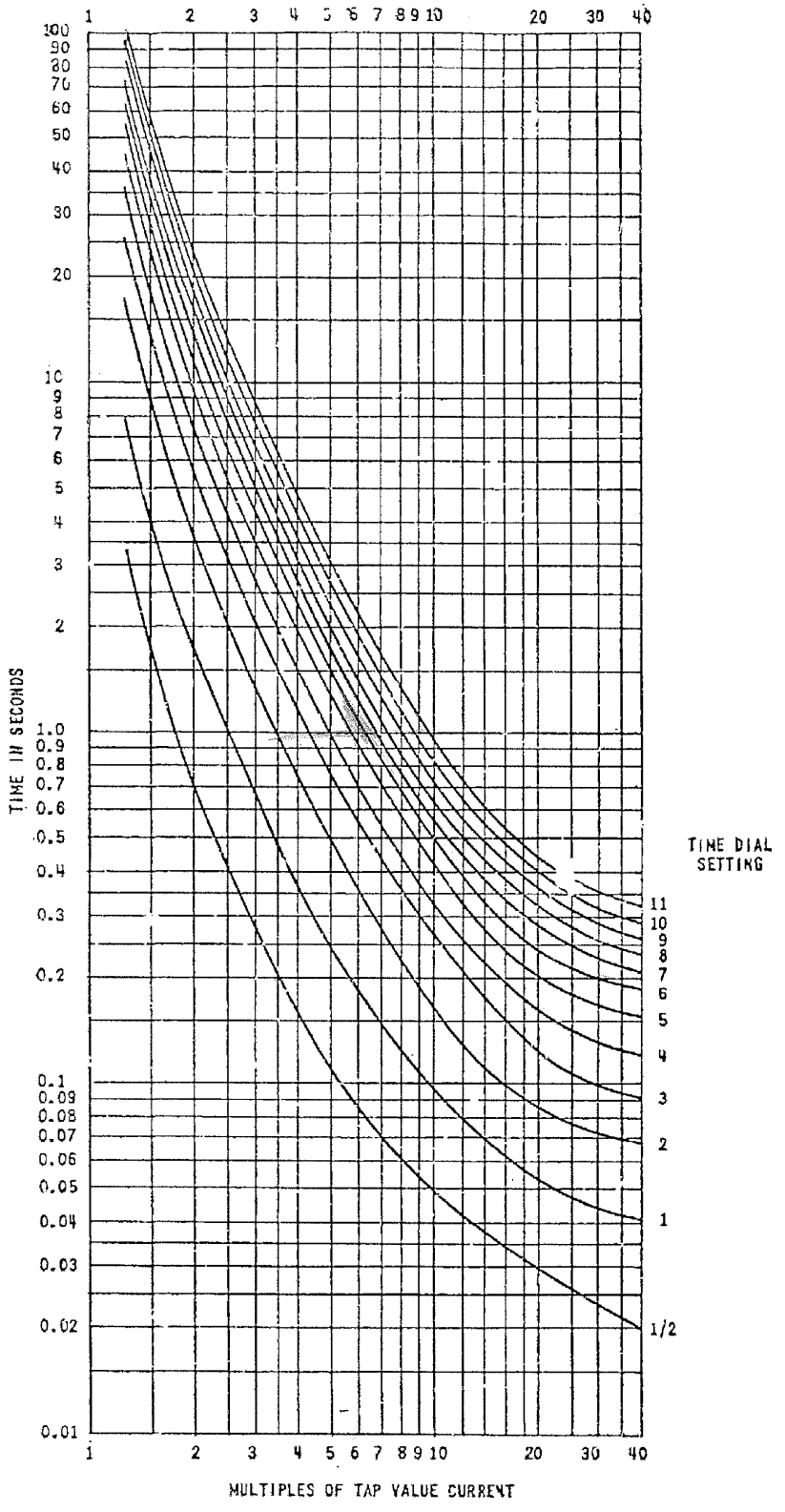

Figure 9: Typical Time Curve of the Type CO-11 Relay

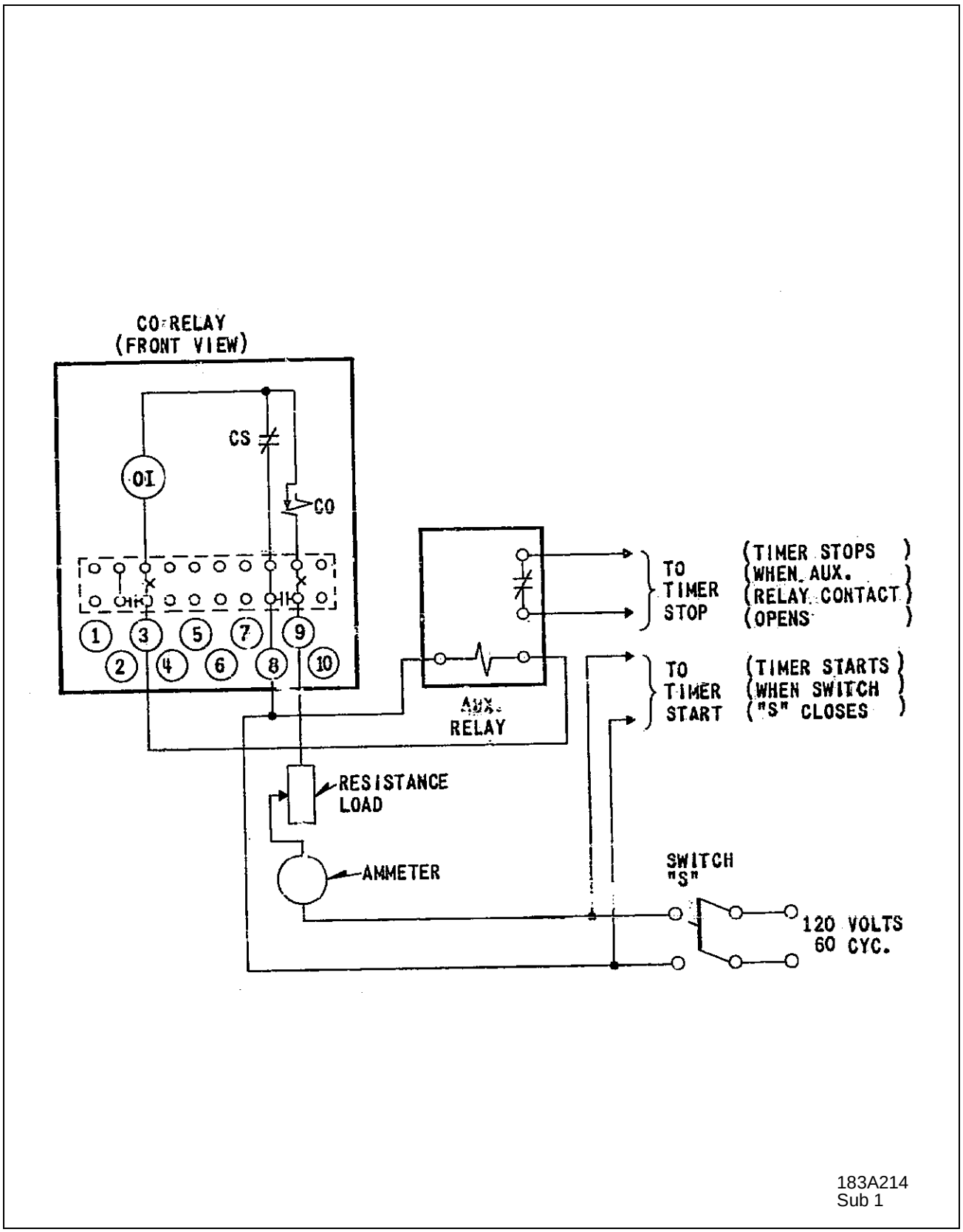

Figure 10: Diagram of Test Connections for the Circuit Opening CO Relay in the Type FT-21 Case

