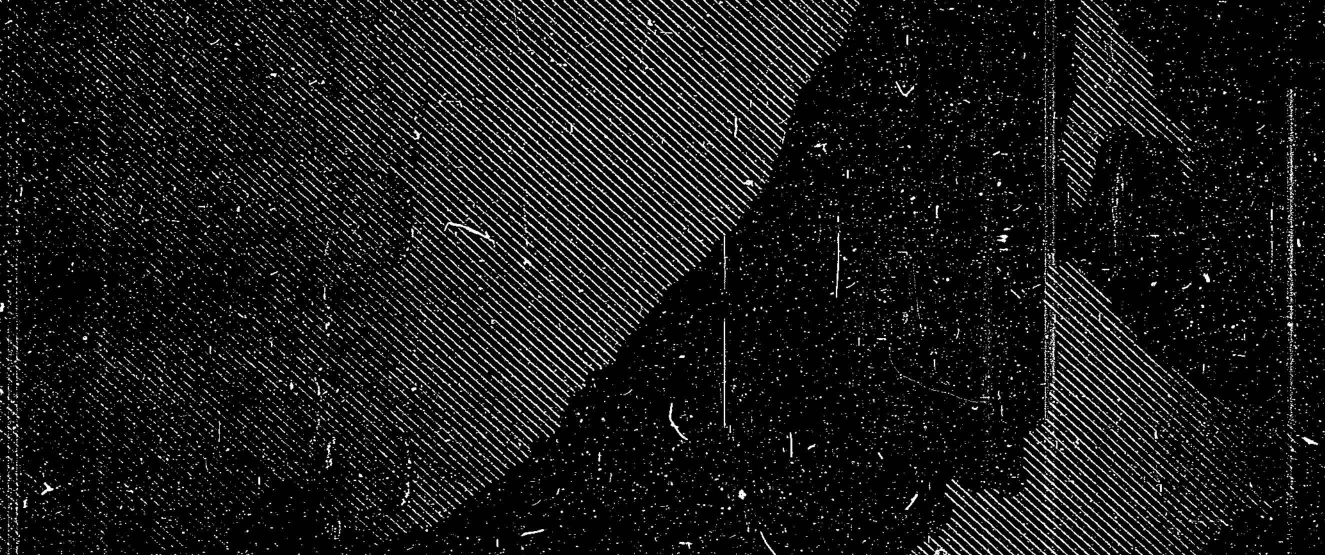

ELECTRONICS TARGETS

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U. S. NAVAL TECHNICAL MISSION TO JAPAN
CARE OF FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

28 December 1945

RESTRICTED

From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Submarine and Shipborne Radar.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering Target E-01 of Fascicle E-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Lieut. A. A. Lang, USNR, assisted by Lieut. W. G. Lamb, USNR, and Lt.(jg) S. H. Kadish, USNR, and S. E. Pulis, ETM2c, USNR, who also acted as interpreters.

C. G. GRIMES
Captain, USN

32408

RESTRICTED E-01

JAPANESE SUBMARINE AND SHIPBORNE RADAR

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE E-1, TARGET E-01

DECEMBER 1945

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ELECTRONICS TARGETS

JAPANESE SUBMARINE AND SHIPBORNE RADAR

The radars in use on Japanese ships were all of conventional design and mediocre construction. None of the production models or experimental equipments were found to have any unusual design features or any exceptionally high performance parts or components except a unique duplexing system used with the Mark 2 Model 2 radar. Only three radar models were in use on surface ships and submarines at the end of the war, Type 3 Mark 1 Model 3 and Type 2 Mark 2 Model 1 for air search and the Mark 2 Model 2 for surface search. There was no fire control radar as such in use. A modified version of the Mark 2 Model 2 radar was used for fire control as well as surface search but results were in general unsatisfactory. The radars listed above and the history of radar development, installation methods, procedures and difficulties, maintenance techniques and operational procedures are described.

Several new equipments in the test stage and intended as replacements for the Mark 2 Model 2 radar are discussed.

TABLE OF CONTENTS

LIST OF ENCLOSURES

LIST OF ILLUSTRATIONS

REFERENCES

Activities and Targets Investigated:

Headquarters of Second Naval Technical Institute, Kanazawa, YOKOHAMA.
Meguro Laboratory of Second Naval Technical Institute, Meguro, TOKYO.
Tsukishima Naval Radar Experimental Station, TOKYO.
Yokosuka Naval Base.
Kure Navy Yard.
Various Japanese Combatant Vessels.

Japanese Personnel Interrogated:

Vice Admiral (Tech.) T. NAWA - Chief of the Radar and Communications Section of the Second Naval Technical Institute.
Capt. H. TAKAHARA - Head of the Fourtn Section of the Second Naval Technical Institute (Radar intercept equipment, radio beacons and direction finders).
Captain and Dr. Y. ITO - Head of the First and Second Sections of Second Naval Technical Institute (Fundamental Research). Specialist on centimeter techniques.
Comdr. OHNO - Electronics Officer, Kure Navy Yard. Installation and operation of radar equipment.
Lt. Comdr. (Tech.) T. HYODO - Researcher of materials and components for high frequency use.
Lt. Comdr. (Tech.) S. MORI - Specialist on centimeter techniques. Worked on design of the Mark 2 Model 2 radar.
Lt. Comdr. (Tech.) O. OKAMURA - Researcher of tubes for centimeter wave applications.
Lt. Comdr. S. MATSUI - Head of research at Yokosuka Naval Base on the installation of shipborne and land based radio and radar.
Lt. Comdr. UCHIDA - Radar instructor at ordnance school, Yokosuka Naval Base.
Lt. Comdr. (Tech.) W. SUGIYAMA - Researcher on high frequency cable, Yokosuka Naval Base.
Lt. K. MORI - Instructor in Naval Radar Training School.
Dr. K. TAKAYANAGI - Consultant to Vice Admiral NAWA and head of the Third Section of the Second Naval Technical Institute (Radar).
Mr. H. SHINKAWA - Researcher on meter wave radars (L2, L3, S3, S24, N6, M13).
Mr. M. HATIYAMA - Researcher on high frequency circuits for centimeter radar.

