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NAVY DEPARTMENT

Report of Test

on

Contact Makers - Types "L" and "N"

Submitted by

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AUTHORIZATION FOR TEST

1. This problem was authorized by reference (a), and other references pertinent to this problem are listed as references (b) and (c).

Reference: (a) BuShips Ltr. S62-2-(3)(350) of 2 June 1942.
(b) Specification 17C16a of 2 March 1942,
and Amendment 1 of 15 March 1942.
(c) Specification 17E13 (INT) of 1 March 1942.

OBJECT OF TEST

2. The object of this test was to determine the conformance of the sample Contact Makers with specification, reference (b), and their suitability for Naval use.

ABSTRACT OF TEST

3. The sample Contact Makers were set up at this Laboratory in connection with suitable test equipment where their performance was carefully observed for compliance with the specification. An inspection of the sample to determine compliance in the matter of materials, design, and workmanship, concluded the test.

CONCLUSIONS

(a) The sample Contact Makers are of good workmanship and were found to be, in general, satisfactory throughout the test. However, they failed to meet the specification in the following respects:

Type L

- (1) The operating point increased approximately one pound when the case cover was put on.
- (2) The pressure chamber is not provided with a means for draining.
- (3) It was found that water leaked into the case where the mounting bracket was riveted to the case. This could be avoided by welding.

Type N - Single Throw, Remote Switching

- (4) The tolerance for accuracy under the self-compensating test was exceeded by -0.5° F. at an ambient temperature of 158° F.
- (5) The instrument failed to operate after the shock and vibration tests. However, it satisfactorily withstood these tests following repair by the manufacturer's engineer.

Type N - Double Throw, Remote Switching

- (6) Contacts stuck in closed position after 24 hours of endurance. In order that additional information could be obtained, the contacts were opened and the tests continued. The instrument operated satisfactorily after this one failure.

Type N - Single Throw, Local Switching

- (7) This instrument exceeded the tolerance for accuracy at 50° F. ambient temperature by 1.5° F.
- (8) The expansion chamber should be silver-soldered at the thread instead of soft-soldered.
- (9) The location of the terminal tube boss does not allow sufficient space for an angular terminal tube such as would be required in the usual installation.

General

- (10) The terminals are so mounted in the instrument as to cause considerable difficulty in attaching the incoming wires. The terminal screws should be mounted on brass angles rather than strips.
- (11) The nameplates on all instruments should be plastic instead of steel and have proper identification data.

CONCLUSIONS (Cont'd)

General

- (12) The instrument cases are not sufficiently rigid. Rigidity could be increased by flanging the case.
- (13) No drawings were provided for descriptive and identification purposes.
- (14) On the remote switching instruments, the expansion tube is supported only by the capillary tubing which is gripped by the packing material in the threaded glands.
- (15) The dimensions of the Contact Makers do not comply with the specification requirements.
- (16) There is not sufficient insulation between the electrical circuits and ground. The insulating material should be at least 1/8 of an inch thick and of an approved material. The 1/32" un-impregnated fiber used on all samples is not an approved insulating material.

(b) The results of the HI Shock Test indicated that the Contact Makers withstood high intensity shock, except in the following respects:

- (1) In the Type L instrument, the mounting base for the main lever was loosened from the insulating block. The contact leaf spring was damaged slightly.
- (2) In the Type H, double throw, remote switching instrument, the lower contact leaf spring was damaged.
- (3) In the Type N, local switching instrument, the bottom lever stop was not strong enough to limit the downward motion of the lever.

RECOMMENDATIONS

It is recommended that the subject Contact Makers be approved for Naval use subject to the correction of the deficiencies noted under "Conclusions" and satisfactory check tests.

DESCRIPTION OF MATERIAL TESTED

4. The mechanism of the Type "L" (low pressure actuated) Contact Maker submitted is housed in a formed steel case, part being mounted on a removable chassis and part being supported by assembly to the bottom of the case. The chassis supports a phenolic terminal block and a second phenolic block on which is mounted the switch mechanism. The chassis is formed of 1/16" steel and is supported at three points by small angular projections which are screwed to mounting angles inside the case.

5. The switch mechanism is of the quick make and break type, incorporating a permanent magnet. The magnet also serves as a means of preventing excessive arcing at the contacts and prevents contact fluttering due to vibration. By adjusting the gap between the magnet and the (steel) switch lever, the differential can be adjusted.

6. The actuating mechanism (pressure responsive) is assembled into the bottom of the case and is secured by a threaded bushing. It consists of a formed brass pressure chamber containing a plunger and a siphon unit, which is recessed in the chamber. One male and one female 3/8" pipe connection are provided in a fitting which is silver soldered to the bottom of the pressure chamber, the male connection being a brass nipple soft soldered after threading into the fitting. A small orifice is provided in the wall between the chamber and the extending fitting.

7. The operating pressure may be set by turning the adjusting screw which varies the compression of the helical spring which applies force in opposition to the pressure acting on the plunger.

8. Further details are given by photograph, Plates 1 and 2, and photostats, Plates 9 to 13 inclusive. The differential adjusting screw, provided in the commercial models, has been eliminated in the sample submitted.

Type "N" Contact Maker (Remote Switching, Single-pole, Single-throw)

9. The mechanism of the Type "N", remote switching, single-pole, single-throw, temperature-operated contact maker is similar to that of the Type "L" pressure-operated contact maker. The principal difference is that the actuating unit responds to the pressure resulting from the charge of a volatile liquid in the expansion tube. The expansion tube is thus a thermo-sensitive element which varies the pressure in the system in accordance with the temperature of the medium in which it is immersed.

10. The fitting provided to permit installation of the expansion tube in a standard 3/4" pipe fitting is of a special type, employing a slotted packing nut and split packing plates to allow its complete removal from the tube and capillary. The bulb is of monel sealed with silver solder at both ends.

DESCRIPTION OF MATERIAL TESTED (Cont'd)

11. Further details are given by photographs, Plates 3 and 4, and photostats, Plates 9 to 13 inclusive.

Type "N" Contact Maker (Remote Switching, Single Pole, Double-throw)

12. The mechanism of the Type "N", remote switching, single-pole, double-throw, temperature-operated contact maker is identical to that of the single-throw sample except for the addition of a second pair of contacts and a terminal block. The additional terminal block supports a fixed contact and a terminal.

13. The expansion tube of this sample is of nickel plated copper and is provided with a special fitting of the type previously described

14. Further details are given by photographs, Plates 5 and 6, and photostats, Plates 9 to 13 inclusive.

Type "N" Local Switching Contact Maker (Single-pole, Single-throw)

15. The mechanism of the Type "N" local switching, single-pole, single-throw, temperature-operated contact maker is identical to that of the remote switching, single-throw sample except that the expansion tube is directly connected to the actuating mechanism.

16. The monel bulb is soft soldered at the threaded section, while the other end is silver soldered.

17. Further details are given by photographs, Plates 7 and 8, and photostats, Plates 9 to 13 inclusive.

METHOD OF TEST

18. The sample contact makers were set up in connection with the usual testing equipment and subjected to the tests as outlined in specification, reference (b).

19. The operating range of the Type "L" Contact Maker was determined, and the instrument was then set to operate at a particular pressure (25 lbs./sq. in.). The operating point was re-checked after the endurance, shock, vibration, and overpressure tests.

20. The operating range of each of the three Type "N" Contact Makers was determined in an oil bath. Each was then so mounted on the cover of an insulated, watertight tank that the entire expansion chamber projected into the tank. The tank was provided with an inlet and outlet which was connected to a pump to provide forced circulation of the water used as a heat conducting medium. By the use of immersion heaters and a cooling coil, suitable rates of temperature rise could be obtained over the desired temperature range.

METHOD OF TEST (Cont'd)

21. The operating points of the sample contact makers were set at a particular temperature. The tank and contact maker assembly was then placed in a compartment in which the ambient temperature could be maintained at 50, 104, or 158° F. Before the start of each run, the temperature of the water in the testing tank was held at 140° F. for at least fifteen minutes. The water temperature was determined by a precision thermometer extending from the tank and having its bulb located near the expansion chamber of the contact maker.

22. The operating temperature of each of the instruments was re-determined after the endurance, shock and vibration, overtemperature, and hydrostatic tests.

23. Tests were conducted on all four contact makers for dielectric strength, insulation resistance, and watertight integrity.

24. In order to determine the efficiency of the self-compensating means incorporated in the sample contact makers, additional tests were conducted on two of the Type "H" samples (the single-throw, remote switching and the single-throw local switching) with the ambient temperature higher than the operating temperature.

25. These contact makers were set to operate at approximately 140° F. and were subjected to ambient temperatures of 104° F, 158° F, and approximately 50° F.

26. The operating temperatures of the contact makers during these tests are shown in Tables 5 and 6.

27. The contact makers were also subjected to the III shock test, as requested by the manufacturer. The operating point of each was re-checked after this test.

RESULTS OF TEST

28. The results of the tests were as follows:

(a) Type "L"

Requirements

Contact Load: Switch shall be capable of breaking a load of 4 amperes, 0.5 P.F., 115 volts, 60 cycles.

Test Values

Complied.

RESULTS OF TEST (Cont'd.)

(a) Type "L"

Requirements

Test Values

Endurance Test: Shall operate 48 hours, "on" 2 seconds, "off" 2 seconds.

Complied.

Operating Range: Adjustable over a range of 0 to 50 lbs.

0.25 lbs. to 50 lbs.

Accuracy: Operating point shall not vary more than ± 2 lbs.

Complied.
See Table 1.

Shock and Vibration Tests: Paragraph F-2e.

Complied.
See Table 1.

Dielectric: Shall withstand 1250 volts, 60 cycles for one minute between open contacts and to ground.

Complied.

Insulation Resistance: Shall be not less than 10 megohms at 500 volts.

Complied.
Greater than 100 megohms at 500 volts.

Overpressure Test: Shall withstand 15 pressure cycles of 200 lbs./sq.in. for 10 seconds each, applied at a rate not exceeding 200 lb./sq.in./sec.

Complied.
See Table 1.

Watertight Integrity: Shall be submerged under three feet of water for one hour without the entry of water into the case.

*A few drops of water leaked into the case where the mounting bracket is riveted to the case.

Clearance: There shall be not less than $\frac{3}{4}$ " between electrical circuits and ground unless separated by at least $\frac{1}{8}$ " of approved insulating material.

*Did not comply.
See "Conclusions".

Dimensions: Shall not exceed the following: Width-4-15/16", Depth-3-3/4", Length-9 inches. Weight-Not specified.

*Width-7 $\frac{1}{2}$ inches,
Depth-2-3/8 inches,
Length-4 $\frac{1}{2}$ inches,
Weight-4 lbs., 4 ozs.

RESULTS OF TEST (Cont'd)

(a) Type "L"

Requirements

Test Plans: Paragraph H-3b.

Nameplate: Shall be of a satisfactory plastic material.

Pressure Chamber: Shall be provided with one 3/8" IPS male connection for pressure supply and one 3/8" IPS female tap for drainage connection.

Test Values

*No test plans furnished.

*Steel.

*Fitting for chamber is provided with specified connections, but chamber proper is isolated by partition, having only a small orifice through it.

*Denotes failure to comply with specification.

Results of HI Shock Test

On the 5th and 6th blows of the 2000 ft. lb. shock machine, (horizontal side blows), the mounting base for the main lever was loosened from the insulating block. An examination of the instrument after shock showed that the contact leaf spring was bent. The contacts closed before the final snap of the lever. The lever stop was also bent slightly. The accuracy of the instrument after HI shock is shown in Table 1.

