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NAVAL RESEARCH LABORATORY REPORT

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TEST OF "AGASTAT" TIME DELAY RELAY AND COMPARISON WITH TYPE "PQ" TIME DELAY RELAY

By
R. B. Meyer
C. C. Dresser

Report No. RE-1007

NAVY DEPARTMENT
OFFICE OF NAVAL RESEARCH
NAVAL RESEARCH LABORATORY
WASHINGTON 20, D. C.

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BUREAU OF ENGINEERING

REPORT ON

Test of "Agastat" Time Delay Relay and Comparison with Type "PQ" Time Delay Relay.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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Date of Test: Tests conducted October 30, 1933 to November 13, 1933.

Reported by: R.B. Meyer, Assoc.Radio Engr. O.C. Dresser, Asst.R.Engr.

Approved by: H.R. Greenlee, Captain, USN, Director.

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TABLE OF CONTENTS

APPENDICES

AUTHORIZATION:

1. The test of the "Agastat" Time Delay Relay manufactured by the American Gas Accumulator Company was authorized by the Bureau of Engineering on 6 September 1933; letter file No. S67/24/L5(9-2-W8) to the Director, Naval Research Laboratory, Bellevue, D.C.

OBJECT:

2. The object of the test was to determine:

(a) The suitability of the "Agastat" relay for Naval use.

(b) The effects of temperature variations upon the operation of the relay.

(c) The operational characteristics of the "Agastat" relay as compared to devices of a similar nature when subjected to at least 5,000 breaks while carrying full rated load.

(d) The mechanical suitability of the relay and what improvements were deemed desirable or necessary.

3. The performance of the materials under test may be summarized as follows:

(a) The "Agastat" relay functioned satisfactorily over a range of temperatures of 3° Centigrade to approximately 35° Centigrade. At temperatures in excess of 35° Centigrade the relay ceased to function.

(b) The General Electric Company Type "PQ" relay, when subjected to the same operating conditions as the "Agastat" relay, functioned successfully over a range of temperatures of 2° Centigrade to 50.4° Centigrade.

(c) Note: Due to the limitations of the refrigerating system used in these tests a temperature of 0° Centigrade could not be obtained.

4. In view of the test results it may be concluded that:

(a) The "Agastat" relay in the form in which it was submitted is not suitable for Naval use in locations where the ambient temperature may exceed 35° Centigrade.

(b) The Type "PQ" relays, manufactured by the General Electric Company, operate successfully at temperatures between the limits of 2° Centigrade and 50° Centigrade.

(c) It may be assumed that both the "Agastat" and the "PQ" relays will function successfully at temperatures down to 0° Centigrade since no signs of failure were detectable when operating at temperatures of 2 or 3° Centigrade.

RECOMMENDATIONS

In view of the facts determined from this test it is recommended that the Bureau withhold approval of the "Agastat" relay for use in Naval radio transmitting equipment.

MATERIALS UNDER TEST:

5. The materials under test were a sample "Agastat" time delay relay manufactured by the American Gas Accumulator Company and a type "PQ" relay manufactured by the General Electric Company.

METHOD OF TEST:

6. The "Agastat relay was subjected to a careful inspection and the following facts were noted:

(a) The relay is of rugged and compact construction and is of the following outside dimensions:

Width - 2-1/2"
Depth - 2-1/2"
Height - 5"

The appended photograph, Plate No. I, illustrates the details of construction and affords an opportunity to compare the "Agastat" relay with the type "PQ" relay.

(b) The contacts of the "Agastat" relay are of silver and are of sufficient size to carry the rated current (6 amperes) without heating. This was determined from the fact that no contact trouble was experienced during the test in which the load circuit was broken 5,698 times.

(c) The relay case is of steel, as are also the mounting studs and coil supports. The exterior of the case was finished with a coating of baked crystalline lacquer. The interior of the case had no protective coating and showed some signs of rust. The various parts of the assembly are, in general, riveted together which precludes the possibility of removing the relay coil for repair without considerable difficulty. The contacts, however, can be removed readily for replacement.

