X-75305

ENGINEERING REFERENCE DATA

280-TYPE RELAYS

BELL TELEPHONE LABORATORIES

Issued to

Name _____

Department _____

Location _____

INTRODUCTION

This is one of a series of Engineering Reference Data Bulletins containing information on apparatus designed by the Bell Telephone Laboratories, Inc., for other than military applications, and manufactured by the Western Electric Company or by other suppliers in accordance with specifications prepared by the Laboratories. It is intended primarily for use by engineers of the Laboratories, and contains information on apparatus which may be rated AT&TCo Standard, A&M Only, Component Part, or Special; codes classified ML; or codes designated for non-associate use. Codes rated Manufacture Discontinued are not included.

Items designated as PREFERRED are those recommended for use wherever practicable. Items not so designated are NONPREFERRED and should not be specified in new applications unless there is no other way of economically accomplishing the desired results. The NONPREFERRED items include (a) the older designs which may have been superseded but are still required for maintenance purposes, (b) designs more expensive to manufacture than others which may perform the same functions, and (c) items in such small demand that they are more costly to furnish.

It is planned to bring this bulletin up to date periodically; however, the information contained herein may not be complete and ratings of the items are not shown. The final selection of apparatus should, therefore, be made on the basis of the usual sources of information such as the Western Electric Apparatus Card Catalog, the manufacturing specifications, and price data. For information regarding the output of apparatus refer to the Western Electric Report A-822.1.

The bulletin may include some codes of apparatus for which catalog cards will not be found in the Western Electric Apparatus Card Catalog. Such codes are in general rated "Component Part." This rating is applied to apparatus where it is believed that the associated telephone companies will have no need for apparatus card catalog information and orders for the apparatus from the field are not expected.

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When apparatus which is not listed on a white card in the Western Electric Apparatus Card Catalog is selected for use in new applications, the Standards Engineer, Department 5241, Bell Telephone Laboratories, Inc., 463 West Street New York, should be notified of the new use and probable demand so that consideration can be given to rerating the apparatus. When such new applications are made within the Laboratories, the selection should first be discussed with the department responsible for the design of the apparatus.

CODE INFORMATION FOR 280-TYPE RELAYS

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CODE INFORMATION FOR 280-TYPE RELAYS

GENERAL INFORMATION

Scope

This specification contains the code information for 280-type relays and specifies the codes of 280-type relays which replace 206- and 239-type relays.

Maintenance

Requirements and maintenance procedures are covered in BSP A460.059.

The use of the contact closure test set is covered in BSP A702.019.

DESCRIPTION

General Description

The 280-type relay is a polarized relay designed to replace all 206 and 239 types. The 280-type relay utilizes a die cast aluminum alloy frame, a bar remalloy permanent magnet, a filled-type coil, hydrogen annealed magnetic iron pole-piece posts, mica insulation under contact posts, molybdenum permalloy return-path bracket and cover, and a new design of cover cap. Tests of models of the relay have shown that it has superior adjustment stability to the 239 and 206 relays under various conditions of vibration, shock, humidity, and temperature. The improved magnetic capability of this relay results in higher magnetic air gaps, which partly accounts for the improvement in adjustment stability. Remalloy is an alloy of molybdenum, cobalt, and iron.

The physical mounting centers are the same as the 206 and 239 types, but no mounting restrictions apply to the 280-type relay since it is practically free from magnetic interference.

All 280-type relays are equipped with chatterless armatures and with BM contacts. The new method of adjustment recently developed for the 239-type relay is specified for the 280 types. BSP A460.059 which gives adjusting requirements for 280-type relays will provide only two adjustment figures, A and B. Fig. A refers to the adjustment of relays not equipped with biasing springs and Fig. B to relays equipped with biasing springs.

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APPLICATION

Circuit Reissues (See Examples on Page 3)

On reissues of old circuits using iron 206-type relays (206A to 206CM) add the requirements for the 280-type relays and continue to show the old requirements for the 206-type relays.

On reissues of circuits using permalloy 206-(206FA to 206GU) and 239-type relays, the new adjustments will be the same as the adjustments for the 280-type relay, the old requirements will be removed except as stated below in the paragraphs under the heading Relays Without Biasing Springs.

The 280-type relay adjustment should not be applied to permalloy 206-type relays with chatterless armatures. There are three such relays, namely, 206GA, 206GH, and 206GR. For these relays, continue to show their present requirements and add the 280-type relays with their requirements.

New Circuits

All new circuits should specify only the 280-type relay.

Relays Without Biasing Springs

Adjustment A consists of a readjust operate of about 3-ampere turns and a nonoperate of about 2.2-ampere turns both after a negative soak of 125-ampere turns. This has been termed an electrical balance adjustment. The operate test requirement is identical with that now shown on the circuit requirements table. An open circuit (OC) nonoperate test requirement is specified, which means that the armature must remain or stick against each contact after applying the soak current.

Use the readjust values specified for the 280-type relay in this X- specification and the test operate value now shown on the circuit requirements table, and specify an open circuit (OC) nonoperate test.

Pulse generator circuit using 239-type relays with Fig. 13 (BSP Section) adjustment may require changes in resistance networks when 280-type adjustment is applied. For these cases the Relay Requirements Group should be consulted.

Relays With Biasing Springs

Adjustment B is given in two parts. First, the so-called electrical balance is applied as the A adjustment with the biasing spring disengaged. For this part of the adjustment test currents will not be specified. The second part of the adjustment is obtained by varying the tension of the biasing spring against the armature to meet the specified current flow requirements.

Use the operate and nonoperate readjust values specified for the 280-type relay in the first two lines of this X- specification for the replacing code, followed by the test and readjust values now shown on the circuit requirements table. For new circuits all of the current flow requirements in the X- specification may be used. Where these current flow values do not meet circuit requirements, other current flow requirements within the capability of the relay can be obtained by consulting the Relay Requirements Group.

Relays Bridged by Condensers

Where polar relays are bridged by condensers, the balance requirements cannot be obtained unless the filter consisting of either a capacity and resistance or a 500-ohm ±1 per cent noninductive resistance is bridged across the relay.

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Contact Closure Test Set

The requirements for the 280 relay should be specified on the basis that the contact closure test set may be used, if available, in applying the requirements. BSP A702.019 covers the contact closure test set per J94724 and SD-95365-01. This test set makes use of lamp signals as a positive means of indicating contact closure of the relay under test.

In applying the contact closure indicator to the contacts of the relay under test it is necessary to analyze the circuit to insure that the lamps will not be lighted falsely through the circuit wiring, that the lamps provided in the indicator will not be burned out, and that the current from the contact closure test set will not pass through the relay windings. An analysis of representative circuits has shown that, to accomplish this, it is necessary to provide for lighting the lamps from an ac supply for some conditions and a nongrounded battery supply for other conditions.

Following are the instructions for the use of the test circuit:

(a) Tentatively assume ac connection and proceed as follows:

(1) Check that alternating current from the contact closure test set will not affect any winding of relay under test either by metallic conduction or through condensers of the circuit under test.

(2) Check that the lamps will discriminate properly between an open and closed contact on the test relay by checking that the circuit loop resistance is greater than 160 ohms. Disregard any dc battery voltage in this loop less than 60 volts.

(3) If (1) and (2) can be satisfied without blocking relays or insulating contacts, the ac connection can be used and no note is required on circuit requirements table.

(4) If (1) and (2) can be satisfied with a blocking or insulating note, use following wording:

Test Note:

When contact closure test set is used, insulate . . . . etc.

(b) If ac connection cannot be used because alternating currents are introduced into relay winding, then tentatively assume dc connection and proceed as follows:

(1) Check that direct current from the contact closure test set will not affect any winding of the relay under test either by direct metallic conduction or by an oscillatory surge through the condensers of the circuit under test. If uncertain of the analysis, refer condition to Relay Requirements Group.

(2) Check that the lamps will discriminate properly between an open and closed contact on the test relay by checking that the circuit loop resistance is greater than 130 ohms in series with zero voltage or greater than 1100 ohms when in series with 50 volts.

(3) If (1) and (2) can be satisfied without blocking relays or insulating contacts, the dc connection can be used and the following note should be added to the circuit requirements table:

Test Note:

When contact closure test set is used, use dc connection.

(4) If (1) and (2) can be satisfied with a blocking or insulating note use the following wording:

Test Note:

When contact closure test set is used, use dc connection and insulate...etc.

(c)(1) If neither ac nor dc connection can be used without unsoldering wires, add note similar to the following:

Test Note:

Do not use contact closure test set when testing or adjusting L relay.

(2) In some cases the use of the contact closures test set may be satisfactory on the winding used for adjustment but not when checking other windings, in which case a note similar to the following should be used:

Test Note:

Remove contact closure test set connection when testing secondary winding of M relay.

INSULATED COVER CAP

An insulated cover cap, P15A137, can be obtained in place of the standard cap if specified in the order.

PREFERRED RELAYS

Because the 280-type relay is a special purpose relay, no codes are indicated as preferred. Relays with winding, of ±10 per cent resistance variation should be used wherever possible for economic reasons.

Examples of 280-type Relay
Replacements for Iron 206-, Permalloy
206-, and 239-type Relays

Code	BSP Fig.	Test Wdg	Test For	Soak MA	Test MA	Readj MA
206BM	3		O R	-80 80	4.8 0.C	4.5 0.C
280J	B		O NO O R	-12 -12 -12 12	 4.8 1.6	0.3 0.2 4.5 1.7 A
206E	8	P//S	O	-55	9.	8.5
280DR	A	P//S P//S	O NO	-60 -60	3.0 0.C	1.2 B 0.9
239HH or 280AF	B	S S S S P	O NO O R O	-45 -45 -45 45	 4.5 0.9 10.3	1.1 0.8 4.2 1.0
239FC or 280A	A	P P S	O NO O	-65 -65	3. 0.C 0.5	1.5 1.1

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Note A: Consult Relay Requirements Group for 280-type relay current flow release requirements.

Note B: A test operate of approximately six ampere turns should be specified for the 280-type relay.