(b) Type "N" -Single-Throw, Remote Switching

Requirements

Contact Load: Switch shall be capable of breaking a load of 4 amperes, 0.5 P.F., 115 volts, 60 cycles.

Endurance Test: Shall operate 48 hours, "one complete cycle each 5 minutes" with contacts carrying rated current.

Operating range: Shall be adjustable over a range of 100° F. to 225° F. and shall be self-compensating for any ambient temperature between 50° F. and 158° F.

Test Values

Complied.

Complied.

*Operating range complied.
(1) Compensation complied except at 158° F. where tolerance was exceeded by -0.5° F. See Table 5.

RESULTS OF TEST (Cont'd)

(b) Type "H" -Single-Throw, Remote Switching

Requirements

Accuracy: Operating point shall not vary more than $\pm 5^\circ$ for a rate of temperature rise of or less than 5° F. per minute.

Shock and Vibration Tests:
Paragraph F-2e.

Dielectric: Shall withstand 1250 volts, 60 cycles, for one minute between open contacts and to ground.

Insulation Resistance: Shall be not less than 10 megohms at 500 volts.

Watertight integrity: Shall be submerged in 3 feet of water for 1 hour without the entry of water into the case.

Clearance: Shall not be less than $\frac{1}{4}$ " between electrical circuits and ground unless separated by at least $\frac{1}{8}$ -inch of approved insulating material.

Dimensions: Shall not exceed the following:
Width- $4\frac{15}{16}$ inches.
Depth- $3\frac{3}{4}$ inches.
Length-9 inches.
Weight- Not specified.

Attachment to piping system:
Shall be threaded $\frac{3}{4}$ "(IPS) and shall not project into the system more than $\frac{1}{2}$ ".

Nameplate: Shall be of a satisfactory plastic material.

Test Values

Complied.
See Table 2.

*Main lever failed to
(2) snap into position.
Contact leaf spring bent. Instrument failed to operate.

Complied.

Complied.
Greater than 100 megohms at 500 volts.

Complied.

*Did not comply-
See "Conclusions."

*Width- $7\frac{1}{2}$ ", Depth $2\frac{3}{8}$ ",
Length- $4\frac{1}{2}$ ", Weight-5 lbs.

Complied.
 $3\frac{7}{8}$ inches from tip of expansion chamber to first thread on pipe connection.

*Steel.

RESULTS OF TEST (Cont'd)

(b) Type "N" - Single-Throw, Remote Switching

Requirements

Test Plans: Paragraph H-3b.

Test Values

*No Test Plans
furnished.

Due to the failure of this instrument under shock and vibration, no further tests were conducted.

*Denotes failure to comply with the specification.

- Notes: (1) When set at low operating point (100° F), the instrument operated with a 30° F. differential. The contacts appeared to stick in the closed position.
- (2) When the instrument failed to operate after shock and vibration, the manufacturer's engineer repaired the instrument. The operating point was reset to 160° F. and the contact maker again subjected to shock and vibration. There was no observed damage to the instrument and no appreciable change in the operating point.

(c) Type "N"-Double Throw, Remote Switching

Requirements

Contact Load: Switch shall be capable of breaking a load of 4 amperes, 0.5 P.F., 115 volts, 60 cycles.

Endurance Test: Shall operate 48 hours, "one complete cycle each 5 minutes" with contacts carrying rated current.

Operating Range: Shall be adjustable over a range of 100° F. to 225° F. and shall be self-compensating for any ambient temperature between 50° F. to 158° F.

Accuracy: Operating point shall not vary more than $\pm 5^\circ$ F. for a rate of temperature rise of or less than 5° F. per minute.

Test Values

Complied.

*Partial compliance.
See "Conclusions."

Operating range complied.
(Compensation not checked due to similarity with single-throw remote switching sample.)

Complied.
See Table 3.

RESULTS OF TEST (Cont'd)

Type N - Double Throw, Remote Switching

Requirements

Shock and Vibration Tests:
Paragraph F-2e.

Dielectric: Shall withstand 1250 volts, 60 cycles for one minute between open contacts and to ground.

Insulation Resistance: Shall be not less than 10 megohms at 500 volts.

Overtemperature test: Expansion chamber shall be subjected to a temperature of 300° F. for five minutes without damage.

Expansion Chamber: Shall be designed for operation when submerged in a liquid at or less than 50 lb./sq. in. Shall be of corrosion-resisting material, such as to minimize electrolysis when submerged in hot salt water in the presence of copper.

Watertight Integrity: Shall be submerged in 3 feet of water for 1 hour without the entry of water into the case.

Clearance: Shall not be less than $\frac{1}{4}$ inch between electrical circuits and ground unless separated by at least $\frac{1}{8}$ " of approved insulating material.

Dimensions: Shall not exceed the following:

Width: 4-15/16 inches

Depth: 3-3/4 inches.

Length: 9 inches.

Weight: Not specified

Test Values

Complied.
See Table 3.

Complied.

Complied. Greater than 100 megohms at 500 volts.

Complied following this and the 50 lb./sq. in. hydrostatic test. See Table 3.

Complied.
Monel tube-Silver soldered.

Complied.

*Did not comply.
See "Conclusions."

* Width-7 $\frac{1}{2}$ inches.
Depth-4 $\frac{1}{2}$ inches.
Length-2-3/8 inches.
Weight-5 lbs., 1 oz.

RESULTS OF TEST (Cont'd)

Type "N" - Double-Throw, Remote Switching

Requirements

Attachment to piping system:
Shall be threaded $3/4$ " (IPS)
and shall not project into the
system more than $4\frac{1}{2}$ inches.

Nameplate: Shall be of a satisfactory plastic material.

Test Plans: Paragraph H-3b.

Test Values

Complied.
 $3-7/8$ inches from tip
of expansion chamber to
first thread on pipe
connection.

*Steel

*No Test Plans furnished.

*Denotes failure to comply with the specification.

Results of HI Shock Test

On the back blows of the 2000 ft.-pound shock machine, the lower contact leaf spring (contact carrier) was bent. There was enough torsion on the side blows to shift the contact out of alignment with the stationary contact. After the HI shock, the instrument was repaired by bending the lower contact leaf spring back into position so as to allow the instrument to be operated. The accuracy after HI shock and this repair is shown in Table 3.

Type "N" - Single-Throw, Local Switching

Requirements

Contact Load: Switch shall be capable of breaking a load of 4 amperes, 0.5 P.F., 115 volts, 60 cycles.

Endurance Test: Shall operate 48 hours, "one complete cycle each 5 minutes" with contacts carrying rated current.

Operating Range: Shall be adjustable over a range of 100° F. to 225° F. and shall be self-compensating for any ambient temperature between 50° F. and 158° F.

Accuracy: Operating point shall not vary more than $\pm 5^{\circ}$ F. for a rate of temperature rise of or less than 5° F. per minute.

Test Values

Complied.

Complied.

Complied.
See Table 6.

*Exceeded the tolerance
at 50° F. ambient
by 1.5° .

RESULTS OF TEST (Cont'd.)

Type "N"-Single-Throw, Local Switching

Requirements

Shock and Vibration Tests:
Paragraph F-2e.

Dielectric: Shall withstand 1250 volts, 60 cycles for one minute between open contacts and to ground.

Insulation Resistance: Shall be not less than 10 megohms at 500 volts.

Overtemperature Test: Expansion chamber shall be subjected to a temperature of 300° F. for five minutes without damage.

Expansion Chamber: Shall be designed for operation when submerged in a liquid at or less than 50 lb./sq. in. Shall be of corrosion-resisting material, such as to minimize electrolysis when submerged in hot salt water in the presence of copper.

Watertight Integrity: Shall be submerged in 3 feet of water for 1 hour without the entry of water into the case.

Clearance: Shall not be less than $\frac{1}{4}$ " between electrical circuits and ground unless separated by at least $\frac{1}{8}$ " of approved insulating material

Dimensions: Shall not exceed the following:

Width-4-15/16 inches.

Depth-3-3/4 inches.

Length-9 inches.

Weight-Not specified.

Test Values

Complied.
See Table 4.

Complied.

Complied.
Greater than 100 megohms at 500 volts.

Complied following this and the 50 lb./sq. in. hydrostatic test. See table 4.

*Nickel plated copper tube-silver soldered at end but soft soldered where assembled with piece having pipe thread.

Complied.

*Did not comply.
See "Conclusions."

*Width-7 inches.
Depth-4 $\frac{1}{2}$ inches.
Length-2-3/8 inches.
Weight-4 lbs., 10 ozs.

RESULTS OF TEST (Cont'd)

Type "N"- Single-Throw, Local Switching

Requirements

Attachment to Piping System:
Shall be threaded 3/4-inch (IPS)
and shall not project into the
system more than 1/2 inches.

Nameplate: Shall be of a satis-
factory plastic material.

Test Plans: Paragraph H-3b.

Test Values

Complied..
3-9/16 inches from
tip of expansion cham-
ber to first thread on
pipe connection.

*Steel.

* No Test Plans furnished.

*Denotes failure to comply with the specification.

Results of HI Shock Test

On the second blow (vertical top) of the 2000 ft.-pound shock machine, the bottom lever stop bent. The lever dropped below the stop so that it was impossible for the instrument to operate. The lever stop was straightened and the test continued. There was no further observed damage. Accuracy of the instrument after shock and this repair is shown in Table 4.

CONCLUSIONS

(29) The sample Contact Makers are of good workmanship and were found to be, in general, satisfactory throughout the test. However, they failed to meet the specification in the following respects:

Type L

- (1) The operating point increased approximately one pound when the case cover was put on.
- (2) The pressure chamber is not provided with a means for draining.
- (3) It was found that water leaked into the case where the mounting bracket was riveted to the case. This could be avoided by welding.

Type N - Single Throw, Remote Switching

- (4) The tolerance for accuracy under the self-compensating test was exceeded by -0.5° F. at an ambient temperature of 158° F.
- (5) The instrument failed to operate after the shock and vibration tests. However, it satisfactorily withstood these tests following repair by the manufacturer's engineer.

Type N - Double-Throw, Remote Switching

- (6) Contacts stuck in closed position after 24 hours of endurance. In order that additional information could be obtained, the contacts were opened and the tests continued. The instrument operated satisfactorily after this one failure.

Type N - Single-Throw, Local Switching

- (7) This instrument exceeded the tolerance for accuracy at 50° F. ambient temperature by 1.5° F.
- (8) The expansion chamber should be silver-soldered at the thread instead of soft-soldered.
- (9) The location of the terminal tube boss does not allow sufficient space for an angular terminal tube such as would be required in the usual installation.

General

- (10) The terminals are so mounted in the instrument as to cause considerable difficulty in attaching the incoming wires. The terminal screws should be mounted on brass angles rather than strips.
- (11) The nameplates on all instruments should be plastic instead of steel and have proper identification data.

CONCLUSIONS (Cont'd.)

General

- (12) The instrument cases are not sufficiently rigid. Rigidity could be increased by flanging the case.
 - (13) No drawings were provided for descriptive and identification purposes.
 - (14) On the remote switching instruments, the expansion tube is supported only by the capillary tubing which is gripped by the packing material in the threaded glands.
 - (15) The dimensions of the Contact Makers do not comply with the specification requirements.
 - (16) There is not sufficient insulation between the electrical circuits and ground. The insulating material should be at least 1/8 of an inch thick and of an approved material. The 1/32" un-impregnated fiber used on all samples is not an approved insulating material.
- (30) The results of the HI Shock Test indicated that the Contact Makers withstood high intensity shock, except in the following respects:
- (1) In the Type L instrument, the mounting base for the main lever was loosened from the insulating block. The contact leaf spring was damaged slightly.
 - (2) In the Type N, double-throw, remote switching instrument, the lower contact leaf spring was damaged.
 - (3) In the Type H, local-switching instrument, the bottom lever stop was not strong enough to limit the downward motion of the lever.