(d) The gas chamber is of brass while the flexible membrane appears to be treated leather, or some special fabric closely resembling leather. The timing of the relay is not adjustable after it is received from the manufacturer.

(e) No lock washers are used in the assembly of the relay, nuts with fibre inserts being substituted therefor. Experience has indicated that the fibre insert nuts may remain tight if the initial adjustment is not disturbed, but if it becomes necessary to remove and replace the nut, then the friction between the nut and the screw is materially lessened and the nut will not remain tight under vibration. Hence, the fibre insert nut is not considered a satisfactory substitute for lock washers on connection studs and other parts which may require removal.

7. The circuits illustrated in Plate II show in detail the means and methods used to test the relays. The relays themselves and a portion of the associated equipment were placed in a thermostatically controlled cabinet. The load circuits, magnetic counter and such other portions of the equipment as were not actually under test were mounted outside of the temperature controlled cabinet.

8. Table No. 1, appended hereto, is a record of the test of the "Agastat" relay. In this test a "PQ" relay was used to break the coil circuit of the "Agastat" relay and a load circuit was so connected as to cause the contacts of the "Agastat" relay to break the full rated load of 6 amperes. The timing feature of the "PQ" relay was not utilized. The timing was checked accurately every thirty minutes by means of a solenoid operated plunger in conjunction with a stop watch. Reference to Table No. 1 shows that the "Agastat" relay functions satisfactorily between the ambient temperatures of 3° and 35° Centigrade. At 36° Centigrade, and above, the relay failed to make contact. This failure is attributed to the fact that as the temperature rose the expansion of the gas increased to the point where the power of the solenoid plunger was insufficient to cause the contacts to close against the pressure of the expanded gas.

9. A similar test was conducted with a General Electric type "PQ" time delay relay, using the contacts of a second "PQ" relay to break the coil circuit of the relay under test. The timing was set at 20 seconds and the contacts were caused to break the full rated load current (5 amperes). The record of this test is shown in Table No. 2 appended hereto. No contact trouble was experienced during the test during which the contacts were opened 5447 times. It will be noted that the timing cycle gradually increased to 27.2 seconds. After the completion of the test, the "PQ" relay was examined in an effort to determine the cause for the increase in the timing cycle. A small quantity of light lubricating oil was applied to the toggle joints and to the plunger. After this treatment it was found that the timing cycle returned to its original value of approximately 20 seconds.

DATA RECORDED:

10. The data recorded during the test is appended hereto as Tables No. 1 and No. 2. Table No. 1 covers the test of the "Agastat" relay and the ambient temperature, the timing cycle and the number of breaks occurring at the relay contacts are recorded at thirty minute intervals. Table No. 2 covers similar data with respect to the type "PQ" relay.

DISCUSSION OF PROBABLE ERRORS IN RESULTS:

11. All practicable precautions were taken to eliminate errors from the results of the test. The timing cycle was checked by means of an electrically operated plunger actuating a stop watch. Thermometers, whose calibrations had been checked, were

used for determining the ambient temperature. A magnetic counter was used to record the number of breaks made by the relay contacts and an accurate ammeter was used to adjust the load broken by the relay contacts. When it was discovered that the "Agastat" relay ceased functioning at 36° Centigrade, several checks were made at this temperature in order to verify the results.

RESULTS:

12. The results of the test indicate that the "PQ" relay is much more flexible in its applications than the "Agastat" relay. The timing of the "PQ" relay is adjustable within wide limits. It can be connected either front or back contact and can be made to work time delay either with current on or off. Further, it can readily be disassembled for cleaning and repair.

13. The Laboratory has no information with respect to the cost of the "Agastat" relay, hence no comparison can be made on this basis.

14. The paramount objection to the "Agastat" relay lies in the fact that at temperatures in excess of 36° Centigrade the relay ceases to function. Since temperatures on board ship very frequently exceed 36°, especially in the confined space within a radio transmitter, it is felt that this defect alone is sufficient to prevent the use of the "Agastat" relay for Naval use.