INTRODUCTION

This report attempts to outline the state of development of the radar equipment installed aboard Japanese naval vessels at the end of the war and the extent to which operational and maintenance procedures had been developed.

The operational and installation data included were obtained through the interrogation of navy yard engineers at the Kure and Yokosuka Navy Yards and from interrogations conducted aboard submarines, destroyers, and aircraft carriers in Kure Harbor. The technical data was largely obtained from the Second Naval Research Establishment at TOKYO and through interrogation of engineers concerned with the design and production of the equipment.

Documents concerning the equipment mentioned in the report will be available at the Washington Document Center.

THE REPORT

Part I
DEVELOPMENT AND PRODUCTION OF SHIPBOARD RADAR EQUIPMENT

A. History

Interrogations indicated that the first information available in Japan on any type of electronic detecting equipment was based upon a report of the ultra short wave iceberg detecting equipment installed on the French liner NORMANDIE and inspected in New York Harbor by a Japanese engineer. The next information was received early in 1941 in the form of a report from Germany which described the principles of radar, but gave no details of construction. This report resulted in the beginning of Japanese radar research in April of the same year. The design of the first equipment was completed early in 1942.

B. Research and Production Allocation Methods Used

The organization of research and development and the production allocation methods used are mentioned because many of the troubles consistently experienced with electronic equipment in the Japanese Fleet are believed to be a direct result of such organization and methods. Until January 1945, research and production were carried out on a component basis rather than on a complete equipment basis. The research group and the company assigned to produce a unit were given little insight into the design and manufacture of the other components of the equipment and little information on how the equipment would later be used in the field. This fact, coupled with an apparent total lack of provision for informing research and production personnel of service deficiencies, resulted in a very poor modification program. The organization of the Second Naval Technical Institute in January 1945 to consolidate all research activities under one head was an apparent attempt to rectify this condition.

Part II
INSTALLATION OF EQUIPMENT

A. Type Allowance

Tabulation of Shipborne Radar Installations

	Type 2 Mark 2 Model 1 Radar	Type 3 Mark 1 Model 3 Radar	Mark 2 Model 2 Radar	Radar cm-wave	Intercept m-wave
Battleships					
FUSO class	1	2	2	1	1
ISE class	1	2	2	1	1
NAGATO class		3	2	1	1
KONGO class	1	2	2	1	1
YAMATO class	1	2	2	1	1
Cruisers					
MYOKO class	1	2	2	1	1
TAKAO class	1	2	2	1	1
FURUTAKA class	1				1
AOBA class	1	2	2	1	1
KUMA class	1		1	1	1

	Type 2 Mark 2 Model 1 Radar	Type 3 Mark 1 Model 3 Radar	Mark 2 Model 2 Radar	Radar	Intercept
				cm-wave	m-wave
NAGARA class	1			1	1
MOGAMI class	1	2	2	1	1
TONE class	1	2	2	1	1
AGANO class	1	2	2	1	1
OYODO class	1	2	2	1	1
Aircraft Carriers					
AKAGI class	2				1
UNRYU class	1	3	1	1	1
SHOKAKU class	2				1
ZUIHO class		2		1	1
JUNYO class	2	2		1	1
TAIYO class		2		1	1
TAIHO class	2	2		1	1
SHINANO class	2	2		1	1
Destroyers					
MINEKAZE class		1	1	1	1
KAMIKAZE class		1	1	1	1
AKIZUKI class		2	1	1	1
KURI class		1			1
WAKATAKE class		1			1
All other classes		1	1	1	1
Coast Defense Boats		1	1	1	1
Minesweeper					
1, 7, 13 classes		1		1	1
19 class			1	1	1
Submarine Chasers					
1 class		1			1
14 class			1		1
Submarines					
I-400 class		2	1	1	1
I-10 class		1	1	1	1
Ro-100 class		1		1	
Transports					
First class			1		1
Second class		1			1
Torpedo Boats		1			1
Minelayers		1 or	1		1
Patrol Ships		1			1

Remarks

1. There are some coast defense boats without cm-wave radar intercept receivers.

2. Some first class transports have Type 3 Mark 1 Model 3 radar.

B. Arrangement of Equipment

A Shipboard Installation Instruction Book, forwarded to WDC, (NavTechJap Document No. ND21-6276) contains installation notes and inter-connection wiring diagrams for the shipboard radar equipment and intercept receivers in use at the end of the war. No installation of electronic jamming equipment in naval vessels existed at the time of surrender. A large portion of the shipboard radar installation work done during the latter part of the war was accomplished at Kure Navy Yard under the direction of Commander OHNO, the former radar material officer. Through him, the installations described below were investigated because they were typical and represented the best and most complete installation jobs.

It was general practice to select compartments that provided the shortest antenna runs and yet were large enough to accomodate a complete equipment. Each equipment usually occupied its own compartment. Separation of duplicate equipments was accomplished to provide the best possible damage control. An example of this practice was noted in CV KATSURAGE, in which two air search radars were installed in the island structure but separated as much as possible and a third air search radar was installed on a retracting platform located about amidships on the port side of the flight deck. The actual arrangement of equipment in compartments was left largely to the discretion of the navy yard making the installation. As a result, little standardization existed. Apparently little thought was given in the arrangement plan either to the ease of servicing or the methods of operation to be used. Figure 1 illustrates the crowded conditions existing in a typical Mark 2 Model 2 Modification 4 fire control and surface search installation. Admittedly such an arrangement made difficult the problem of reaching simultaneous ranges and bearings by two operators. A technician adjusting the various controls made the task almost impossible. The location of the transmitter and rectifier in the crowded operating spaces usually resulted in a larger heat dissipation than the inadequate ventilation system could handle. This problem was largely solved by avoiding continuous operation.

