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SHIP-SHORE RADIO DIVISION - M. AND D. F. SECTION

28 November 1945

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REDUCTION OF INSTRUMENTAL ERROR IN
MODEL DAB DIRECTION FINDING EQUIPMENT

By A. G. Loveberg, Jr.

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By A. G. Loveberg, Jr.

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ABSTRACT

Instrumental errors in the Model DAB direction finder equipment, observed most readily by a difference in bearing on two adjacent bands at the same frequency and amounting to as much as four or five degrees, have been dealt with in this report and a method proposed whereby these errors can be reduced to the point of their becoming practically negligible in normal equipment operation. The proposed correction provides for an increase in symmetry and the reduction of undesirable pickup in the two loop collector systems by shielding the upper loop tracking units and revising certain wiring to the trimmer capacitors in one of these units. The appendices include a list of the items necessary to incorporate the proposed correction in the equipment, together with photographs and manufacturing drawings to permit their procurement and assembly into a "kit", and also instructions for use by station personnel in effecting the modification of the DAB equipments.

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INTRODUCTION

1. The Model DAB direction finder is a spaced vertical loop equipment covering the frequency range from 2 to 18 megacycles in four bands, the mean overlap frequencies between bands being 3.4, 6.0, and 10.4 megacycles. Reference 1 authorizes investigation of bearing errors described in Reference 2 as existing on Band 2 of a Model DAB-3 direction finder equipment installed at Brigantine, New Jersey, by the Coast Guard. This error was first discovered as a result of the observance of a bearing difference between bearings taken on Band 2 and Band 3 on a single fixed target at the same frequency on both bands. The spirit of the problem assigned to this Laboratory, therefore, has been assumed to be the reduction of instrumental error in the DAB equipment which is most readily observable in the difference in bearings between adjacent bands at frequencies in the overlap regions. References 3 and 4 outline the progress through May 1945. This report summarizes the investigation conducted by the Naval Research Laboratory and details the most suitable method found to reduce bearing differences between bearings on the overlap frequencies of Bands 2 and 3.

2. The investigation was requested by the Coast Guard upon observation of a four degree difference existing between bearings taken on Band 2 and Band 3 at the same frequency. This observation was made at the Coast Guard Training Station, Brigantine, N. J. Errors of a similar nature have been observed by other stations as described in Reference 5 and a possible solution consisting of manipulation of the loop tuning inductances was suggested in an article of this reference. An investigation confirming these observations and studying the reasons for the observed error was started by this Laboratory at the Coast Guard Training Station, Brigantine, N. J., resulting in the proposal of the modification contained in this report. Further study on this problem was made at the Coast Guard Washington Radio Station near Alexandria, Virginia, and at the National Bureau of Standards Station, Sterling, Virginia.

3. The investigation under this problem was limited to that which was necessary to give a solution applicable in the field and of sufficient effectiveness to reduce the error observed to a value within the present normal operating limits of the outfit. This has not been carried out to the extent that all equipment error is eliminated. Undesirable frequency characteristics still exist in the equipment which may be eliminated by further investigation, but this is not recommended.

COAST GUARD TRAINING STATION - BRIGANTINE

4. The investigation encompassed by this report was started and concluded with experimentation at the Coast Guard Training Station, Brigantine. Two different equipments were studied at this station. One equipment was used during the first work, which is covered by the interim report, Reference 3, and then replaced by DAB-3, Serial 113, which was used during the second set of experiments in August 1945. The two equipments reacted quite similarly to the various tests conducted. During the first experiments,

tests were conducted to determine the cause of the observed 4 degree difference between bands. Sky wave bearings were attempted which indicated errors at least as great as with local target transmitters. The method outlined in Reference 5 for correcting such errors by "balancing" the inductance loading coils on the two loops was investigated and shown to be both difficult and incapable of producing satisfactory results. The error can be reduced by this method, but the over-all characteristic of the equipment is not satisfactorily altered. This is shown best by the curves for the experiments performed at Sterling, Va. (Plates 3 to 6 inclusive). Physical movement of the condensers in the loop tracking circuit gave a definite correction and indicated that a major portion of the trouble is connected with the upper loop tracking unit. This is further emphasized by the fact that replacing the upper loop tracking unit with a single capacitor eliminated the error. The installation of a grounded screen enclosing the upper loop tracking unit greatly reduced the error by both increasing the symmetry of the loop arrangement and reducing the possibility for pickup in the loop tracking unit affecting the bearing.

5. The second investigation conducted at the Coast Guard Training Station, Brigantine, consisted mainly of a pilot installation of the Naval Research Laboratory prototype of the recommended modification. Plates 1 and 2 show the calibration taken before modification was attempted. This indicates a bearing difference of 4 degrees between Bands 2 and 3, as well as differences of 0.25 degrees between Bands 1 and 2 and 2.1 degrees between Bands 3 and 4. Following modification, the calibration also shown in Plates 1 and 2 was taken. This indicates the order of improvements to be expected and shows a reduction of difference in bearing between Bands 2 and 3. The existing difference between bands was now less than 1.5 degrees average in all cases. The difference between Bands 2 and 3 was 0.22 degrees and the difference between Bands 1 and 2 and between 3 and 4 were 0.15 degrees and 1.5 degrees respectively. The error shown in Plates 1 and 2 with respect to true bearing is the error determined by use of a local target transmitter at a distance of approximately 100 yards from the DAB equipment. These values, therefore, may be influenced to some extent by local site conditions, but should, in any case, give a reasonably accurate means of comparison between the unmodified and modified conditions.

6. According to the station personnel, the bearings obtained on distant stations prior to modification, had a tendency toward excessive swing which made accurate results difficult to obtain. After the modification was completed a test was made to determine the operational characteristics of the equipment on sky wave signals. Table 1 summarizes the data which indicate that the between-band difference is reasonably small with signals of random polarization and no adverse effect is noticeable. Station personnel also indicated that some improvement in the bearing swing was made, but this cannot be verified by any of the experiments performed. Analysis of the bearings on distant stations show that the sky wave bearings are accurate within the limits set down in Table 1 and vary from the true mainly on the weak and obscure signals.

7. The modification of the equipment at Brigantine, N.J., was performed by the regular station personnel aided by photographs of a modified equipment, Plates 10 to 15, and a set of instructions comparable to those found in Appendix 1.

The equipment used was not as simple as that specified in the modification kit, Appendix 1, due to the fact that no capacitor assembly was furnished and the rewiring had to be accomplished by revising the original assembly. The station personnel seemed perfectly competent to make such a change, however, and no difficulty is anticipated when the process is simplified by using the prescribed kit.

COAST GUARD WASHINGTON RADIO STATION

8. A major portion of the actual experimental work was done at the Coast Guard Washington Radio Station, Va., a non-operational installation. The equipment, Model DAB-3, Serial 99, was installed for the purpose of providing a place to investigate this type of direction finder when necessary, and as such did not include a site satisfactory for actual accurate operation of the direction finder on distant signals. The data obtained at this station, therefore, are somewhat limited in accuracy but are considered sufficiently good that the general trend and comparative quality of the data are not impaired.
9. Reference 4 describes the work done through May 1945 at the Coast Guard Washington Radio Station. The between-band difference was not as great as that found at Brigantine, N. J. (see Paragraph 5) amounting to only 3 degrees between Bands 2 and 3, but was otherwise similar in characteristics. An attempt was made to correct the observed difference by adjustment of the loop tuning slugs as described in Reference 5. The correction, however, could not be made complete and an error of 1.5 degrees remained. Installation of a shield, similar to that used at Brigantine, N. J. was made with the equipment aligned normally and a resulting improvement over the original condition was observed. The shield reduced the error from 3 to 1.8 degrees but was not a complete solution. After installation of this shield the sense of the error was reversed, as if the shield produced overcompensation. By turning one of the upper loop tuner units end for end, the error was reduced to zero. This indicated dissymmetry in the upper loop tuner unit. The positioning of the trimmer condensers was shown to be the largest contributing factor to this dissymmetry and was corrected by interchanging the location of the trimmers for Band 1 with that of Band 2 and, similarly, interchanging the location of the Band 3 trimmer with that of Band 4. When this change is made on one loop only, it increases the front-to-back symmetry of the loop circuit to such an extent that the difference between Bands 2 and 3 is almost eliminated. Table 2 shows the results of this change. The difference between bands is now within seven-tenths of one degree. Difficulty in tuning the loop on Band 4 with the shield can in place was eliminated by the insertion of a small variable padder (.5 to 2 micromicrofarads) in series with the Band 4 trimmer condenser. This was found to be more effective than attempting to reduce the capacity effects of the shield box. The need for a low impedance ground to the shield box was also demonstrated as well as the need for careful placement of the ground lead in the center line of the equipment and in the plane of the loop.
10. Correction, by use of the field and rewiring, as specified in this report is not absolutely complete. Examination of the "frequency characteristic" curves in Plate 7 will show that a difference between Bands 3 and 4 is still present after the modification is made. It will also be apparent that there is a bearing

error which varies with frequency and appears in about the same way on all of the Model DAB equipments tested. This error cannot be completely attributed to the site. An investigation of this error indicates that the cause is associated with an unbalanced condition of the loop, caused or accentuated by the characteristic of the lower loop tuner units; in particular, the characteristics of the loop coupling transformer. This error is less than two degrees between bands and average 1.6 degrees over the several experiments conducted. Due to the complexity of the cause of this error, and due to its relatively small value, a complete investigation and solution was not attempted under this problem. A brief discussion of the error, however, will be found in Paragraph 11 below.

11. Plate 9 shows the construction of the loop coupling transformer as detailed by the manufacturer in Reference 6. The wiring of these transformers is not alike in all respects, as is most easily shown by the drawings in Plate 8. This drawing indicates two cases in which the connections to the primary of the loop coupling transformer are reversed. In Figure (a) of Plate 8, the transformers are connected normally. In this condition, the bearing difference between Bands 3 and 4 is 1.8 degrees; and the flux linkage between the coupling transformer and the Band 3 inductances is as shown in (c) of Plate 8. In this case, it may be considered that the flux linkage amounts to a change in the coupling, which may explain part of the existing error. In the second case, the connections to the primary of the coupling transformer on the left loop were reversed, resulting in the circuit of (b) and (d), Plate 8. In this case, the difference in bearing between Bands 3 and 4 was reduced to 0.4 degrees. This may be explained by the same consideration as above due to the increased symmetry and more symmetrical coupling. Data showing the effect at the overlap frequencies of reversing the connections to the coupling transformer primary are given in Table 3. This reversal of the primary leads of one coupling transformer is not a complete solution, but indicates the direction in which a complete solution must proceed. In the case of one primary reversed, it will be noticed that the current flow in the secondary circuits of the two transformers aid rather than buck each other. This leads to a thumping sound in the audio output of the receiver due to the periodic shorting out of the receiver inputs in commutation. A complete solution of this problem would probably necessitate the replacement of the unbalanced receiver inputs with a more nearly balanced system. This, however, would be a sizeable problem in itself. The amount of this error varies with equipment and in some cases, such as at the Bureau of Standards Station, Sterling, Va., Plate 7, is so small after the prescribed modification has been made, that further correction is unnecessary.

NATIONAL BUREAU OF STANDARDS STATION

12. Tests were conducted at the National Bureau of Standards Station, Sterling, Va., on the Model DAB-3 equipment, Serial 23, during July 1945. The equipment at this station is installed in a relatively good direction finding site and is in the best site of any of the three locations used in this investigation. Three calibrations were made at this station. The first calibration was made to show the results obtained when correction was attempted by "balancing" the inductances in the two loops. This process was carried out

carefully by the engineers at the station prior to the experiments by this Laboratory and during the time that the equipment was in operation in the study of ionospheric conditions in the problem referred to in Reference 5. This reference also describes in the process more fully. It consists, however, of adjusting the loading inductances in the loops by movement of the slugs so that the apparent errors are reduced. In general it tends to compensate for the unbalance between the two halves of each loop rather than eliminate that unbalance as is done in the modification prescribed in this report. The calibration of the "balanced" condition is compared to those taken when the equipment was aligned in the normal manner both with and without modification. (Plates 3 to 6). The "balanced" condition shows a definite improvement over the normal condition at the overlap frequency between Bands 2 and 3, but otherwise is not very successful. Correction by installation of the modification at this station was successful to the extent that the between-band error was reduced approximately from 0.7 to 0.3 degrees between Bands 1 and 2, from 1.8 to 0.2 degrees between Bands 2 and 3, and from 1.1 to 0.3 degrees between Bands 3 and 4.

13. An investigation was undertaken at this station to determine whether the addition of the shield boxes and ground leads adversely affects the response of the equipment to abnormally polarized signals. Although no specific data can be given, limited tests indicate that the modification produced no increase in the possible polarization error and, if anything, tends to reduce it. Accurate confirmation of the absence or presence of polarization error is extremely difficult with this equipment and was not attempted. The absence of polarization error is believed to be quite complete as indicated by the theory of operation of this equipment.

REPORTS OF MODIFICATIONS

14. In order that the Laboratory might be able to analyze the results obtained by the modification recommended in this report, it is considered desirable that each station submit the data outlined in Tables 4 and 5. This data must be taken both before and after the modification is made to be of great value. These tables are designed to cover both near and distant signal sources, giving the most usable data for each case. All blanks should be filled in carefully using the designations appearing on the reverse side of the tables when applicable.

15. Table 4 pertains to that information obtained by a local calibration with target transmitter. One sheet should be used for each frequency. Space is provided so that the readings taken on both bands at the same frequency in the regions of overlap may be entered on a single page. In this connection it is advisable to read the bearings on both bands at a given azimuth before moving the target or changing the frequency. Bearings should be taken at intervals of not greater than 15 degrees separation in azimuth and not fewer than three frequencies on each band with the possible exception of one frequency on Band 1. The target should be placed at least 200 feet from the direction finder and preferably, at least twice the length of the radials. The placement of the target may be limited by site or power considerations. In this case, a statement under "Remarks" is desirable giving details of site limitations and trouble

encountered while calibrating which may affect the validity or accuracy of the data. A portable transmitter placed at carefully designated spots is preferable to airborne or vehicle born equipment. If airborne calibrations are made, however, data on them would be of interest to the Laboratory. Obviously, the procedure outlined in this report cannot be used for calibrations involving moving targets either airborne or in vehicles. In these cases, a description of the method of calibration used should be included in the report of data.

16. Table 5 provides for data concerning bearings taken on stations remote from the direction finder site. No advantage is obtained in taking bearings on weak or extremely difficult signals. Only bearings readily repeatable on each band concerned is of interest for between-band comparisons. The taking of many bearings over a period of time on one station are highly desirable, however, stations should be chosen so that relatively the same frequency coverage is made as in Table 4, with the exception that the bearings taken on two different bands at the same frequency are of even greater importance. It is felt that these data may most easily be collected over a period of several days by making observations in between the regular station operational schedules. A large number of readings are mandatory to make a true analysis possible. Data are called for in this table concerning the condition of the collector systems with regards to tuning. These data are obtained by tuning the loops as prescribed in the instruction book for the equipment and denoting the number of divisions (maximum) that the "loop tuning dial" must be adjusted to produce a maximum reading on the carrier strength meter. The loops should be properly adjusted before making any measurements and the number of divisions of tuning required should be within the limits given in the instruction book. The amount of bearing swing, requested as part of the data for each reading of bearings, is obtained by noting the number of degrees on either side of the observed bearing that bearings may occasionally be taken. This effective swinging of the bearings is presumably caused by variations in the signal path resulting from ionospheric changes.

CONCLUSIONS

17. With the modification described in this report, it is possible to reduce the difference in bearing between bands of the Model DAB direction finder to such an extent that it is within the limits of normal operating accuracy. This modification will not eliminate all equipment error but the remainder is relatively small and is so much a part of the equipment that the reduction of it would entail a major revision of the loop coupling system. The simplicity of the modification is sufficient that no unusual training is required in its installation, other than a working knowledge of the DAB equipment.

RECOMMENDATIONS

18. It is recommended:

- (a) That the present Model DAB equipments be modified to reduce instrumental error.

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- (b) That modification be made through the use of modification kits as detailed in Appendix 1.
- (c) That data be sent to the Laboratory covering conditions before and after modification for each station, in accordance with the information presented in Paragraphs 14 to 16 and Tables 4 and 5.

ACKNOWLEDGEMENTS

19. Acknowledgement is made to the United States Coast Guard and to the National Bureau of Standards for their cooperation in making available stations, equipment, and personnel for this investigation, as well as to E. L. Kilpatrick, Lt., USCG, whose untiring efforts and close cooperation with the NRL representative, as well as the definition of the original problem in his report, Reference 2, were of invaluable assistance in the final completion of this work.