TABLE 1

OPERATING POINTS OF CONTACT MAKER

Type I

Condition	Amb. Temp. in Deg. Fah.	Operating Point lbs/sq.in.	Contacts Open		Differential		Error in lbs. from Original Setting #
			Max.	Min.	Max.	Min.	
(Start of test-cover off.)	77	25	28	27-1/4	3	2-1/4	-
(Start of test-cover on.)	77	*25-7/8	29	28	3-1/8	2-1/8	-
(After 45-1/2 hours endur- ance.)	50	26-1/4	28	27	1-3/4	3/4	+3/8
(After 48 hours endur- ance.)	158	25	27-5/8	26-3/4	2-5/8	1-3/4	-7/8
(After endur- ance.)	78	26-3/8	28-1/2	27-5/8	2-1/8	1-1/4	+1/2
(After shock)	78	27-3/8	29-1/2	28-3/8	2-1/8	1	+1-1/2
* (After vibra- tion.)	78	27-1/4	29-3/8	27-3/4	2-1/8	1/2	+1-3/8
* (After over- pressure)	80	24	25-5/8	24-1/4	1-5/8	1/4	-1-7/8
* (After HI Shock test.)	80	25-1/2	25-3/4	25-5/8	1/4	1/8	- 3/8

Note* After vibration it was noted that, if the pressure was reduced to a pressure no lower than the operating point and increased to a pressure no greater than that necessary to open the contacts, the instrument would operate with less than 1/8 lb. differential.

TABLE 2

OPERATING POINTS OF CONTACT MAKER

Type N
(Single Throw, Remote Switching)

Condition	Amb. Temp. in Deg. Fah.	Operating Point in Deg. Fah.	Contacts open in Deg. Fah.	Differential in Deg. Fah.	Rate of Rise in Deg. F./Min.	Error in Deg. Fah. from Setting
(Before endurance)	78.5	160	151	9	0.35	+2.0
(After endurance)	80.0	159	149	10.0	1.6	+1.0
"	80.0	158.5	149	9.5	0.5	+0.5
"	104	158	147.5	10.5	0.38	-
"	104	159	149.0	10.0	3.1	+1.0
"	104	159	149.5	9.5	4.8	+1.0
"	158	157	139	18	0.23	-1.0
"	158	158.5	139	19.5	2.6	+0.5
"	158	159	139	20.0	4.8	+1.0
"	50	160	152	8.0	0.27	+2.0
"	50	160	152	8.0	2.5	+2.0
"	50	160	152	8.0	4.9	+2.0
(After Shock and vibration)Failed						
*(Reset)	78	160	157	3	0.25	-
	80	161	157	4	2.6	+1.0
	80	161.5	157.5	4	5.3	+1.5
*(After Shock and vibration)80		161.5	155	6.5	0.75	+1.5

*Following repair by manufacturer's engineer.

TABLE 3

OPERATING POINTS OF CONTACT MAKER

Type N
(Double Throw, Remote Switching)

Condition	Amb. Temp. in Deg. Fah.	Operating Point in Deg. Fah.	Contacts Open in Deg. Fah.	Differential in Deg. Fah.	Rate of Rise in Deg. Fah./ Min.	Error in Deg. Fah. from Setting
(Before endurance)	75.0	161	152	9	0.33	+1.0
(After endurance)	80.0	161	155.5	5.5	0.6	+1.0
"	80.0	161	156.0	5.0	0.28	+1.0
"	104	160	155	5.0	0.26	-
"	104	161	155	6.0	2.6	+1.0
"	104	160.5	155	5.5	4.1	+0.5
"	158	159	146	13	0.25	-1.0
"	158	160	146.5	13.5	2.0	0
"	158	160	144.5	15.5	5.0	0
"	50	162.5	157	5.5	0.23	+2.5
"	50	162	157	5.0	2.6	+2.0
"	50	162.5	157	5.5	5.0	+2.5
(After Shock and vibrat- ion)	76.5	160	155.5	4.5	0.26	0
(After over- Temp. & Hy- drostatic Tests)	76	161.0	156	5.0	3.3	+1.0
(After HI Shock Test)	75	161.5	156.5	5.0	5.3	+1.5
		162	158	4	0.85	+2.0
	78	162	159	3	0.78	+2.0

TABLE 4

OPERATING POINTS OF CONTACT MAKER

Type N
(Single Throw, Local Switching)

Condition	Ambient Temp. in Deg. Fah.	Operating Point in Deg. Fah.	Contacts Open in Deg. Fah.	Differential in Deg. Fah.	Rate of Rise in Deg. Fah./Min.	Error in Deg. Fah. from Setting
(Before Endurance)	78.0	153.5	152	6.5	0.3	+1.5
(After Endurance)	77.0	150	151.5	6.5	0.25	+1.0
"	77.0	158	151.5	6.5	0.32	+1.0
"	104	157	150.5	6.5	0.24	-
"	104	157	150.5	6.5	2.1	0
"	104	156.5	151.5	5.0	4.5	-0.5
"	158	154	147	7.0	0.30	-3.0
"	158	154.5	147	7.5	2.1	-2.5
"	158	155	147	8.0	5.0	-2.0
"	50	162	157	5.0	0.27	+5.0
"	50	163	157	6.0	2.1	+6.0
"	50	163.5	157.5	6.0	5.2	+6.5
(After Shock	78	155	151	4.0	0.28	-2.0
and Vibrat-	78	155	151	4.0	3.0	-2.0
ion.)	78	155	151	4.0	5.0	-2.0
(After Over-						
Temp. and Hy-75		156	152	4	0.35	-1.0
drostatic						
Test)						
(After HI	80	159	155	4	1.0	+2.0
Shock Test)						

TABLE 5
OPERATING POINTS OF CONTACT MAKER

Type N
(Single Throw, Remote Switching)
(Self-Compensating Test)

Ambient Temp. in Deg. Fah.	Operating Point in Deg. Fah.	Contacts Open in Deg. Fah.	Differential in Deg. Fah.	Rate of Rise in Deg. Fah./Min.	Error in Deg. Fah. from Setting
104	138.5	132	6.5	0.25	-
104	139.5	132	7.5	2.8	+1.0
104	140.0	132	8.0	5.0	+1.5
158	133	124.5	8.5	0.28	-5.5
158	135	124.5	10.5	2.3	-3.5
158	137.5	124.5	13.0	4.5	-1.0
59	139.5	133	6.5	0.25	+1.0
60	140	134	6.0	2.7	+1.5
60	140	134	6.0	5.0	+1.5

TABLE 6

OPERATING POINTS OF CONTACT MAKER

Type N
(Single Throw, Local Switching)
(Self-Compensating Test)

Ambient Temp. in Deg. Fah.	Operating Point in Deg. Fah.	Contacts Open in Deg. Fah.	Differential in Deg. Fah.	Rate of Rise in Deg. Fah./Min.	Error in Deg. Fah. from Setting.
104	136.5	133.5	3	0.26	-
104	137.5	134.5	3	2.41	+1.0
104	138	134.5	3.5	5.20	+1.5
158	134.5	131.0	3.5	0.32	-2.0
158	135.0	131.0	4.0	2.16	-1.5
158	135.5	131.0	4.5	5.17	-1.0
58	139.5	135.0	4.5	0.23	+3.0
55	141.0	136.5	4.5	2.7	+4.5
55	141.5	137.0	4.5	4.8	+5.0

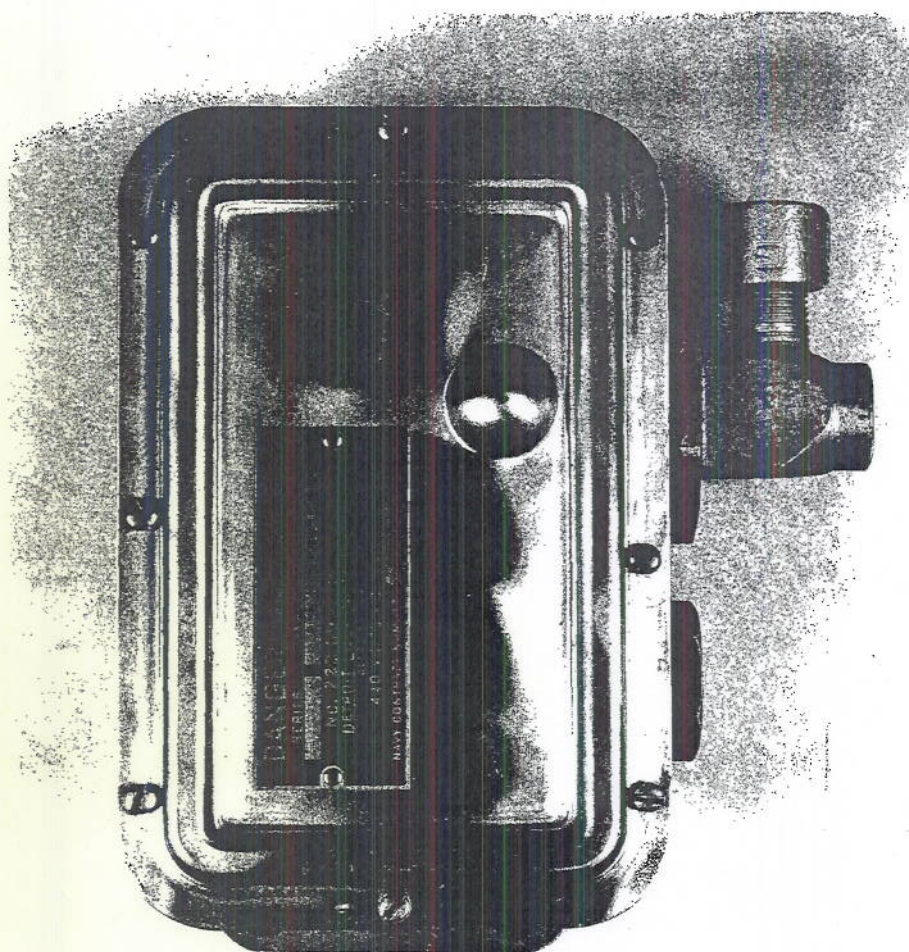
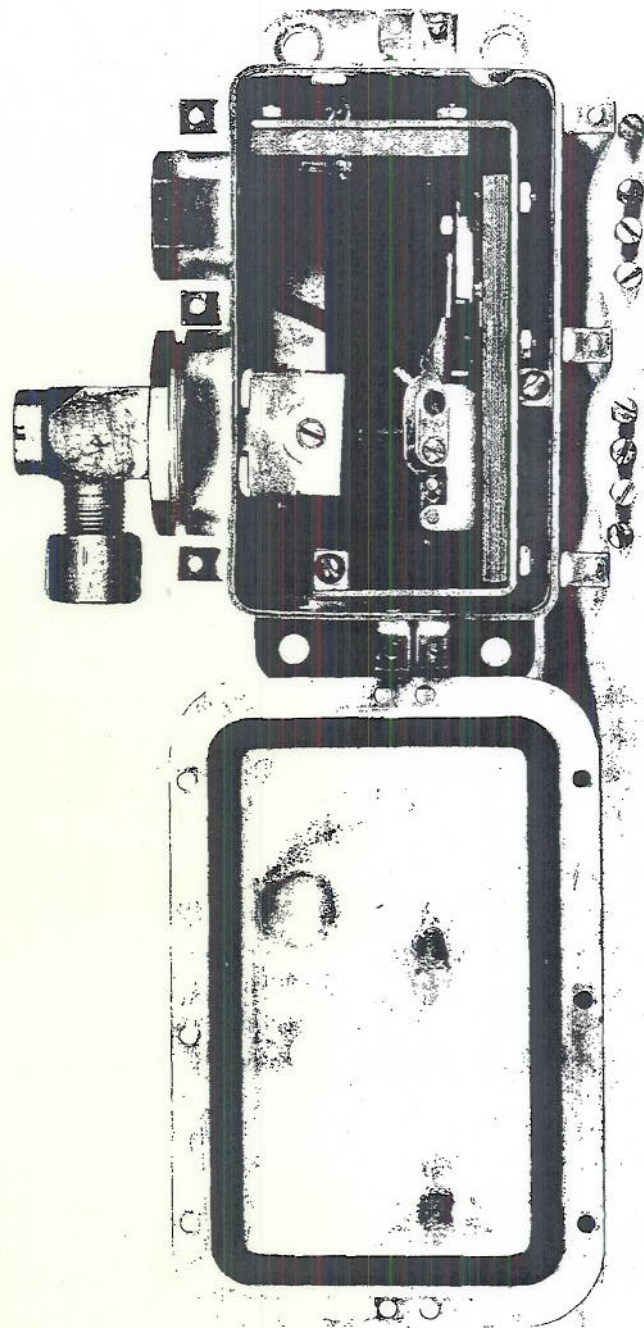