No plotting facilities were observed in the radar compartment of any Japanese vessel. The photographs and index sketch contained in Eclosure (A) show the arrangement and installation in the forward air search radar compartment and the fire control and surface search radar compartment of a TERUTSUKI class destroyer. Enclosures (B), (C) and (D) include photographs and index sketches of the Mark 2 Model 2 Modification 4, the Type 2 Mark 2 Model 1 Modification 2, and one of two Type 3 Model 1 Model 3 radars installed in CV KATSURAGI. The sketches show the general arrangement of these compartments and orient the photographs.

Intercept receivers were installed in the same compartment as the radars and were usually given some preference in location since they were normally manned continuously while underway.

C. Power Supplier and Cabling

The 10 centimeter surface search and fire control equipments operated on a special motor-alternator. The output from this unit, in the case of fire control installations, was fed into a voltage stabilizer that produced a very constant power source. CV KATSURAGI, which was one of the most modern combatant vessels still afloat at the end of the war, produced only direct current from her main generators, and all radar equipments operated from individual motor-alternators. The motor-alternators were usually tied into the main

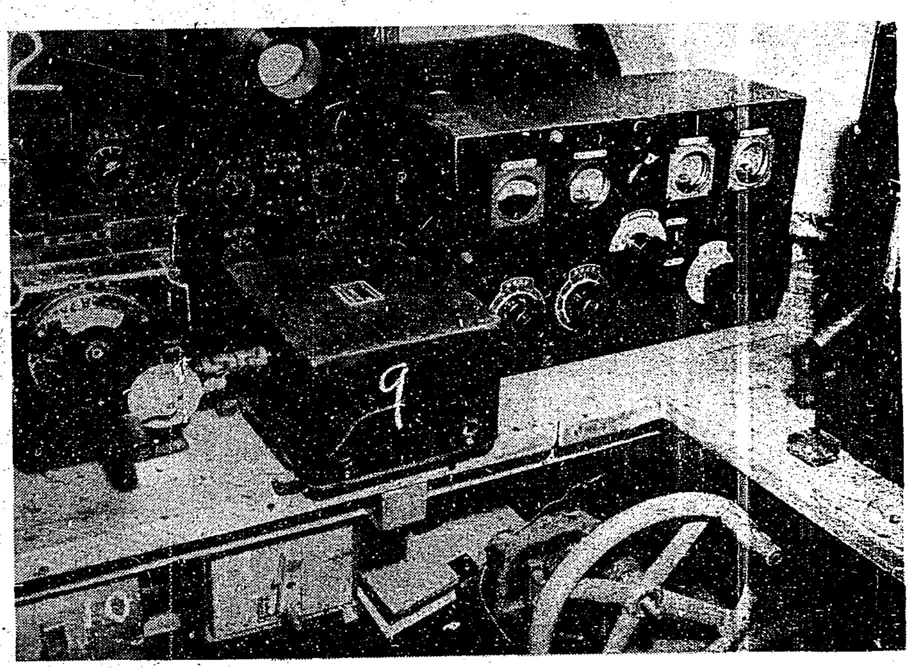


Figure 1
MARK 2 MODEL 2 MODIFICATION 4 RADAR INSTALLED IN DD HANAZUKI

Figure 2
CABLE TRUNK IN AIR SEARCH RADAR INSTALLATION IN CV KATSURAGI

power distribution panel which could transfer them to an emergency generator when such units were installed.

Interconnection wiring was universally poor and such connections as shown in Figure 2 were not uncommon. Most of the cables used were armoured but in many cases the cables were permitted to pass through decks and bulkheads without any protection against chafing. Bonding of cable shields was poorly done and in many cases was accomplished to remove trouble from the equipment rather than as a part of the original installation. In a number of cases wood was used on compartment bulkheads to facilitate cable clamping.

D. Shock Mounting

Shock mounting was used in only the most critical compartments such as the transmitter and indicators, while the rest of the units were either bolted to wooden tables or to brackets welded to the deck. The mounts used were in general constructed similar to standard lord mounts. Figure 3 shows a Mark 2 Model 2 Modification 4 transmitter (1) on shock mounts with the receiver (3) and the voltage controller (4) bolted directly to a wooden platform and the deck respectively. Although considerable trouble was experienced with tubes, the cause was said to be a result of non-uniformity in production rather than the shock of gunfire.

E. R. F. Transmission Liner and Antennas

The installation of the 75 millimeter round wave guide for the 10 centimeter wave equipment was carried out in a conventional manner using standard flange connections. It was claimed that little trouble was experienced with moisture in the line and that the zinc plating stood up well, although an inspection of one run that was removed from a destroyer showed the plating to be in bad condition.

Simple two wire lines were used for the installation of all air search radar on surface vessels. Coaxial lines were used for submarine installations. Figure 4 shows a typical duplexer installation for a Type 3 Mark 1 Model 3 equipment. Various types of flexible and rigid coaxial lines were in use for interconnection wiring and submarine installations. Further information on the specifications and construction of these lines may be obtained from NavTechJap Report, "Japanese R. F. Transmission Lines, Wave Guides, Wave Guide Fittings, and Dielectric Materials," Index No. E-20.