280-TYPE RELAYS TO REPLACE 206-TYPE RELAYS

TABLE 1

IRON 206 CODES**							
206 CODE	USE CODE	206 CODE	USE CODE	206 CODE	USE CODE	206 CODE	USE CODE
206A (MD)	None	206AA	280CW*	206BA	280J*	206CA	280BY*
206B (MD)	None	206AB (MD)	None	--	--	206CB	280J*
206C	280J	206AC	280BK	--	--	206CC	280H*
--	--	206AD	280F	206BD	280AA*	206CD	280AD*
206E	280DR	206AE	280M	206BE	280AA*	206CE	280DM
--	--	206AF	280DK	206BF	280CF	206CF	280DA
206G	280DC	206AG	280FD	206BG	280CF	--	--
206H	280CF	206AH	280BA	206BH	280F	206CH	280EP*
206J	280BY	206AJ	280EA	206BJ	280DK*	206CJ	280CT
206K (MD)	None	206AK	See xxx	206BK	280M	206CK	280DG*
206L	280J	206AL (MD)	None	206BL	280M	206CL	280DG
206M (MD)	None	206AM	280J	206BM	280J*	206CM	280BP
206N	280U	206AN	280F	206BN (MD)	None		
206P	280CF	206AP	280DB	206BP	280EE*		
206R (MD)	None	206AR	280CF	206BR	280CA		
206S	280DB	206AS	280AD	206BS (MD)	None		
206T (MD)	None	206AT	280DF	206BT	280BY*		
206U	280AG*	206AU	See xxx	206BU	280U		
206W	280EA	206AW	280EM	206BW	280CB		
206Y	280T	206AY	280J*	206BY	280J*		
PERMALLOY 206 CODES							
206 CODE	USE CODE	206 CODE	USE CODE	206 CODE	USE CODE	206 CODE	USE CODE
206FA	280AB	206FL	280DD*	206GA***	280AY	206GL	280AA
206FB	280AA*	206FM	280CD*	206GB	280AT	206GM	280CH
206FC	280DD*	206FN	280EN*	206GC	280CN*	206GN	280Y
206FD	280EH	206FP	280CH*	206GD	280DT	206GP (MD)	None
206FE	280AH*	206FR	280AC	206GE	280CM	206GR***	280EB
206FF	280F	206FS	280EJ	--	--	206GS	280B
206FG	280F	206FT	280EK	206GG	280H*	--	--
206FH	280F	206FU	280EL	206GH***	280BU	206GU	280D
206FJ	280J	206FW	280AD	206GJ	280DN	206GW	280P
206FK	280EB*	206FY	280L	206GK	280CL	206GY	280H

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*Note changed terminal numbering.

**Consult Relay Group for current flow requirements to be used on replacements for iron 206 types. For permalloy 206 replacements use requirements now specified.

xxxUse the 280CC relay with its current flow requirements as a replacement for the 206AK or 206AU relays.

***Show present requirement for these relays and add requirements for 280-type relays.

280-TYPE RELAYS TO REPLACE 239-TYPE RELAYS

TABLE 2

239 CODE	USE CODE	239 CODE	USE CODE	239 CODE	USE CODE	239 CODE	USE CODE
239FA	280BH	239GA	280AC	239HA	280AY	239JA	280CG
239FB	280K	239GB	280AW	239HB	280ED	239JB	280BF
239FC	280A	239GC	280CY	239HC	280DF	239JC	280DY
239FD	280BD	239GD	280ES	239HD	280CC	239JD	280CK
239FE	280BC	239GE	280BS	239HE	280W	239JE	280CS
239FF	280R	239GF	280AR	239HF	280EC	239JF	280CR
239FG	280DW	239GG	280AN	239HG	280ET	239JG	280CE
239FH	280AA	239GH	**	239HH	280AF	239JH	280CD
239FJ	280H	239GJ	280DL	239HJ	280AC	239JJ	280BT
239FK	280B	239GK	280CJ	239HK	280S	239JK	280AJ
239FL	280E	239GL	280BL	239HL	280AS	239JL	280DH
239FM	280J	239GM	280BW	239HM	280F	239JM	280EF
239FN	280J	239GN	280R	239HN	280EU	239JN	280BN
239FP	280F	239GP	None	239HP	280BJ	239JP	280AL
239FR	280DJ	239GR	280A	239HR	280AU	239JR	280AP
239FS	280CD	239GS	280C	239HS	280EG	239JS	280FB
239FT	280CU	239GT	280DS	239HT	280K	239JT	280DE
239FU	280G	239GU	280U	239HU	280EW	239JU	280BA
239FW	280AE	239GW	280E	239HW	280EY	239JW	280N
239FY	280CP	239GY	xxx	239HY	280FA	239JY	280AP

239 CODE	USE CODE
239KA	280ER
239KB	280FC
239KC	280BM
239KD	280BR
239KE	280BB
239KF	280AK
239KG	280AM
239KH	280DP
239KJ	280BE
239KK	280BG

**Use 280DU to replace 239GH when tertiary winding is not required.

xxxUse 280R and specify insulated cover cap per P-15A137.

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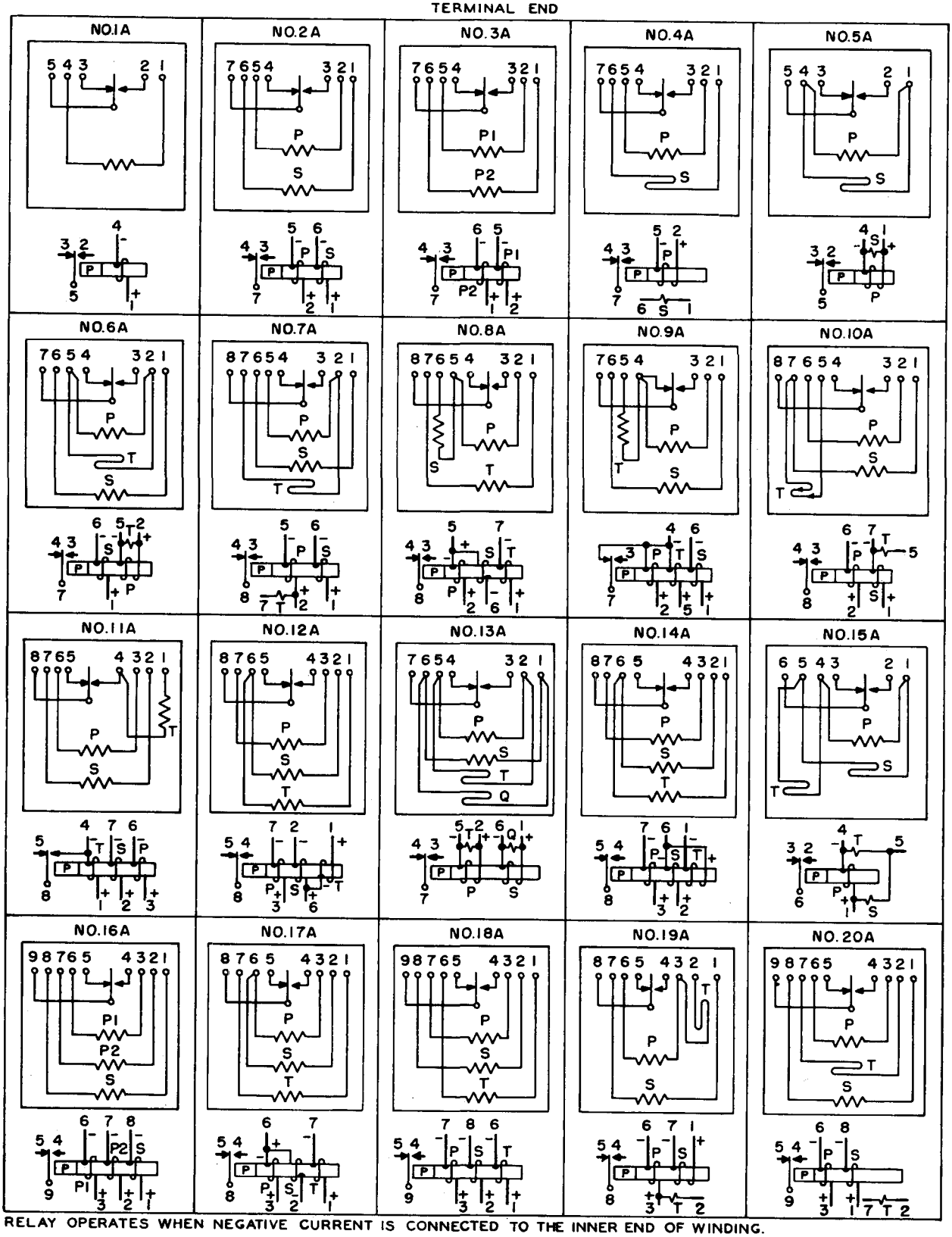
280 TYPE RELAYS WINDING ARRANGEMENTS
TERMINAL END



RELAY OPERATES WHEN NEGATIVE CURRENT IS CONNECTED TO THE INNER END OF WINDING.

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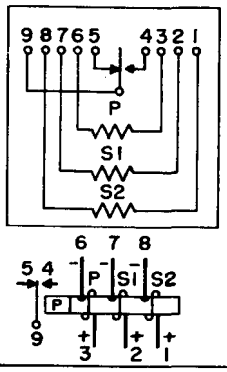
280 TYPE RELAYS WINDING ARRANGEMENTS
TERMINAL END

NO.21A



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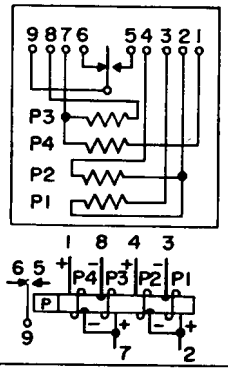

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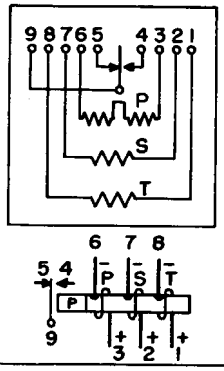

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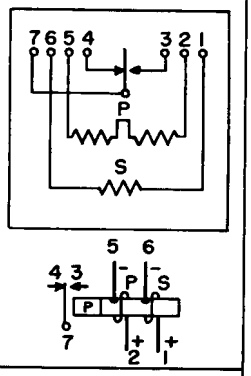

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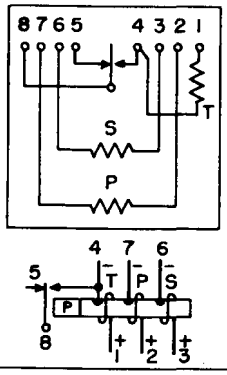

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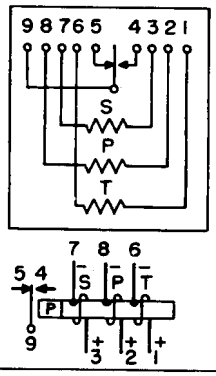

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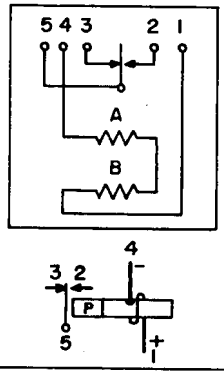

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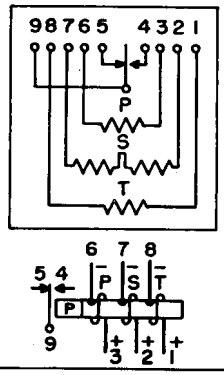