PLATE I



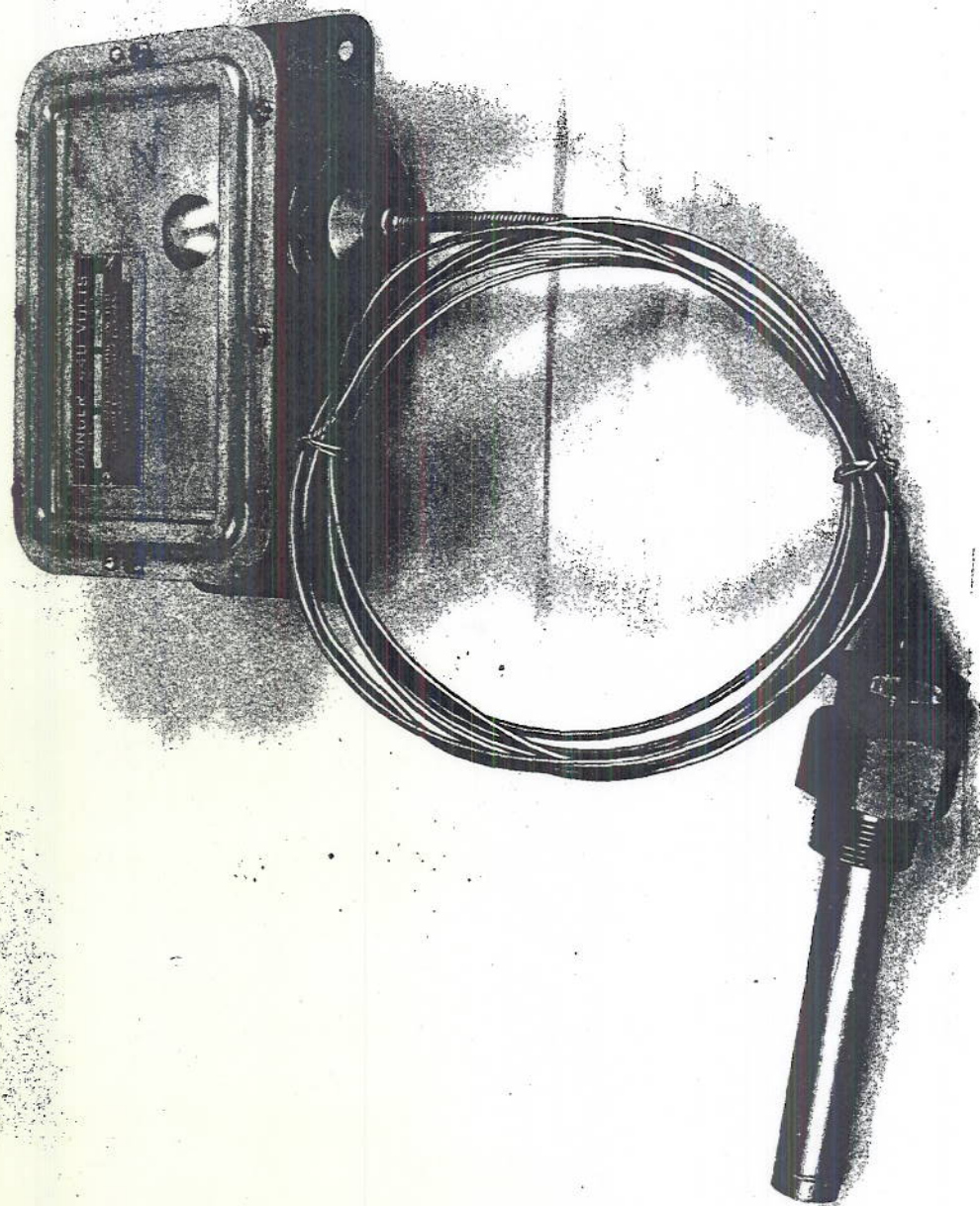


PLATE 3

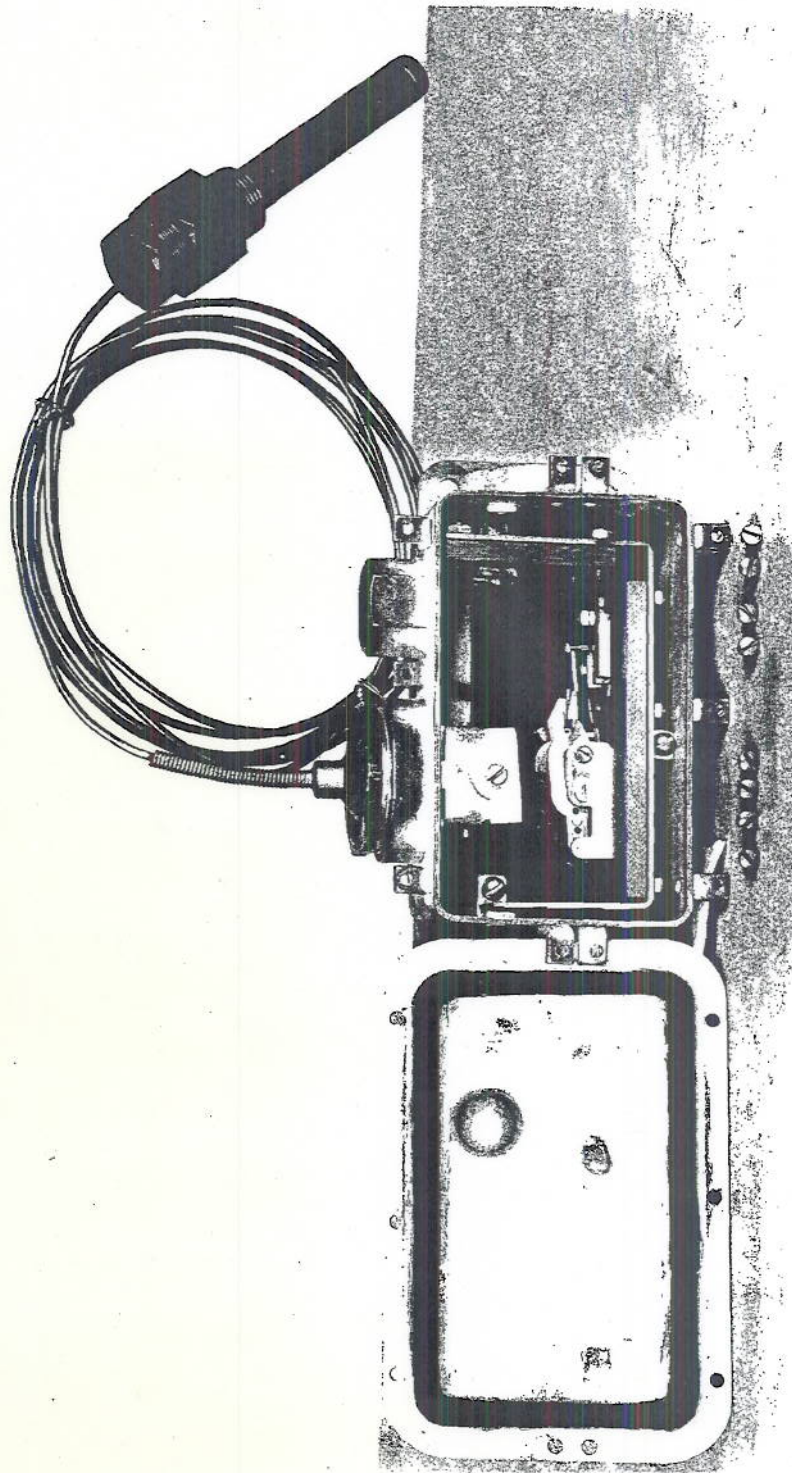
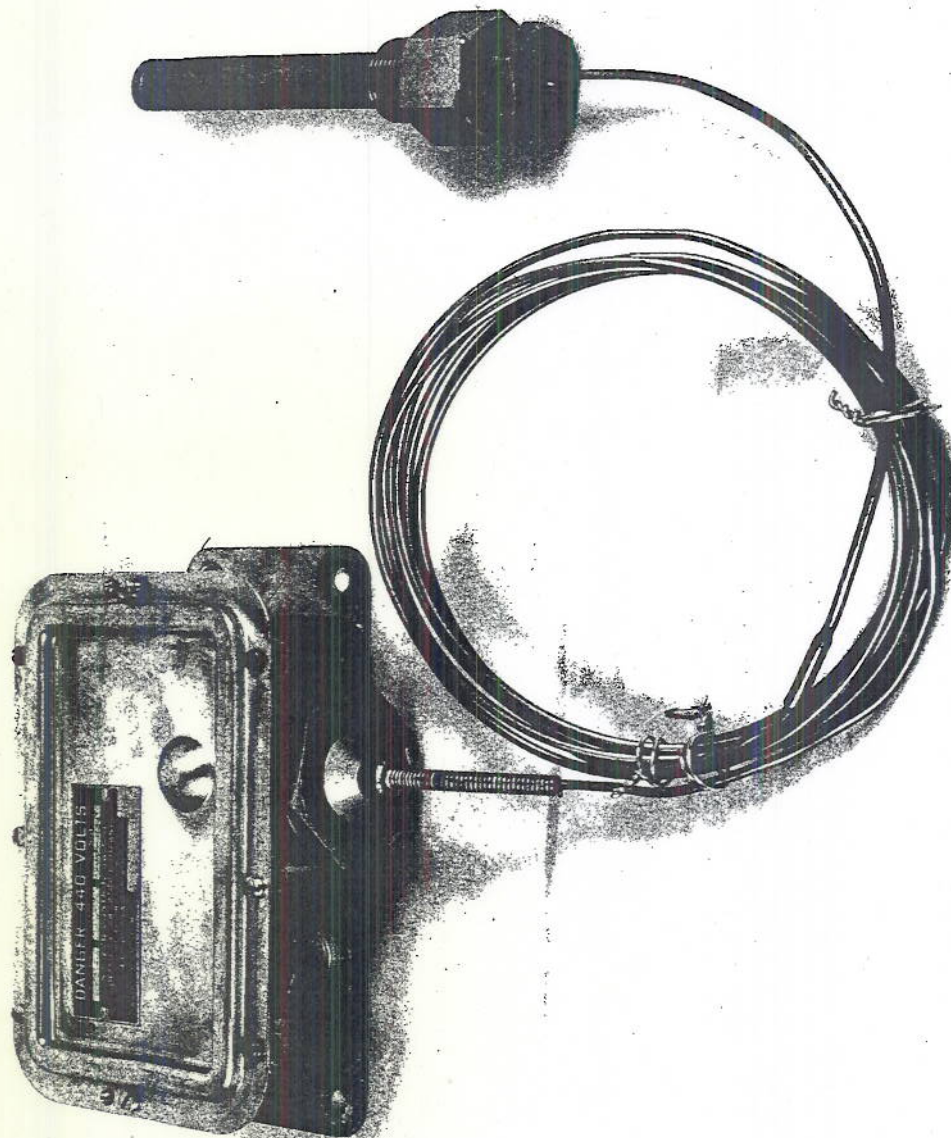