15. If the membrane used in the "Agastat" were punctured, gas would escape and make the relay inoperative. In the case of the "PQ" design a puncture would cause only a temporary disablement since there is no gas to escape and repairs may be effected through the use of glue or cement.

16. A feature in favor of the "Agastat" construction is its small size which would permit its being mounted in more restricted locations than is possible with the "PQ" relay.

17. The "Agastat" relay is capable of only one speed of operation, that for which it is adjusted at the time of manufacture. Furthermore, the "Agastat" functions only as a time delay closing relay. In comparison the "PQ" relay when fitted with a universal contact head is capable of time delay opening, time delay closing, or for use as a bus transfer switch. With a slight modification to the contacting arm, two isolated circuits may be controlled simultaneously.

DISCUSSION:

18. It is believed that if the "Agastat" relay could be modified in such a manner as to permit it to operate successfully at temperatures of 50° Centigrade or higher, it could find a useful application in the Naval Service. It should be pointed out that for certain types of operation it may be desirable to provide a relay where the time cycle could not be re-adjusted or tampered with once the initial adjustment has been fixed. For such types of service the "Agastat" relay would possess distinct advantages.

TABLE NO. 1

TEST RECORD OF "AGASTAT", 110 VOLT, 60 CYCLE, TIME DELAY RELAY.
TIMING - 20 SECONDS. CONTACTS BREAKING 6 AMPERES.

Time	Ambient Temperature Degrees C	Time Cycle Seconds	Number of Breaks
	(30 October 1933)		
0900	19.2	20.8	0
0930	8.2	20.4	95
1000	5.2	18.6	187
1030	4.0	19.3	301
1100	3.5	18.8	369
1130	3.2	19.0	464
1200	3.1	19.5	558
1230	3.0	18.9	657
1300	3.2	18.6	756
1330	3.2	19.0	864
1400	3.4	19.6	937
1430	3.4	19.9	1026
1500	3.5	19.8	1115
1530	3.7	20.8	1213
1600	3.7	20.6	1318
1630	3.7	19.1	1390
	(31 October 1933)		
0900	6.8	19.8	1399
0930	6.1	20.1	1487
1000	4.9	20.6	1571
1030	4.5	20.6	1660
1100	4.2	19.6	1749
1130	4.1	20.6	1845
1200	4.1	20.3	1941
1230	4.1	21.3	2036
1300	8.4	23.0	2111
1330	11.8	24.8	2146*
1400	15.7	21.4	2214
1430	17.5	21.1	2300
1500	18.0	22.0	2383
1530	20.3	23.1	2461
1600	21.3	20.9	2544
1630	22.2	21.0	2624

*Cleaned "PC" relay contacts.

TABLE NO. 1 (cont'd)

Time	Ambient Temperature Degrees C	Time Cycle Seconds	Number of Breaks
	(1 November 1933)		
0930	26.0	20.6	2712
1000	30.0	21.2	2796
1030	31.1	22.5	2881
1100	32.0	22.8	2960
1130	32.2	22.9	3052
1200	32.4	22.0	3120
1230	33.0	21.4	3202
1300	33.4	20.6	3286
1330	33.6	20.5	3373
1400	34.0	21.1	3463
1430	34.2	20.8	3546
1500	34.7	21.3	3648
1530	34.5	21.1	3717
1600	35.2	21.6	3799
1630	36.4		3826*
	*Agastat failing to make regular contact.		
	(2 November 1933)		
0930	26.3	19.4	3873
1000	27.0	19.4	3975
1030	27.1	20.0	4053
1300	31.5	19.7	4064
1330	31.6	19.1	4135
1400	31.5	20.3	4231
1430	33.3	21.0	4311
1500	32.9	21.6	4408
1530	34.0	21.6	4494
1600	33.5	21.9	4567
1630	33.6	21.0	4659