RELAY OPERATES WHEN NEGATIVE CURRENT IS CONNECTED TO THE INNER END OF WINDING

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280-TYPE RELAY - CODE INFORMATION												
CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280A	P	2000	200	±1%	2A	A	P	O	-65	3	1.5	
	S	14000	2600	±1%			P	NO	-65	O.C.	1.1	
							S	O		0.5		
280B		4300	80	±10%	1A	B		O	-30		0.7	
								NO	-30		0.5	
								O	-30	2.9	2.7	
								R	30	0.6	0.7	
280C	P	2800	100	±10%	21A	A	P	O	-45	2	1	
	S1	2800	300	±10%			P	NO	-45	O.C.	0.7	
	S2	2800	300	±10%			S1	O		2.1		
							S2	O		2.1		
280D		9800	500	±10%	1A	B		O	-13		0.3	B
								NO	-13		0.2	
								O	-13	3.9	3.7	
								R	13	1.4	1.5	
280E		32300	6300	±5%	1A	B		O	-65		1.1	A
								NO	-65		0.8	A
								O	-4	0.4	0.3	
								R	4	O.C.	O.C.	
280F		7800	250	±10%	1A	B		O	-16		0.4	
								NO	-16		0.3	
								O	-16	1.6	1.5	
								R	16	0.3	0.4	
280G	P	3900	80	±10%	20A	B	P	O	-35		0.7	
	S	4700	1000	±10%			P	NO	-35		0.5	
	T	N.I.	60	±5%			P	O	-35	2.4	2.2	
							P	R	35	O.C.	O.C.	
							S	O		2.3		
280H	P	815	5.5	±10%	13A	B	P//T	O	-150		3.5	
	S	815	6	±10%			I.S.W.	NO	-150		2.5	
	T	N.I.	6.5	±5%			S//Q	O	-150	13.7	13	
	Q	N.I.	6.5	±5%				R	150	1	1.1	
	P//T		2.98	±8%								
	S//Q		3.12	±8%								
280J		10450	500	±10%	1A	B		O	-12		0.3	
								NO	-12		0.2	
								O	-12	3.2	3	
								NO	12	1.7	1.8	
								R	12	0.9	1	
280K	P1	1550	30	±10%	16A	A	P1/P2	O	-40	1.8	1	
	P2	1550	30	±10%			P1/P2	NO	-40	O.C.	0.7	
	S	3000	3000	±1%			S	O		1.9		

Note A: Adjusted with relay shunted by 500$^{\omega}$ ±1 per cent resistance.

Note B: Equipped with permalloy shells next to core.

280-TYPE RELAY - CODE INFORMATION												
CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280L	P	4670	200	±10%	2A	B	P	O	-30		0.6	
	S	16990	16500	±5%			P	NO	-30		0.4	
							P	O	-30	3.1	2.9	
							P	R	30	0.1	0.2	
							P/S	O		0.8		
280M		5025	100	±10%	1A	B		O	-25		0.6	
								NO	-25		0.4	
								O	-25	6.9	6.5	
								R	25	2.4	2.6	
280N		6800	200	±10%	1A	A		O	-19	0.9	0.4	
								NO	-19	O.C.	0.3	
280P	P	3900	190	±10%	18A	B	P	O	-35		0.7	
	S	22925	16500	±5%			P	NO	-35		0.5	
	T	1560	13500	±5%			P	O	-35	4.6	4.3	
							P	R	35	0.1	0.2	
							P/S/T	O		0.8		
280R	P1	3080	175	±10%	16A	A	P1	O	-41	1.9	1	
	P2	3080	175	±10%			P1	NO	-41	O.C.	0.7	
	S	3000	1145	±1%			P2	O		1.9		
							S	O		2		
280S	P	3400	67	±10%	2A	B	P	O	-40		0.9	
	S	2000	400	±1%			P	NO	-40		0.6	
							P	O	-40	2.9	2.7	
							P	R	40	0.2	0.3	
							S	O		4.9		
280T		5000	275	±10%	1A	B		O	-25		0.6	
								NO	-25		0.4	
								O	-25	10	9.5	
								R	25	1.1	1.2	
280U	P	1960	14.5	±10%	5A	B	P//S	O	-105		2.3	
	S	N.I.	27	±5%				NO	-105		1.7	
		P//S	9.5	±8%				O	-105	20.5	19.5	
								NO	105	9.5	10	
280W	P	3800	185	±10%	18A	A	P	O	-33	1.6	0.8	
	S	5550	800	±10%			P	NO	-33	O.C.	0.6	
	T	1400	110	±1%			S	O		1.1		
							T	O		4.4		
280Y	P	2860	200	±10%	2A	B	P	O	-45		1.1	
	S	21425	30000	±5%			P	NO	-45		0.8	
							P	O	-45	5.2	4.9	
							P	R	45	1.2	1.3	
							P/S	O		0.8		

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280-TYPE RELAY - CODE INFORMATION												
CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280AA		3350	42	±10%	1A	B		O	-40		0.9	
								NO	-40		0.6	
								O	-40	3.2	3	
								R	40	0.1	0.2	
280AB	P	9400	500	±10%	2A	B	P	O	-13		0.3	
	S	2600	12000	±5%			P	NO	-13		0.2	
							P	O	-13	4.8	4.5	
							P	NO	-13	2.8	3	
							P	R	13	1.9	2.1	
							P/S	O		3.8		
280AC	P	5200	135	±10%	2A	B	P	O	-24		0.6	
	S	6700	15000	±5%			P	NO	-24		0.4	
							P	O	-24	2.8	2.6	
							P	R	24	0.4	0.5	
							P/S	O		1.4		
280AD		26550	12000	±5%	1A	B		O	-90		2.7	A
								NO	-90		1.9	A
								O	-3.5	1.2	1.1	
								R	3.5	0.2	0.3	
280AE	P	5550	415	±10%	2A	B	P	O	-23		0.6	
	S	17180	15400	±5%			P	NO	-23		0.4	
							P	O	-23	2.8	2.6	
							P	R	23	0.7	0.8	
							P/S	O		0.9		
280AF	P	1200	10	±10%	2A	B	S	O	-45		1.1	
	S	2800	200	±1%			S	NO	-45		0.8	
							S	O	-45	3.8	3.6	
							S	R	45	0.6	0.7	
							P	O		8.9		
280AG	P	4300	80	±10%	7A	B	P	O	-30		0.7	
	S	2105	1000	±5%			P	NO	-30		0.5	
	T	N.I.	125	±5%			P	O	-30	4.5	4.2	
							P	NO	-30	0.9	1	
							S	O		9.7		
280AH		27600	3500	±10%	1A	B		O	-40		0.8	A
								NO	-40		0.6	A
								O	-4.5	1.2	1.1	
								R	4.5	0.2	0.3	
280AJ	P	2540	95	±10%	24	A	P/S	O	-25	1.2	0.6	
	S	2540	95	±10%			P/S	NO	-25	O.C.	0.4	
	T	12700	3600	±2%			T	O		0.5		
280AK	P	1800	29	±2%	2A	B	P	O	-70		1.7	
	S	3130	220	±1%			P	NO	-70		1.2	
							P	O	-70	6.8	6.4	
							P	R	70	1.6	1.7	
							S	O		3.9		

Note A: Adjusted with relay shunted by 500ω ±1 per cent resistance.

280 TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280AL	P	4500	350	±1%	18A	B	P	O	-28		0.7	
	S	5100	1200	±1%			P	NO	-28		0.5	
	T	5800	800	±10%			P	O	-28	2.8	2.6	
							P	R	28	0.6	0.7	
							S	O		2.5		
							T	O		2.7		
280AM	P	3700	110	±2%	2A	B	P	O	-34		0.8	
	S	3950	700	±1%			P	NO	-34		0.6	
							P	O	-34	3.3	3.1	
							P	R	34	0.7	0.8	
							S	O		3.1		
280AN	P	2000	200	±1%	2A	A	P	O	-65	2.9	1.5	
	S	9000	1000	±1%			P	NO	-65	O.C.	1.1	
							S	O		0.7		
280AP	P	2000	200	±1%	2A	B	P	O	-65		1.5	
	S	9000	1000	±1%			P	NO	-65		1.1	
							P	O	-65	6.1	5.8	
							P	R	65	0.2	0.3	
							S	O		1.4		
280AR		2700	40	±1%	1A	A		O	-46	2.2	1.1	
								NO	-46	O.C.	0.8	
280AS	P	2290	29	±10%	2A	B	P	O	-55		1.3	
	S	1000	950	±2%			P	NO	-55		0.9	
							P	O	-55	5	4.7	
							P	R	55	1	1.1	
							S	O		11.5		
280AT	P	1800	25	±10%	2A	B	P/S	O	-40		0.9	
	S	1600	25	±10%			P/S	NO	-40		0.6	
							P/S	O	-40	9.9	9.4	
							P/S	NO	-40	7.2	7.6	
							P/S	R	40	4.4	4.7	
280AU	P	13330	930	±10%	2A	B	S	O	-75		2.1	
	S	1435	600	±1%			S	NO	-75		1.5	
							S	O	-75	7.4	7	
							S	R	75	1.6	1.7	
							P	O		0.9		
280AW		2570	25	+15% -10%	1A	B		O	-50		1.1	
								NO	-50		0.8	
								O	-50	13.5	12.8	
								R	50	5.4	5.7	
280AY		1760	13.6	+7.5% -5%	1A	B		O	-75		1.5	
								NO	-75		1.1	
								O	-75	7.6	7.2	
								NO	75	2.5	2.7	
								R	75	1.9	2	

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280BA		1040	5	±5%	1A	B		O	-120		2.6	
								NO	-120		1.9	
								O	-120	8.8	8.3	
								NO	120	2.2	2.4	
								R	120	1.3	1.4	
280BB	P	5862	285	±10%	18A	A	P/S	O	-12	0.6	0.3	
	S	4580	285	±10%			P/S	NO	-12	O.C.	0.2	
	T	4000	3230	±2%			T	O		1.6		
280BC	P	11700	1535	±5%	2A	A	S	O	-32	1.5	0.8	
	S	3900	845	±5%			S	NO	-32	O.C.	0.6	
							P/S	O		0.4		
280BD	P	5862	285	±10%	14A	A	P/S	O	-12	0.6	0.3	
	S	4580	285	±10%			P/S	NO	-12	O.C.	0.2	
	T	4000	3230	±2%			T	O		1.6		
280BE	P	10300	620	±1%	2A	B	P	O	-13		0.3	
	S	3100	640	±1%			P	NO	-13		0.2	
							P	O	-13	1.2	1.1	
							P	R	13	0.2	0.3	
							S	O		3.9		
280BF	P	4340	135	±10%	21A	B	P	O	-30		0.7	
	S1	1630	440	±1%			P	NO	-30		0.5	
	S2	1630	440	±1%			P	O	-30	2.9	2.7	
							P	R	30	0.6	0.7	
							S1	O		7.8		
							S2	O		7.8		
280BG	P	2690	31	±10%	2A	B	P	O	-47		1.1	
	S	2690	1000	±5%			P	NO	-47		0.8	
							P	O	-47	4.6	4.3	
							P	R	47	1	1.1	
							S	O		4.7		
280BH	P1	1800	40	±10%	3A	B	P1	O	-75		1.7	
	P2	1800	40	±10%			P1	NO	-75		1.2	
							P1	O	-75	9.5	9	
							P1	R	75	0.4	0.5	
							P1/P2	O		4.8		
280BJ	P	400	3.7	±10%	2A	B	P	O	-315		7.5	
	S	7625	580	±10%			P	NO	-315		5.5	
							P	O	-315	29	27.5	
							P	R	315	6.2	6.6	
							S	O		1.6		
280BK		10500	595	±10%	1A	B		O	-12		0.3	
								NO	-12		0.2	
								O	-12	4	3.8	
								NO	-12	2.8	3	
								R	12	1.6	1.7	