PLATE 4



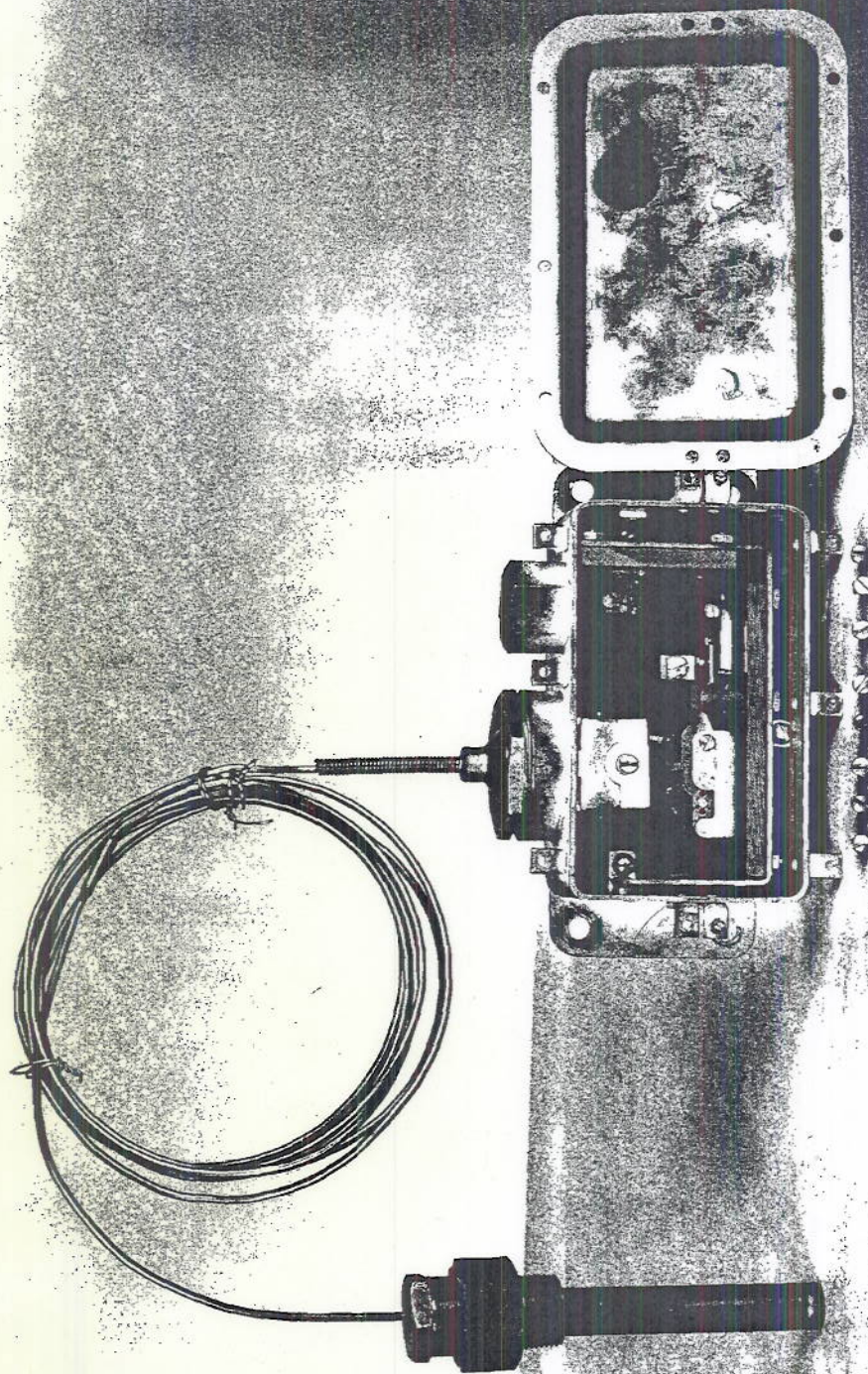
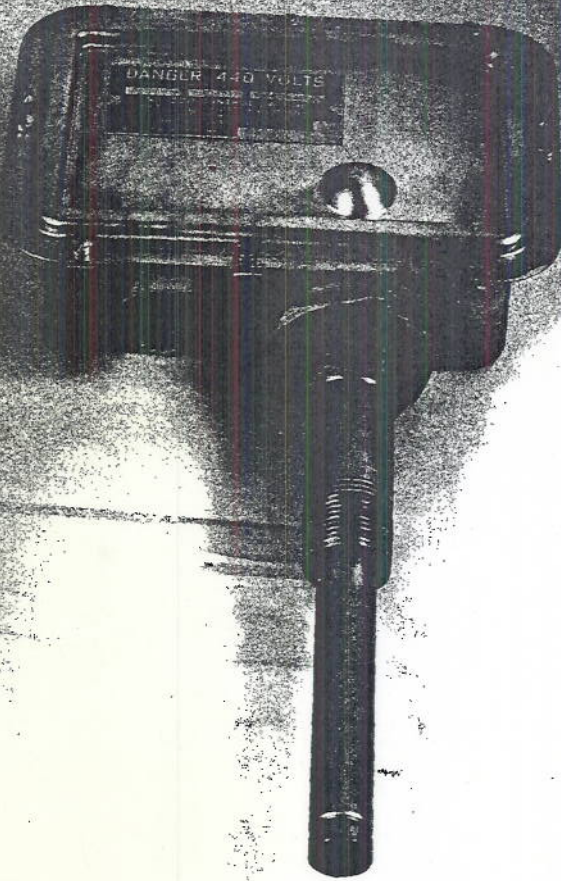


PLATE 6



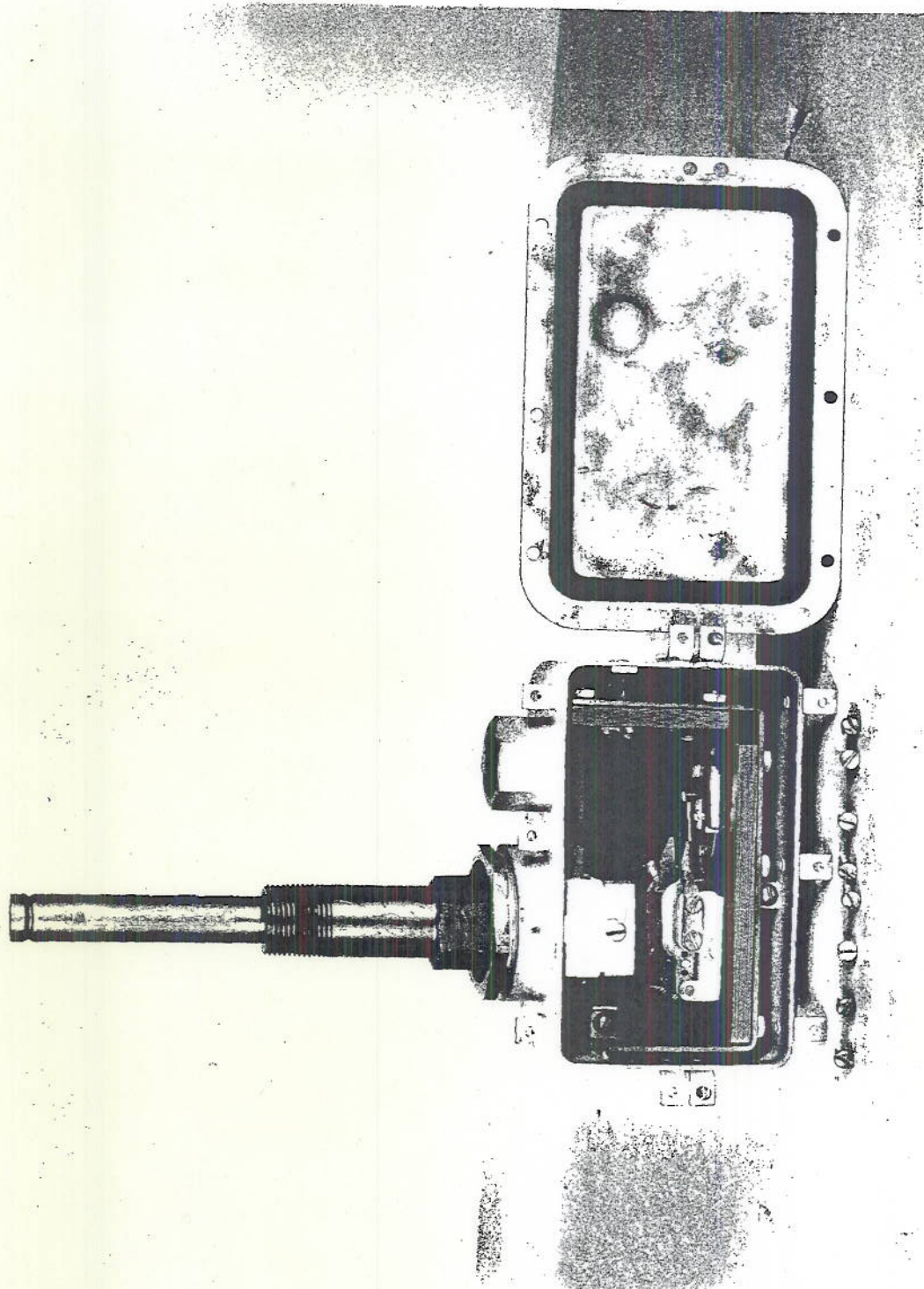


PLATE 8

CONTACT MAKERS FOR MARINE USE

For use on both fighting and auxiliary ships the war has developed a need for HI "high impact" Contact Makers built to withstand 2000 foot pound shock; also, for Contact Makers which may be depended upon to operate reliably under various conditions of moisture, even to the extent of submergence in 25 feet of water.

The "Genuine Detroit" No. 220 Heavy Duty Control has been especially designed to meet both the exacting HI shock and watertight requirements of our fighting ships. It will operate reliably even when completely submerged in 25 feet of water or when subjected to stunning blows or severe vibration, conditions which would quickly cause conventional controls to fail. Such drastic conditions of service are not encountered every day. On fighting ships and auxiliary war craft where they may be encountered an "every day" control is not reliable. But "Genuine Detroit" No. 220 Controls designed, manufactured and rigidly inspected with these conditions in mind may be used with utmost confidence.