REFERENCES

1. BuShips ltr 1327(925D) of 18 January 1945 to NRL. (Extension of Problem S502T-C.)
2. Commandant U.S. Coast Guard ltr EGM-8, CG-815 of 2 January 1945 to BuShips. (Observed bearing error, Navy Type DAB-3 HF/DF Equipment.)
3. NRL ltr C-S67/69 (342:AGL), Ser. C342-19/45 of 24 February 1945 to BuShips. (First interim report on Problem S502T-C.)
4. NRL ltr C-S67/69 (342:AGL), Ser. C342-93/45 of 2 June 1945 to BuShips. (Second interim report on Problem S502T-C.)
5. National Bureau of Standards - Progress Reports - NDRC Projects 13.2 - (88 to 99): Correlation of Direction Finder Errors with Ionospheric Conditions.
6. RINM Cedar Rapids ltr NXss-17111 of 25 July 1945 to NRL. (Reply to request for information on design details of DAB loop tuning and coupling circuits.)


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INSTRUCTIONS

FOR

MODIFICATION OF MODEL DAB EQUIPMENT

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PURPOSE OF MODIFICATION

1. This modification is made for the purpose of obtaining both similarity and symmetry in the collector systems of the Model DAB equipment, to eliminate between-band bearing difference which has been observed in some equipments. It consists of shielding the two upper loop tracking units and modifying the construction of one of these two units by repositioning the four trimmer condensers and inserting an additional series condenser in the Band Four circuit of both loops. The repositioning of the trimmer condensers consists simply of interchanging the location of the Band Four trimmer with that of the Band Three trimmer and interchanging the location of the Band Two trimmer with that of the Band One trimmer. New leads between the trimmer condensers and the tracking condensers are necessary to conform to the new positions of the trimmer condensers. The shield boxes are to be grounded to the loop support beam. These facts should be kept in mind at all times while making the modification and care exercised to do all work in a direct, neat manner. Symmetry is vitally important, and both loops should be as nearly alike as possible after the modification is complete. NRL drawing RA 69F 227A sheet 3, is a pictorial assembly of the shield and drawing, sheet 1, shows the necessary wiring change.

PARTS LIST

2. Material required for modification:

- Unit one: Shield box - right loop - NRL drawing number RA 69F 227A - sheet 5 - one required.
- Unit two: Shield box - left loop - NRL drawing number RA 69F 227A - sheet 5 - one required.
- Unit three: Ground rod assembly - NRL drawing number RA 69F 227A - sheet 4 - two required.
- Unit four: Condenser assembly - NRL drawing number RA 69F 227A - sheet 1, 2, and 4 - one required.
- Unit five: Padder assembly - NRL drawing number RA 69F 227A - sheet 1, part number 7 and 57 - one required.
- Unit six: Spare padder condenser - NRL drawing number RA 69F 227A - sheet 4, part number 57 - one required.
- Unit seven: Six drawings - NRL drawing RA 69F 227A - sheets 1 to 6.

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METHOD OF MODIFICATION

3. The first step in making the modification is the removal of the upper loop tracking unit on the right loop.

Step one: Unsolder and disconnect the leads joining the unit to the loop at the top flattened ends of the loop.

Step two: Remove the four studs which hold the condenser unit to the supporting frame by removing the nuts from the top end of the studs, then lift the whole assembly off. The studs and spacers will be necessary in reassembling the unit.

4. Rewiring the upper loop tracking assembly for the right loop is the next step in the modification. This consists of replacing the four trimmer condensers, their mounting board, and the leads connecting them to the tracking condenser, with a new unit in which the four trimmer condensers are shifted by interchanging the positions of the Band Three and Band Four trimmer, and interchanging the positions of the Band One and Band Two trimmers.

Step three: Unsolder the leads connecting the trimmer condensers (C1403, C1404, C1405, C1406) to the tracking condensers by unsoldering at the tracking condenser. Referring to drawing, sheet 1, the equivalent of leads numbered as parts 1 through 8 on the original assembly are to be unsoldered at the points marked A and C on C1401 and C1402 and also disconnected from the switches S1401 A, D, and E and S1402 A, D, and E.

Step four: Remove the trimmer condensers, their leads, and their mounting board as one unit by removing the screws and nuts, parts 60 and 61 on drawing, sheet 1, and lifting out the unit by lifting out panel, part 11.

Step five: Insert unit four in reverse order to step four above.

Step six: Resolder leads, parts 1 through 8 in the positions shown in drawing, sheet 1.

(Note: Care must be taken when soldering the leads into position that the leads or drops of solder do not extend below the lower solder lug, i.e., do not make contact with the frame of tracking condenser.)

5. Installation of the ground rod base is the next step. This consists of bolting unit three to the upper side of the loop support beam so that the ground rod socket is in the center between the two loop tuning remote control rods. The ground rod base is bolted in position by use of the four studs on the sides of the top of the loop support beam. This installation is shown in drawing, sheet 3.

Step seven: Remove the nuts and washers from the four studs on the sides of the loop support beam which match the position of the holes in part 12, drawing, sheet 3.

Step eight: Remove paint or dirt from loop support beam around stubs to provide the best possible electrical contact between part 12, drawing, sheet 3, and the loop support arm.

Step nine: Bolt part 12 in place so that the flange part 14, drawing, sheet 4, is upright in the center between the two loop tuning remote control rods.

6. Installation of the base of the shield box and ground rod comprises the next step. The shield boxes are provided in three pieces, top, sides, and base. The base plate has the ground rod flange attached. The boxes are marked right loop and left loop to permit correct marking of the trimmer condenser positions and they should be installed on the proper loops.

Step ten: Place the bottom plate of the shield box part 21 on the supporting frame so that the four studs protrude through the four holes provided for them.

(Note: It will be noticed, that the two center holes for the remote tuning rods are off center and the bottom plate must be placed so the hole nearest the center of the base is toward the center of the DAB receiver.)

Step eleven: The four metal spacers, removed in Step two, should be slipped over the studs protruding through the four holes in the base plate. These four studs should be held up in this position to act as guides when setting the condenser unit in place.

7. Replacement of the upper loop tracking unit on the right loop is the next step. This is the reverse procedure in step one.

Step twelve: Holding the four studs so that they extend well above the base plate and spacers, carefully lower the condenser unit in place using the studs as guides.

(Note: This unit must be replaced in the same position that it was in before removal, i.e., with the trimmer condenser mounting board facing away from the center of the DAB receiver.)

Step thirteen: Replace the nuts and washers and tighten the unit in place.

Step fourteen: Resolder the connections to the loop, making sure that a good contact is made.

8. Installation of the ground rod is the next step.

Step fifteen: Make sure parts 13 are in place on the end of the rods, parts 15 and 16 and insert part 17 between parts 15 and 16, as shown in drawing, sheet 3.

Step sixteen: Put the unit formed in step fifteen in place between the two flanges, parts 14, and lengthen until snug by turning part 17, and lock tightly with the two nuts, parts 58 and 62.

Step seventeen: Tighten nuts, parts 13.

9. Assembly of the shield box is the next step.

Step eighteen: Install the sides and top of the shield box, making sure that the marking on the sides corresponds to the loop on which it is installed.

10. Modification of the left loop is the final step.

Step nineteen: This step is the same as steps one and two.

Step twenty: Replace the original lead between trimmer C1506 and capacitor C1502C and switch S1502A, with parts 7 and 57.

Step twenty-one: Steps 7 through 18 are to be followed for the left loop the same as for the right loop.

TABLE 1

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DAB DISTANT STATION CALIBRATION
EXCERPT OF OPERATIONAL DATA OF
COAST GUARD TRAINING STATION, BRIGANTINE, N.J.

Covering overlap frequencies between Bands 2 and 3, and 3 and 4.

Equipment Modified

Overlap between Bands 2 and 3 (5.9 - 6.08 Mc) (Average difference 0.48 degrees)

Station	Freq. in Mc.	Bearing		Diff. in Deg.	Bearing			Qual.*	Signal Strength
		Band 2	Band 3		Aveg.	True	Error in Deg.		
CFRB	6.08	325.5	324.8	.7	325.1	-	-	AA	S3
-	5.935	154.2	154.1	.1	154.15	-	-	AA	S4
NPM	6.06	282.1	282.7	.6	282.4	282.9	.5	AA	S4
-	6.02	56.0	55.5	.5	55.7	-	-	BB	S4

Overlap between Bands 3 and 4 (10.3 - 10.5 Mc) (Average difference 1.1 degrees)

Station	Freq. in Mc.	Bearing		Diff. in Deg.	Bearing			Qual.*	Signal Strength
		Band 3	Band 4		Aveg.	True	Error in Deg.		
-	10.31	161.8	160.6	1.2	161.2	-	-	AA	S5
-	10.49	236.5	234.5	2.0	235.5	-	-	BB	S4
XDAS(XDL)	10.34	233.0	235.0	2.0	234.0	234.1	0.1	AA	S4
-	10.33	147.2	147.8	0.6	147.5	-	-	AA	S4
-	10.38	167.9	168.8	0.9	168.3	-	-	AA	S3
-	10.38	163.9	163.7	0.2	163.8	-	-	AA	S4
-	10.3	282.0	283.0	1.0	282.5	-	-	CC	S3
WFD	10.48	241.5	240.5	1.0	241.0	238.7	2.3	CC	S4

*Quality of bearing

Probable error not to exceed the following:

A - $\nless 2^\circ$

B - $\nless 5^\circ$

C - greater than $\nless 5^\circ$

Double letter indicates front and back bearing.

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CALIBRATION OF MODEL DAB EQUIPMENT
COAST GUARD WASHINGTON RADIO STATION

Equipment Modified

Band No.	Freq. in Mc.	True Bearing F ₁ 279.3°		True Bearing F ₂ 213.5°		True Bearing F ₃ 21.2°	
		Observed Brg. in Deg.	Error in Deg.	Observed Brg. in Deg.	Error in Deg.	Observed Brg. in Deg.	Error in Deg.
1	2.6	280.5	+1.2	212.0	-1.5	19.3	-1.9
1	3.4	278.5	-0.8	211.5	-2.0	22.7	+1.5
			*0.5		*0.3		*0.1
2	3.4	279.0	-0.3	211.8	-1.7	22.8	+1.6
2	4.5	277.4	-1.9	213.7	+0.2	19.7	-1.5
2	6.0	279.5	+0.2	214.1	+0.6	20.4	-0.8
			*0.0		*0.7		*0.5
3	6.0	279.5	+0.2	214.8	+1.3	20.9	-0.3
3	7.8	282.0	+2.7	218.7	+5.2	22.2	+1.0
3	10.4	278.3	-1.0	211.7	-1.8	19.1	-2.1
			*1.5		*2.1		*1.3
4	10.4	279.8	+0.5	213.8	+0.3	20.4	-0.8
4	13.5	278.9	-0.4	214.7	+1.2	22.9	+1.7
4	17.0	280.5	+1.2	215.7	+2.2	22.2	+1.0

Notes:

*Difference between observed bearings on adjacent bands at the same frequency.

F₁ Distance to target transmitter one-half mile approximately.

F₂ Target located at Fort Belvoir Tower PA-41-T. Distance approximately two miles.

F₃ Target located on grounds of Mays' Dairy Farm. Distance approximately three miles.

TABLE 3

EFFECT OF CHANGES IN
LOOP COUPLING CIRCUIT

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Effect of reversing primary leads of coupling
transformer on between-band bearing difference.

<u>Frequency in Megacycles</u>	<u>Bands Affected</u>	<u>Difference in observed bearing between two bands at the same frequency Degrees</u>	
		<u>Normal ∇ Circuit</u>	<u>Reversed* Primary</u>
3.4	1 & 2	0.1	0.0
6.0	2 & 3	0.7	0.7
10.4	3 & 4	1.8	0.4

Note:

- ∇ Connections to the loop coupling transformer normal, with the corrective modification of the loop made, and bearings taken on a fixed local target transmitter.
- * Connections to the primary of the left loop coupling transformer reversed, and with all other conditions as described above for the normal circuit condition. This condition corresponds to that shown in Figures (b) and (d) of Plate 8.

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TABLE 4a

This table to be printed on reverse of Table 4.

Model _____ Serial # _____ Date _____

I Station Data (Necessary only once for each calibration)

Latitude _____ Longitude _____ Equipment Modified? _____ Alignment _____

Maximum divisions that loop tuning dial must be moved to resonate loops.

Band	1	2	3	4
Right Loop				
Left Loop				

Length of radials _____ feet. Number of radials _____.

II Calibration Data

Conveyance of local target transmitter _____.
 Elevation of local target transmitter _____.
 Power output of target transmitter approximately _____ watts.
 Radius of calibration circle* _____.

*Calibration circle should not be less than 200 feet in radius and should be at least twice the length of the radials.

III Preferred Frequencies for Local Target Calibration

Frequencies in the mid-band region should be omitted if it becomes necessary to take fewer than the requested number of calibrations.

Approximate 3.4 Mc, 6.0 Mc, and 10.4 Mc - readings taken on both bands at one frequency in each overlap region.

Approximate 2.5 Mc, 4.5 Mc, and 17 Mc - readings taken in middle area of each band.

TABLE 5

REMOTE STATION OBSERVATIONS

	Date _____ Station _____											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Observation Number												
2. Station Identification												
3. Frequency (Mc)												
4. Band												
5. Time (GMT)												
6. Emission (A1 etc.*)												
7. Strength (S1 etc.**)												
8. Readability (R1 etc.***)												
9. Quality (A etc.****)												
10. Bearing Swing (Degrees)												
11. Bearing Sharpness												
12. Observed Brg. Direct												
13. Observed Brg. <u>Reciprocal</u>												
14. Average Bearing												
15. True Bearing												
16. Bearing Error												
17. Operator's Initials												
Remarks:												



TABLE 5a

This table to be printed on reverse of Table 5.

Model _____ Serial # _____ Date _____

I Station Data (Necessary only once for each calibration)

Latitude _____ Longitude _____ Equipment Modified? _____ Alignment _____

Maximum divisions that loop tuning dial must be moved to resonate loops.

Band	1	2	3	4
Right Loop				
Left Loop				

Length of radials _____ feet.

Number of radials _____.

*Type of Transmission

- A0 - CW
- A1 - Keyed CW
- A2 - MCW
- A3 - Voice
- A4 - Facsimile
- A5 - Television

**Signal Strength

- S1 - Faint - barely perceptible.
- S2 - Weak signals.
- S3 - Good signals.
- S4 - Strong signals.
- S5 - Extremely strong signals.

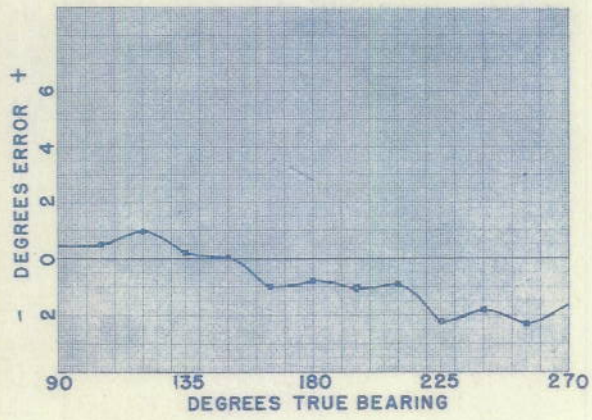
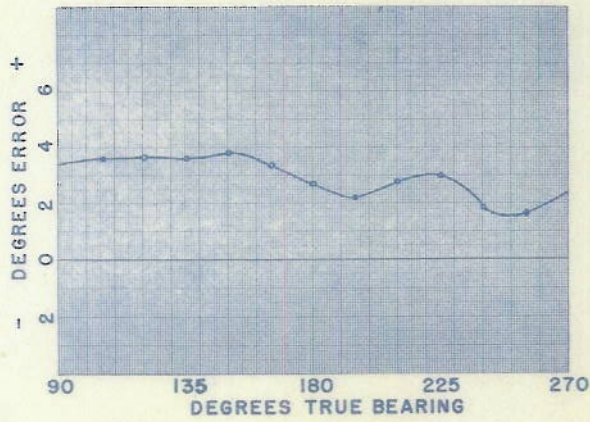
***Readability

- R1 - Unreadable
- R2 - Barely readable (occasional words).
- R3 - Readable with considerable difficulty.
- R4 - Readable - practically no difficulty.
- R5 - Perfectly readable.