TABLE NO. 1 (cont'd)

Time	Ambient Temperature Degrees C	Time Cycle Seconds	Number of Breaks
		(3 November 1933)	
0900	25.6	18.0	4663
0930	33.2	19.8	4749
1000	32.0	20.4	4836
1030	33.6	20.8	4934
1100	34.0	19.7	5017*
1130	34.5	19.9	5090**
1200	36.0	19.8	5140
1230	37.1		5207***
1300	36.4		5212#
1330	35.6	20.3	5302
1400	35.2	20.5	5383
1430	35.5	20.5	5465
1500	36.2	20.1	5555
1550	35.8	19.3	5641
1600	37.0		5658##
1630	36.5		5698###

The increase in the number of breaks between 1600 and 1630 was due to opening cabinet door and permitting relay to cool.

* PQ contacts sticking at times.
** Cleaned PQ contacts.
*** Agastat failing to make regular contact.
\# 5 breaks in 30 minutes.
17 breaks in 30 minutes.
40 breaks in 30 minutes.

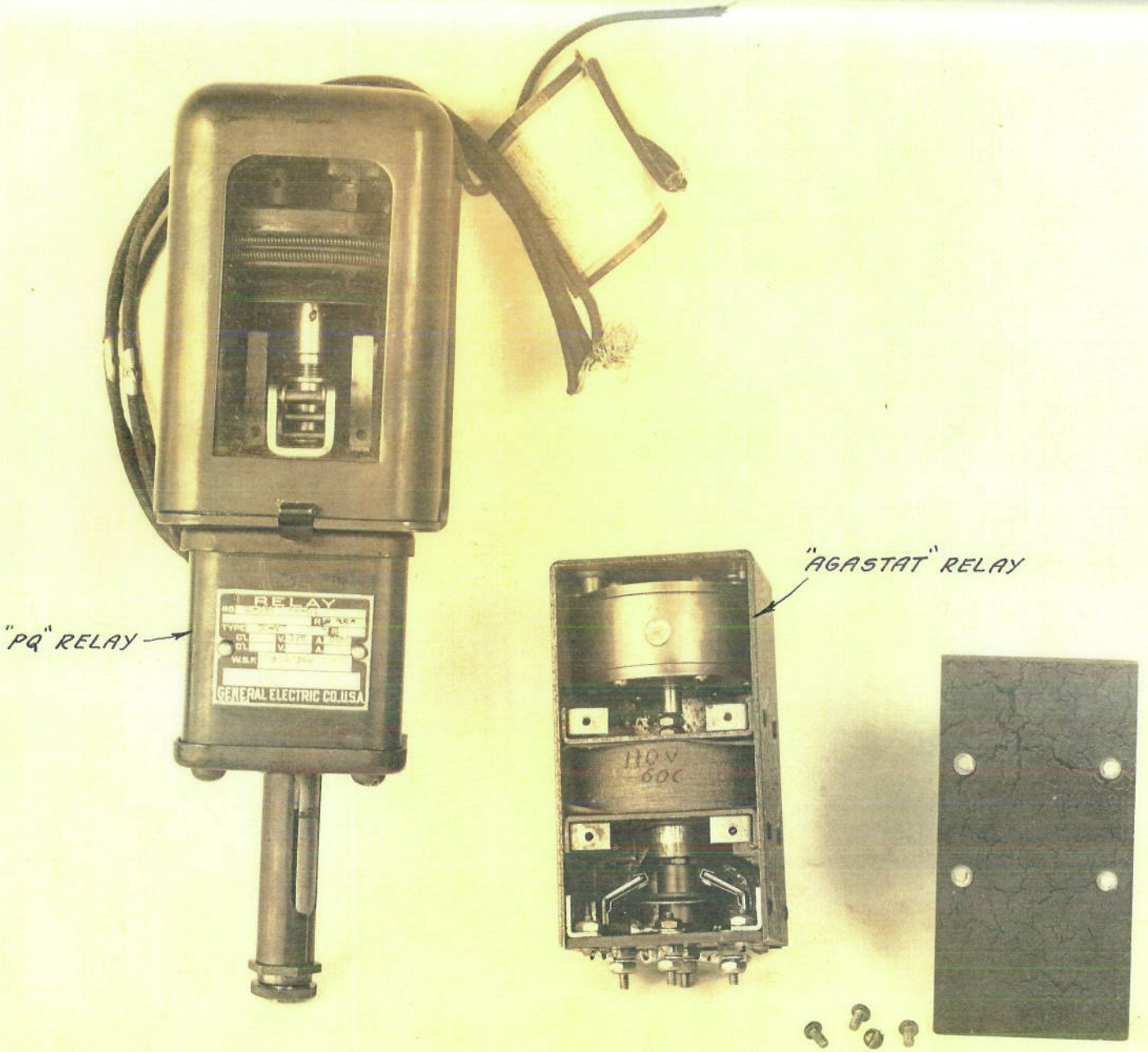
TABLE NO. 2

TEST RECORD OF TYPE "PQ" TIME DELAY RELAY. TIMING - 20 SECONDS.
CONTACTS BREAKING 5 AMPERES.