280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280BL	P	2975	105	±2%	2A	A	P	O	-42	2	1	
	S	2975	105	±2%			P	NO	-42	O.C.	0.7	
							S	O		2		
280BM	P	1330	11	±10%	2A	B	P	O	-95		2.2	
	S	1000	9	±10%			P	NO	-95		1.6	
							P	O	-95	8.2	7.8	
							P	R	95	1.4	1.5	
							S	O		11		
280BN	P	1700	29	±2%	2A	B	P	O	-75		1.7	
	S	2575	200	±1%			P	NO	-75		1.2	
							P	O	-75	7.2	6.8	
							P	R	75	1.7	1.8	
							S	O		4.8		
280BP		9375	365	±10%	1A	B		O	-14		0.3	
								NO	-14		0.2	
								O	-14	3.9	3.7	
								R	14	1.6	1.7	
280BR	P	5700	230	±10%	2A	B	P	O	-22		0.5	
	S	4200	200	±2%			P	NO	-22		0.3	
							P	O	-22	1.9	1.8	
							P	R	22	0.2	0.3	
							S	O		2.7		
280BS	P1	1060	9.5	±10%	3A	A	P1	O	-135	6.1	3.2	
	P2	1060	9.5	±10%			P1	NO	-135	O.C.	2.3	
							P2	O		6.1		
280BT	P1	1060	9.5	±10%	3A	B	P1	O	-135		3.2	
	P2	1060	9.5	±10%			P1	NO	-135		2.3	
							P1	O	-135	11	10.4	
							P1	R	135	2.3	2.5	
							P2	O		11		
280BU	P	7500	525	±1%	2A	A	P	O	-17	0.8	0.4	
	S	2000	230	±1%			P	NO	-17	O.C.	0.3	
							S	O		3		
280BW	P	1460	13	±10%	2A	B	P	O	-85		2	
	S	1270	45	±2%			P	NO	-85		1.4	
							P	O	-85	7.5	7.1	
							P	R	85	1.3	1.4	
							S	O		8.8		
280BY		10650	1000	±10%	1A	B	P	O	-12		0.3	
								NO	-12		0.2	
								O	-12	1.6	1.5	
								R	12	0.5	0.6	

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280CA		10650	1000	±10%	1A	A		O	-12	0.6	0.3	
								NO	-12	O.C.	0.2	
280CB		1615	1000	±5%	1A	B		O	-45		1.8	
								NO	-45		1.3	
								O	-45	20	19	
								NO	45	8	8.5	
280CC	P	6000	360	±2%	2A	B	P	O	-21		0.5	
	S	1500	1450	±2%			P	NO	-21		0.3	
							P	O	-21	2.1	2	
							P	NO	21	0.7	0.8	
							S	O		8.4		
280CD	P	1860	56	±10%	2A	B	P	O	-70		1.5	
	S	29300	30000	±5%			P	NO	-70		1.1	
							P	O	-70	7.2	6.8	
							P	R	70	0.1	0.2	
							P/S	O		0.5		
280CE	P	14600	4000	±2%	18A	B	T	O	-65		1.5	
	S	14600	4000	±2%			T	NO	-65		1.1	
	T	2000	700	±1%			T	O	-65	6	5.7	
							T	R	65	1.4	1.5	
							P	O		0.9		
							S	O		0.9		
280CF		3100	50	±10%	1A	B		O	-40		1	
								NO	-40		0.7	
								O	-40	9.5	9	
								R	40	3.4	3.6	
280CG	P	1850	45	±2%	2A	B	P	O	-70		1.6	
	S	4975	500	±1%			P	NO	-70		1.2	
							P	O	-70	6.7	6.3	
							P	R	70	1.5	1.6	
							S	O		2.6		
280CH		560	2	±15%	1A	B		O	-180		4.3	
								NO	-180		3.1	
								O	-180	44.5	42	
								R	180	13.3	14	
280CJ	P	34000	6500	±10%	2A	B	S	O	-65		1.5	
	S	2000	700	±5%			S	NO	-65		1.1	
							S	O	-65	5	4.7	
							S	R	65	0.9	1	
							P	O		0.4		
280CK	P1	4000	365	±10%	16A	A	P1/P2	O	-16	0.8	0.4	
	P2	4000	365	±10%			P1/P2	NO	-16	O.C.	0.3	
	S	2000	1000	±1%			S	O		3.2		

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280CL	P1	4000	365	±10%	16A	A	P1/P2	O	-16	0.8	0.4	
	P2	4000	365	±10%			P1/P2	NO	-16	O.C.	0.3	
	S	2000	1500	±1%			S	O		3.2		
280CM	P1	4000	365	±10%	16A	A	P1/P2	O	-16	0.8	0.4	
	P2	4000	365	±10%			P1/P2	NO	-16	O.C.	0.3	
	S	2000	2800	±1%			S	O		3.2		
280CN	P1	4000	365	±10%	16A	A	P1/P2	O	-16	0.8	0.4	
	P2	4000	365	±10%			P1/P2	NO	-16	O.C.	0.3	
	S	2000	9500	±1%			S	O		3.2		
280CP	P	4000	100	±2%	2A	B	P	O	-32		0.7	
	S	3100	200	±2%			P	NO	-32		0.5	
							P	O	-32	5.3	5	
							P	NO	32	2.8	3	
							S	O		7.5		
280CR	P	1050	10	±10%	2A	B	P	O	-120		2.8	
	S	4600	350	±1%			P	NO	-120		2	
							P	O	-120	11.6	11	
							P	R	120	2.3	2.5	
							S	O		2.8		
280CS	P	10000	1915	±10%	25	B	P	O	-13		0.3	
	S	10000	1915	±10%			P	NO	-13		0.2	
							P	O	-13	1.1	1	
							P	R	13	O.C.	O.C.	
							S	O		1.1		
280CT	P	9400	500	±10%	5A	B	P//S	O	-40		0.8	
	S	N.I.	295	±5%			P//S	NO	-40		0.6	
	P & S in Par.		185	±8%			P//S	O	-40	9.5	9	
							P//S	NO	-40	6.3	6.7	
280CU		22850	30500	±5%	1A	B		O	-90		7.5	A
								NO	-90		5.5	A
								O	-1.4	0.7	0.6	
								R	1.4	0.1	0.2	
280CW	P	2040	135	±5%	8A	B	P	O	-65		1.5	
	S	11900	15000	±5%			P	NO	-65		1.1	
	T	9890	15500	±5%			P	O	-65	12.6	12	
							P	R	65	3.1	3.3	
							S/T	O		1.3		
280CY	P	3535	50	±10%	6A	B	P//T	O	-85		1.7	
	S	540	100	±10%			P//T	NO	-85		1.2	
	T	N.I.	40	±5%			P//T	O	-85	9	8.5	
	P & T in Par.		22.3	±8%			P//T	R	85	2.4	2.6	
							S	O		28		

Note A: Adjusted with relay shunted by 500$^{\omega}$ ±1 per cent resistance.

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280DA	P1	2635	85	±10%	3A	A	P1	0	-50	2.2	1.1	
	P2	2635	85	±10%			P1	NO	-50	0.C.	0.8	
							P2	0		2.2		
280DB	P	3300	54	±10%	2A	B	P	0	-40		0.9	
	S	3200	6400	±10%			P	NO	-40		0.6	
							P	0	-40	6.9	6.5	
							P	R	40	2.4	2.6	
							S	0		7		
280DC	P	3300	54	±10%	6A	B	P//T	0	-65		1.3	
	S	3200	6400	±10%			P//T	NO	-65		0.9	
	T	N.I.	100	±5%			P//T	0	-65	10.5	10	
	P & T in Par.		35	±8%			P//T	R	65	3.8	4	
							P//T ISW S	0		4.5		
280DD		21370	2100	±10%	1A	B		0	-33		0.7	A
								NO	-33		0.5	A
								0	-6	0.8	0.7	
								R	6	0.2	0.3	
280DE	P	2480	185	±1%	18A	A	P	0	-50	2.4	1.2	
	S	12000	2800	±1%			P	NO	-50	0.C.	0.9	
	T	1000	500	±5%			S	0		0.5		
							T	0		6		
280DF	P	3500	160	±10%	26	B	S	0	-30		0.7	
	S	4500	170	±10%			S	NO	-30		0.5	
	T	7000	3000	±5%			S	0	-30	3.2	3	
							S	R	30	0.8	0.9	
							P	0		4.1		
							T	0		2.1		
280DG	P	3500	160	±10%	27	B	P	0	-36		0.9	
	S	4500	170	±10%			P	NO	-36		0.6	
	T	7000	3000	±5%			P	0	-36	5.6	5.3	
							P	NO	-36	3	3.2	
							S	0		4.5		
							T	0		2.9		
280DH	P	15000	1600	±1%	2A	B	S	0	-23		0.6	
	S	5500	1330	±1%			S	NO	-23		0.4	
							S	0	-23	2.5	2.3	
							S	NO	23	0.6	0.7	
							S	R	23	0.4	0.5	
							P	0		1		

Note A: Adjusted with relay shunted by 500$^{\omega}$ ±1 per cent resistance.

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG.	TURNS	RESISTANCE		WDG. ARR.	BSP FIG.	TEST WDG.	TEST FOR	SOAK MA	TEST MA	READJ. MA	SEE NOTE
280DJ	P	8500	500	±10%	2A	B	P	O	-15		0.3	
	S	3900	250	±10%			P	NO	-15		0.2	
							P	O	-15	1.6	1.5	
							P	R	15	0.3	0.4	
							S	O		3.8		
280DK	A-B	450	1020	±10%	28	B		O	-40		6.3	
	A & B Wdgs. connected							NO	-40		4.7	
	series opposing - resulting							O	-40	60	57	
	in 450 affective turns							NO	40	43	46	
280DL	P	4000	220	±10%	25	A	P	O	-32	1.5	0.7	
	S	4000	220	±10%			P	NO	-32	O.C.	0.5	
							S	O		1.5		
280DM	P	13200	940	±10%	2A	B	S	O	-125		3	
	S	1025	40	±10%			S	NO	-125		2.2	
							S	O	-125	26.5	25	
							S	R	125	9.5	10	
							P/S	O		2.3		
280DN		14930	1100	±10%	1A	B		O	-29		0.6	A
								NO	-29		0.4	A
								O	-9	0.9	0.8	
								R	9	0.1	0.2	
280DP	P1	3000	370 Approx.		23	A	P4	O	-42	2	1	
	P2	3000	370 Approx.				P4	NO	-42	O.C.	0.7	
	P3	3000	370 Approx.				P1	O		2		
	P4	3000	370 Approx.				P2	O		2		
	Four Wdgs.						P3	O		2		
280DR	P	3590	54	±10%	5A	A	P//S	O	-60	2.6	1.2	
	S	N.I.	100	±5%				NO	-60	O.C.	0.9	
	P-S in Mult.		35	±8%								
280DS	P	6155	250	±10%	2A	A	S	O	-65	2.9	1.5	
	S	2015	530	±10%			S	NO	-65	O.C.	1.1	
							P	O		1		
280DT	P1	3000	140	±10%	3A	B	P1/P2	O	-21		0.5	
	P2	3000	140	±10%			P1/P2	NO	-21		0.3	
							P1/P2	O	-21	5.7	5.4	
							P1/P2	R	21	1.7	1.8	
280DU	P	5560	565	±10%	25	B	P/S	O	-12		0.3	
	S	5560	565	±10%			P/S	NO	-12		0.2	
							P/S	O	-12	1.2	1.1	
							P/S	R	12	0.2	0.3	

Note A: Adjusted with relay shunted by 500Ω ±1 per cent resistance.