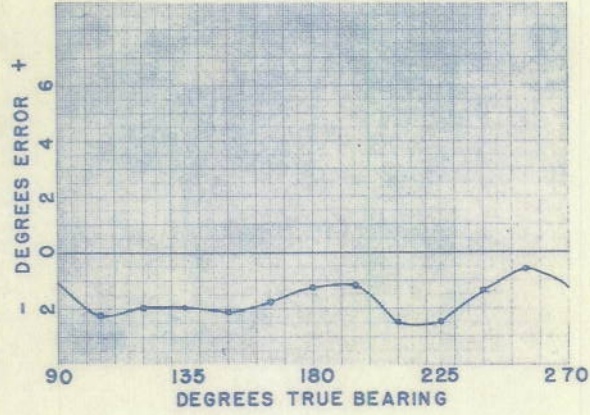
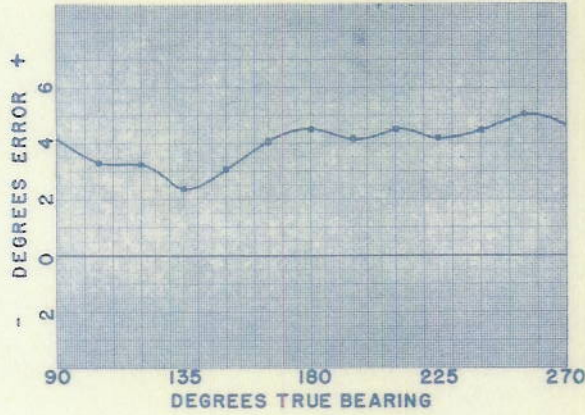
****Estimated Quality

- A - Excellent bearing repeatability, $\angle 0.5^\circ$.
- B - Good bearing repeatability, $\angle 1.5^\circ$.
- C - Fair bearing repeatability, $\angle 2.5^\circ$.
- D - Poor bearing repeatability, $\angle 5^\circ$.
- E - Very poor bearing repeatability, $\angle 10^\circ$.
- F - Bearing not repeatable.

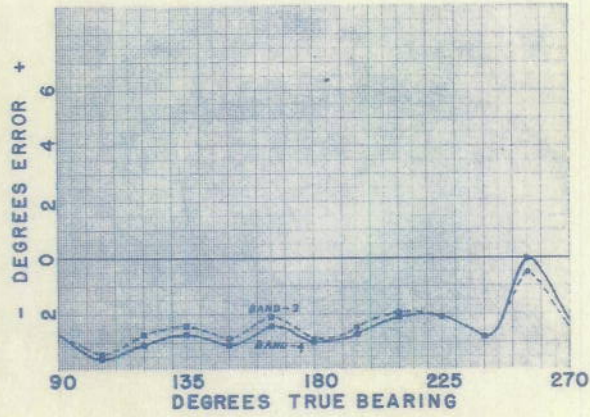
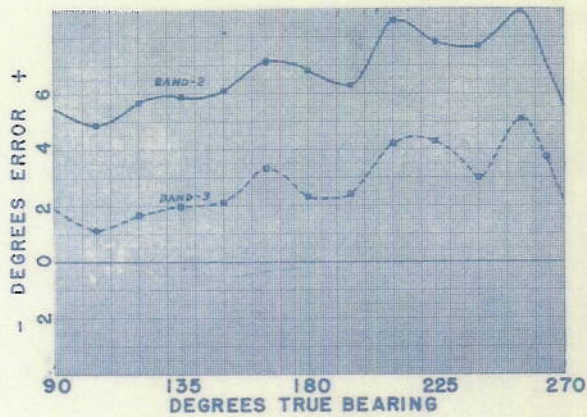
FREQUENCY 2.36 MEGACYCLES



FREQUENCY 4.75 MEGACYCLES



FREQUENCY 5.92 MEGACYCLES



BEFORE MODIFICATION

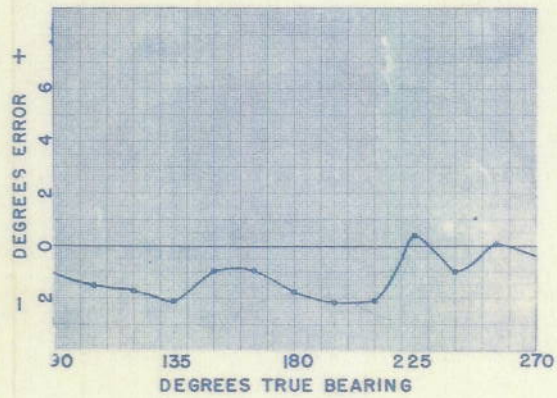
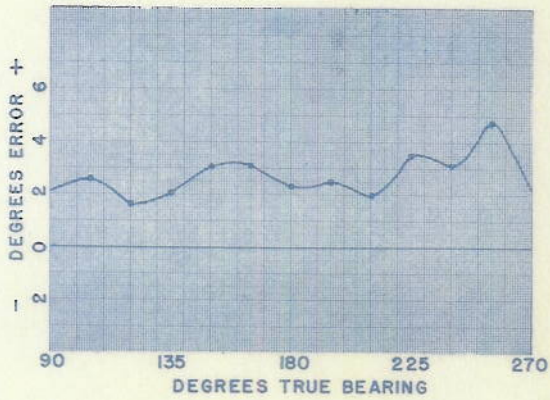
AFTER MODIFICATION

ERROR vs TRUE BEARING

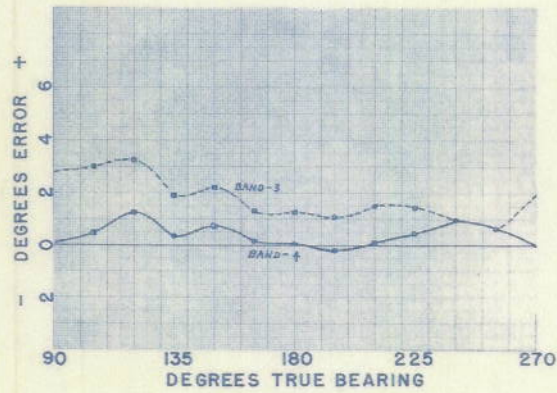
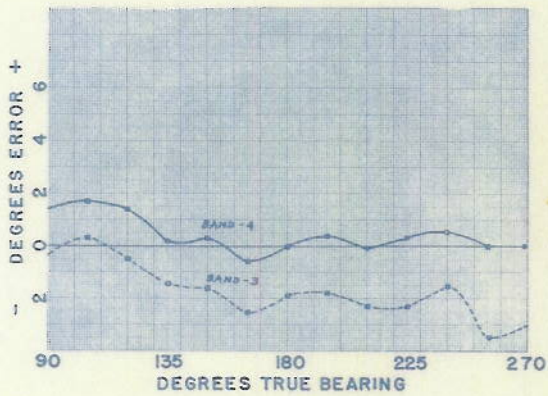
DAB-3 RADIO DIRECTION FINDER
COAST GUARD TRAINING STATION
BRIGANTINE N.J.

DECLASSIFIED

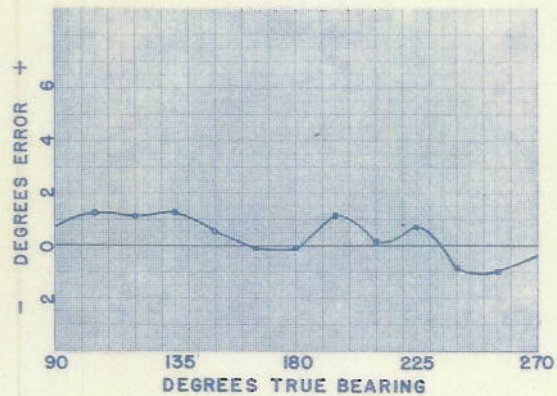
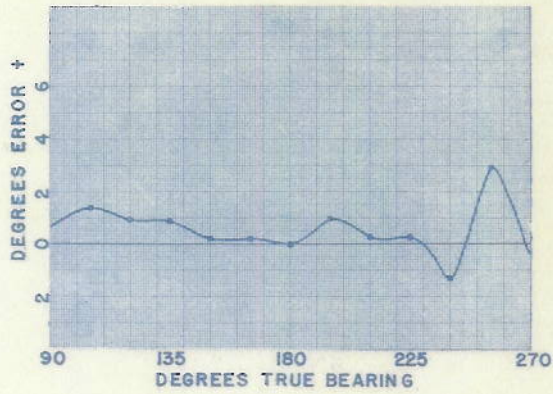
FREQUENCY 8.3 MEGACYCLES



FREQUENCY 10.4 MEGACYCLES



FREQUENCY 14.2 MEGACYCLES



BEFORE MODIFICATION

AFTER MODIFICATION

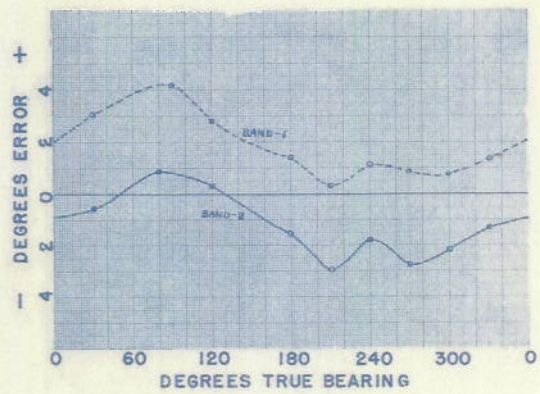
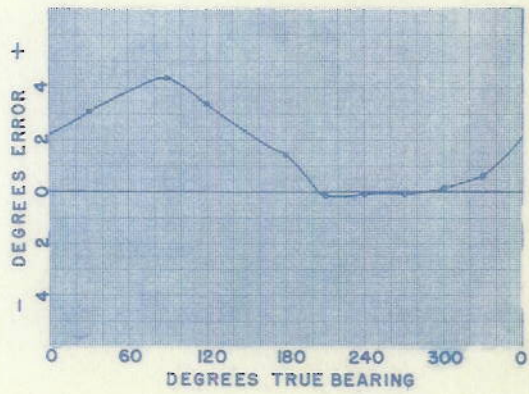
ERROR vs TRUE BEARING

DAB-3 RADIO DIRECTION FINDER
COAST GUARD TRAINING STATION
BRIGANTINE N.J.

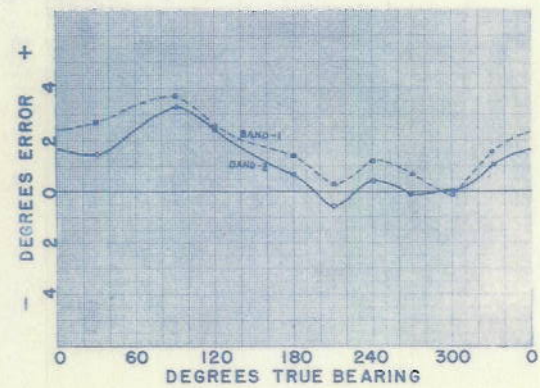
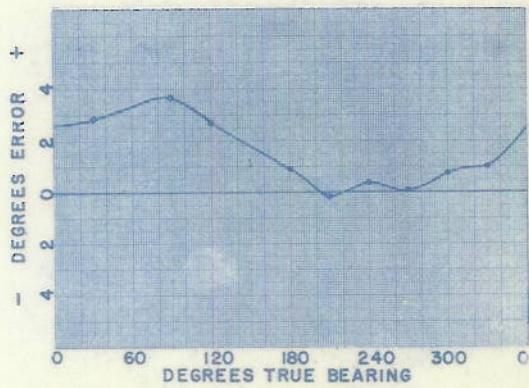
CONFIDENTIAL

PLATE 2 DECLASSIFIED

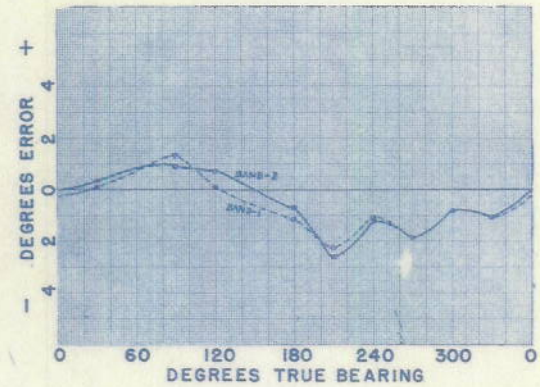
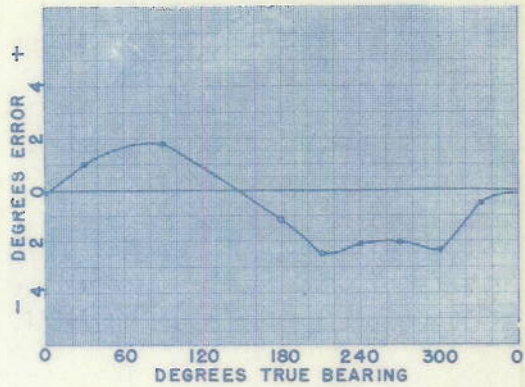
CORRECTION MADE BY "BALANCED INDUCTANCE" METHOD



NORMAL ALIGNMENT



AFTER CORRECTION BY N.R.L. PROPOSED MODIFICATION



FREQUENCY 2.36 MEGACYCLES

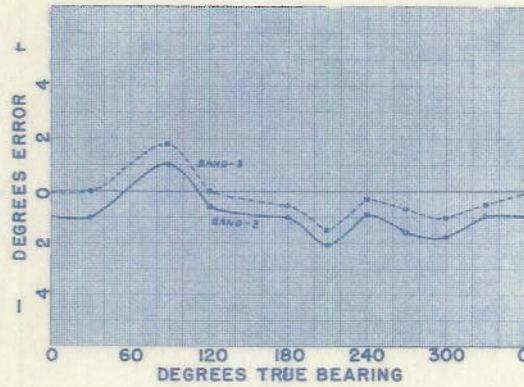
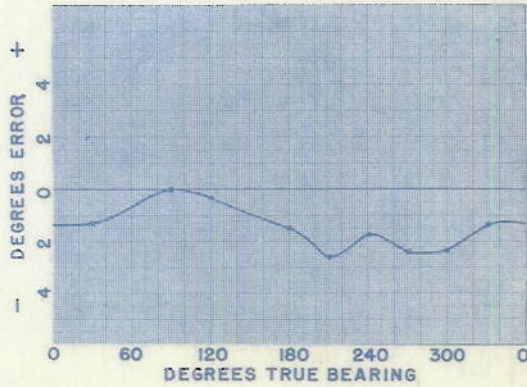
FREQUENCY 3.4 MEGACYCLES

ERROR vs TRUE BEARING

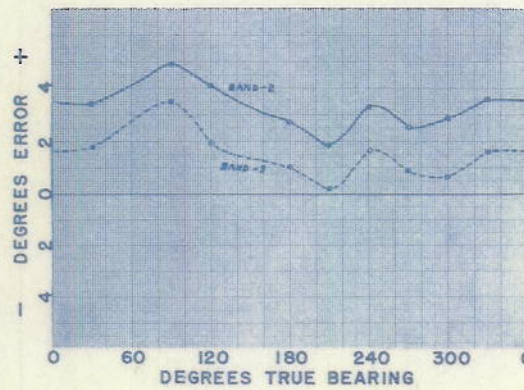
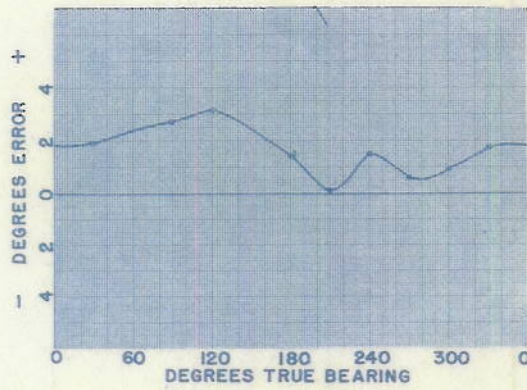
DAB-3 RADIO DIRECTION FINDER
BUREAU OF STANDARDS STATION
STERLING, VIRGINIA

DECLASSIFIED

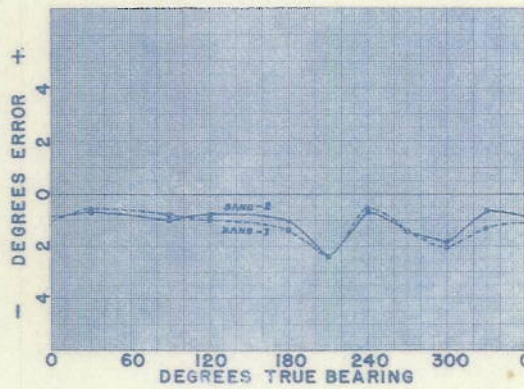
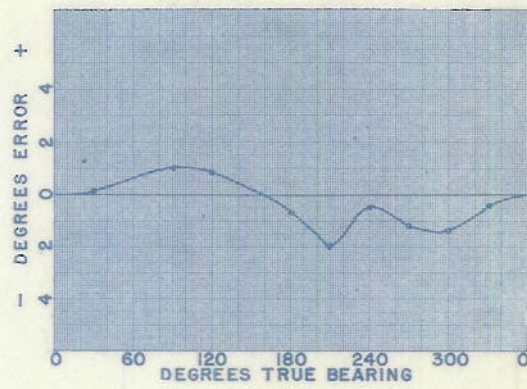
CORRECTION MADE BY "BALANCED INDUCTANCE" METHOD