Figures 5 and 6 show a typical installation of Mark 2 Model 2 Modification 4 and Type 3 Mark 1 Model 3 antennas on a TERUTSUKI class destroyer. The photographs were taken from the forward edge of the director and from just abaft the stack, respectively. The horn type antenna shown (see Figure 5) is an enlarged version used with fire control installations. The small box to the right of the antenna pedestal houses the antenna control selsyns. The Type 3 Mark 1 Model 3 antenna shown just forward of the foremast in Figure 6 is a typical air search antenna installation. This type of antenna was usually constructed by the navy yard making the installation and slight variations in mechanical construction were noted. A second air search antenna of this type was installed on the mainmast of this class of destroyers while the equipment itself was installed in the radio transmitter room directly below the mast. Figure 7 shows this antenna installation.

Modification 3 (meter wave) intercept receiver antennas were usually installed with the non-directional metox antenna secured to the yardarm and the directional racket type antenna mounted on a small platform just above the air search antenna. Figure 8 shows a typical installation in an aircraft carrier. In this case two sets of metox and racket antennas may be seen, one set for each air search radar installed in the island structure. The Model 3 (centimeter wave) intercept receiver utilized the hand-held parabolic antenna and fixed installations seem to have been made only on submarines.

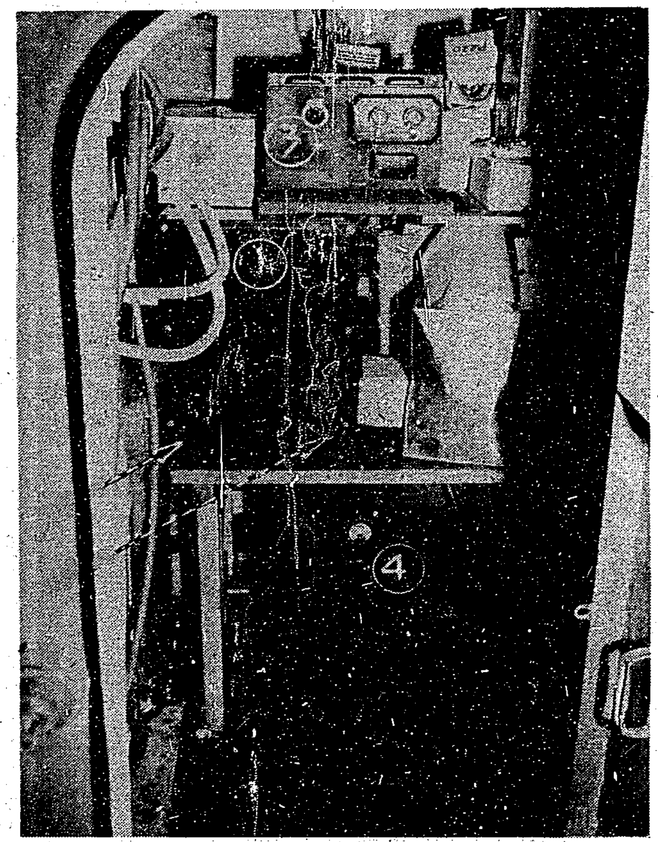
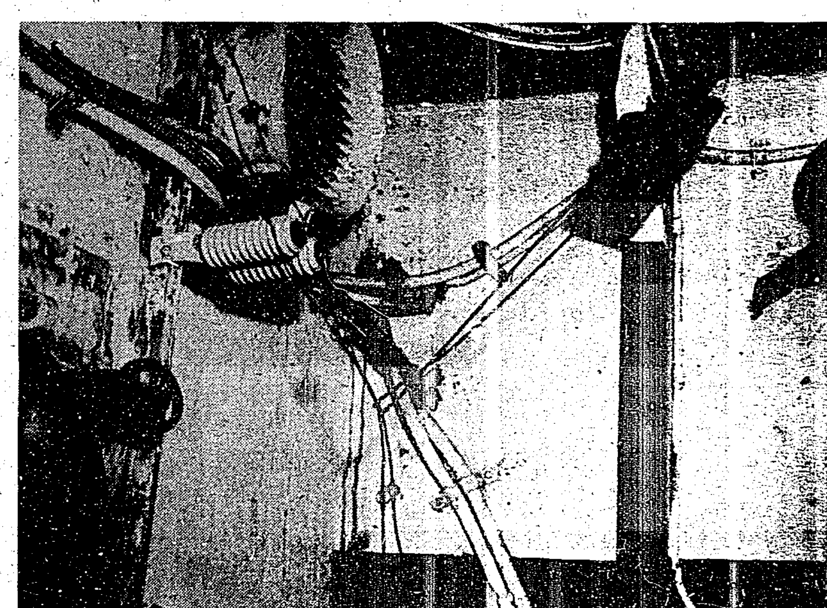