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280-TYPE RELAY - CODE INFORMATION

CODE	WDG	TURNS	RESISTANCE		WDC ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280DW	P	8300	1210	±5%	17A	A	T	O	-110	5	2.6	
	S	8300	1210	±5%			T	NO	-110	O.C.	1.9	
	T	1150	250	±5%			P	O		0.7		
							S	O		0.7		
280DY	P1	2335	120	±10%	16A	B	P1	O	-55		1.3	
	P2	2335	120	±10%			P1	NO	-55		0.9	
	S	3000	480	±10%			P1	O	-55	5.3	5	
							P1	R	55	1.1	1.2	
							P2	O		5.3		
							S	O		4.2		
280EA	P	2910	75	±10%	2A	B	P	O	-43		1	
	S	2910	80	±10%			P	NO	-43		0.7	
							P	O	-43	8.4	8	
							P	R	43	3	3.2	
							S	O		9.5		
280EB	P	5750	254	±10%	12A	A	S	O	-55	2.2	1.1	A
	S	5750	643	±10%			S	NO	-55	O.C.	0.8	A
	T	5750	828	±10%			P	O		1.		
							T	O		1.		
280EC	P	4200	260	±10%	2A	A	P	O	-30	1.4	0.7	
	S	5300	1850	±1%			P	NO	-30	O.C.	0.5	
							S	O		1.1		
280ED	P	4200	260	±10%	18A	A	P	O	-30	1.4	0.7	
	S	5450	2500	±1%			P	NO	-30	O.C.	0.5	
	T	3760	675	±10%			S	O		1.1		
							T	O		1.6		
280EE	P	3300	54	±10%	2A	B	P	O	-40		0.9	
	S	2375	3000	±10%			P	NO	-40		0.6	
							P	O	-40	4.2	4	
							P	R	40	1.2	1.3	
							S	O		6		
280EF	P	2730	80	±5%	29	A	P	O	-45	2.2	1.1	
	S	2800	400	±10%			P	NO	-45	O.C.	0.8	
	T	2800	400	±10%			S	O		2.2		
							T	O		2.2		
280EG	P	8000	1150	±10%	2A	A	P	O	-16	0.7	0.4	
	S	8000	1150	±10%			P	NO	-16	O.C.	0.3	
							S	O		0.7		
280EH	P	2060	30	±10%	2A	B	P	O	-60		1.4	
	S	13975	16500	±5%			P	NO	-60		1	
							P	O	-60	6.6	6.2	
							P	R	60	1.6	1.7	
							P/S	O		1.1		

Note A: Adjusted with relay shunted by 500Ω ±1 per cent resistance.

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280-TYPE RELAY - CODE INFORMATION												
CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280EJ	P	1000	7.4	±10%	2A	B	P	O	-125		3	
	S	453	1.9	±10%			P	NO	-125		2.2	
							P	O	-125	12.5	11.9	
							P	R	125	0.1	0.2	
							S	O		28		
280EK	P	1100	6.9	±10%	2A	B	P	O	-115		2.8	
	S	338	1.9	±10%			P	NO	-115		2	
							P	O	-115	11.6	11	
							P	R	115	0.1	0.2	
							S	O		38		
280EL	P	1000	7.4	±10%	2A	B	P	O	-125		3	
	S	870	7.4	±10%			P	NO	-125		2.2	
							P	O	-125	12.6	12	
							P	R	125	0.1	0.2	
							S	O		14.5		
280EM	P	625	4	±10%	2A	B	P	O	-200		4.8	
	S	3800	90	±10%			P	NO	-200		3.5	
							P	O	-200	55	52	
							P	NO	200	28.5	30	
							P	R	200	19	20	
							S	O		9.2		
280EN	P	1170	79	±10%	2A	B	P	O	-110		2.5	
	S	16530	1860	±10%			P	NO	-110		1.8	
							P	O	-110	45.5	43	
							P	R	110	17	18	
							P/S	O		3.4		
280EP	P	4940	365	±10%	2A	B	P	O	-25		0.6	
	S	18630	16650	±5%			P	NO	-25		0.4	
							P	O	-25	6.3	6	
							P	R	25	2.2	2.4	
							P/S	O		1.5		
280ER	P	2540	95	±10%	24	A	P	O	-50	2.3	1.2	C
	S	2540	95	±10%			P	NO	-50	O.C.	0.9	
	T	12700	3600	±2%			S	O		2.3		
							T	O		0.5		
280ES	P	8400	860	±1%	2A	A	S	O	-30	1.4	0.7	
	S	4200	475	±1%			S	NO	-30	O.C.	0.5	
							P	O		0.7		
280ET	P	1510	21.5	±2%	2A	A	P	O	-85	3.9	2	
	S	6900	1200	±1%			P	NO	-85	O.C.	1.4	
							S	O		0.9		

Note C: Use only where tungsten contact metal is required.

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280-TYPE RELAY - CODE INFORMATION												
CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280EU	P	1860	30	±10%	2A	B	P	O	-68		1.6	
	S	3000	300	±2%			P	NO	-68		1.2	
							P	O	-68	6.9	6.5	
							P	R	68	1.4	1.5	
							S	O		4.4		
280EW	P	4300	185	±10%	18A	B	P	O	-29		0.7	
	S	4800	1700	±1%			P	NO	-29		0.5	
	T	2520	600	±10%			P	O	-29	2.9	2.7	
							P	R	29	0.6	0.7	
							S	O		2.7		
							T	O		5		
280EY	P	4800	300	±1%	2A	B	P	O	-27		0.6	
	S	5000	1350	±1%			P	NO	-27		0.4	
							P	O	-27	2.6	2.4	
							P	R	27	0.5	0.6	
							S	O		2.5		
280FA	P	5600	900	±2%	18A	B	P	O	-23		0.5	
	S	6100	2500	±1%			P	NO	-23		0.3	
	T	4850	800	±10%			P	O	-23	2.3	2.1	
							P	R	23	0.4	0.5	
							S	O		2.1		
							T	O		2.7		
280FB	P1	2500	95	±10%	3A	A	P1	O	-50	2.3	1.2	
	P2	2500	95	±10%			P1	NO	-50	O.C.	0.8	
							P2	O		2.3		
280FC	P1	3080	175	±10%	16A	A	P1	O	-40	1.9	1	C
	P2	3080	175	±10%			P1	NO	-40	O.C.	0.7	
	Sec	3000	1145	±1%			P2	O		1.9		
							S	O		2		
280FD	P	3300	54	±10%	2A	B	P	O	-40		0.9	
	S	6350	3000	±5%			P	NO	-40		0.6	
							P	O	-40	9	8.5	
							P	R	40	2.8	3	
							S	O		4.8		

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Note C: Use only where tungsten contact metal is required.

CODE	WDG	TURNS	RESISTANCE		WDG ARR	BSP FIG.	TEST WDG	TEST FOR	SOAK MA	TEST MA	READJ MA	SEE NOTE
280FE	P	5750	254	±10%	18A	A	S	O	-55	2.2	1.1	A
	S	5750	643	±10%			S	NO	-55	0.C	0.8	A
	T	5750	828	±10%			P	O		1.		
							T	O		1.		
280FF	P	1050	10	±10%	2	A	P	O	-120	5.2	2.8	
	S	32125	8600	±1%			P	NO	-120	0.C	2.0	
							S	O		0.2		
280FG	P	8900	375	±10%	1A	B		O	-14		0.3	B
								NO	-14		0.2	B
								O	-14	3.9	3.7	
								R	14	1.4	1.5	
280FH	P	34000	5900	±10%	2A	B	P	O	-55		1.	A
	S	25	0.104	±15%			P	NO	-55		0.7	A
							P	O	-4	0.4	0.3	
							P	R	4	0.C	0.C	
							S	O		500		
280FJ	P	2080	130	±10%	2A	A	P	O	-60	2.8	1.4	
	S	24400	3060	±10%			P	NO	-60	0.C	1.	
							S	O		0.3		
280FK	P	(U)21900	4000	±10%	2A	B	P	O	-60		1.1	A
							P	NO	-60		0.8	A
	S	(U)19100	4000	±10%			P	O	-6	1.7	1.6	
							P	R	6	0.5	0.6	
							S	O		2		
280FM	P	(L) 3700	110	±2%	2A	B	P	O	-34		0.8	
							P	NO	-34		0.6	
	S	(L) 3950	550	±1%			P	O	-34	3.3	3.1	
							P	R	34	0.7	0.8	
							S	O		3.1		
280FN	P	10400	1100	±10%	18A	B	P	O	-12		0.3	
							P	NO	-12		0.2	
	S	10350_{-0}	1100	±10%			P	O	-12	1.2	1.1	
							P	R	12	0.2	0.3	
	T	3200	3700	±1%			S	O		1.2		
							T	O		3.9		

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Note A: Adjusted with relay shunted by 500 ±1 per cent resistance.
Note B: Equipped with permalloy shells next to core.

BELL TELEPHONE LABORATORIES, INC.

Attached: Appendix 1

APPENDIX 1

DESIGN OF CAPACITANCE-TIMED POLAR RELAY CIRCUITS

General

This appendix is written to provide information for the engineering of capacitance-timed relay circuits using the 280-type relay. This type of circuit generally uses the 280A or the 280AN relay. For operate times less than 100 milliseconds the 280AN provides somewhat greater accuracy. For times greater than 100 milliseconds the 280A is always used.

This information is presented in graphical form in such a way that for any selection of circuit constants, the minimum nominal, and maximum operate times can be easily determined. This information provides the optimum set of circuit constants for obtaining a given time delay, and the loss in accuracy resulting from failure to adhere to the optimum values is clearly indicated. This information can be applied directly by the circuit designer without recourse to further tests.

A capacitance-timed relay circuit consists of a 280A or 280AN polar relay having its two windings differentially connected as shown on Figs. 1 to 7, inclusive. The primary, in the past called the biasing winding, is connected in series with a resistor R1 and tends to operate the relay to the left or front contact. The secondary winding, is connected in series with a timing circuit consisting of a capacitance C in series with a discharge resistor of approximately 200 ohms. The secondary winding may also be connected in series with an additional resistor R2 in cases where the desired time delay cannot be obtained from a given value of capacitance.