NORMAL ALIGNMENT



AFTER CORRECTION BY N.R.L. PROPOSED MODIFICATION



FREQUENCY 4.74 MEGACYCLES

FREQUENCY 5.92 MEGACYCLES

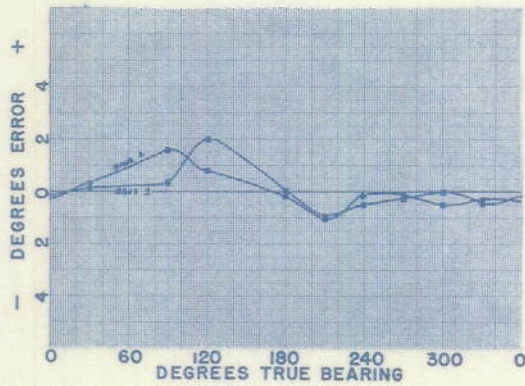
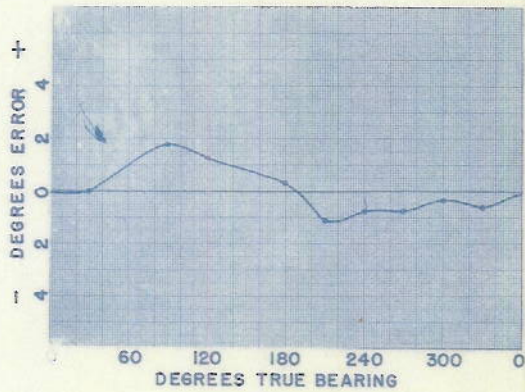
ERROR vs TRUE BEARING

DAB-3 RADIO DIRECTION FINDER
BUREAU OF STANDARDS STATION
STERLING, VIRGINIA

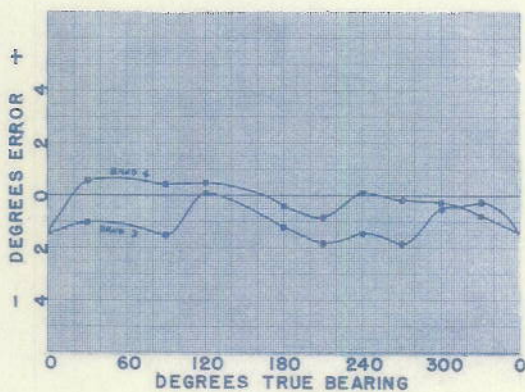
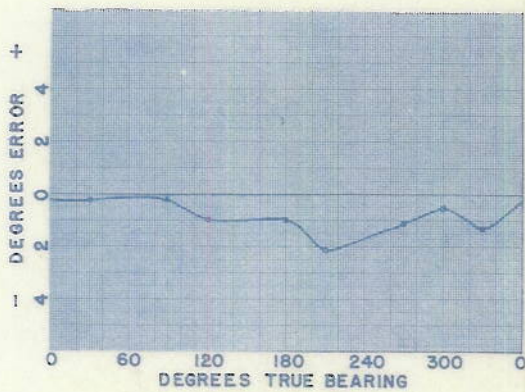
PLATE 4

DECLASSIFIED

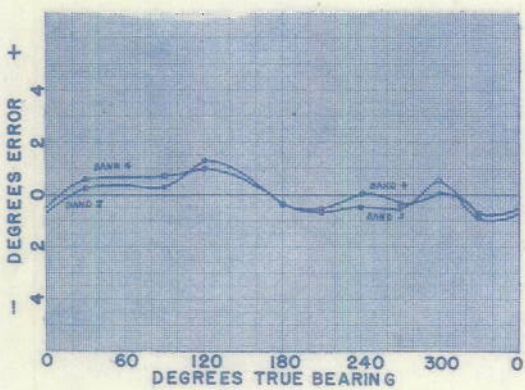
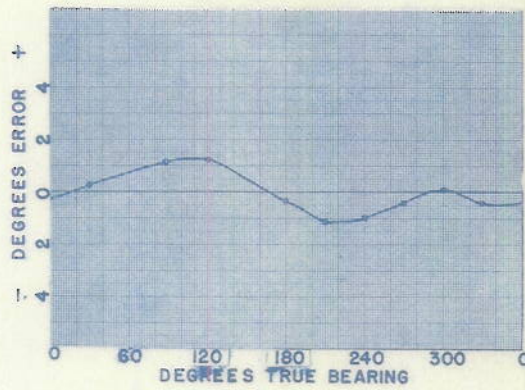
CORRECTION MADE BY "BALANCED INDUCTANCE" METHOD



NORMAL ALIGNMENT



AFTER CORRECTION BY N.R.L. PROPOSED MODIFICATION



FREQUENCY 8.3 MEGACYCLES

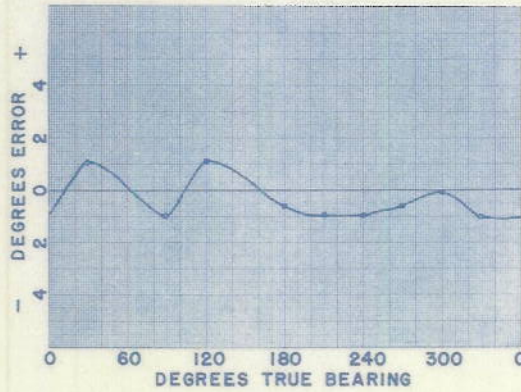
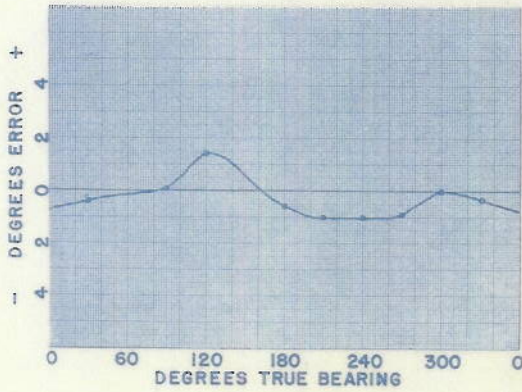
FREQUENCY 10.4 MEGACYCLES

ERROR vs TRUE BEARING

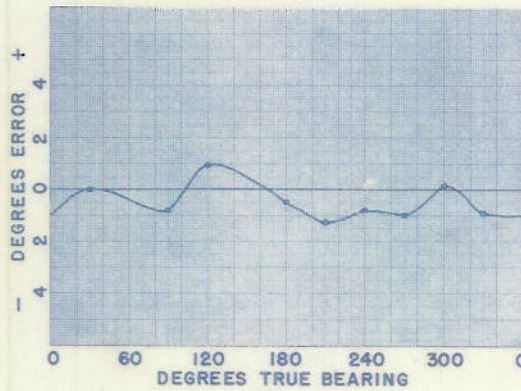
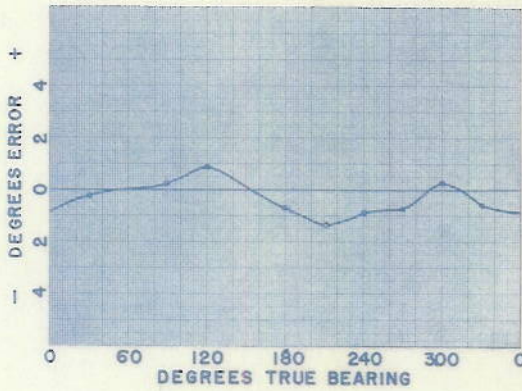
DAB-3 RADIO DIRECTION FINDER
BUREAU OF STANDARDS STATION
STERLING, VIRGINIA

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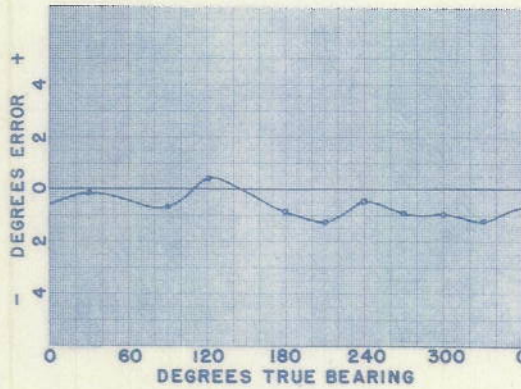
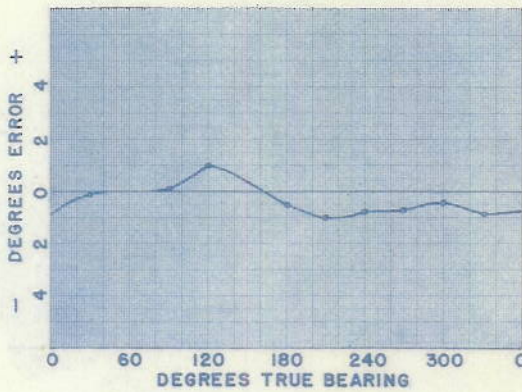
CORRECTION MADE BY "BALANCED INDUCTANCE" METHOD



NORMAL ALIGNMENT



AFTER CORRECTION BY N.R.L. PROPOSED MODIFICATION



FREQUENCY 14.2 MEGACYCLES

FREQUENCY 17.8 MEGACYCLES

ERROR vs TRUE BEARING

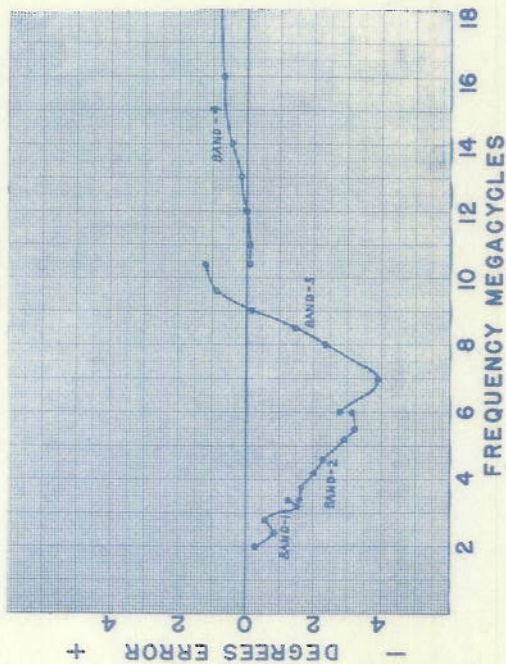
DAB-3 RADIO DIRECTION FINDER
BUREAU OF STANDARDS STATION
STERLING, VIRGINIA

PLATE 6

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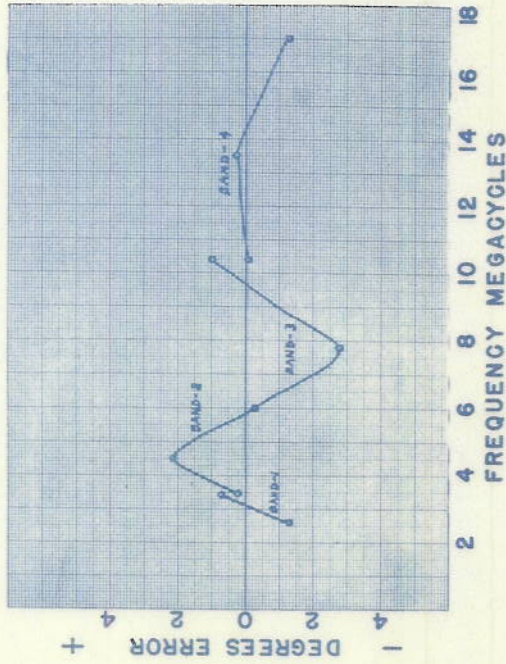
COAST GUARD TRAINING STATION
BRIGANTINE, N.J.

MODIFIED CONDITION



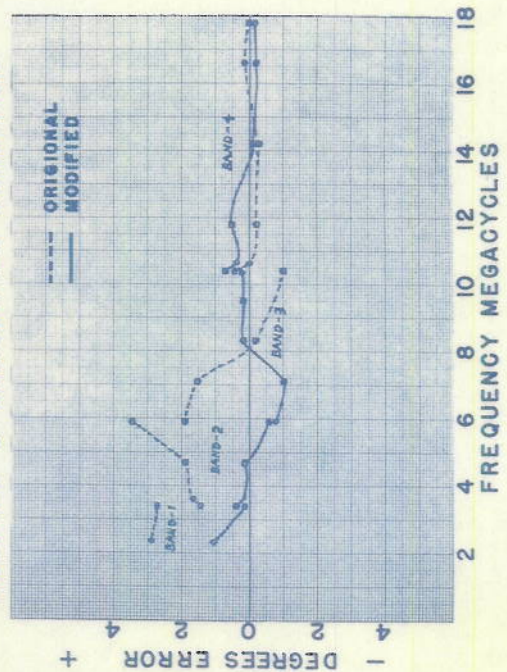
COAST GUARD WASHINGTON RADIO STATION
ALEXANDRIA, VIRGINIA

MODIFIED CONDITION



BUREAU OF STANDARDS STATION
STERLING, VIRGINIA

MODIFIED & UNMODIFIED CONDITION



FREQUENCY CHARACTERISTICS
OF
MODEL DAB EQUIPMENTS

SHOWING CHANGE OF INDICATED BEARING
WITH FREQUENCY ON FIXED SIGNAL SOURCE
AT

COAST GUARD TRAINING STATION
COAST GUARD WASHINGTON RADIO STATION
BUREAU OF STANDARDS STATION

EQUIPMENTS MODIFIED BY N.R.L. SPECIFICATIONS
UNLESS OTHERWISE NOTED

ERROR IS MEASURED FROM TRUE BEARING
OF FIXED TARGET TRANSMITTER

DECLASSIFIED

DECLASSIFIED

MODEL DAB EQUIPMENT
(SCHEMATIC DIAGRAMS)

DIRECTION OF CURRENT FLOW AND FLUX LINKAGE WITH REVERSAL
OF PRIMARY CONNECTIONS TO LOOP COUPLING TRANSFORMER

CURRENT FLOW IN LOOP COUPLING CIRCUITS

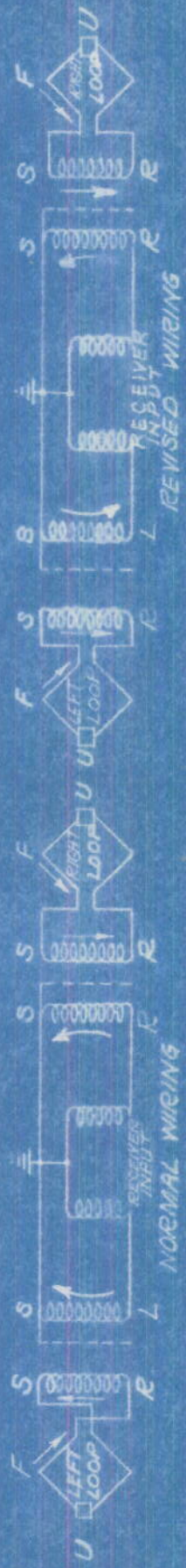


FIG. A
NORMAL WIRING
FIG. B
REVISED WIRING
(PRIMARY CONNECTIONS TO LEFT LOOP
COUPLING TRANSFORMER REVERSED.)

