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Ship-Shore Radio Division - Radio Comm. & Nav. Rec'r. Section

21 February 1946

FR. 2765

ANALYSIS OF MODEL UM
SWITCHING EQUIPMENT

By J. W. Brogden

- Report R-2765

DECLASSIFIED by authority of
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February 1958
Entered by M. Bliss Code 2027

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Date: 1 Jun 2016

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Declassification authority: NAVY DECLASS
MANUAL, 11 DEC 2012, OP SERIES

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*Incl. NRL ltr R-567-9/10/1273: JWB
R-1220-29/46 of 3-27-46.*

ABSTRACT

The Model UM Switching equipment is employed in Loran transmitting stations to correlate the major station equipments and to perform the functions of selection, isolation and discrimination. The equipment contains three electronic discriminators whose purpose is to isolate the timer receivers when the local pulse is being transmitted. Normally only one discriminator unit is used, but if the station is double pulsed and wave antennas are used, two discriminators are necessary; the third being used as a standby. The equipment is also equipped with controls which permit the operator to connect any timer to any transmitter, and any discriminator to any timer.

The equipment was installed at the experimental Loran Station, of this Laboratory, at Chesapeake Bay. Tests were conducted there under actual operating conditions to determine its suitability for Loran Shore Station use.

The equipment was found to be electrically suitable for use at shore stations; but the mechanical design of the equipment should be improved to make servicing and installation easier.

It was found that a large amount of noise was generated by the discriminators, tending to decrease the sensitivity of the receivers. This, however, is not serious with the present geographical separation of the stations, but if the base lines are to be increased, this extra noise might become objectionable.

A summary of the tests conducted is included in this report as well as the shortcomings of the mechanical design.

At the conclusion of these tests, the subject equipment was started on a 3000-hour life test to determine the quality of the components.

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INTRODUCTION

1. A pre-engineering model of the UM switching equipment was submitted to this Laboratory by the General Electric Company on 10 January 1945. Preliminary tests were conducted on this model (reference 2). The reproduction model was submitted 19 February 1945, and tests were carried out to determine major changes to be made (reference 3). The production model was received at the experimental Loran station of this Laboratory on 10 December 1945. A complete electrical and mechanical analysis of the equipment was conducted on the final model from 10 December 1945 to 31 January 1946.

INSTALLATION OF THE EQUIPMENT

2. Some difficulties were encountered when the Model UM Switching gear was installed at the experimental Loran Station. It was found that good contact could not be made between the inner screen of the shielded room and the flange of the entrance box. This would be avoided if the inner flanges were provided with slotted mounting holes, which would permit enough adjustment to obtain good contact against the inner screen.

3. It was found excessively difficult to connect the co-axial cables leading from the timers. This situation was due to the crowding of the jacks on TB3701. The terminals on TB3705 were found to be too close together for easy connection of the power leads.

MECHANICAL INSPECTION

4. The second discriminator could not be slid in and out of the cabinet without using a great amount of force. This was due to a poor fit between the runners and the sides of the cabinet. No adjustment has been provided to correct this binding.

5. The switches on the power control panel do not work properly. The slot through which the switches fit is not wide enough to permit proper operation.

6. The cover on the rear of the power control panel is very flimsy, and the result is a poor fit.

7. The leads to the terminal board on the first attenuator stage are too short. Since these leads have to be removed to replace the tube, the stretching necessary to reconnect them might cause failure in time.

8. The antenna switch should be relocated to permit the operator to check its setting more readily.

9. The output power terminals are not covered. This might result in injury to personnel. The space heaters also should be provided with an adequate guard to prevent injury.

ELECTRICAL ANALYSIS

10. The attenuation characteristics of the equipment were measured using the local transmitted Loran signal as the high voltage source. While the transmitter was on, the effect of grounds was studied. It was found that neither the location of the discriminator units in the cabinet nor the position of the rear door had any appreciable effect on the attenuation.