Time	Ambient Temperature Degrees C	Time Cycle Seconds	Number of Breaks
	(7 November 1933)		
1400	23.9	20.0	0
1430	30.0	19.8	90
1510	28.4	20.2	207
1530	28.2	19.8	277
1600	28.0	20.0	364
1630	28.0	19.9	449
	(8 November 1933)		
0940	28.2	20.2	542
1000	29.0	20.3	616
1030	30.0	20.4	694
1100	31.2	20.6	800
1130	32.0	20.5	868
1200	33.2	20.6	956
1230	33.0	20.6	1044
1300	33.6	20.3	1131
1330	33.8	20.4	1222
1400	34.0	20.4	1308
1430	35.6	20.4	1402
1500	35.0	20.5	1490
1530	36.0	20.6	1573
1600	37.3	20.6	1666
1630	38.0	20.7	1749
	(9 November 1933)		
0930	37.6	19.9	1749
1000	38.0	20.7	1850
1030	40.0	20.5	1926
1100	40.5	20.9	2016
1130	40.2	21.2	2101
1200	42.0	21.7	2189
1230	41.8	21.9	2277
1300	42.3	21.5	2359
1330	43.6	22.2	2436
1400	44.6	22.3	2518
1440	45.5	22.8	2622
1500	46.0	23.0	2674
1530	47.4	22.9	2750
1600	49.2	23.2	2835
1630	50.4	23.6	2903

TABLE NO. 2 (cont'd)