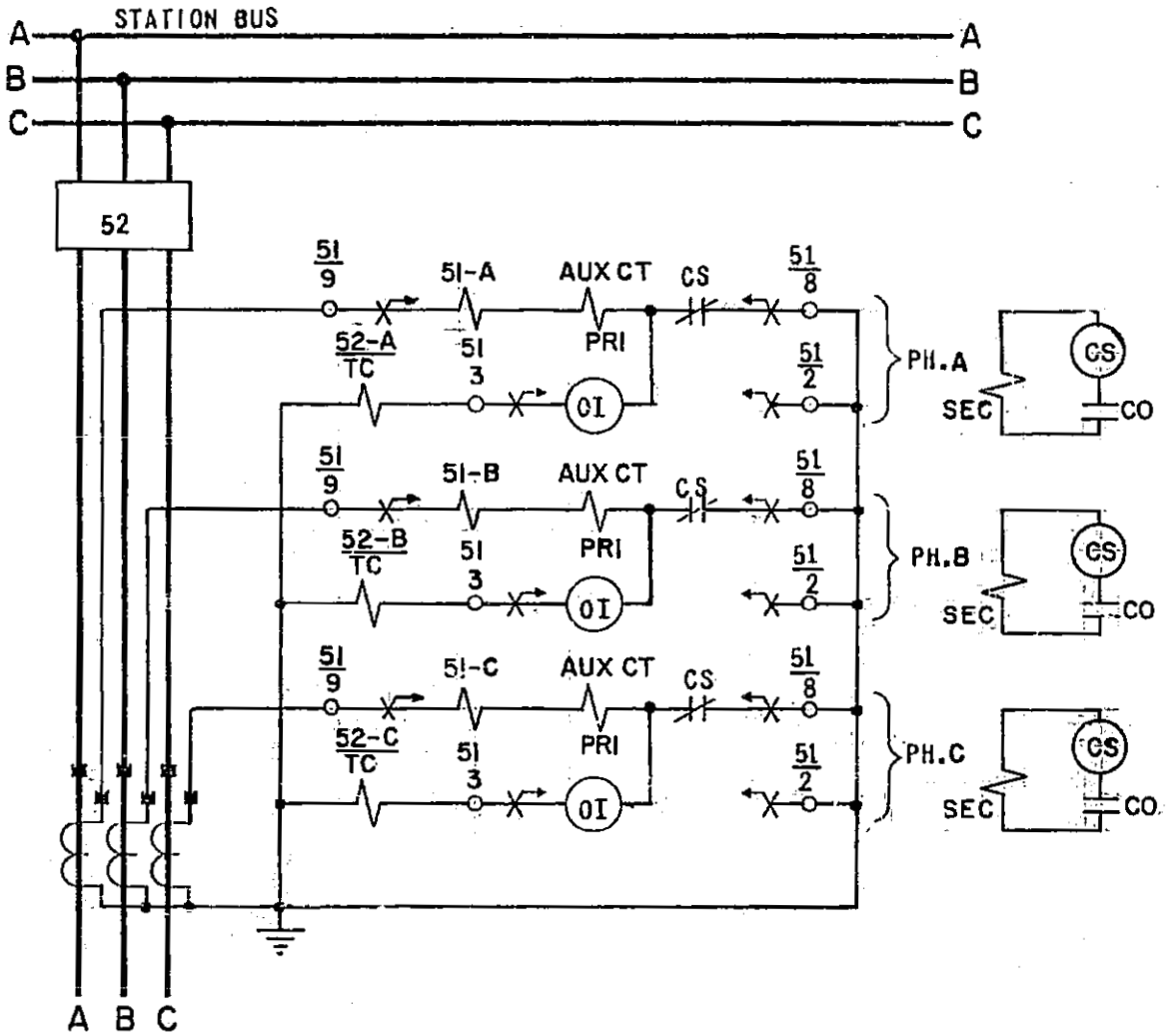

Figure 11: External Schematic of the Circuit Opening Type CO Relay for Phase Overcurrent Protection on a Three Phase System