11. The attenuation between the input of the discriminators and their output was measured during the blanked period. The attenuation was as follows:

<u>UNIT</u>	<u>ATTENUATION</u>
1	> 137 db
2	> 137 db
3	137 db

The discriminator returned to normal gain in 300 micro-seconds after passing of the blanking pulse. The received signal suffered no breathing, (over shoot), during this return to normal gain. Because of the lack of breathing, there will be no harmful effects on the timer synchronizer. The gain of the discriminator units during an unblanked period was $6 \pm .5$ db for all three discriminators.

12. The delay through the discriminator units was measured by a model UJ timer which had two microsecond markers. This delay was found to be less than 0.25 microseconds. The delay through the filters was 1.75 microseconds. This large delay is not serious, since when a filter is used it is always common to both local and remote channels, and the difference in delay remains less than 0.25 microseconds.

13. The attenuation between the input of the distant signal branch and the terminated output of the local signal branch was found to be 143 db. The specifications require an attenuation greater than 130 db (reference 4).

14. A signal impressed on the local signal input was attenuated 137 db to the remote output. In this case also, the specifications require not less than 130 db attenuation (reference 4).

15. The attenuation between the input remote channel and the input local channel was 43 db. The specifications require 40 db.

16. The attenuation between the local and remote sections of the timer selection switch was greater than the specification limit of 60 db (reference 4).

17. The leakage between the 100 kc harmonics at the 100 kc selector switch is insufficient to cause interference between channels when checking one of the timer frequencies against the WWV standard frequency broadcast.

18. It was found that enough noise was generated in the discriminator units to increase the noise output of the timer receivers by about 13 db. This was sufficient to reduce the receiver sensitivity by about 10 db. This reduction is not serious with the present station separation as the signal strengths will still be above the noise, but if a greater station separation is used, trouble might be encountered.

19. The equipment was found to operate satisfactorily over a temperature range from 0°C to plus 50°C and with relative humidities up to 95 per cent.

CONCLUSIONS

20. The subject equipment was found to be electrically satisfactory for Naval use in Loran shore stations. However, a mechanical inspection suggested the desirability of minor changes to insure closer compliance with Naval specifications.

RECOMMENDATIONS

21. The following changes are recommended in the Model UM switching equipment to make it more suitable for Loran Shore Station use:

(a) Mechanical

1. The design of the chassis slides should be improved to permit proper adjustment. (Paragraph 4).
2. The mounting of the power switches should be improved to allow more ready operation.
3. The inside grounding flanges should be provided with slots for adjustment. (Paragraph 2).
4. The size of the heads on the screws that secure the cover plate to the entrance box is too large for the screws used. This large head gives a false impression of strength which might result in the breaking of the screw.
5. The cover on the rear of the power panel is not easily removed and replaced. A cover of heavier material is recommended.
6. A greater distance should be provided between the timer jacks on TB 3701 so installation and maintenance will be less difficult. (Paragraph 3). An increase of one-half inch would improve the situation considerably, and even more would be desirable.
6. A more positive method of grounding the rear of the discriminator chassis should be used.
7. The spacing of the terminals on the power output terminal board should be increased by at least one inch to make installation easier. (Paragraph 3).