FLUX LINKAGE IN LOWER LOOP TRACKING UNITS

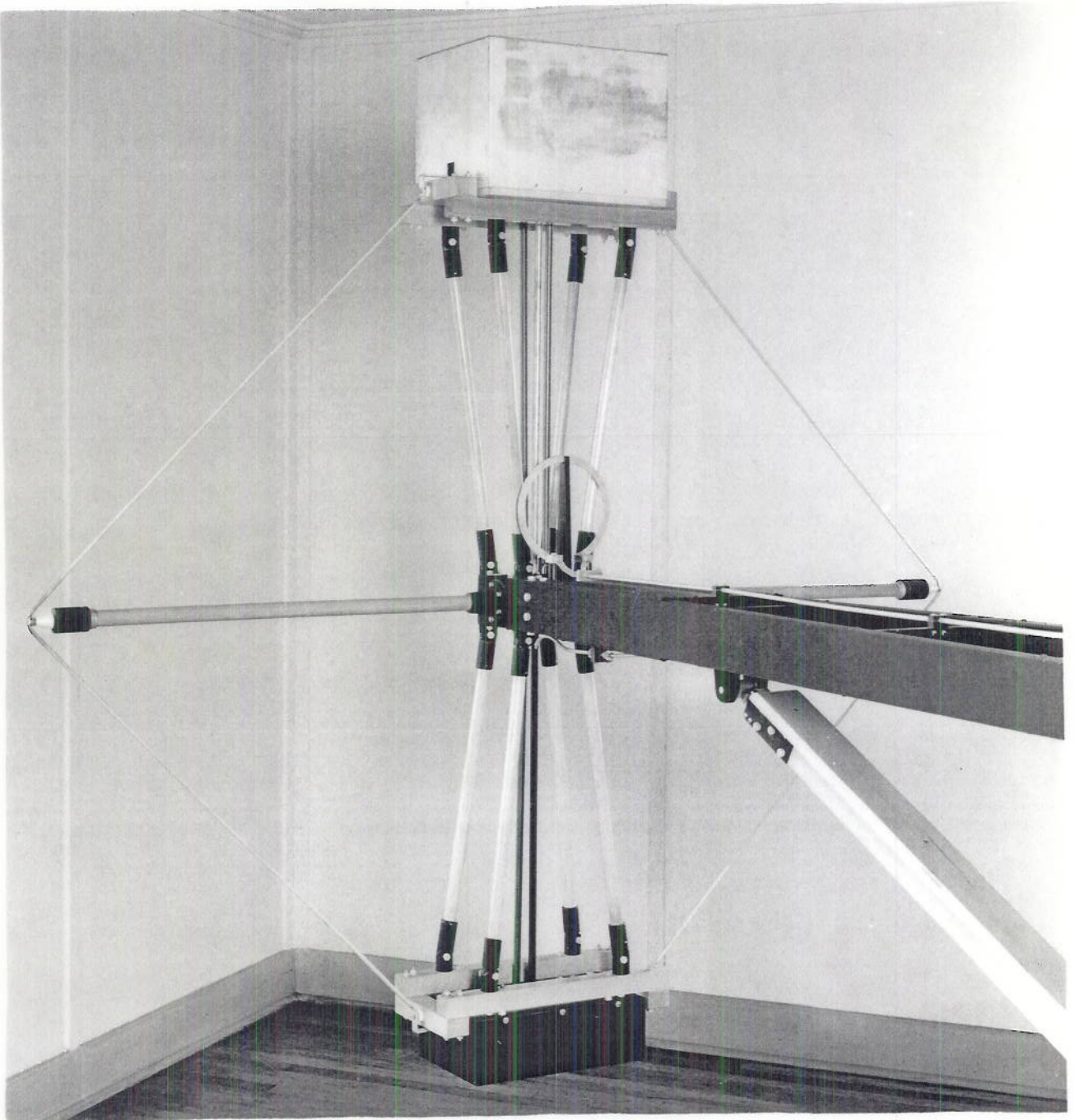


FIG. C
NORMAL WIRING
FIG. D
REVISED WIRING
(PRIMARY CONNECTIONS TO LEFT LOOP
COUPLING TRANSFORMER REVERSED)

NOTES:

- ↓ DIRECTION OF CURRENT FLOW.
- ↑ LINES OF FORCE - FLUX LINKAGE
- S - START OF WINDING - ASSUMING SLUG ADJUSTMENT END OF LEADING INDUCTANCE AS START.
- R - RIGHT HAND WINDINGS - ASSUMED AS CLOCKWISE ROTATION WHEN FEEDINGS FROM START TO FINISH.
- L - LEFT HAND WINDINGS.
- F - LEADING EDGE OF LOOP - ASSUMED WHEN OPERATOR IS FROM THE DIRECTION FROM WHICH THE WAVE IS
ARRIVING.
- U - UPPER LOOP TRACKING ASSEMBLY.
- T - LOOP COUPLING TRANSFORMER.
- L₂ - BAND THREE LEADING INDUCTANCE - LOCATED ADVANTAGE TO LOOP COUPLING TRANSFORMER
IN THE LOWER LOOP TRACKING UNIT.