The rigid cover into which the heavy rubber gasket is cemented is securely held to the control case by means of 8 screwdriver-slotted fillister head screws. The opening in the case through which the power element projects is sealed with a threaded gland and packing. Thus the case is absolutely watertight yet, since the cover is easily removable, all adjustments are quickly and readily accessible. Cover guide pins are provided on the case to insure accurate alignment of the cover and gasket, thus permitting repeated removal and replacement of the cover without damage to the gasket. Inasmuch as the mounting brackets, the cover brackets, electrical connection and power element housing, etc., are hydrogen welded to the case, there are no bolt holes, adjustment or other openings which would permit the entrance of moisture or water. In order to protect the case against rust or corrosion, it is finished with a heavy coating of cadmium plate.

Brackets, welded to the back of the case, project beyond each end and provide a rigid and easy method of mounting. The name plate showing the pressure or temperature range and the type and series number is affixed to the outside of the cover, making this necessary information readily available.

For types in which this control is made, and the pressure and temperature ranges, see Page 5.

The No. 220 Control is offered for many marine applications for control of air conditioning, refrigeration, compressor, water and sump pumps, Diesel engine alarm systems, etc. However, while this control

is especially designed for marine use it is equally adapted to other requirements for control of heating equipment, drying ovens, water level, gas and oil pressure, and numerous other industrial uses where a particularly sturdy and dependable control is desired.

The "Genuine Detroit" No. 220 Control is made in a wide variety of types and ranges to suit any of these various requirements.

A seamless metallic bellows power element, directly actuated by pressure in the case of pressure controls, or by the pressure exerted by a volatile liquid charge in the case of temperature controls, operates the switch mechanism to close and open the electrical circuit. A permanent magnet at the contacts provides a definite snap-action to the switch mechanism and prevents excessive arcing, prolongs contact life, and eliminates the fluttering of contacts where vibration is encountered.

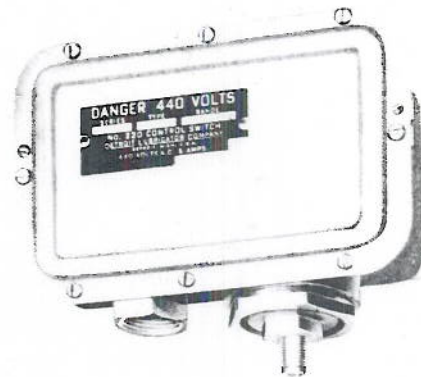


Figure 1—"Genuine Detroit" No. 220 NA or NB Pressure Control

All "Genuine Detroit" No. 220 Controls are available with either single pole, single throw; or single pole, double throw switch mechanism.

Single pole, single throw switches are furnished either to close or open the circuit on pressure or temperature increase. Switches are available with an additional contact for alarm circuits, and in such cases the lower contact is always for the alarm circuit, the upper contact for the load circuit. This provides a single pole, double throw switch action. It is imperative to specify whether load circuit is to open or close on pressure or temperature increase, even in the case of those instruments furnished with extra contact for alarm circuit.

The pressures or temperatures at which the switch mechanism opens and closes the circuit are adjustable within the limits of the operating range. The range and differential adjustment screws are located inside the

and provide an accurate and quick means for setting the operating pressures or temperatures. The range adjustment always governs the point at which the switch "closes" the circuit. The differential adjustment always governs the point at which the switch "opens" the circuit. A change in setting of the range adjustment will raise or lower both the "closing" and "opening" points without changing the differential of pressure controls, and with only a slight change in differential in the case of temperature controls. Detailed instructions for making adjustments are given on Page 6.

220 MODELS NA AND NB HEAVY DUTY PRESSURE CONTROLS

Models NA and NB Pressure Controls are exactly alike in external appearance. The only difference between the two models is the pressure range through which they operate. A tabulation of pressure ranges is given on Page 5. These models may be used for starting and stopping pumps according to changes in water level or pressure; sounding an alarm or stopping fuel, gasoline or gas engines when lubricating oil pressure falls below a safe minimum; controlling refrigeration and air compressors; controlling motorized valves on steam lines and for numerous other purposes.

Pressure connections available— $\frac{1}{4}$ " SAE and $\frac{1}{4}$ " NPT male or female.

All "Genuine Detroit" No. 220 Temperature Controls are furnished with a remote type thermal bulb connected to the control by means of flexible capillary tubing, which is available in various lengths. On special order the tubing may be armored for additional protection against damage by accidental blows, etc.

220 MODEL NL

The Model NL thermal bulb is normally used for temperature control of liquids. It may be used for air and gases where circulation is rapid and temperature change is slow. Regularly furnished without threaded connection at the thermal bulb but on special order a demountable union is available. Immersion wells are also available on special order.

220 MODEL NN

The coiled tubing Model NN thermal bulb has a large surface and less mass than the NL bulb and is

designed for the control of air and gases, especially when temperature change is rapid and circulation abnormally slow. Regularly furnished without threaded connection at the thermal bulb. A 1" attached union is available on special order. Immersion wells are not available for this model.

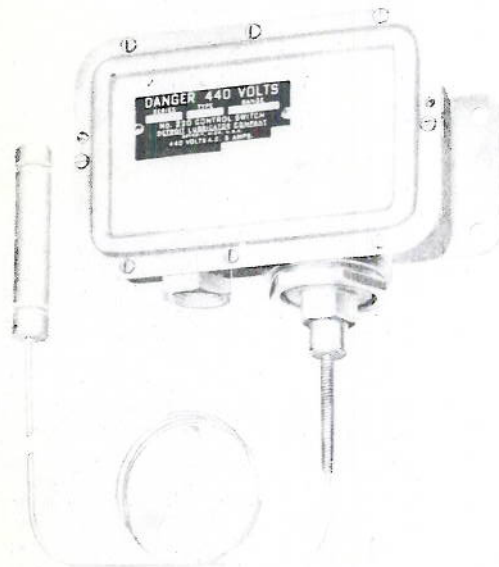


Figure 2 "Genuine Detroit" No. 220-NL Temperature Control

MODELS NLM AND NNM "SPECIAL" WARMER AND COLDER BULB

For those conditions where the temperature surrounding the control case is sometimes warmer and sometimes colder than the temperature at the thermal bulb, a special "warmer and colder" thermal bulb must be used for accurate regulation. The special bulb is usually necessary on those controls operating near room temperature. The 35° to 95° range is generally furnished with the special NLM or NNM bulb.

The NLM bulb is for temperature control of liquids and measures $1\frac{1}{16}$ " x 12". The coiled tubing NNM bulb, for the control of gases, measures $1\frac{1}{8}$ " x 13 $\frac{3}{4}$ ". Immersion wells are not available for either the NLM or NNM bulbs.

"Genuine Detroit" No. 220 Heavy Duty Temperature Controls find wide use as engine safety controls to flash a warning in case cooling water temperatures or bearing temperatures become excessive; to control refrigeration compressors in packing houses, ice plants, locker plants, cargo holds in ships; air conditioning systems, industrial ovens, and for a great many other purposes.

SPECIFICATIONS AND ELECTRICAL RATING

"GENUINE DETROIT" No. 220 HEAVY DUTY PRESSURE CONTROLS

Model	Range	Minimum Differential	Maximum Differential	Maximum Momentary Pressure
NA-1	0- to 10"	1 $\frac{1}{4}$ "	3"	80"
NA-2	20" Vac. to 2" Vac.	2" Vac.	17" Vac.	80"
NA-3	10" Vac. to 15"	1 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	80"
NB-1	10- to 60"	1 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	80"
NB-3	20" Vac. to 40"	7"	15"	200"
NB-4	15- to 90"	3"	8"	125"
NB-5	20- to 180"	5 $\frac{1}{2}$ "	23"	200"
NB-6	5- to 160"	5"	13"	200"
NB-7	60- to 350"	10"	27"	360"

*Differentials shown are for S.P.S.T. switches. For controls with alarm circuit, differentials are slightly wider.
Electrical conduit connection— $\frac{3}{4}$ " Female N.P.T.
Shipping weight approximately 6 lbs.

"GENUINE DETROIT" No. 220 HEAVY DUTY TEMPERATURE CONTROLS

Model	Range	Approximate Minimum Differentials* When Operating in Range At			Maximum Allowable Temperature	Bulb Size			
		Low	Medium	High		NL	NLM	NN	NNM
NL	-30° to +50°	12	3 $\frac{1}{2}$	2	90°	3 $\frac{1}{8}$ " x 3"	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	0° to 60°	3	2	1 $\frac{1}{2}$	90°	3 $\frac{1}{8}$ " x 3"	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	35° to 95°	2	1 $\frac{1}{2}$	1	115°	3 $\frac{1}{8}$ " x 3"	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	120° to 210°	8	4	2 $\frac{1}{2}$	260°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	122° to 195°	3	2	2	220°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
NLM	160° to 235°	3	2	2	260°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
NN	195° to 260°	3	2	2	280°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
NNM	186° to 288°	8	4	2	310°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	235° to 290°	3	2	2	310°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	224° to 330°	8	4	2	350°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	270° to 345°	3	2	2	350°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	300° to 415°	14	8	6	540°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	350° to 480°	9	5	4	540°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "
	380° to 495°	4	4	3	540°	1 $\frac{1}{16}$ " x 3 $\frac{5}{8}$ "	1 $\frac{1}{16}$ " x 12"	1 $\frac{1}{8}$ " x 6"	1 $\frac{1}{8}$ " x 13 $\frac{3}{4}$ "

*Differentials shown are for S.P.S.T. switches. For controls with alarm circuit, differentials are slightly wider.
Differential adjustment provides maximum differentials approximately four times the minimum differentials listed above.
Thermal bulbs regularly furnished without threaded connection.
On special order a $\frac{3}{4}$ " demountable union is available for NL and NLM type bulbs.
On special order a 1" attached union is available for NN and NNM type bulbs.
Electrical conduit connection— $\frac{3}{4}$ " Female N.P.T.
Temperature element tubing available in various lengths, both plain and armored.
Immersion wells can be furnished for NL type bulbs only.
Maximum external pressure allowable on NL type bulb is 500 P.S.I.
Shipping weight—approximately 7 lbs.

ELECTRICAL RATING

Conduit Connection— $\frac{3}{4}$ " Female N.P.T.

NON-INDUCTIVE LOAD RATING

A. C.				D. C.			
110 V.	220 V.	440 V.	550 V.	115 V.	230 V.	440 V.	550 V.
15 A.	10 A.	3.3 A.	3.3 A.	15 A.	10 A.	2.6 A.	2.6 A.

MOTOR RATINGS

Voltage	Repulsion-Induction Motors (A. C.)	Split-Phase Motors (A. C.)	D. C. Motors
110-550	1 H. P.	1 $\frac{1}{2}$ H. P.	1 $\frac{1}{2}$ H. P.

Alarm contacts rated for pilot circuit, low current bell, or signal light only.

ORDERING, SPECIFY:

Complete stock and model number, as No. 220 NL, No. 220 NLM, etc.
Temperature or pressure range.
Whether S.P.S.T. or S.P.D.T. (with alarm contact desired).
If single pole, single throw, whether electrical

circuit is to "close" or "open" with increasing temperature or pressure.

5. If double throw (with alarm contact) is desired, specify whether load circuit is to "close" or "open" with increasing temperature or pressure.

6. Length of tubing on temperature control.

7. Type of connection on pressure control.

8. Specials, such as threaded union at bulb, armored tubing, etc.

INSTALLATION INSTRUCTIONS

PRESSURE TYPES: Fasten No. 220 Control to suitable support by means of flanges on control case. Select power element to the point where pressure regulation is required with pipe or tubing. On steam pressure over 15 pounds a siphon (water seal) must be in the connection to the power element, in order to prevent excessive temperatures from damaging the control.