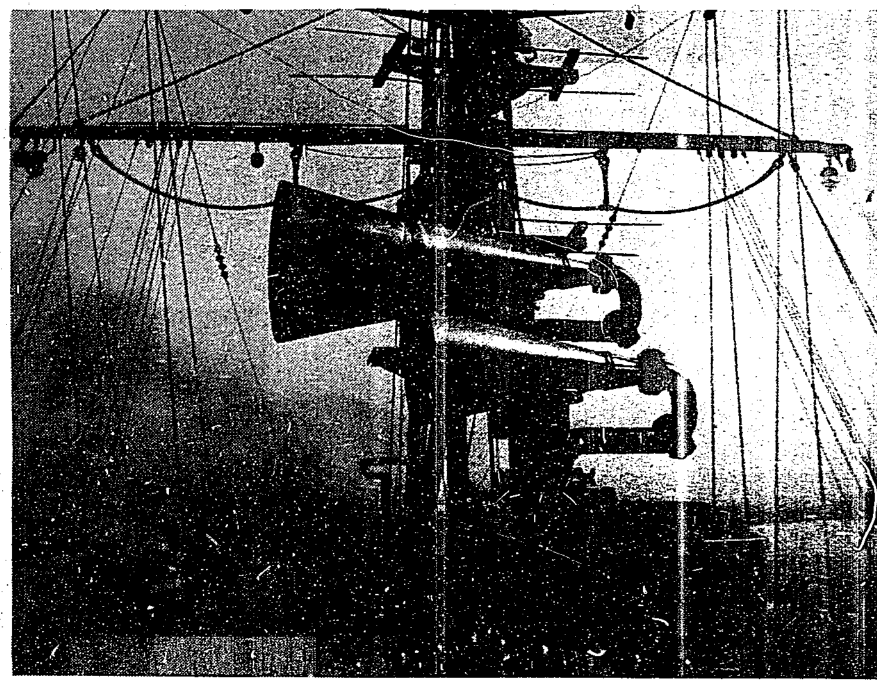
Figure 3

MARK 2 MODEL 2 RADAR INSTALLATION IN DD HANAZUKI

Figure 4

DUPLEXER FOR TYPE 3 MARK 1 MODEL 3 INSTALLATION IN DD HANAZUKI





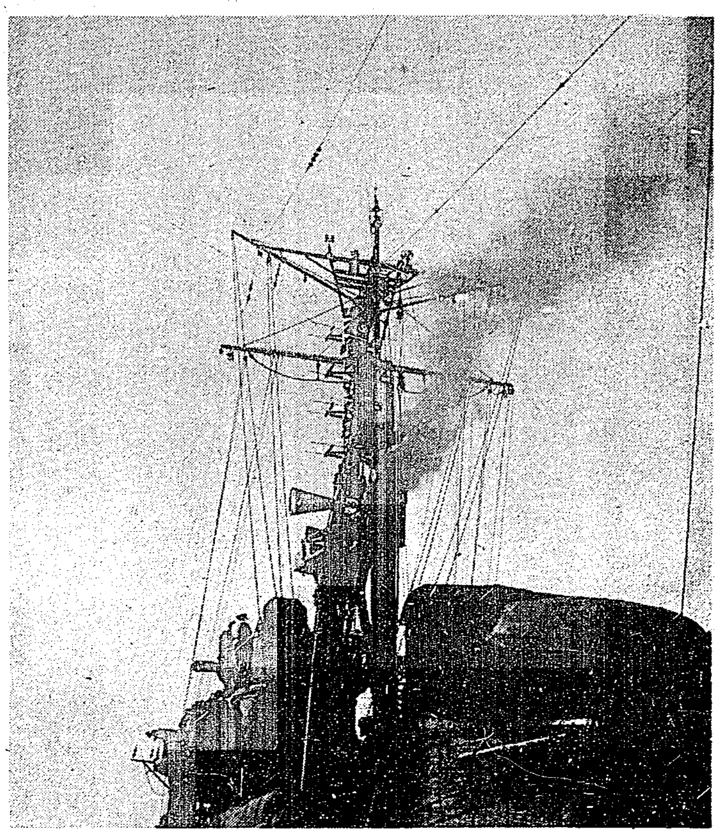


Figure 5
ANTENNA INSTALLATION IN DD HANZUKI

Figure 6
ANTENNA INSTALLATION IN DD HANAZUKI

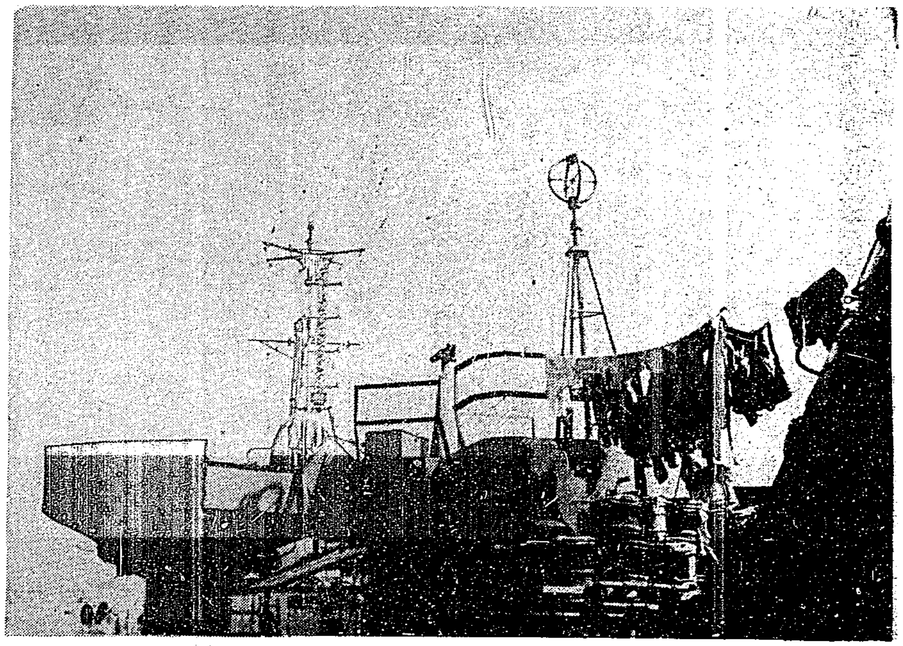


Figure 7

ANTENNA INSTALLATION IN DD HANAZUKI

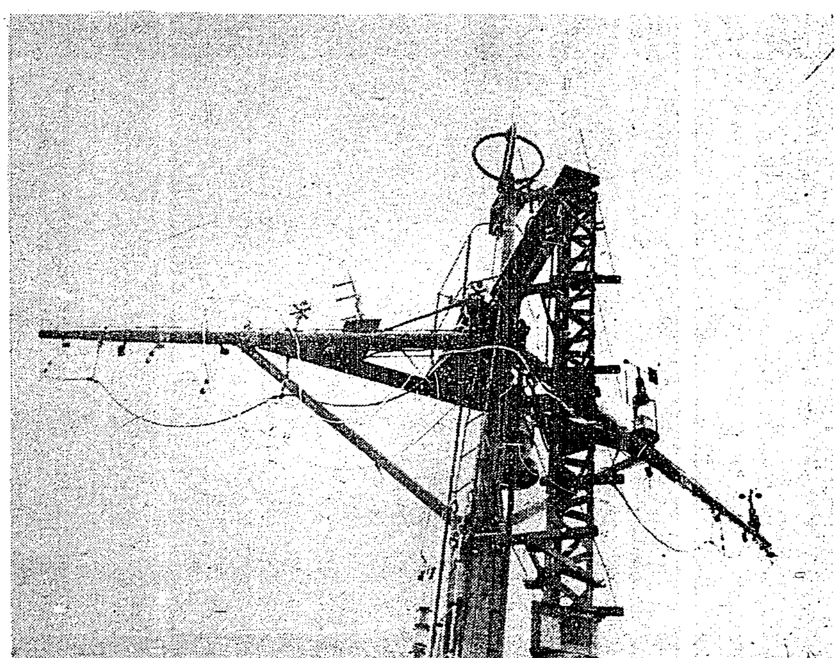


Figure 8

AIR SEARCH AND INTERCEPT RECEIVER ANTENNA INSTALLATION IN CV KATSURAGI

Figure 9 shows what was claimed to be the latest antenna arrangement for submarines. The single horn Mark 2 Model 2 Modification 3 antenna is not shown but was mounted just forward of the conning tower.

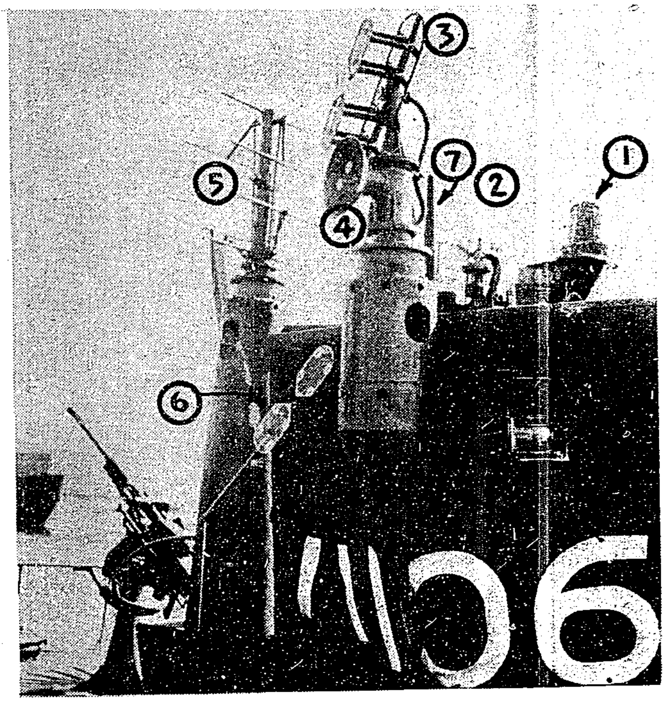


Figure 9

ANTENNA INSTALLATION IN SS I-106

The water seal for the wave guide of this equipment consisted of a rubber seal inserted just below the rotary joint and one safty gate valve located in the radar compartment about two meters from the pressure hull. The single non-directional dipole (1) was used both for radio transmitting and as the transmitting antenna for the Type 3 Mark 1 Model 3 radar. Details on coaxial connections and switching are shown in the Shipboard Installation Instructions Book, (NavTechJap Document No. ND21-6276). The YAGI antenna (5) was used as the air search receiving antenna. The combination racket antenna (3) and the parabolic antenna (4) were alleged to be the latest in intercept receiver antenna installations and the first and only one of this type completed at the end of the war. Fixed racket antenna (6) were mounted on both sides of the conning tower and in some cases, to reduce water resistance, were installed on the inside of the conning tower behind rubber or fabric inserts. The small cylindrical antenna (1) is the new type used with the ultra long wave receiver for underwater reception. The non-directional metox antenna is identified as (2) in Figure 9.

All directional radar antennas and the racket type intercept receiver antennas had a mechanical control system. In addition to the mechanical system, the 10 centimeter fire control installations had an electric motor drive with selsyn control. Some of the air search installations also had a simple motor drive.