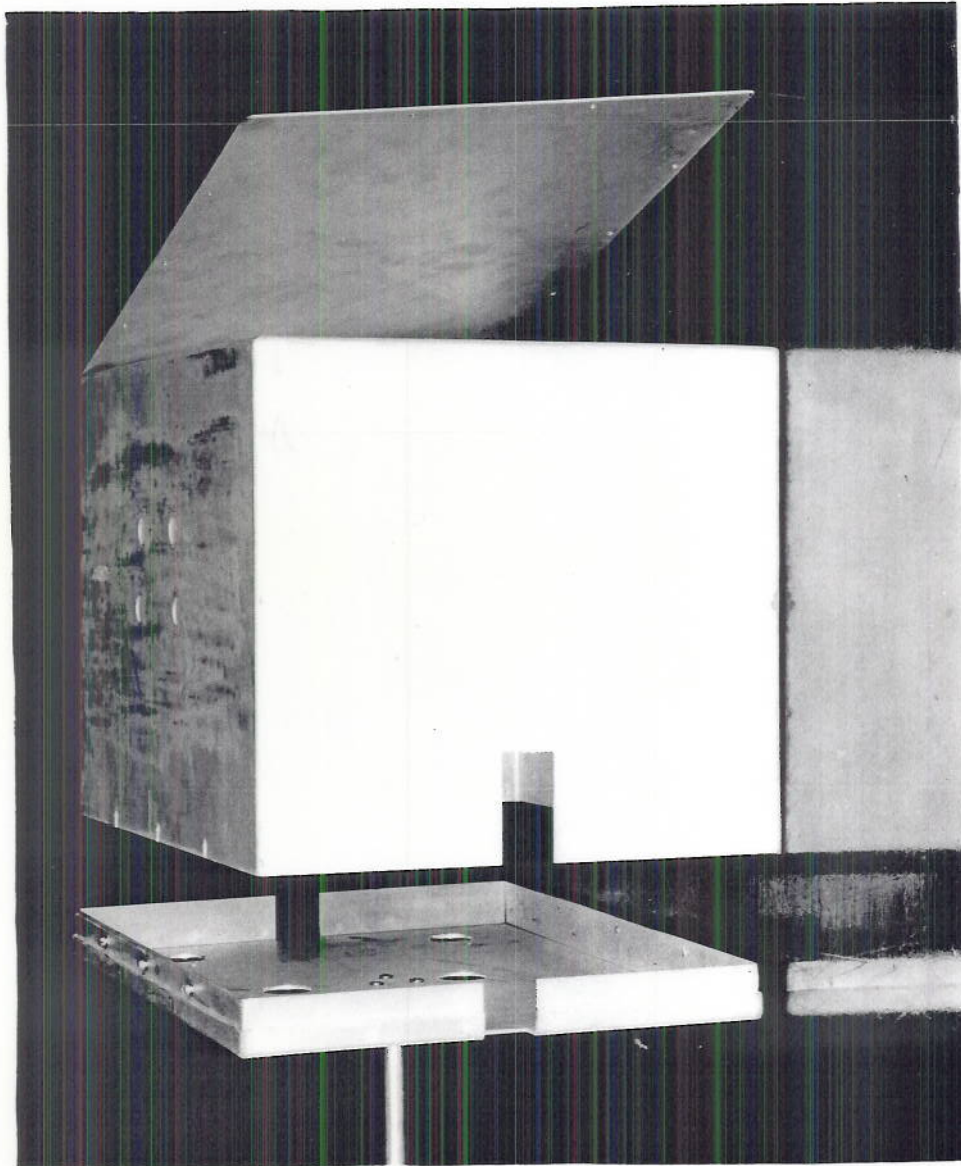
DECLASSIFIED



LOOP SHIELDING UNIT
INSTALLED

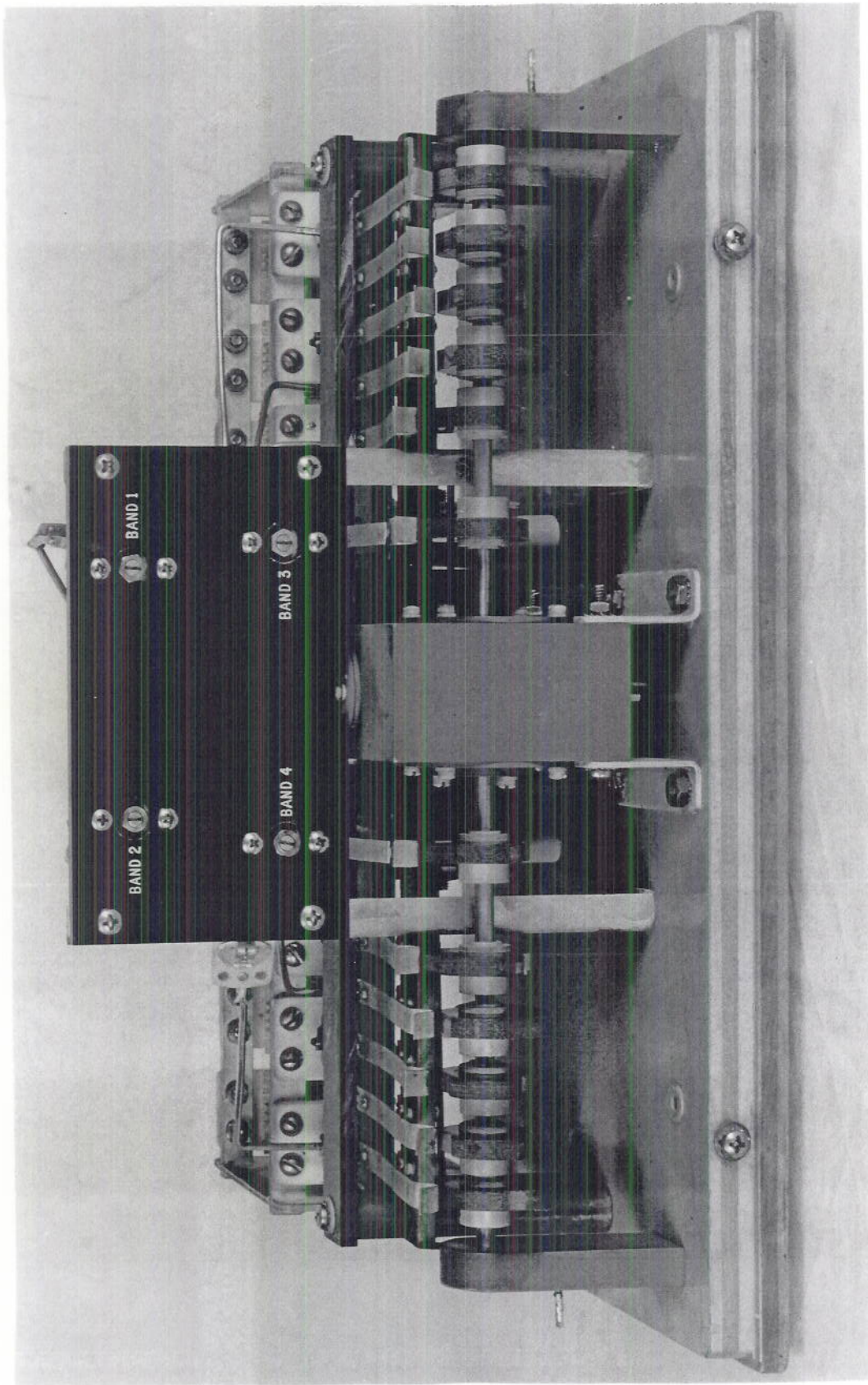
DECLASSIFIED

DECLASSIFIED



SHIELD BOX ASSEMBLY

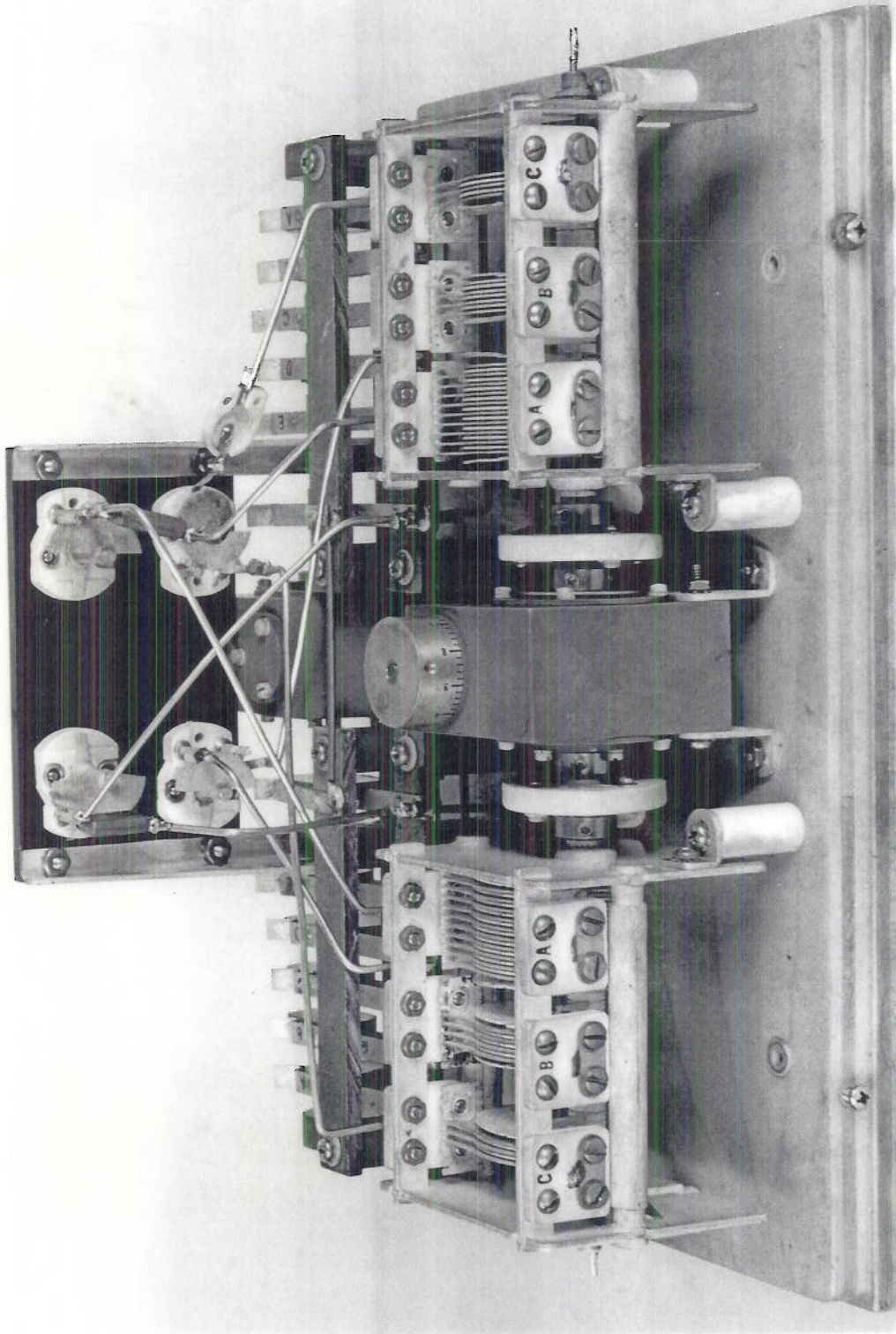
DECLASSIFIED



MODIFIED RIGHT UPPER LOOP TUNING UNIT
FRONT VIEW

DECLASSIFIED

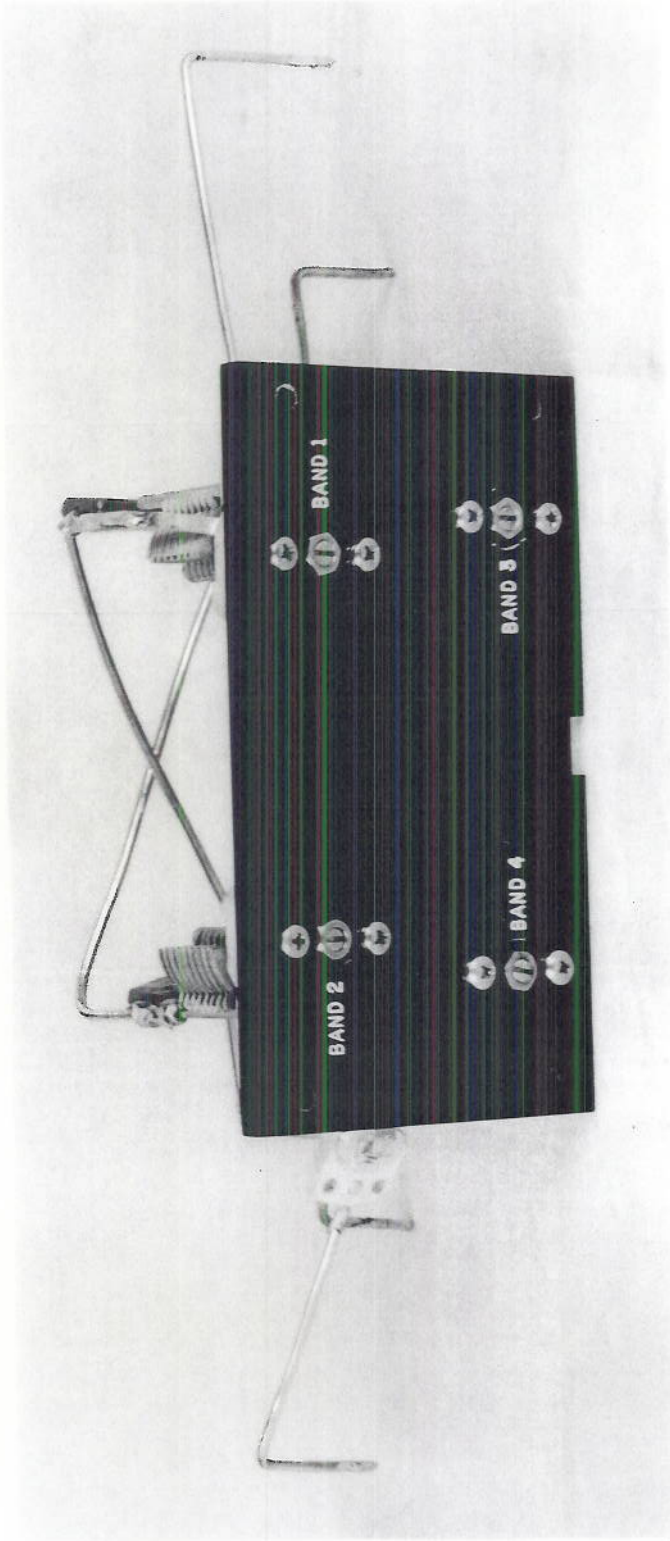
DECLASSIFIED



MODIFIED RIGHT UPPER LOOP TUNING UNIT
REAR VIEW

DECLASSIFIED

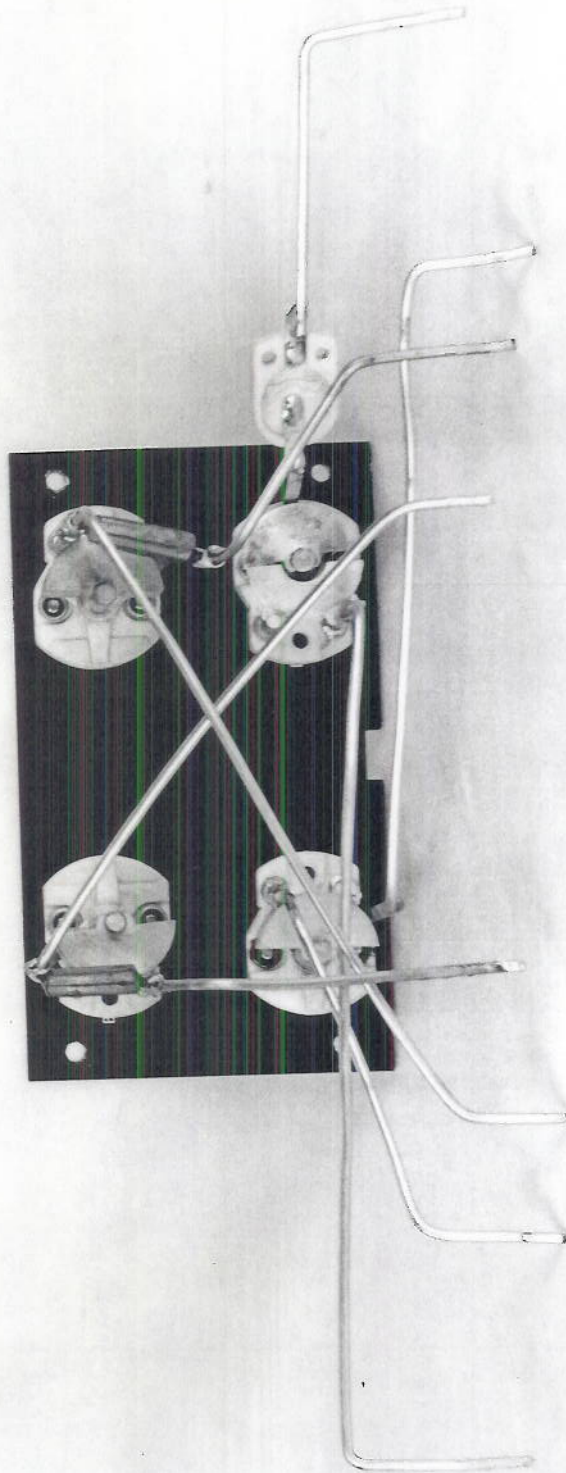
DECLASSIFIED



MODIFIED TRIMMER CONDENSER ASSEMBLY
FRONT VIEW

DECLASSIFIED

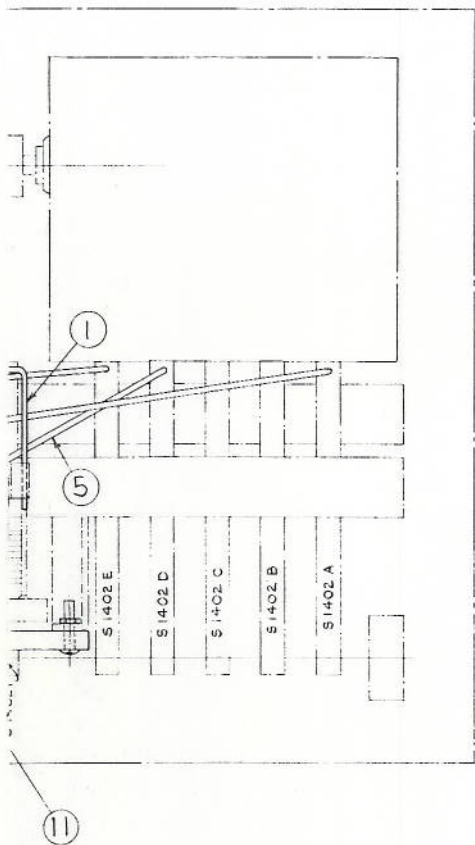
DECLASSIFIED



DECLASSIFIED

MODIFIED TRIMMER CONDENSER ASSEMBLY
REAR VIEW

DECLASSIFIED



NOTE:
SEE SHEETS 2 & 4 FOR DETAILS

TOLERANCES UNLESS OTHERWISE SPECIFIED	
1 PLACE DECIMAL	= ± .1
2 PLACE DECIMAL	= ± .01
3 PLACE DECIMAL	= ± .005
DIMENSIONS IN INCHES	

ALTERATION TABLE

REFERENCE DRAWINGS

DRAWN	CHRISTELSON SP/02c	IN CHARGE OF DESIGN	SUPT. DESIGN & DRAFTING DIVISION
TRACED			<i>Edgesson</i>
CHECKED	<i>OPP</i>	<i>CR</i>	FOR DIRECTOR
APPR'VD	<i>A. G. Ferebee, Jr.</i>		COMDR. U.S.N.

NAVAL RESEARCH LABORATORY
WASHINGTON 20. D. C.

MODEL CAG
DIRECTION FINDER
WAVELENGTH
41.1 MBT

SCALE FULL SIZE DATE 3 OCT. 1945

RD 608 7A

NAVEX06-2142

7 SHEETS

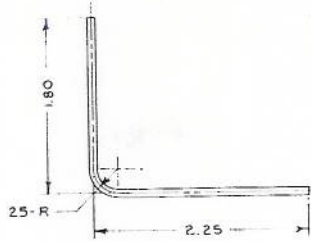
SHEET 1

DECLASSIFIED

PLATE 16

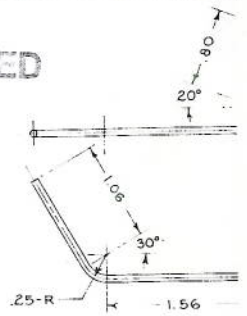
16

DECLASSIFIED



① WIRE (FOR BAND 1 - LOWER)
#12 (.080) COPPER WIRE
TINNED
1 REQ'D

SCALE: FULL SIZE
RA 69F 227

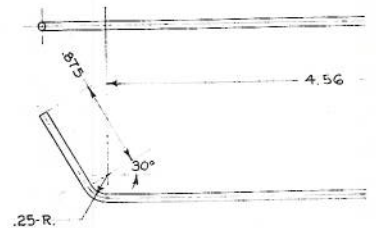


③ WIRE (FOR BAND 1 - UPPER)
#12 (.080) COPPER WIRE
TINNED
1 REQ'D

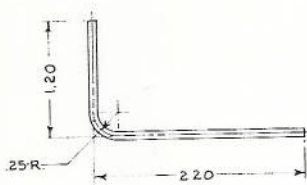


② WIRE (FOR BAND 1 - UPPER)
#12 (.080) COPPER WIRE
TINNED
1 REQ'D

SCALE: FULL SIZE
RA 69F 227



④ WIRE (FOR BAND 1 - UPPER)
#12 (.080) COPPER WIRE
TINNED
1 REQ'D



⑦ WIRE (FOR BAND 4 - LEFT)
#12 (.080) COPPER WIRE
TINNED
2 REQ'D

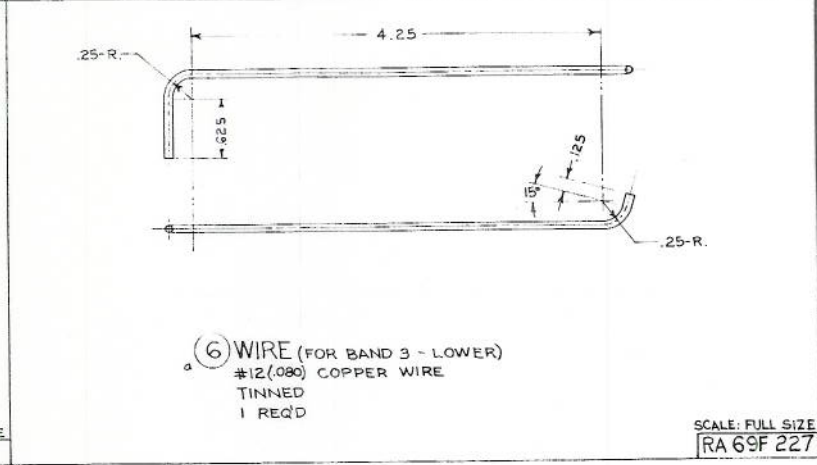
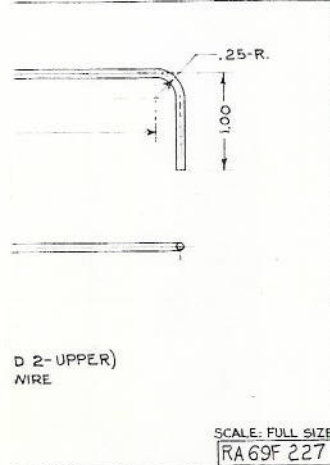
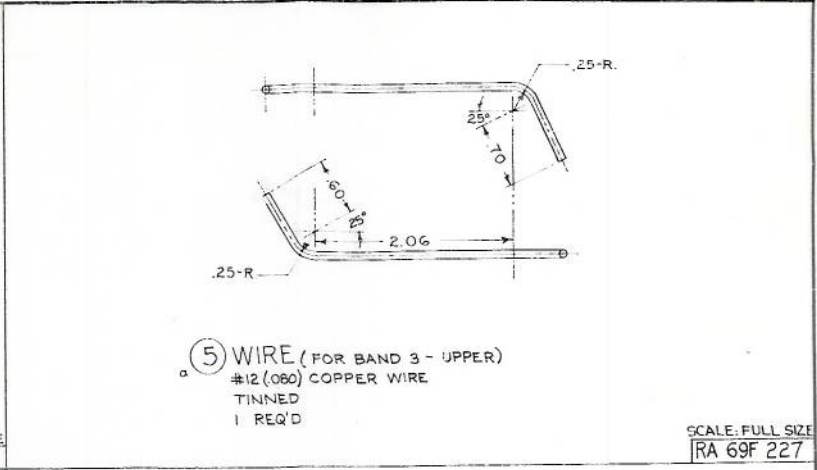
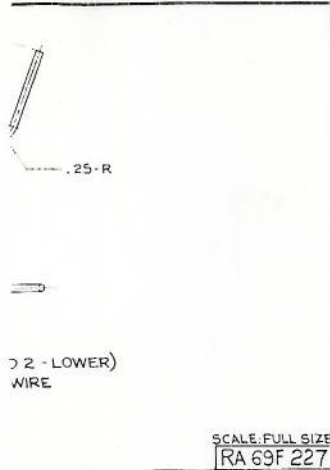
SCALE: FULL SIZE
RA 69F 227



⑧ WIRE (FOR BAND 4 - RIGHT)
#12 (.080) COPPER WIRE
TINNED
1 REQ'D

SCALE: FULL SIZE
RA 69F 227

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TOLERANCES	
UNLESS OTHERWISE SPECIFIED	
1 PLACE DECIMAL	= ± .1
2 PLACE DECIMAL	= ± .01
3 PLACE DECIMAL	= ± .005
DIMENSIONS IN INCHES	

ALTERATION TABLE	

REFERENCE DRAWINGS			
DRAWN	CHIRKELSON	IN CHARGE OF DESIGN	SUPV. DESIGN & DRAFTING DIVISION
TRACED			<i>Chirkelson</i>
CHECKED	<i>8/13</i>	<i>ORL</i>	DIRECTOR
APPR'VD			

NAVAL RESEARCH LABORATORY
WASHINGTON 20, D. C.