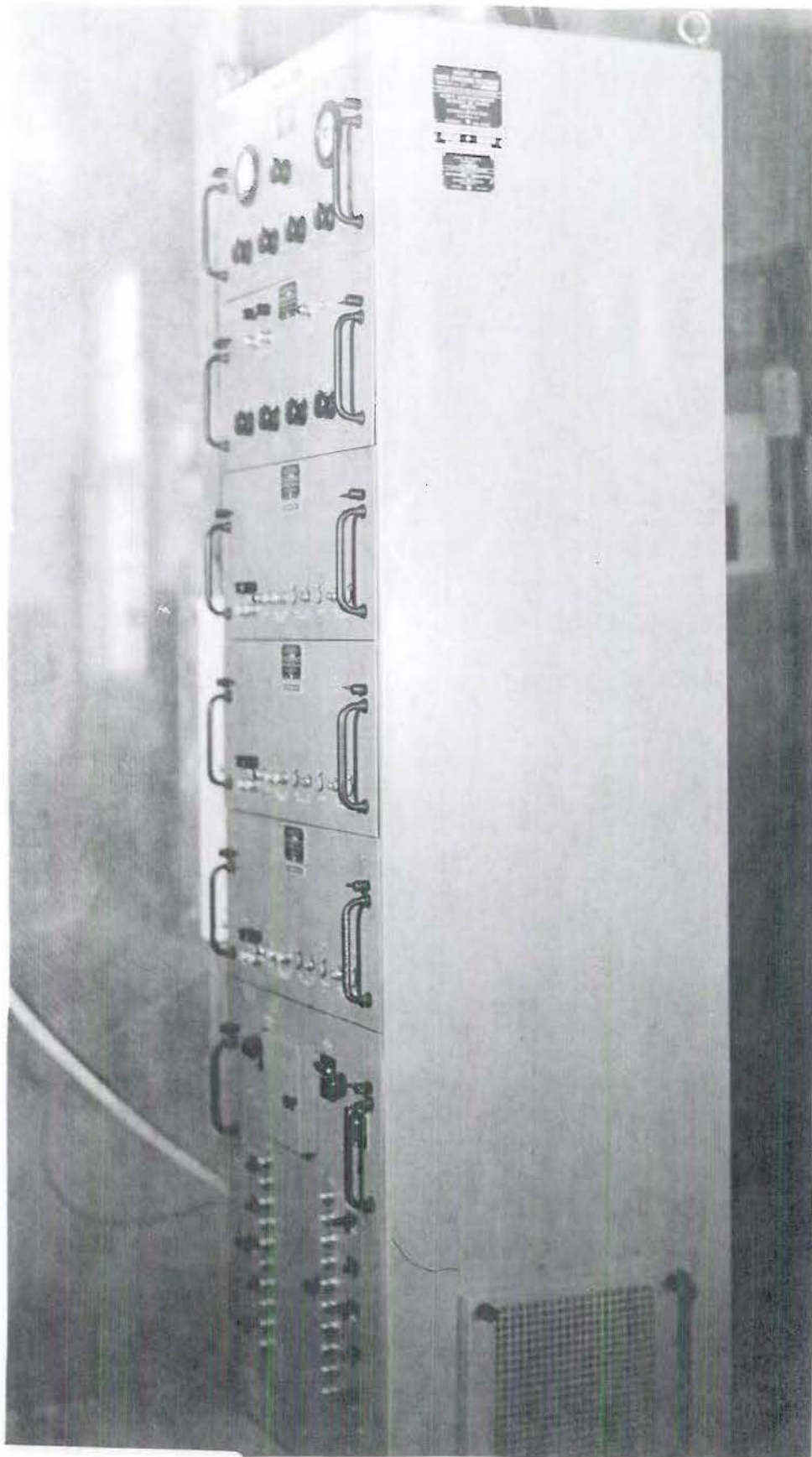
8. The antenna switch on the discriminators should be made more accessible.
9. A guard should be placed in front of the power switches to prevent damage of these switches due to operation by the feet of the operators.
10. The leads to the terminal board on the first attenuator stage of the discriminator should be lengthened by at least one-fourth inch. (Paragraph 7).
11. The spare fuse rack should be made to accommodate spare fuses of all sizes as well as the panel lamps.
12. Allen set-screw wrenches should be provided to permit removal of control knobs
13. The pigtails of the components should not be clipped close to the lug to which they are soldered. A short end about one-sixteenth of an inch long should be left protruding to make removal easier.
14. Covers should be placed over the space heaters and the power output terminal board to prevent possible injury to personnel. (Paragraph 9).

(b) Electrical

1. The amount of noise generated by the discriminators should be reduced. (Paragraph 18). This is not covered by applicable specifications; however, some attempt should be made to reduce this large amount of noise, provided the attenuation characteristics are not prejudiced as a result.

REFERENCES

1. BuShips ltr NXsr 81395 Ser C-935-1131c of 5 January 1945 to NRL - Assignment of Problem.
2. NRL ltr. C-S67-9/10(357:JWB) C-350-26/45 of 8 February 1945 to BuShips. NRL Report on Pre-Engineering Model of UM Switching Equipment.
3. NRL ltr. C-S67-9/10(354:JWB) C-350-95/45 of 30 March 1945 to BuShips. NRL Report on Pre-Production Model of UM Switching Equipment.
4. BuShips Specification RE 13A 1104A. BuShips Specifications for Switching Equipment.