WIRING

Use a straight wire hookup be sure control is connected in the "hot" side of the line. If in doubt as to which is the hot wire determine by using test lamp. The electrical entrance in the control case is 3/4". Fuses installed in line switch should not exceed 15 amps. at 110 V., 10 amps. at 220 V., 4 amps. at 550 V.

SETTING

The adjusting screws for setting the range and differential operating points are located inside the control case and are exposed when the water-tight control cover is removed (see Fig. 3).

RESERVE TYPE NUMBER OF CONTROL BEFORE MAKING ANY ADJUSTMENT

Controls which "open" the circuit with increasing temperature or pressure are identified by the numerals 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

RANGE ADJUSTMENT: Establishes the point at which the circuit is "closed".

Changing the range adjustment raises or lowers both the "closing" and "opening" points but does not change the differential.

DIFFERENTIAL ADJUSTMENT: Turning the differential adjusting screw "wider" raises the point at which the circuit "opens" without changing the point at which the circuit "closes".

TO SET THE CONTROL: Turn differential adjustment screw to "wider" position. Set range adjustment screw to desired "closing" point. Increase temperature or pressure to the desired "opening" point then turn differential adjustment counter-clockwise slowly, until circuit "opens" at point desired. Check setting by observing an operating cycle.

Controls which "close" circuit with increasing temperature or pressure are identified by the numerals 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

RANGE ADJUSTMENT: Establishes the point at which the circuit "closes". Changing the range adjustment raises or lowers both the "closing" and "opening" points but does not alter the differential.

DIFFERENTIAL ADJUSTMENT: Turning the differential adjustment screw "wider" lowers the point at which the circuit "opens" without changing the point at which the circuit "closes".

TO SET THE CONTROL: Turn differential adjustment screw to "wider" position. Set range adjustment screw to desired "closing" point. Lower temperature or pressure to the desired "opening" point and then turn differential adjustment counter clockwise slowly, until circuit "opens" at point desired. Check setting by observing an operating cycle.

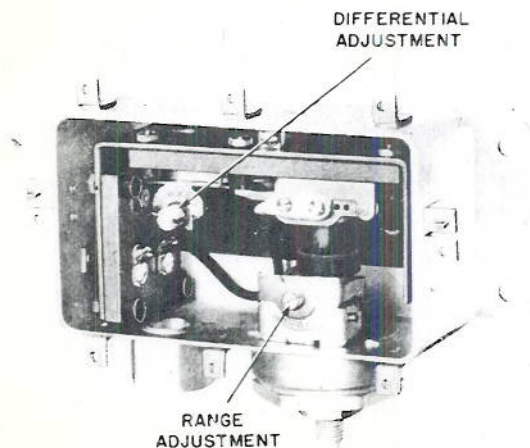


Figure 3 Location of Range and Differential Adjustments

When replacing the water-tight cover, be sure to gradually tighten the cover screws in rotation so as to uniformly compress the cover gasket.

TEMPERATURE TYPES: Fasten No. 220 Control to suitable support by means of flanges on control case. Temperature bulb must be located at a point of unrestricted circulation and where it will "feel" the average temperature of the substance to be controlled. Do not twist the flexible tube.

The position in which the temperature bulb is mounted is of utmost importance for accurate temperature regulation. It is, therefore, essential to follow the mounting instructions given on the tag attached to each temperature bulb.

CONTACT MAKERS FOR MARINE USE

or use on both fighting and auxiliary ships the war developed a need for HI "high impact" Contact makers built to withstand 2000-foot pound shock; for Contact Makers which may be depended on to operate reliably under various conditions of moisture, even to the extent of submergence in 25 feet water.

The "Genuine Detroit" No. 220 Heavy Duty Control has been especially designed to meet both the fighting HI shock and watertight requirements of fighting ships. It will operate reliably even when completely submerged in 25 feet of water or when subjected to stunning blows or severe vibration, conditions which would quickly cause conventional controls to fail. Such drastic conditions of service are encountered every day. On fighting ships and auxiliary war craft where they may be encountered "every day" control is not reliable. But "Genuine Detroit" No. 220 Controls designed, manufactured rigidly inspected with these conditions in mind may be used with utmost confidence.

The rigid cover into which the heavy rubber gasket cemented is securely held to the control case by means of 8 screwdriver-slotted fillister head screws. The opening in the case through which the power element projects is sealed with a threaded gland and locking. Thus the case is absolutely watertight yet, the cover is easily removable, all adjustments quickly and readily accessible. Cover guide pins provided on the case to insure accurate alignment of the cover and gasket, thus permitting repeated removal and replacement of the cover without damage to the gasket. Inasmuch as the mounting brackets, the cover brackets, electrical connection power element housing, etc., are hydrogen welded to the case, there are no bolt holes, adjustment or other openings which would permit the entrance of moisture or water. In order to protect the case against rust or corrosion, it is finished with a heavy coating of aluminum plate.

Mounting brackets, welded to the back of the case, project from each end and provide a rigid and easy method of mounting. The name plate showing the pressure or temperature range and the type and series number is attached to the outside of the cover, making this necessary information readily available.

For types in which this control is made, and the pressure and temperature ranges, see Page 5.

The No. 220 Control is offered for many marine applications for control of air conditioning, refrigeration, compressor, water and sump pumps, Diesel engine alarm systems, etc. However, while this control

is especially designed for marine use it is equally adapted to other requirements—for control of heating equipment, drying ovens, water level, gas and oil pressure, and numerous other industrial uses where a particularly sturdy and dependable control is desired.

The "Genuine Detroit" No. 220 Control is made in a wide variety of types and ranges to suit any of these various requirements.

A seamless metallic bellows power element, directly actuated by pressure in the case of pressure controls, or by the pressure exerted by a volatile liquid charge in the case of temperature controls, operates the switch mechanism to close and open the electrical circuit. A permanent magnet at the contacts provides a definite snap-action to the switch mechanism and prevents excessive arcing, prolongs contact life, and eliminates the fluttering of contacts where vibration is encountered.

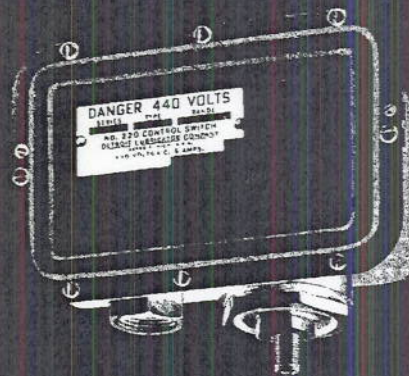


Figure 1—"Genuine Detroit" No. 220 NA or NB Pressure Control

All "Genuine Detroit" No. 220 Controls are available with either single pole, single throw; or single pole, double throw switch mechanism.

Single pole, single throw switches are furnished either to close or open the circuit on pressure or temperature increase. Switches are available with an additional contact for alarm circuits, and in such cases the lower contact is always for the alarm circuit, the upper contact for the load circuit. This provides a single pole, double throw switch action. It is imperative to specify whether load circuit is to open or close on pressure or temperature increase, even in the case of those instruments furnished with extra contact for alarm circuit.

The pressures or temperatures at which the switch mechanism opens and closes the circuit are adjustable within the limits of the operating range. The range and differential adjustment screws are located inside the

and provide an accurate and quick means for the operating pressures or temperatures. The adjustment always governs the point at which the switch "closes" the circuit. The differential adjustment always governs the point at which the switch "opens" the circuit. A change in setting of the range adjustment will raise or lower both the "closing" and "opening" points without changing the differential of the controls, and with only a slight change in the case of temperature controls. Detailed instructions for making adjustments are given on page 6.

20 MODELS NA AND NB HEAVY DUTY PRESSURE CONTROLS

Models NA and NB Pressure Controls are exactly alike in external appearance. The only difference between the two models is the pressure range through which they operate. A tabulation of pressure ranges is given on Page 5. These models may be used for starting and stopping pumps according to changes in oil level or pressure; sounding an alarm or stopping a gasoline or gas engine when lubricating oil pressure falls below a safe minimum; controlling refrigeration and air compressors; controlling motorized valves on steam lines and for numerous other purposes.

Pressure connections available: $\frac{1}{4}$ " SAE and $\frac{1}{4}$ " male or female.

"Genuine Detroit" No. 220 Temperature Controls are furnished with a remote type thermal bulb connected to the control by means of flexible capillary tubing, which is available in various lengths. On special order the tubing may be armored for additional protection against damage by accidental bending, etc.

20 MODEL NL

Model NL thermal bulb is normally used for temperature control of liquids. It may be used for air conditioning where circulation is rapid and temperature change is slow. Regularly furnished without threaded connection at the thermal bulb but on special order a demountable union is available. Immersion wells are also available on special order.

30 MODEL NN

The coiled tubing Model NN thermal bulb has a large surface and less mass than the NL bulb and is

designed for the control of air and gases, especially when temperature change is rapid and circulation abnormally slow. Regularly furnished without threaded connection at the thermal bulb. A 1" attached union is available on special order. Immersion wells are not available for this model.

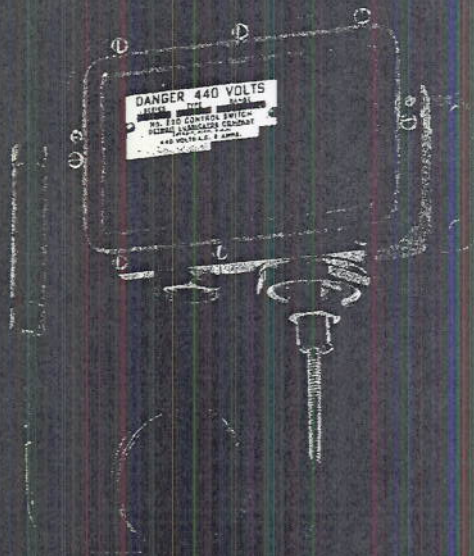


Figure 2 "Genuine Detroit" No. 220-NL Temperature Control

MODELS NLM AND NNM "SPECIAL" WARMER AND COLDER BULB

For those conditions where the temperature surrounding the control case is sometimes warmer and sometimes colder than the temperature at the thermal bulb, a special "warmer and colder" thermal bulb must be used for accurate regulation. The special bulb is usually necessary on those controls operating near room temperature. The 35° to 95° range is generally furnished with the special NLM or NNM bulb.

The NLM bulb is for temperature control of liquids and measures $1\frac{1}{16}$ " x 12". The coiled tubing NNM bulb, for the control of gases, measures $1\frac{1}{8}$ " x $13\frac{3}{4}$ ". Immersion wells are not available for either the NLM or NNM bulbs.

"Genuine Detroit" No. 220 Heavy Duty Temperature Controls find wide use as engine safety controls to flash a warning in case cooling water temperatures or bearing temperatures become excessive; to control refrigeration compressors in packing houses, ice plants, locker plants, cargo holds in ships; air conditioning systems, industrial ovens, and for a great many other purposes.

SPECIFICATIONS AND ELECTRICAL RATING

"GENUINE DETROIT" No. 220 HEAVY DUTY PRESSURE CONTROLS

Model	Range	Minimum ^a Differential	Maximum ^b Differential	Maximum Momentary Pressure
NA-1	0# to 10#	1 1/2"	3"	80#
NA-2	20" Vac. to 2" Vac.	2" Vac.	17" Vac.	80"
NA-3	10" Vac. to 15"	1 1/2"	3 1/2"	80"
NB-1	10# to 60#	1 1/2"	3 1/2"	80"
NB-3	20" Vac. to 40"	7"	15"	200"
NB-4	15# to 90"	3"	8"	125#
NB-5	20# to 180#	5 1/2"	23"	200#
NB-6	5# to 160#	5"	13"	200#
NB-7	60# to 350#	10"	27"	360#

^aDifferentials shown are for S.P.S.T. switches. For controls with alarm circuit, differentials are slightly wider.
Electrical conduit connection—3/4" Female N.P.T.
Shipping weight approximately 6 lbs.