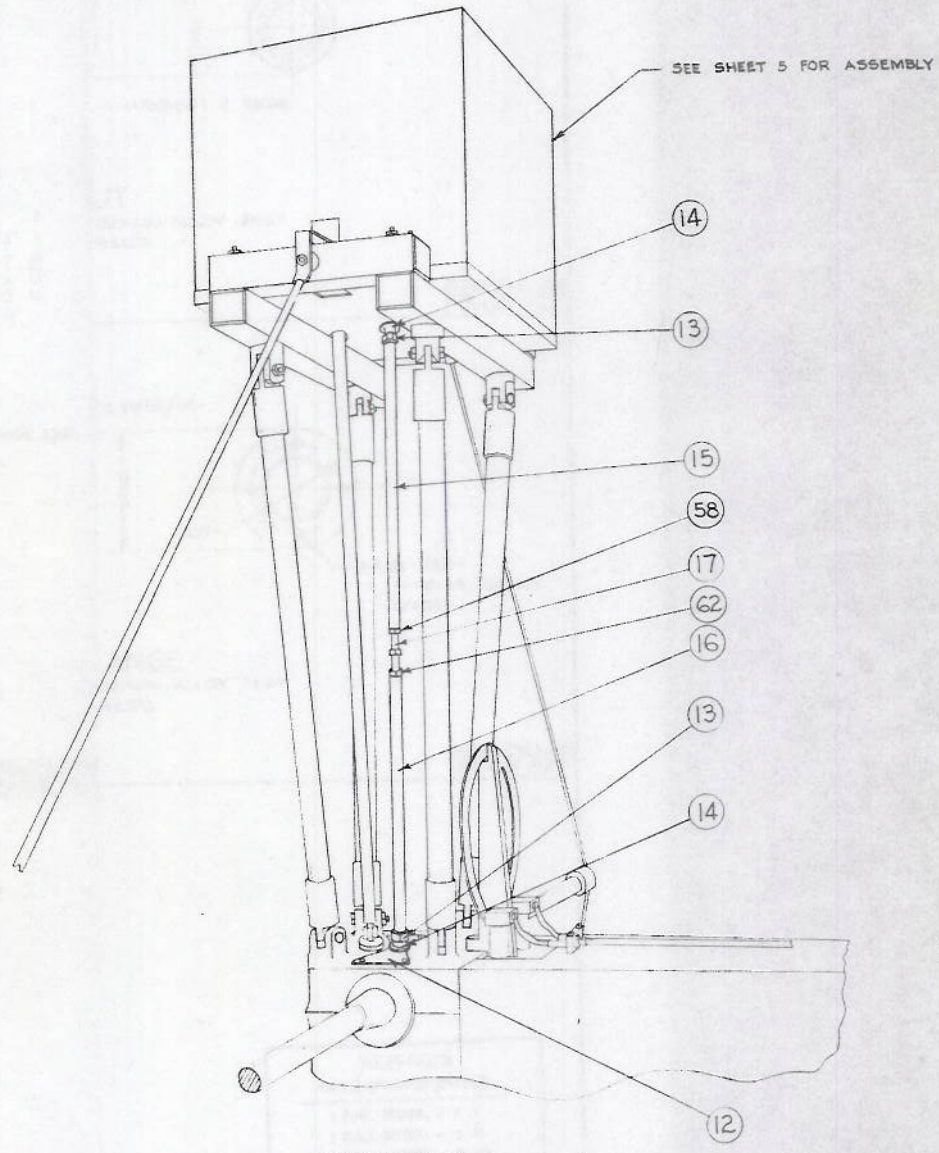
MOD. DAB
DIRECTION FINDER
MODIFICATION
DETAILS

SCALE DATE 3 OCT. 1945

RA 69F 227

17

DECLASSIFIED

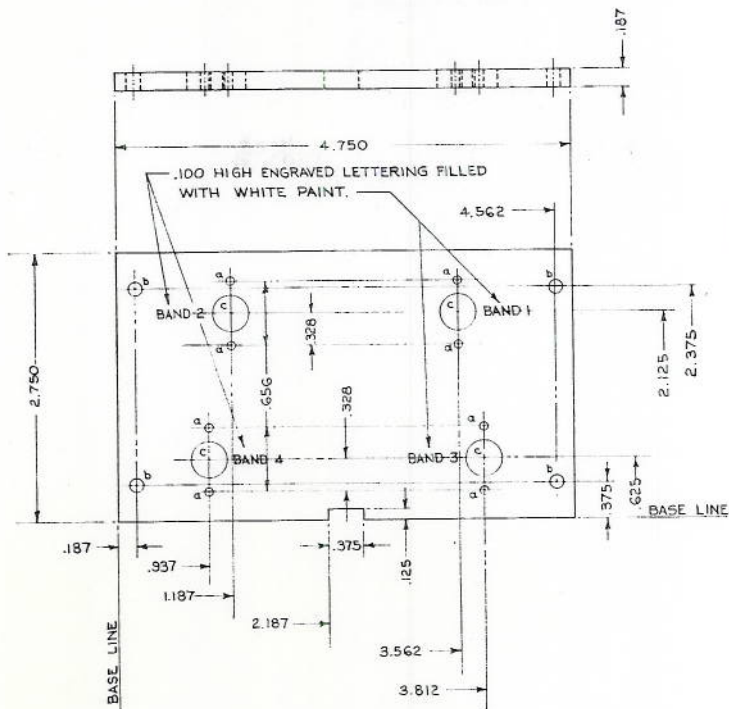


ASSEMBLY (PICTORIAL)

NOTE:
SEE SHEET 4 FOR D

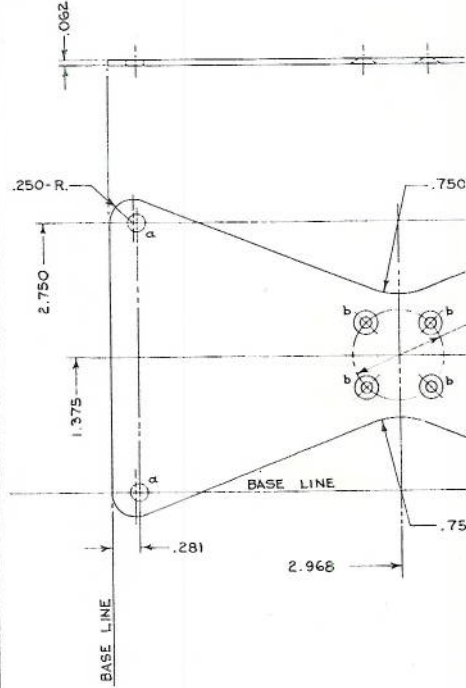
ALTERATION TAB

DECLASSIFIED



- a = # 30 (.028) DRILL
- b = # 30 (.028) DRILL
- c = # 30 (.028) DRILL

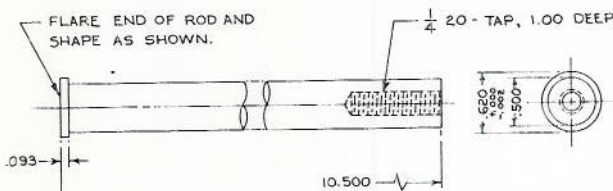
⑪ PLATE
 PHENOLIC INSULATING MATERIAL, TYPE FBE
 1 REQ'D.



- a = #14 (.182) DRILL
- b = #22 (.157) DRILL & COUNTERSINK

⑫ BASE
 ALUMINUM ALLOY
 1 REQ'D.

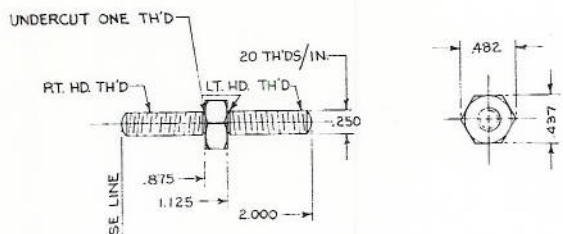
SCALE: FULL SIZE
 RA 69F 227



⑮ ROD (RT. HD. THREAD)
 ALUMINUM ALLOY 24 ST
 1 REQ'D.

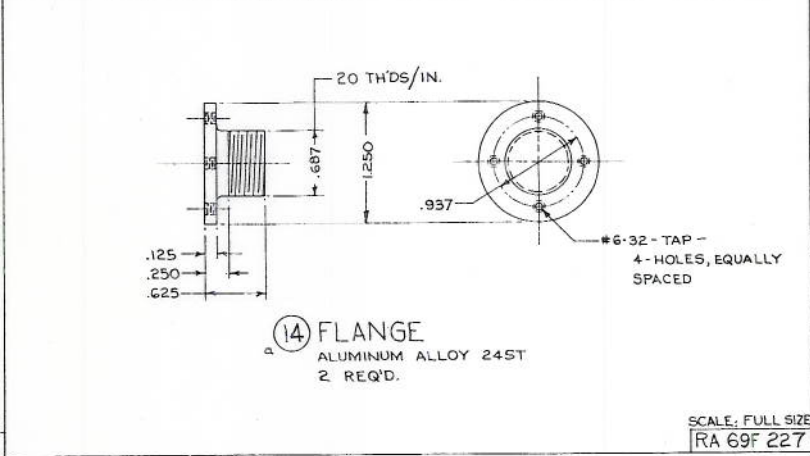
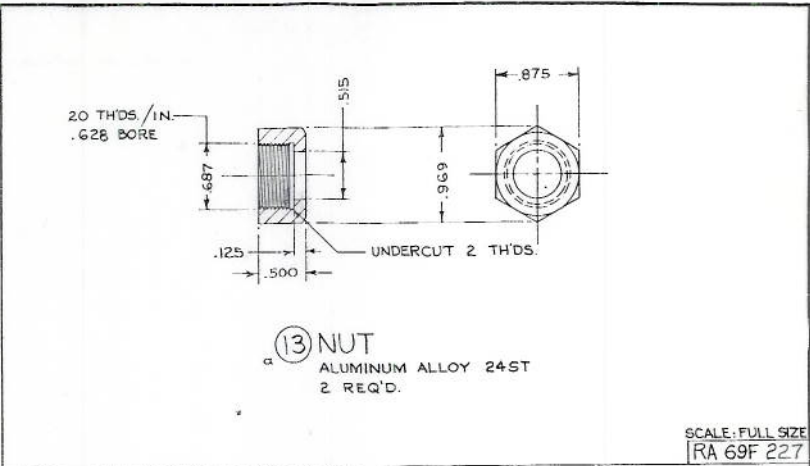
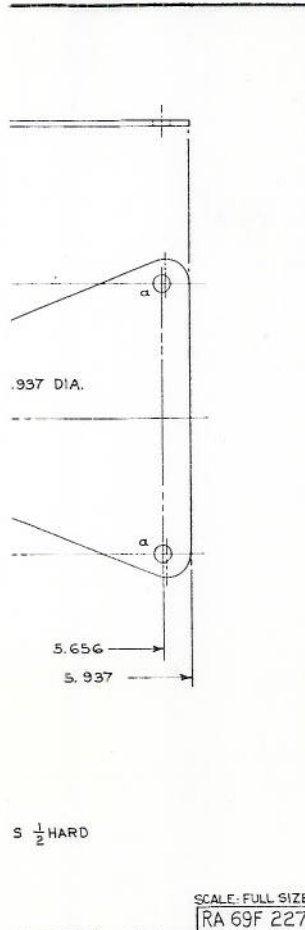
⑯ ROD (LT. HD. THREAD)
 ALUMINUM ALLOY 24 ST
 1 REQ'D.

SCALE: FULL SIZE
 RA 69F 227



⑰ COUPLING SCREW
 ALUMINUM ALLOY 24 ST
 1 REQ'D.

SCALE: FULL SIZE
 RA 69F 227

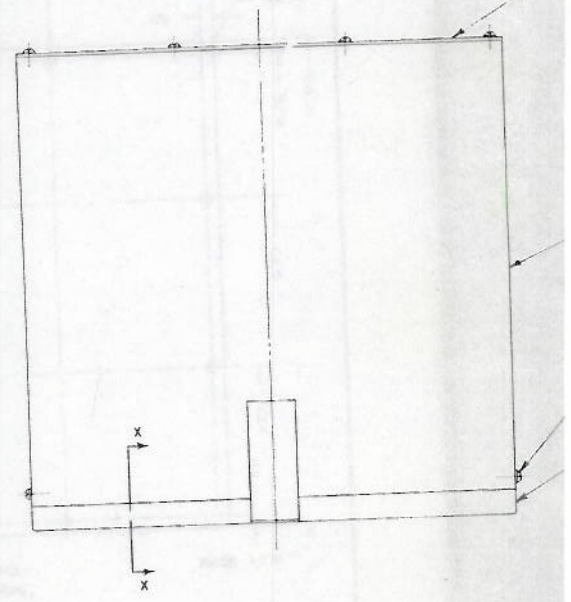
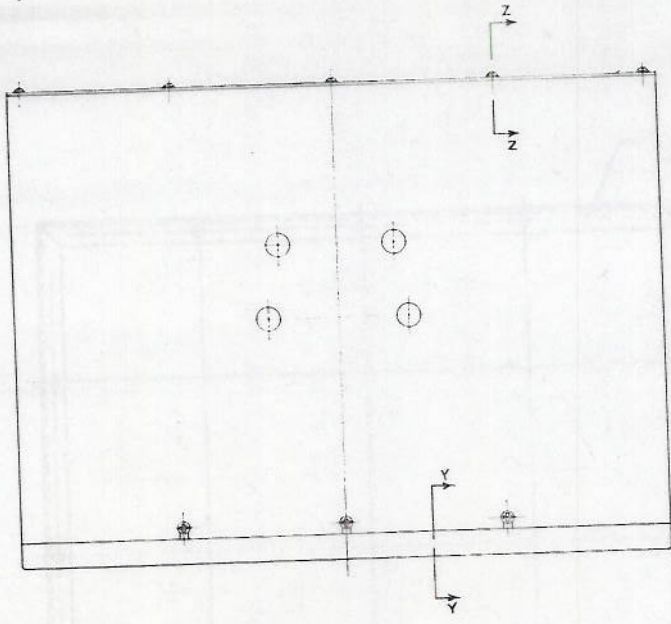


TOLERANCES UNLESS OTHERWISE SPECIFIED	
1 PLACE DECIMAL	= ± .1
2 PLACE DECIMAL	= ± .01
3 PLACE DECIMAL	= ± .005
DIMENSIONS IN INCHES	

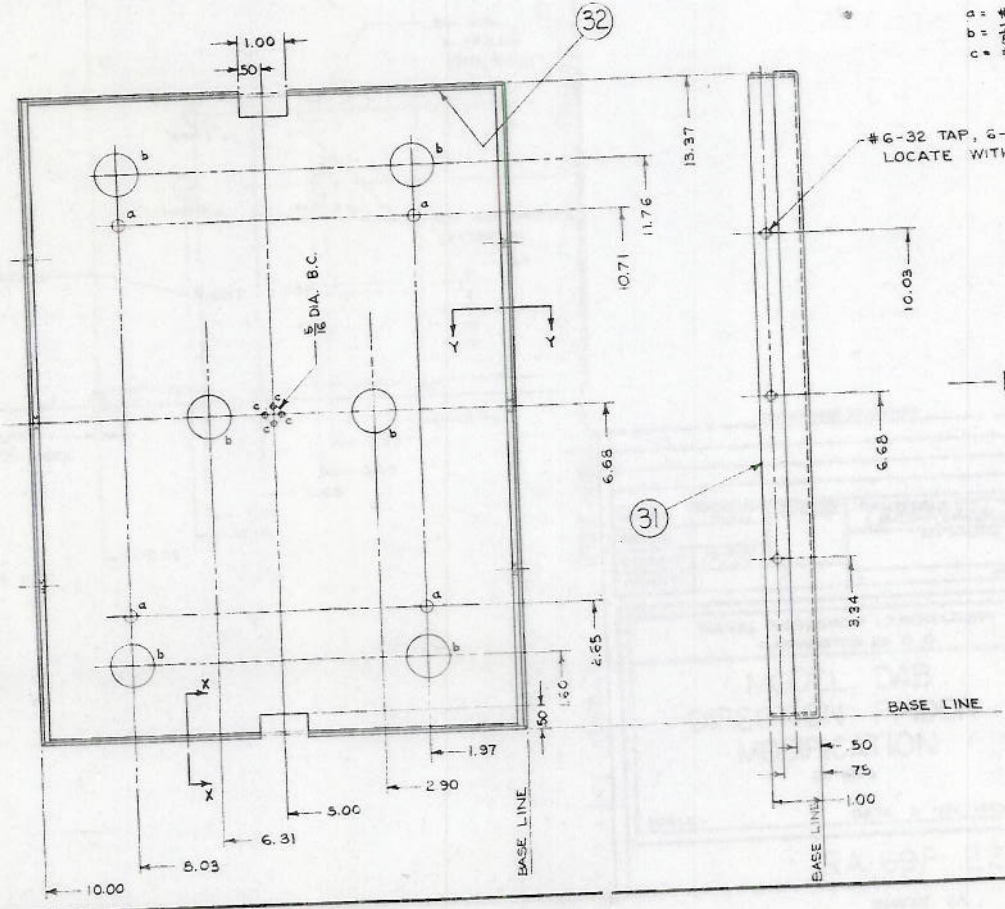
ALTERATION TABLE	

REFERENCE DRAWINGS			
DRAWN	CHRISTELSON SPENCER	IN CHARGE OF DESIGN	SUPT. DESIGN & DRAFTING DIVISION
TRACED			<i>Altresser</i> FOR DIRECTOR
CHECKED	<i>OPB</i>	<i>CRS.</i>	
APPR'VD			COMDR. U.S.N.
NAVAL RESEARCH LABORATORY WASHINGTON 20. D. C. MODEL DAB DIRECTION FINDER MODIFICATION DETAILS SCALE DATE 3 OCT. 1945 RA. 69F 227			

DECLASSIFIED



ASSEMBLY



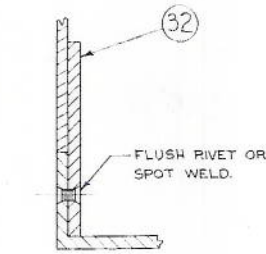
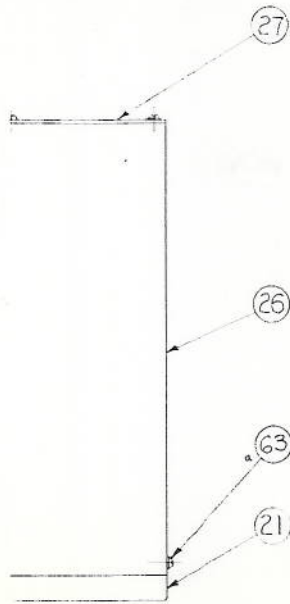
- a = # 1 (.228) DRILL
- b = # 7 DRILL
- c = # 28 (.140) DRILL

BASE UNIT ASSEMBLY & DETAIL

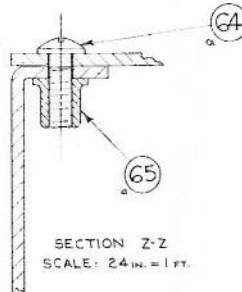
NOTE: SEE TOP OF THIS SHEET FOR COMPLETE ASSEMBLY & SECTIONS.