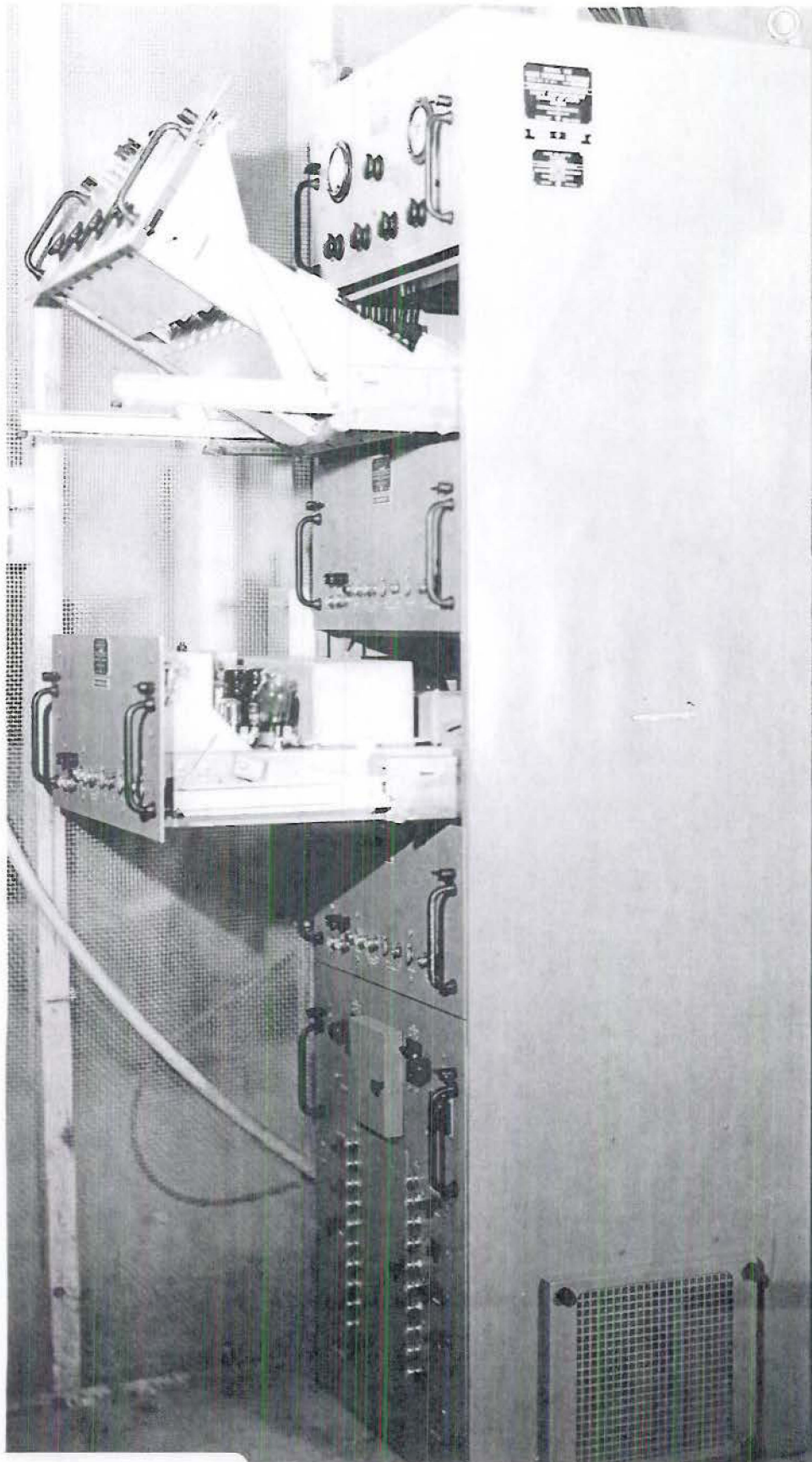


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UM SWITCH GEAR

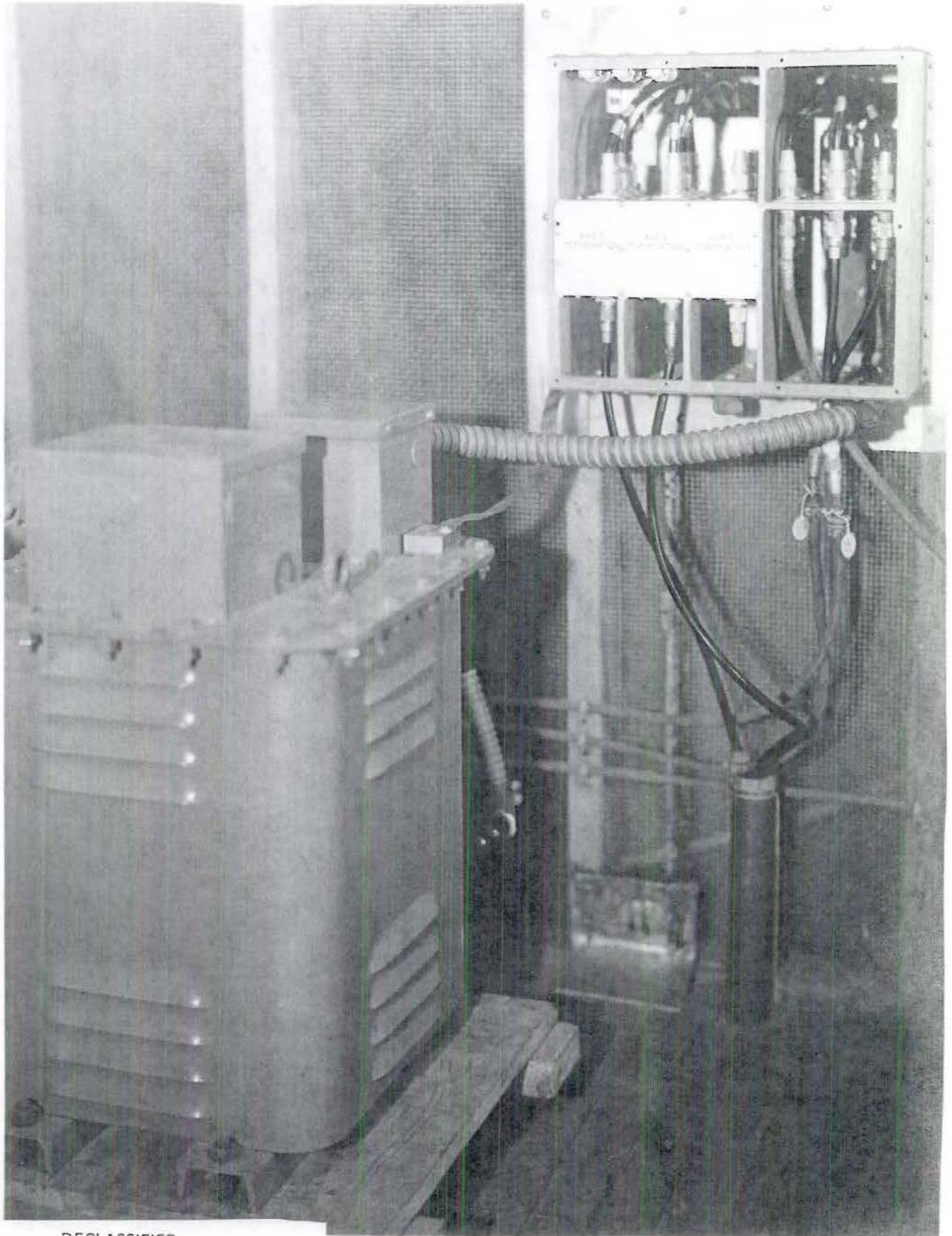
PLATE 1



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UM SWITCH GEAR

PLATE 2



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ENTRANCE BOX
UM SWITCH GEAR

PLATE 3