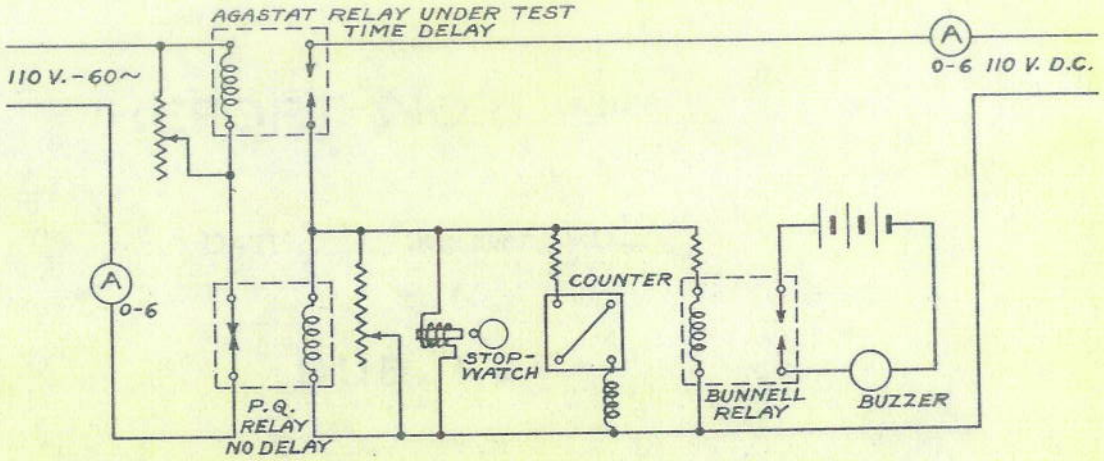
Time	Ambient Temperature Degrees C	Time Cycle Seconds	Number of Breaks
	(10 November 1933)		
0930	20.0	21.5	2906
1000	11.0	22.0	3005
1030	7.8	21.8	3078
1100	4.4	21.7	3165
1130	4.2	21.9	3250
1200	3.8	22.3	3328
1230	3.4	22.2	3413
1300	2.8	22.6	3516
1330	2.7	22.9	3569
1400	2.4	22.8	3645
1430	2.2	22.9	3740
1500	2.0	23.2	3815
1530	2.0	23.4	3893
1600	2.0	23.6	3963
1630	2.0	24.1	4032
	(11 November 1933)		
0930	3.6	23.0	4092
1000	8.2	23.3	4172
1030	10.8	23.1	4237
1100	13.2	23.3	4322
1130	15.0	23.6	4402
1200	16.0	24.1	4460
	(13 November 1933)		
1000	14.4	23.1	4543
1030	15.6	24.0	4620
1100	16.8	24.8	4700
1130	18.0	24.9	4789
1200	18.6	25.2	4835
1245	19.8	25.3	4946
1320	20.6	26.0	5025
1410	21.6	26.7	5135
1450	22.2	27.1	5237
1525	22.6	27.2	5314
1600	23.2	27.1	5386
1630	24.0	26.8	5447



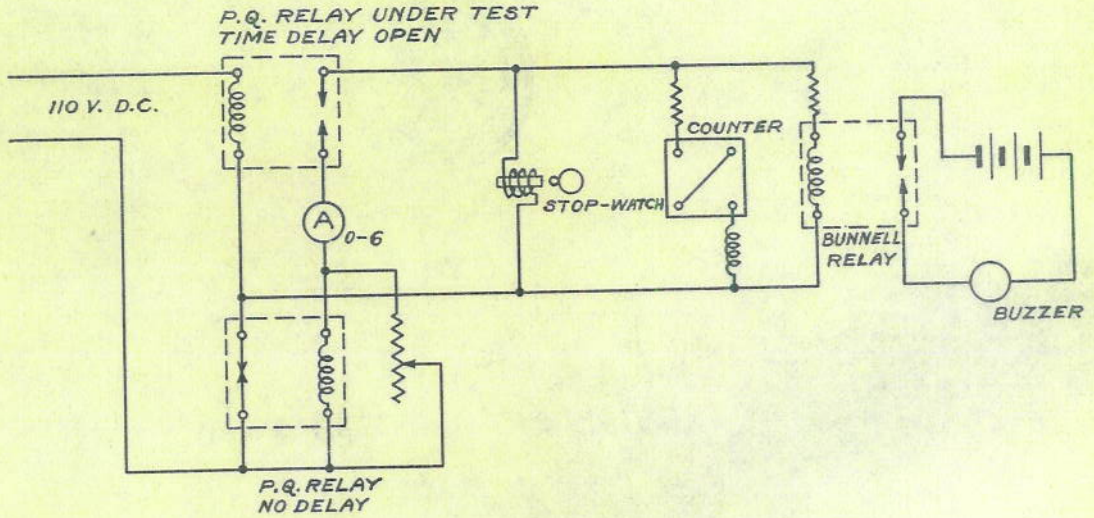
1196

COMPARISON OF "AGASTAT" TYPE RELAY WITH "PQ" TYPE RELAY

PLATE 1



CIRCUIT USED IN TEST OF AGASTAT RELAY



CIRCUIT USED IN TEST OF P.Q. RELAY

PLATE 2