Part III
MAINTENANCE IN THE FLEET

A. Maintenance Personnel

All combatant vessels of destroyer size and above had at least one electronic technical officer who was usually an electrical engineering graduate and who may or may not have had special radar training before reporting aboard. An officer of similar qualifications was also assigned to the larger submarines. In the maintenance of equipment this officer was assisted by a number of enlisted technicians who, after taking a general electronic course in school, specialized in either radar, radio, or sonar after reporting aboard. The number of technicians found aboard DD HANAZUKI, believed to be representative, consisted of three radar specialists, two radio specialists, and two sonar specialists.

B. Maintenance Procedures

All maintenance records had been burned by the Japanese on the day following the surrender and little data was available. It was stated that a maintenance log was normally kept, but little in the way of a routine preventative maintenance program was in effect. The Mark 2 Model 2 equipment was expected to operate only a small percentage of the time. However, considerable difficulty was experienced in maintaining it so that it operated satisfactorily 80% of the time that it was needed. The Type 3 Mark 1 Model 3 equipment was stated to operate satisfactorily an average of 95% of the time that this equipment was needed. Although the Type 2 Mark 2 Model 1 Modification 2 air search equipment gave little trouble, its operation was never considered satisfactory due to the use of acorn type tubes as pre-amplifiers which resulted in a low receiver sensitivity at 200 megacycles. The Model 3 and the Modification 3 intercept receivers were said to give little trouble except for routine tube failures.

The majority of failures were due to vacuum tubes and resistors. Although the same resistors continually failed, little if anything seems to have been done about changing design or ratings in installed equipment or in later production of the same models. There was a great variation in the life expectancy of vacuum tubes and they were a major source of trouble.