"GENUINE DETROIT" No. 220 HEAVY DUTY TEMPERATURE CONTROLS

Model	Range	Approximate Minimum Differentials* When Operating in Range At			Maximum Allowable Temperature	Bulb Size			
		Low	Medium	High		NL	NLM	NN	NNM
NL	-30° to +50°	12°	3 1/2°	2°	90°	3/8" x 3"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	0° to 60°	3°	2°	1 1/2°	90°	3/8" x 3"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	35° to 95°	2°	1 1/2°	1°	115°	3/8" x 3"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	120° to 210°	8°	4°	2 1/2°	260°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	122° to 195°	3°	2°	2°	220°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
NLM	160° to 235°	3°	2°	2°	260°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
NN	195° to 260°	3°	2°	2°	280°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
NNM	186° to 288°	8°	4°	2°	310°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	235° to 290°	3°	2°	2°	310°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	224° to 330°	8°	4°	2°	350°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	270° to 345°	3°	2°	2°	350°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	300° to 415°	14°	8°	6°	540°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	350° to 480°	9°	5°	4°	540°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"
	380° to 495°	4°	4°	3°	540°	1 1/16" x 3 5/8"	1 1/16" x 12"	1 1/8" x 6"	1 1/8" x 13 3/4"

*Differentials shown are for S.P.S.T. switches. For controls with alarm circuit, differentials are slightly wider.
Differential adjustment provides maximum differentials approximately four times the minimum differentials listed above.
Thermal bulbs regularly furnished without threaded connection.
On special order a 3/4" demountable union is available for NL and NLM type bulbs.
On special order a 1" attached union is available for NN and NNM type bulbs.
Electrical conduit connection—3/4" Female N.P.T.
Temperature element tubing available in various lengths, both plain and armored.
Immersion wells can be furnished for NL type bulbs only.
Maximum external pressure allowable on NL type bulb is 500 P.S.I.
Shipping weight—approximately 7 lbs.

ELECTRICAL RATING

Conduit Connection—3/4" Female N.P.T.

NON-INDUCTIVE LOAD RATING

A. C.				D. C.			
110 V.	220 V.	440 V.	550 V.	115 V.	230 V.	440 V.	550 V.
15 A.	10 A.	3.3 A.	3.3 A.	15 A.	10 A.	2.6 A.	2.6 A.

MOTOR RATINGS

Voltage	Repulsion- Induction Motors (A. C.)	Split-Phase Motors (A. C.)	D. C. Motors
110-550	1 H. P.	1/4 H. P.	1/2 H. P.

Alarm contacts rated for pilot circuit, low current bell, or signal light only.

ORDERING, SPECIFY:

Complete stock and model number, as No. 220 NL, No. 220 NLM, etc.

Temperature or pressure range.

Whether S.P.S.T. or S.P.D.T. (with alarm contact desired).

Single pole, single throw, whether electrical

circuit is to "close" or "open" with increasing temperature or pressure.

5. If double throw (with alarm contact) is desired, specify whether load circuit is to "close" or "open" with increasing temperature or pressure.

6. Length of tubing on temperature control.

7. Type of connection on pressure control.

8. Specials, such as threaded union at bulb, armored tubing, etc.

INSTALLATION INSTRUCTIONS

TEMPERATURE TYPES: Fasten No. 220 Control to support by means of flanges on control case. Power element to the point where pressure is required with pipe or tubing. On steam over 15 pounds a siphon (water seal) must be in connection to the power element, in order to prevent excessive temperatures from damaging the

WIRING

For straight wire hookup be sure control is connected to the "hot" side of the line. If in doubt as to which is the hot wire determine by using test lamp. Electrical entrance in the control case is at the top. Fuses installed in line switch should not be less than 10 amps. at 110 V., 10 amps. at 220 V., 4 amps. at 240 V., and 4 amps. at 550 V.

SETTING

Adjusting screws for setting the range and differential operating points are located inside the control case and are exposed when the water-tight control cover is removed (see Fig. 3).

TEMPERATURE TYPE NUMBER OF CONTROL BEFORE MAKING ANY ADJUSTMENT

Points at which "open" the circuit with increasing temperature or pressure are identified by the numerals 1 through 10, starting the type number and are adjusted as follows:

RANGE ADJUSTMENT: Establishes the point at which the circuit is "closed".

Turning the range adjustment raises or lowers both the "closing" and "opening" points but does not change the differential.

DIFFERENTIAL ADJUSTMENT: Turning the differential adjusting screw "wider" raises the point at which the circuit "opens" without changing the point at which the circuit "closes".

TO SET THE CONTROL: Turn differential adjustment screw to "wider" position. Set range adjustment screw to desired "closing" point. Increase temperature or pressure to the desired "opening" point and then turn differential adjustment counter-clockwise slowly, until circuit "opens" at point desired. Check setting by observing an operating cycle.

Points at which "close" circuit with increasing temperature or pressure are identified by the numerals 1 through 10, starting the type number and are adjusted as follows:

RANGE ADJUSTMENT: Establishes the point at which the circuit "closes". Changing the range adjustment raises or lowers both the "closing" and "opening" points but does not alter the differential.

DIFFERENTIAL ADJUSTMENT: Turning the differential adjustment screw "wider" lowers the point at which the circuit "opens" without changing the point at which the circuit "closes".

TO SET THE CONTROL: Turn differential adjustment screw to "wider" position. Set range adjustment screw to desired "closing" point. Lower temperature or pressure to the desired "opening" point and then turn differential adjustment counter-clockwise slowly, until circuit "opens" at point desired. Check setting by observing an operating cycle.



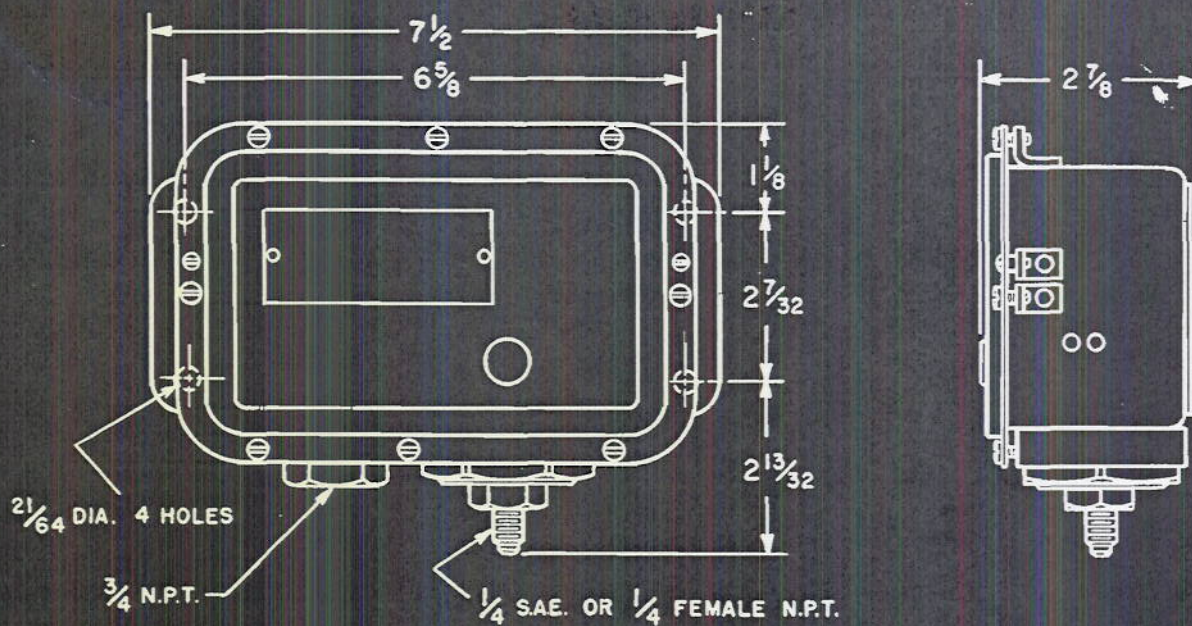
Figure 3 Location of Range and Differential Adjustments

When replacing the water-tight cover, be sure to gradually tighten the cover screws in rotation so as to uniformly compress the cover gasket.

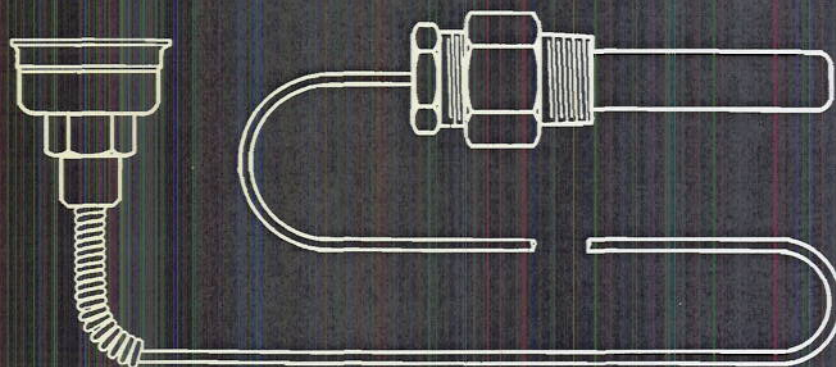
TEMPERATURE TYPES: Fasten No. 220 Control to suitable support by means of flanges on control case. Temperature bulb must be located at a point of unrestricted circulation and where it will "feel" the average temperature of the substance to be controlled. Do not twist the flexible tube.

The position in which the temperature bulb is mounted is of utmost importance for accurate temperature regulation. It is, therefore, essential to follow the mounting instructions given on the tag attached to each temperature bulb.

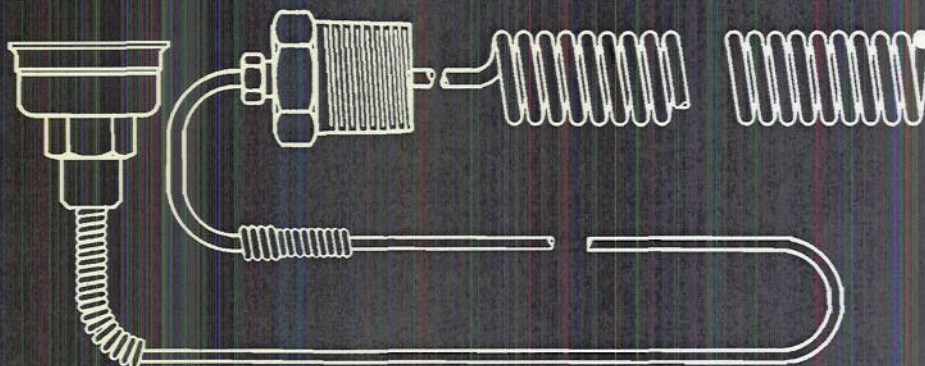
DIMENSIONS



TYPICAL TEMPERATURE CONTROL POWER ELEMENTS. REMOTE TYPE



MODEL NL—Power Element and Thermal Bulb with $\frac{3}{4}$ " Demountable Union



MODEL NN—Power Element and Thermal Bulb with 1" Attached Union