(21) BASE ALUMINUM TYPE 525, BLACK WRINKLE FINISH 2 REQ'D

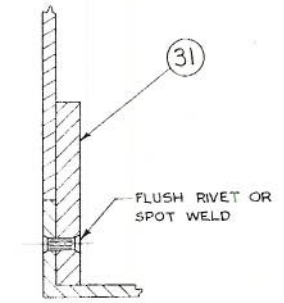
DECLASSIFIED



SECTION X-X
SCALE: 24 IN. = 1 FT.



SECTION Z-Z
SCALE: 24 IN. = 1 FT.



SECTION Y-Y
SCALE: 24 IN. = 1 FT.

SCALE: 6 IN. = 1 FT.
RA 69F 227

- 8) DRILL
- 4C) DRILL
- 16.

UNIT ASSEMBLY
& DETAIL

NOTE:
SEE TOP OF THIS SHEET
FOR COMPLETE ASSEMBLY
& SECTIONS.

BASE
ALUMINUM TYPE 525, .060 THK
BLACK WRINKLE FINISH
2 REQ'D

ALTERATION TABLE

REFERENCE DRAWINGS

DRAWN	CHRISTOPHER SP(+)2c	IN CHARGE OF DESIGN	SUPV. DESIGN & DRAFTING DIVISION <i>Chapman</i> FOR DIRECTOR
TRACED			
CHECKED	OPB		
APPR'VD			COMDR. U.S.N.

SYMBOLS AND THEIR EQUIVALENT TOLERANCES (UNLESS OTHERWISE NOTED)	
SYMBOL 1..... ± .0005	SYMBOL 3..... ± .0050
SYMBOL 2..... ± .0010	SYMBOL 3½..... ± .0100
SYMBOL 2½..... ± .0030	SYMBOL 4..... ± .0250
SYMBOL 5.....	

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WASHINGTON 20, D. C.

MODEL DAB
DIRECTION FINDER
MODIFICATION
ASSEMBLY & DETAILS

SCALE _____ DATE 5 NOV 1945

SCALE: 6 IN. = 1 FT.
RA 69F 227

NAVEDG-2142

RA.69F 227

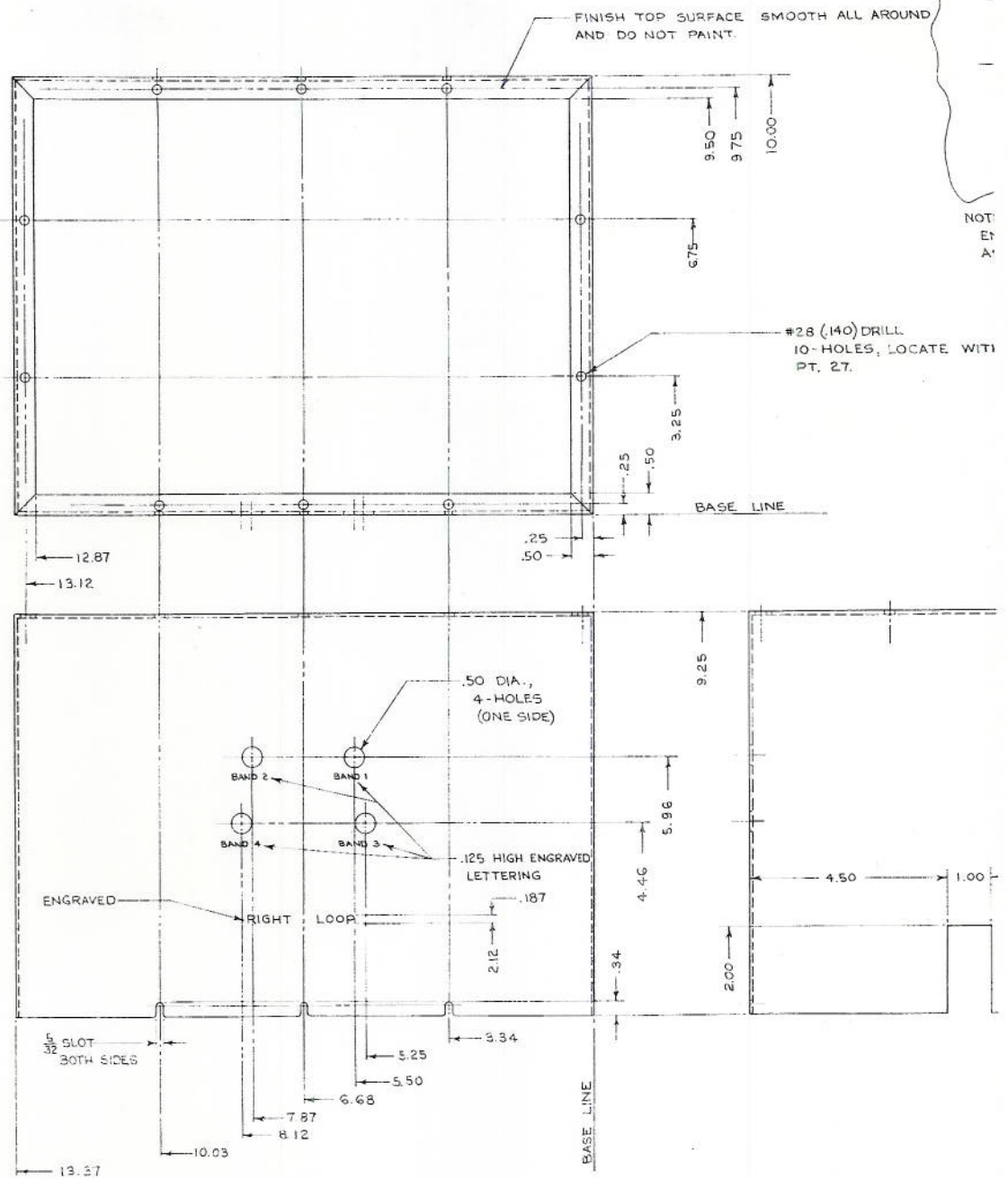
SHEET 5A

DECLASSIFIED

PLATE 20

20

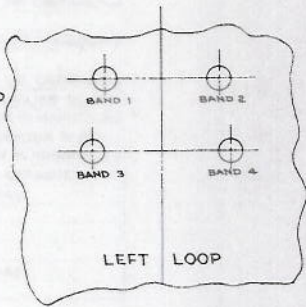
DECLASSIFIED



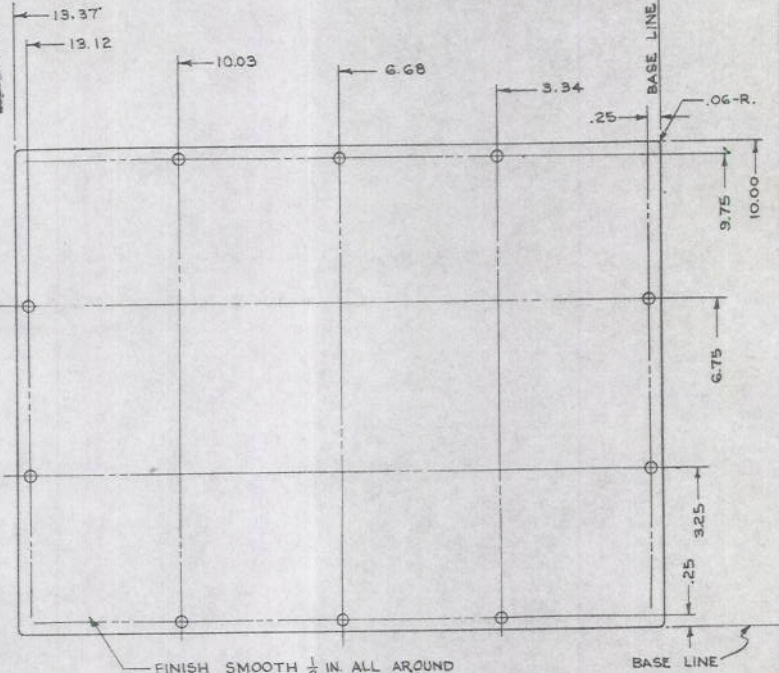
26 SHIELD BOX
ALUMINUM TYPE 525, .062 THK.
BLACK WRINKLE FINISH
2 REQ'D

DECLASSIFIED

DECLASSIFIED



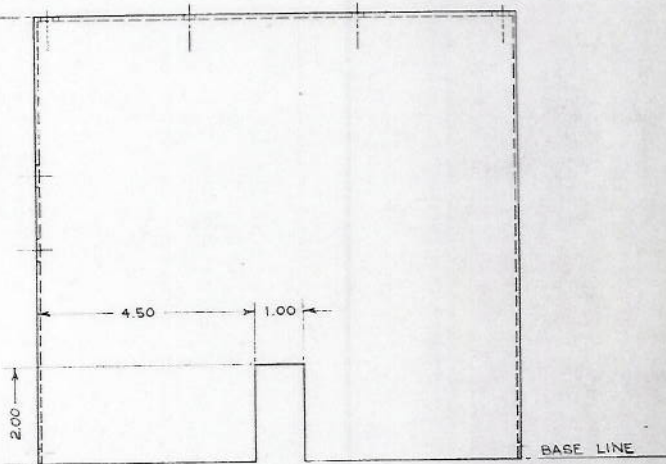
#28 (140) DRILL
10-HOLES, LOCATE WITH
PT. 27.



(27) COVER PLATE
ALUMINUM TYPE 525, .062 THK.
BLACK WRINKLE FINISH
2 REQ'D

SCALE: 6 IN. = 1 FT.
RA 69F 227

SE LINE



X
525, .062 THK.
FINISH

ALTERATION TABLE

SYMBOLS AND THEIR EQUIVALENT TOLERANCES (UNLESS OTHERWISE NOTED)	
SYMBOL 1.....	* .0005
SYMBOL 2.....	* .0010
SYMBOL 2 1/2.....	* .0030
SYMBOL 3.....	* .0050
SYMBOL 3 1/2.....	* .0100
SYMBOL 4.....	* .0250
SYMBOL 5.....	

REFERENCE DRAWINGS

DRAWN	CHRISTIE SP.0102	IN CHARGE OF DESIGN	SUPV. DESIGN & DRAFTING DIVISION <i>Oliver</i> FOR DIRECTOR
TRACED			
CHECKED	<i>BPB</i>		
APPR'D			COMDR. U.S.N.

NAVAL RESEARCH LABORATORY
WASHINGTON 20. D. C.

MODEL DAB
DIRECTION FINDER
MODIFICATION
DETAILS

SCALE DATE 5 NOV. 1945

RA-69F 227

SCALE: 6 IN. = 1 FT.
RA 69F 227

NAVEZ06-2142

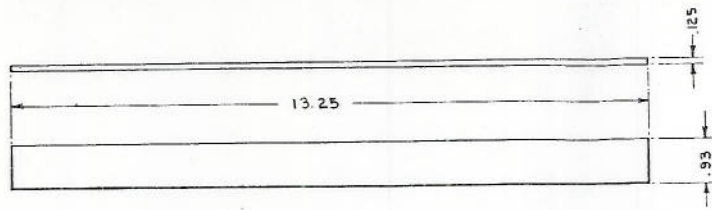
SHEET 6A

DECLASSIFIED

PLATE 21

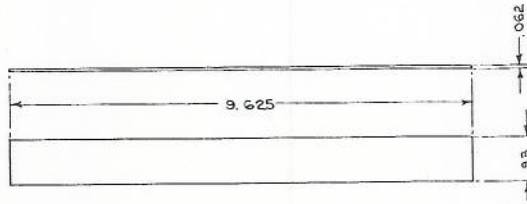
21

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③ STRIP
ALUMINUM TYPE 52 S, .125 TH'K.
4 REQ'D

SCALE: 6 IN. = 1 IN.
RA 69F 227



③ STRIP
ALUMINUM TYPE 52 S, .062 TH'K.
4 REQ'D

SCALE: 6 IN. = 1 IN.
RA 69F 227

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PART NO.	NO. REQ'D.	MATERIAL	DESCRIPTION	SUPPLIED BY OR EQUAL
PARTS NOT DETAILED				
51a	1		C1403 - BAND 1 LOOP TRIMMING CAP 30mmf	RADIO COND. CO. CAMDEN, N.J.
52a	1		C1404 - BAND 2 LOOP TRIMMING CAP 50mmf	RADIO COND. CO. CAMDEN, N.J.
53a	1		C1405 - BAND 3 LOOP TRIMMING CAP 25mmf	RADIO COND. CO. CAMDEN, N.J.
			MIDGET AIR DIELECTRIC	
54a	1		C1406 - BAND 4 LOOP TRIMMING CAP. 2.25mmf	RADIO COND. CO. CAMDEN, N.J.
			MIDGET AIR DIELECTRIC	
55a	1		C1407 - BAND 1 LOOP PADDING CAP. 0.00015mf ±5%	CORNELL DUBILIER ELEC. CORP., SOUTH PLAINFIELD, N.J.
			1000 T.V.	
56a	1		C1408 - BAND 2 LOOP PADDING CAP. 0.00005mf ±5%	CORNELL DUBILIER ELEC. CORP., SOUTH PLAINFIELD, N.J.
			1000 T.V.	
57a	2		TRIMMA 1.0-3.5mmf TYPE 820D	CENTRALAB CERAMIC COMMERCIAL
58a	1	STEEL CAD. PL.	1/4"-20NUT - RT. HD. THREAD	COMMERCIAL
59a	8	" " "	4-40 SCREW - RECESSED HEAD, 1/2" LONG	PHILLIPS
60a	4	" " "	6-32 SCREW - RECESSED HEAD, 1/2" LONG	PHILLIPS
61a	4	" " "	NUT FOR PT. 60	PHILLIPS
62a	1	" " "	1/4"-20NUT - LT. HD. THREAD	COMMERCIAL
63a	6	" " "	6-32 SCREW - RECESSED HEAD, 3/8" LONG	PHILLIPS
64a	10	" " "	6-32 SCREW - RECESSED HEAD, 3/8" LONG	PHILLIPS
65a	10		# 58212 TEENUT	CINCH MFG. CORP.

DECLASSIFIED

ALTERATION TABLE	REFERENCE DRAWINGS																
	<table border="1" style="width: 100%;"> <tr> <td>DRAWN</td> <td>CHRISTOPHER SP/02c</td> <td>IN CHARGE OF DESIGN</td> <td>SUPV. DESIGN & DRAFTING DIVISION</td> </tr> <tr> <td>TRACED</td> <td></td> <td></td> <td><i>W. J. ...</i></td> </tr> <tr> <td>CHECKED</td> <td><i>OPB</i></td> <td></td> <td>FOR DIRECTOR</td> </tr> <tr> <td>APPROV'D</td> <td></td> <td></td> <td>COMDR. U.S.N.</td> </tr> </table>	DRAWN	CHRISTOPHER SP/02c	IN CHARGE OF DESIGN	SUPV. DESIGN & DRAFTING DIVISION	TRACED			<i>W. J. ...</i>	CHECKED	<i>OPB</i>		FOR DIRECTOR	APPROV'D			COMDR. U.S.N.
DRAWN	CHRISTOPHER SP/02c	IN CHARGE OF DESIGN	SUPV. DESIGN & DRAFTING DIVISION														
TRACED			<i>W. J. ...</i>														
CHECKED	<i>OPB</i>		FOR DIRECTOR														
APPROV'D			COMDR. U.S.N.														
SYMBOLS AND THEIR EQUIVALENT TOLERANCES (UNLESS OTHERWISE NOTED)	<table border="1" style="width: 100%;"> <tr> <td colspan="2" style="text-align: center;">NAVAL RESEARCH LABORATORY WASHINGTON 20. D. C.</td> </tr> <tr> <td colspan="2" style="text-align: center;">MODEL DAB DIRECTION FINDER MODIFICATION DETAILS</td> </tr> <tr> <td>SCALE</td> <td>DATE 5 NOV. 1945</td> </tr> <tr> <td colspan="2" style="text-align: center;">RA 69F 227</td> </tr> </table>	NAVAL RESEARCH LABORATORY WASHINGTON 20. D. C.		MODEL DAB DIRECTION FINDER MODIFICATION DETAILS		SCALE	DATE 5 NOV. 1945	RA 69F 227									
NAVAL RESEARCH LABORATORY WASHINGTON 20. D. C.																	
MODEL DAB DIRECTION FINDER MODIFICATION DETAILS																	
SCALE	DATE 5 NOV. 1945																
RA 69F 227																	
SYMBOL 1 ± .0005 SYMBOL 3 ± .0050 SYMBOL 2 ± .0010 SYMBOL 3 1/2 ± .0100 SYMBOL 2 1/2 ± .0030 SYMBOL 4 ± .0250 SYMBOL 5																	

DECLASSIFIED

NAVEXOS-2144

7 SHEETS

SHEET 7A