Part IV
OPERATIONAL PROCEDURES EMPLOYED AND PERFORMANCE DATA

A. Operational Procedures Employed Aboard A TERUTSUKI Class Destroyer

The Mark 2 Model 2 Modification 4 fire control and surface search radar was manned by two operators, one using the main indicator to read ranges and the other the small oscilloscope to read bearings by the maximum amplitude method. Four additional men and one technical radar officer were also in the compartment to operate the intercept receiver and the telephones. Figure 1 and Enclosure (A) show the arrangement of equipment in this installation.

The equipment was operated only during periods of impending battle or during periods of extremely poor visibility. It was seldom used for station keeping, since its minimum range was approximately 1500 meters. The primary function of the equipment on the destroyer was to furnish ranges every 15 seconds to gunnery plot. Radar bearings were used only when visual bearings could not be obtained. Selsyn transmission of both range and bearing information was available to gunnery plot and to the individual gun mounts. Both ranges and bearings were also furnished the chief radar officer on the bridge. This officer usually attempted to maintain a rough plot from the data received and to provide the captain with evaluated radar information. Facilities were available so that a target could be designated electrically from the bridge to a match-the-pointer indicator located in front of the radar bearing operator. This was the closest approach noted to the use of a combat information center.

Voice tubes and battery-powered phones were available between the radar compartment, the bridge and gunnery plot. Of these, the voice tube was considered the primary means of communication. The only means of communication between the fire control and air search radar compartments was the small scuttle shown in Enclosure (A). Figure 10 shows the installation of a gyro repeater on the left with a rough antenna bearing indicator at the right. The voice tube and telephone are shown just above the range indicator. A vernier bearing indicator with a pointer controlled from the bridge was mounted in line and just to the right of the indicators shown. A tabulation of maximum and reliable ranges obtained with range and bearing errors for this type of equipment is given in Table I.

The operation of the air search radars was handled in much the same manner as the fire control radar. The Type 3 Mark 1 Model 3 equipments required two operators with three additional men for the intercept receiver and the phones. The radar technical officer would assist in either the surface search or air search compartments depending on the tactical situation. Figure 11 and Enclosure (A) show a typical arrangement of equipment. The bearing indicating dial located on the bulkhead and the mechanical antenna control system shown in Figure 11 are typical.

Both air search equipments were operated during periods of impending raids, but no definite system for correlatating the two sources of information seems to have been in effect. Both equipments furnished their range and bearing information to gunnery plot, the bridge and the gun mounts via voice tube and telephones. While the radars were only operated for short periods the intercept receivers were manned continuously when in a danger area and a great deal of faith was placed in their performance. The average range of the air search radar on a single aircraft was claimed to be 50 km.

Figure 10

BEARING INDICATOR INSTALLED IN FIRE CONTROL RADAR COMPARTMENT IN DD HANAZUKI

Table I
PERFORMANCE DATA OF MARK 2 MODEL 2 RADAR (MAY 1944)

Modif. of Radar	Ship	Antenna Height (m)	Range - (KM)					Bearing Error (°)			Range Error (m)		
				BB	CA	DD	SS	Max	Min	Aver	Max	Min	Aver
4	YAMATO (BB)	32.5	Max		17.0	16.0	7.0	3	0	2	+400	+100	+200
			Aver			10.0							
2	MUSASHI (BB)	32	Max	25	18	12	7	5	0	2-3	+600	0	+200
			Aver	20	16	9	6						
2	ATAGO (CA)	20	Max	26	20	17		5	1	3	+700	0	+300
			Aver	21	16	10							
4	MAYA (CA)	19	Max	12	12	10		5	0	2.5			
			Aver	10	10	8					+100	+25	+60
2	HAMANAMI (DD)	18.5	Max	12	10	7	6	6	0	.8			
			Aver	10	9	5.5	4				+500	0	+50
2	HAYANAMI (DD)	15.6	Max	23	19	13	7	5	0	1.1	+385	0	+120
			Aver	20	16	11	6.5						
2	HARUSAME (DD)	15	Max	15	13	9	5	5	0	2	+200	0	+100
			Aver	9.5	9	7	5.5						
2	ASASHIMO (DD)	15	Max	15	13	11	6	8	0	2.6	+600	0	+120
			Aver	13	10	8	3.5						
4	TAMANAMI (DD)	16	Max	20	13.5	8		7	3.5	4	-400	-200	-200
			Aver	12.5	8.5	6.1							
2	FUJINAMI (DD)	14	Max	25	23	14	10	5	1.5	2.1	+500	0	+250
			Aver	19	17	12	5						