Normally, the timing circuit is short-circuited, and the relay is therefore held against the right or back contact by the greater energization in the secondary winding. When the short circuit is removed, the current through the secondary winding decreases logarithmically as the capacitance charges, allowing the relay to operate to the left contact after a prescribed time delay.

Description of Data

The data were obtained from laboratory tests of timing circuits in which the constants were varied, assuming the following liminations:

(a) Relay adjustment deterioration from READJUST requirements of operate 3NI and nonoperate 2NI, to TEST requirements of operate 6NI and nonoperate on open circuit after a negative soak.

(b) Voltage limits of 45 to 50 volts (voltage variations within these limits have practically negligible effects on the time delay).

(c) Variations of ± 1 per cent for the capacitance, relay winding resistances, and resistors R1 and R2.

(d) Exact turns for the relay windings.

(e) Limits for the R1 resistor were set at 300 to 6200 ohms and for the R2 resistor at 0 to 4000 ohms. R2 resistors of 500, 1000, 2000, and 4000 were used in our tests.

(f) Capacitances used in our tests varied from 4.32 MF to 51.84 MF, inclusive, in multiples of 4.32 MF. The latter capacitance is the largest precision-type paper condenser commonly used in capacitance-timed polar relay circuits.

Construction of Graphs

The graphs are plotted on Figs. 1, 2, 3, 4, 5, and 6 showing:

(a) Relation of minimum operate time to open right contact (abscissae) and bias resistance R1 (ordinate) for various values of capacitance.

(b) Per cent that must be added (abscissae) to the minimum time to obtain the maximum time in relation to the bias resistance R1 (ordinate).

(c) Lowest variation between the minimum and maximum times (horizontal broken line).

Figs. 1 and 2 apply to the 280A and 280AN relays, respectively, and to circuits not provided with the R2 resistor. Figs. 3, 4, 5, and 6 apply to the 280A relay only, using circuits provided with an R2 resistor as shown on each sketch.

Fig. 7 shows the travel times of the 280A and 280AN relays that are associated with the minimum time to open the right

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contact. This travel time must be added to the minimum time when the time to close the left contact is required.

Use of Graphs

The minimum time is generally specified in terms of time to open the right contact and the graphs shown on the attached sketches are based on this time. If the time to close the left contact is required, obtain armature travel time from Fig. 7.

When a minimum time delay is required, obtain the circuit constants from graphs shown on Fig. 1 through 6 as follows:

(1) Read optimum capacitance required from intersection of the minimum time ordinate with the capacitance graph, using intersection closest to horizontal line marked "Lowest variation Between Minimum and Maximum Times." A lower capacitance can be used if a higher time variation is permissible.

(2) Read bias resistance R1 (vertical scale) by projecting point of intersection obtained in Item 1 horizontally to the right.

(3) Read per cent time variation on bottom scale by projecting point of intersection obtained in Item 1 horizontally until it intercepts the "Per Cent Time Variation" curve and then vertically to the per cent scale.

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Sample Calculations

Design timing circuit for minimum time of 0.060 second to open right contact with smallest time variation.

From Fig. 1 find that when t = .060 sec.
Capacitance C = 12.96 MF ± 1 per cent
Bias Resistance R1 = 1600 ohms ±1per cent
Per cent time variation = 15.5 per cent
Max. time to open right contact = .060 (1 + 0.155) = 0.070 sec.

Design timing circuit for minimum time of 0.012 seconds to close left contact with smallest time variation.

From Fig. 7 travel time = 0.002 sec. and min. time to open right contact = 0.010 sec.
From Fig. 2 find that when t = 0.010 sec.
Capacitance C = 4.32 MF ± 1 per cent
Bias resistance R1 = 600 ohms ±1 per cent
Per cent time variation = 11 per cent
Max. time to close left contact = 0.010 (1 + 0.11) + 0.002 = 0.013 sec.

Design timing circuit for minimum time of 0.5 second to open right contact and for time variation not to exceed 35 per cent.

From Fig. 6 find that when t = 0.5 sec.
Capacitance C = 43.2 MF ± 1 per cent.
Bias resistance R1 = 5000 ohms ±1 per cent.
Per cent time variation = 32 per cent
R2 resistor in series with sec. winding = 4000 ohms
Max. time to open right contact = 0.5 (1 + 0.32) = 0.66 sec.

Supplementary Notes

(a) It will be noted that the optimum bias resistance R1 for the 280A relay is greater than 1800 ohms and for the 280AN relay approximately 800 ohms. This is fortunate since the relay heating from the bias winding will be insignificant.

(b) If energization time is great or the bias resistance is low, it may be necessary to apply a further delay-time correction for heating. This can be done by estimating the resistance rise in the usual manner and interpolating the new relay winding resistances to the curves.

(c) It will be also observed that there is an optimum value of capacitance for the required time delay. Use of greater capacitance than this will be uneconomical and will increase the time variation. Use of lower capacitance will lower the cost of the circuit, but will increase the time variation.

(d) The R2 resistor must be equal to zero for least time variation. Therefore, this resistor should be used only to design an economical circuit with the realization that the time variation is increased.

(e) The 280AN relay (Fig. 2) should be used only for very short time delays demanding small time variations. For longer time delays it requires more than twice as much capacitance as the 280A relay which was especially designed for this type of circuit. The energization time and the frequency of operation per busy hour for this relay should be small, otherwise, time corrections for heating must be considered.

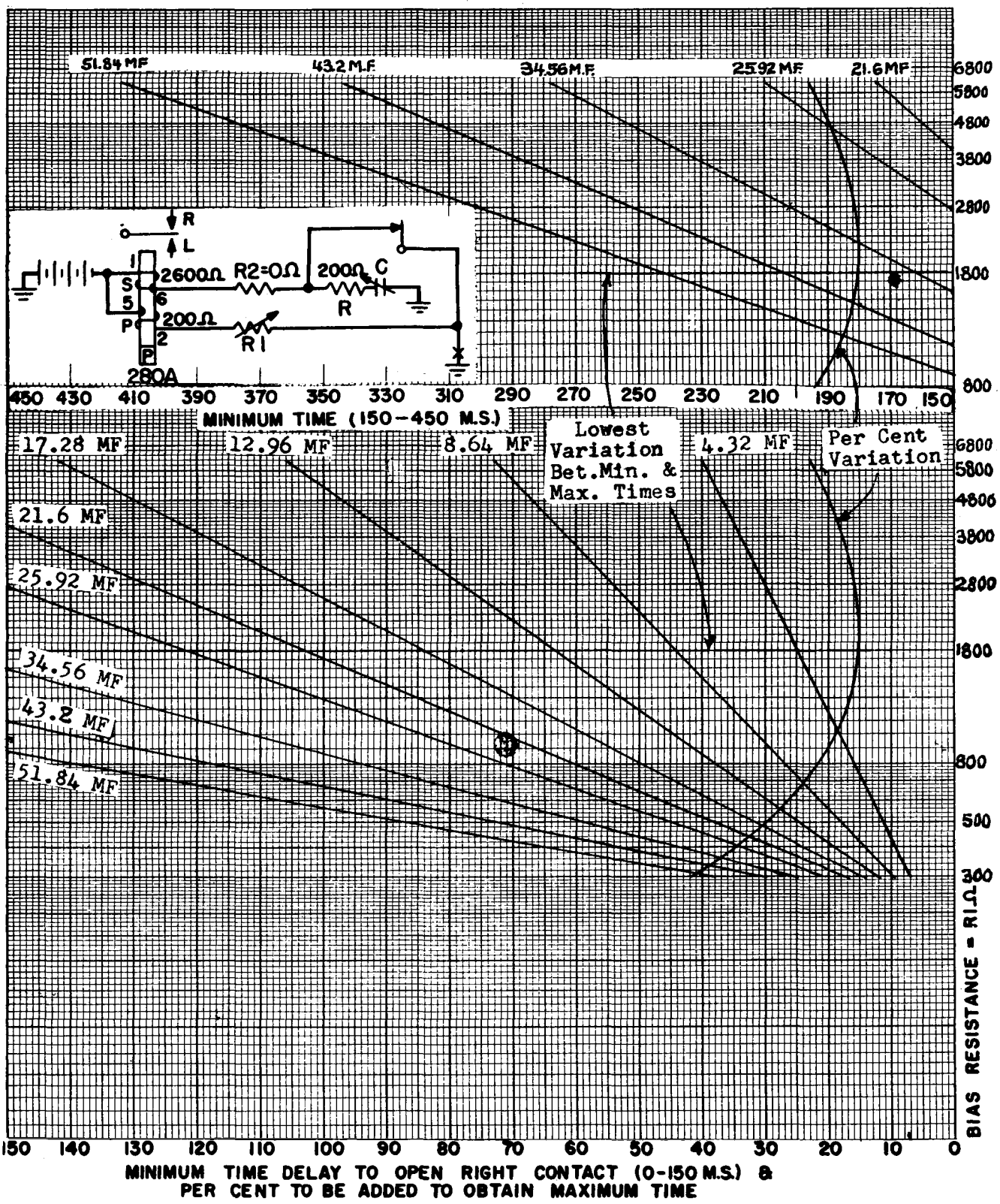

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Fig 1 - Circuit Constants For 280A Polar Relay Time Delay When R2=0