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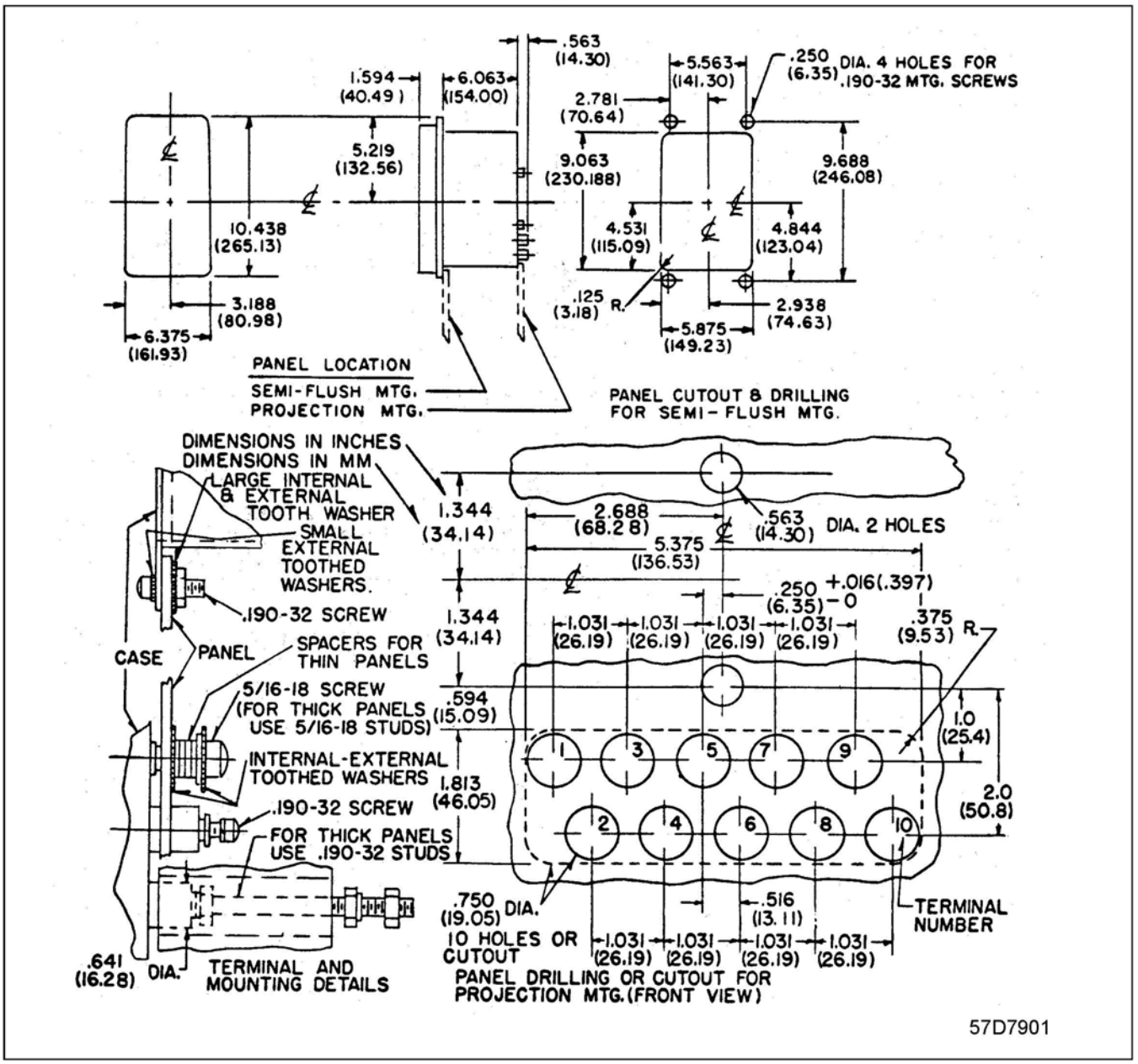

Figure 12: Outline and Drilling Plan for the Circuit Opening CO Relay in the Type FT-21 Case

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ABB Inc.

4300 Coral Ridge Drive
Coral Springs, Florida 33065

Telephone: +1 954-752-6700
Fax: +1 954-345-5329

www.abb.com/substation automation