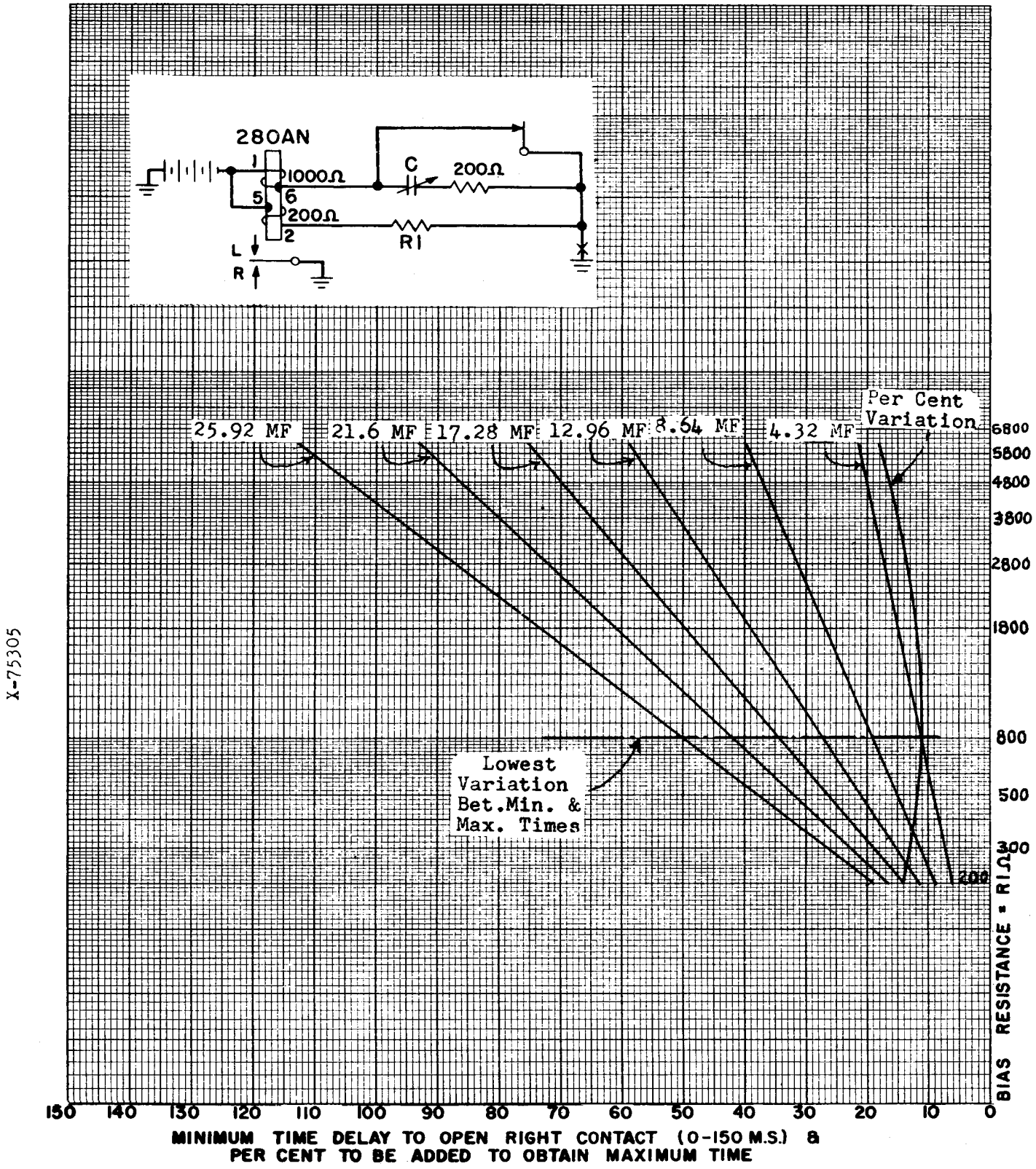

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Fig. 2 - Time Constants For 280AN Polar Relay Time Delay When R2 = 0

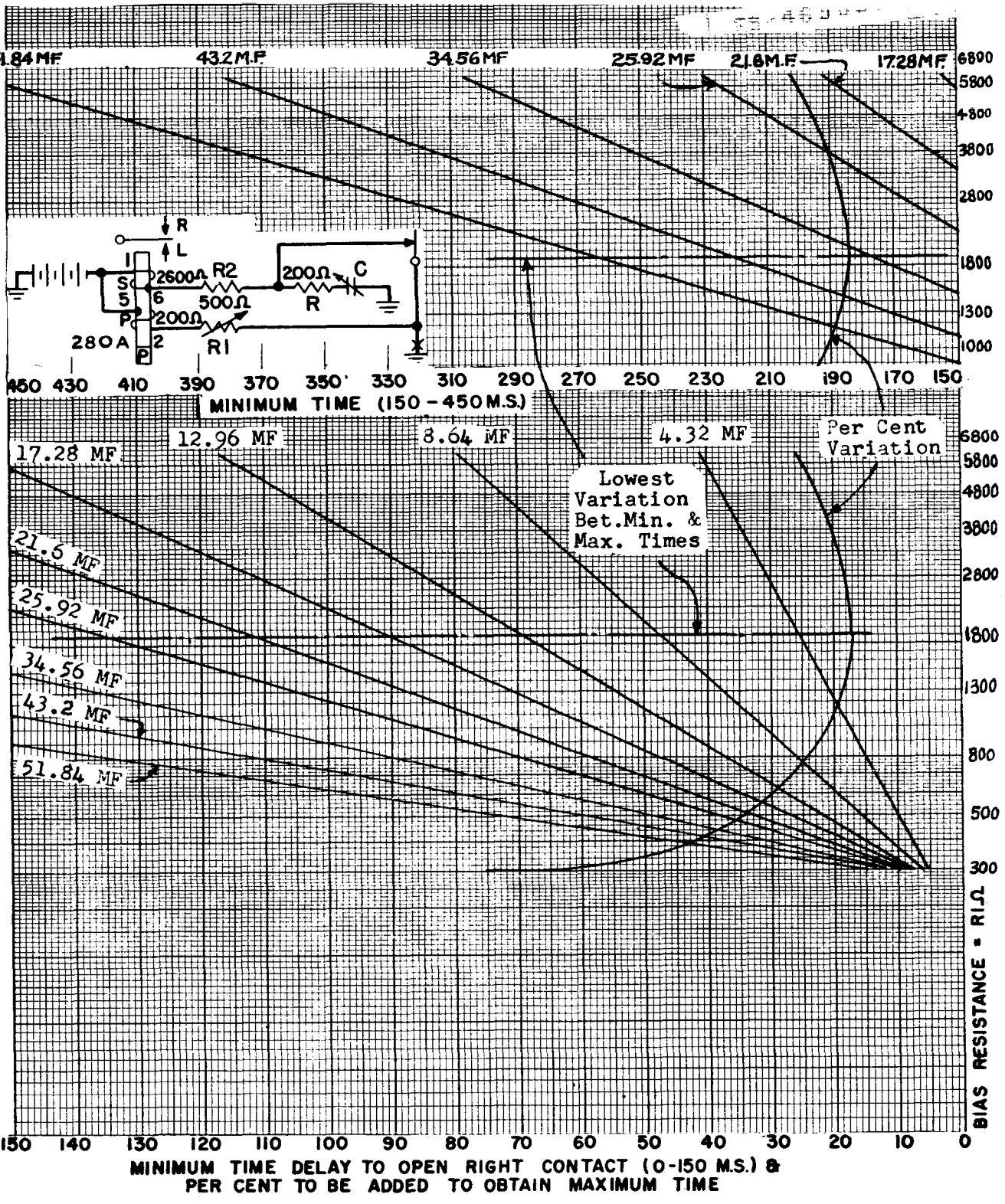

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Fig. 3 - Circuit Constants For 280A Polar Relay Time Delay When R2 - 500 Ohms

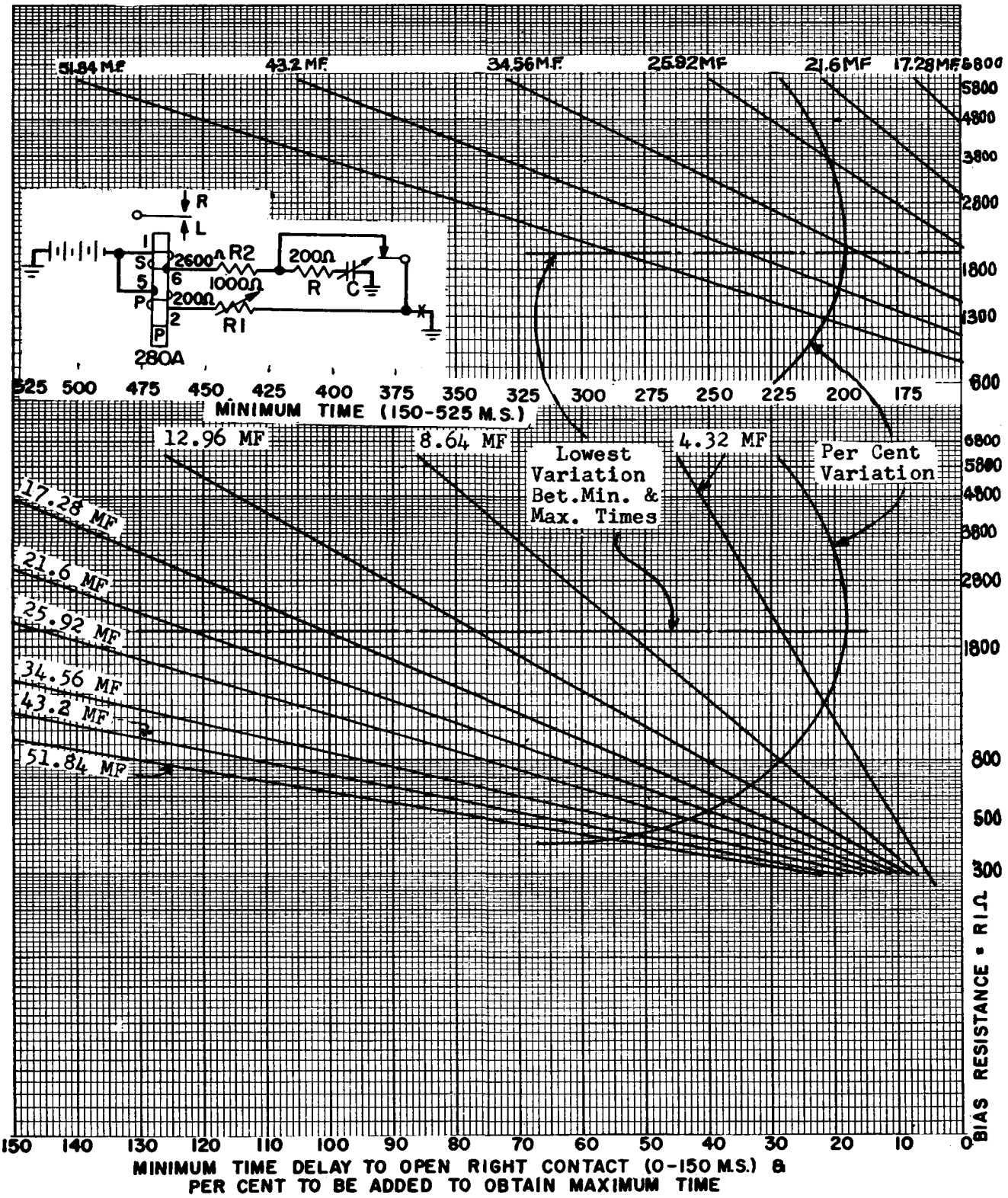

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Fig. 4 - Circuit Constants For 280A Polar Relay Time Delay When R2 = 1000 Ohms

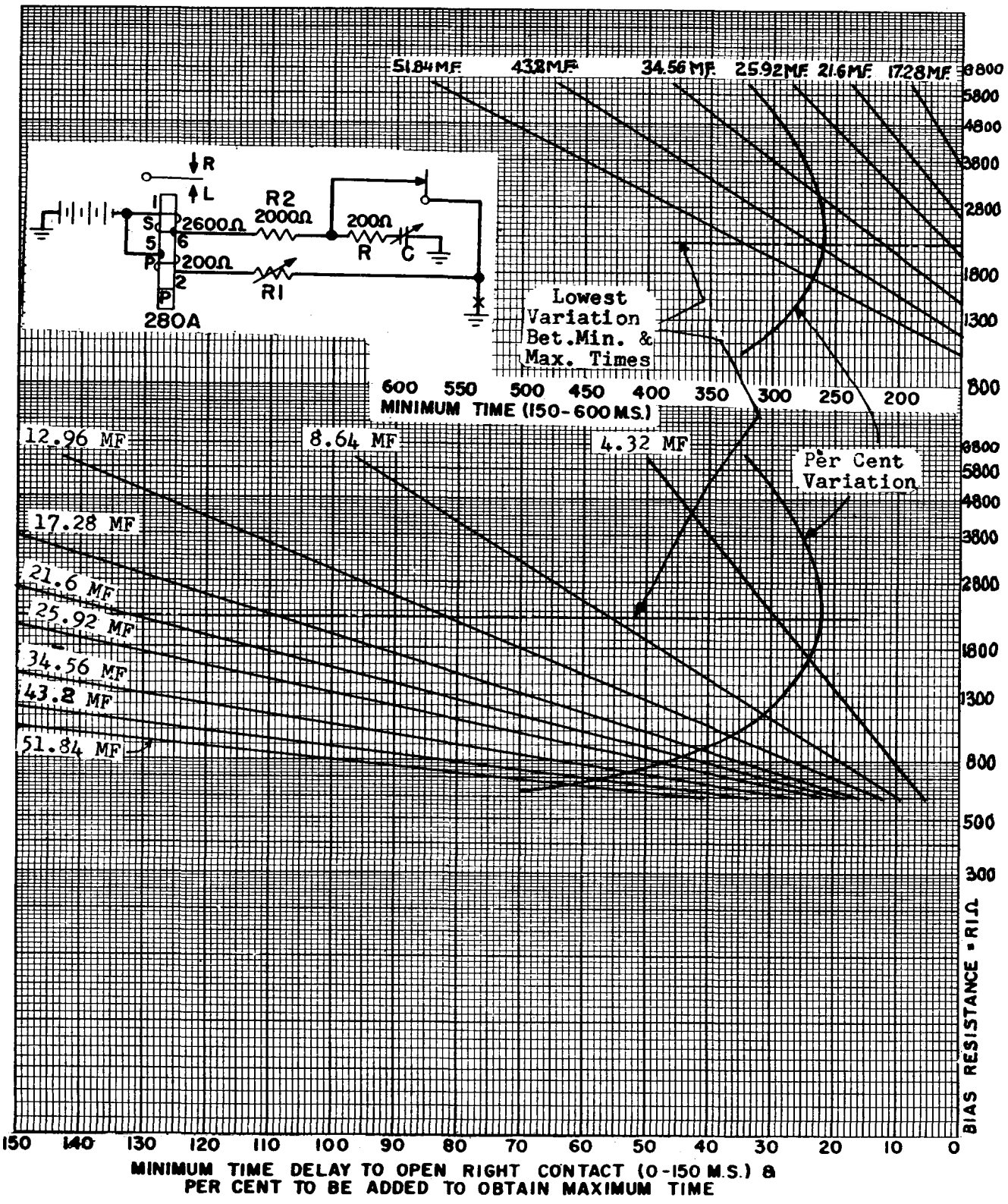

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Fig. 5 - Circuit Constants For 280A Polar Relay Time Delay When R2 = 2000 Ohms

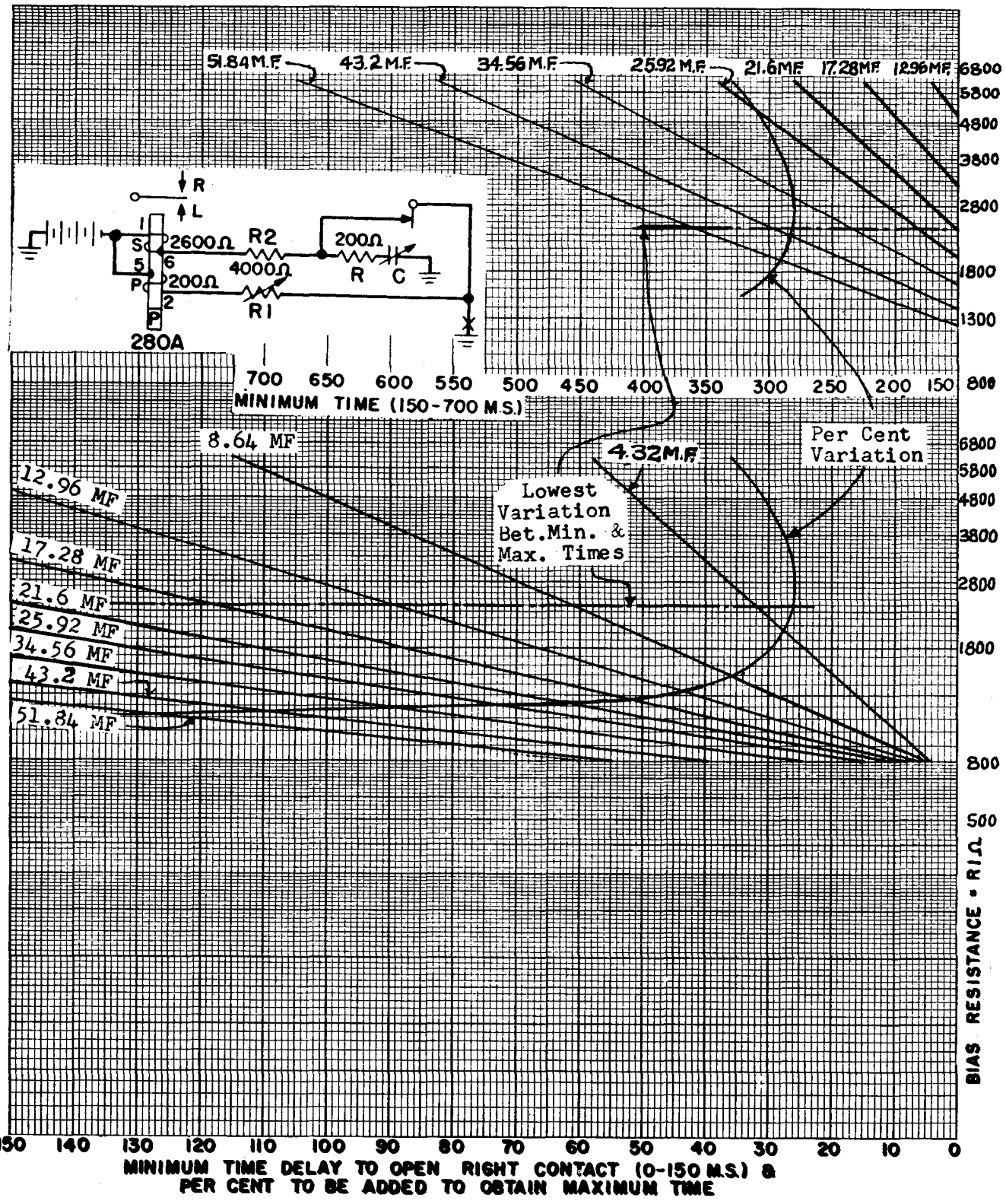

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Fig. 6 - Circuit Constants For 280A Polar Relay Time Delay When R2 - 4000 Ohms

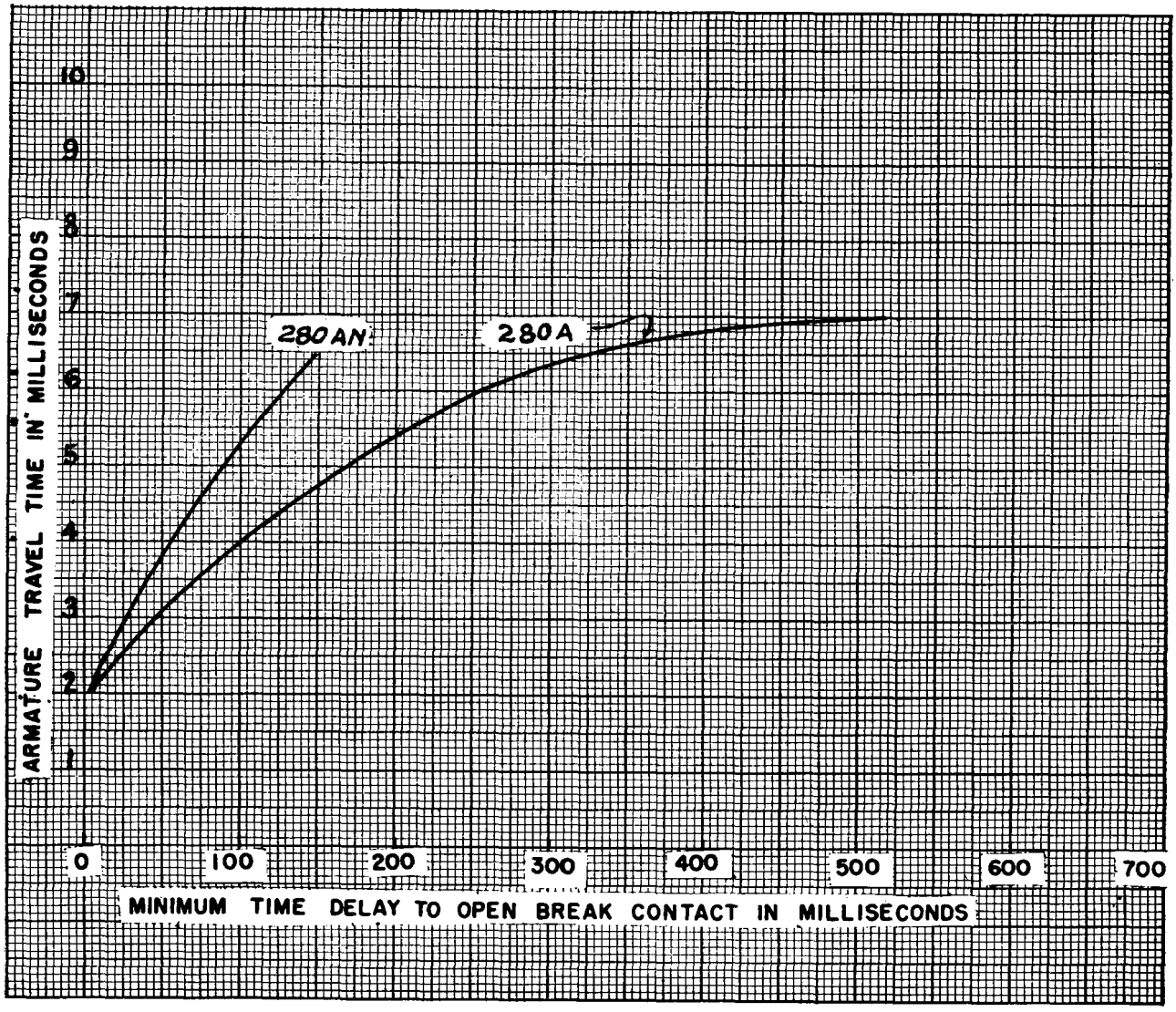

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Fig. 7 - Travel Time of 280A or 280AN Relay Armature To Open Right Contact and Close Left Contact