TABLE II
SHIPBORNE RADAR WITH THEIR CHARACTERISTICS

No.	Name	Designation	Object	Research Started	Research Finished	Remarks	Installation	Freq. Wave	Pulse Length μs	Power Output (Peak) kw	Rep. Freq. cs	Transmitter: Oscillation Circuit	Transmitter: Oscillator Value	Receiver: Inter. Freq. (mc)	Receiver: Detector	Receiver: Local Oscillator
1	Type-3 Mark-1 Model-3 for ships	13 for ship	Anti-air warning	1943-9	1944-2	in use	Both sides of Mizzen Mast	2 m	10	10	500	LC-Circuit	T-311x2	14.5	UN-954	UN-955
2		13 for Submarine	Anti-air warning	1943-9	1944-5	in use.	Communication Mast	2 m	10	10	500	LC-Circuit	T-311x2	14.5	UN-954	UN-955
3		13 for Submarine Anti-Air	Anti-air warning	1943-9	1944-7	in use	On Conning Tower	2 m	10	10	500	LC-Circuit	T-311x2	14.5	UN-954	UN-955
4		13 for small vessels	Anti-air warning	1943-9	1944-7	in use	Foremast	2 m	10	10	500	LC-Circuit	T-311x2	14.5	UN-954	UN-955
5	Type-2 Mark-2 Model-1	21	Anti-air warning	1942-1	1942-4	in use	Bridge (Converted Merchant Ship)	1.5m	10	5	1000	LC-Circuit	T-310x2	21.5 3.5	UN-954	UN-955
6		21-Kai-1	Anti-air warning	1942-8	1942-12	out of use	Fore-top	11.5m	10	5	1000	LC-Circuit	T-310x2	21.5 3.5	UN-954	UN-955
7		21-Kai-2	Anti-air warning	1943-5	1943-8	in use	Fore-top	1.5m	10	5	1000	LC-Circuit	T-310x2.	21.5 3.5	UN-954	UN-955
8		21-Kai-3	Anti-air and Anti-surface warning	1943-8	1944-2	out of use	Fore-top	1.5m	6-10	30	500	LC-Circuit	T-311x4	21.5 3.5	UN-954	UN-955
9		21-Kai-4	Anti-air and Anti-surface warning	1944-2	1944-5	research stopped	Fore-top	1.5m	10	30	1000	LC-Circuit	T-311x4	21.5 3.5	UN-954	UN-959
10		21-Kai-5	Anti-air warning and surface fire control	1944-5	1944-9	not yet used	Fore-top	1.5m	6	30	1000	LC-Circuit	T-311x4	21.5 3.5	UN-954	UN-955
11		F8	Anti-surface warning	1943-3	1943-10	research stopped		58 cm	5	2	500	Resonator-tanc	SN-7 x2	21.5 8.75	2400	UN-955B
12	Type-3 Mark-2 Model-3	23(Sg)	Anti-surface fire control	1943-10	1944-3	not yet used	Fore-top	58 cm	2.5	5	3750	Resonator-tanc	T-321	21.5 8.75	2400	UN-955B
13	Prototype Mark-2 Model-4	24	Anti-surface fire control	1943-11	1943-4 stopped	reasearch stopped		28 cm	2	1	1000	Parallel wire (standing wave)	LD-212-Cx2	15	Crystal	LD-1
14	Prototype Mark-2 Model-2	22-Kai-1	Anti-surface warning	1941-10	1942-6	out of use	Fore-or Mizzen Mast	10 cm	10	500w	2500	Magnetron	M-311	Super regenerative	M-60	
15		22-Kai-2	Anti-surface warning	1942-6	1942-12	out of use	Fore-or Mizzen Mast	10 cm	10	2	2500	Magnetron	M-312	Autodyne	M-60-A	
16		22-Kai-3	Anti-surface warning	1942-10	1943-6	in use	Conning Tower of Submarine	10 cm	10	2	600	Magnetron	M-312-B	14±1	Crystal	M-60-S
17		22-Kai-4	Anti-surface warning	1942-12 1943-12	1943-12 1944-9	in use	Fore-or Mizzen Mast	10 cm	10	2	2500	Magnetron	M-312-A	14±1	Crystal	M-60-S
18	Prototype Mark-3 Model-1	220	Anti-surface fire control	1944-2	1945-3	not yet used	Fore Mast and Sea Shore	10 cm	10	2	2500	Magnetron	M-312-A	14±1	Crystal	M-60-S
19	Prototype Mark-3 Model-3	105 S1	Anti-surface fire control	1944-5	1945-1 stopped	research stopped		10 cm	10	2	2500	Magnetron	M-312-A	14±1	Crystal	M-60-S
20	Prototype Mark-3 Model-2	105 S2	Anti-surface fire control	1944-2	1944-9	not yet used	Fore-Mast of Battle-ship or Sea Shore	10 cm	10	2	2500	Magnetron	M-312-A	14±1	Crystal	M-60-S

No.	Scope Representation: Dia. in mm	Scanning axis	Scale	Antenna: Type	Gain (db)	Beam Hor.	Angle Vert.	Maximum Range, Scale Effective (km)	Minimum Distance (km)	Accuracy of Range	Distance Discrimination	Accuracy of Bearing	Angle Discrimination	Spare Parts	No. of Operators	Degree of Operating Difficulty	Maintenance
1	75	Linear	Mechanical	2 x 4 Horizontal	12	±34°	±17.5°	150(300) 100	5	± 2~3km	3km	±10°	≃60°		2	None	Few troubles
2	75	Linear	Mechanical	Single Vertical	≃ 3	360°		150(300) 30	5	± 2~3km	3km				2	None	Antenna System gave trouble
3	75	Linear	Mechanical	Yagi Hor.	7	±30°	± 25°	150(300) 15	5	± 2~3km	3km	± 5°	≃60°	Number of Vacuum Tubes in use x 3	2	None	Antenna System gave trouble
4	75	Linear	Mechanical	2 x 4 Hor.	12	±34°	±17.5°	150(300) 100	5	± 2~3km	3km	± 5°	≃60°		2	None	Antenna System gave trouble
5	120	Linear	Electric	6 x 2 6 x 2 Hor.	14 14	±11°	± 40°	150 100	5	± 1~2km	≃ 2km	± 5°	≃20°	Number of Resistances in use x 1/3	2	None	At first trouble Frequently broke down
6	120	Linear	Electric	4 x 2 3 x 2 Hor.	12 11	±17° ±23°	± 40°	150 70	5	± 1~2km	~2km	± 8°	≃40°		2	Slight	Antenna System gave trouble
7	120	Linear	Electric	4 x 3 Hor.	14	±17°	± 30°	150 100	5	± 1~2km	≃2km	± 5°	≃20°	Number of Condensers in Use x 1/3	2	None	No troubles
8	75	Linear	Optical Electric	4 x 3 Hor.	14	±17°	± 30°	270, 14 against a battleship	4	± 0.5km	1km	± 1°	8°		4	Difficult	Liable to break down
9	120	Linear	Electric	4 x 4 Hor. Interchangeable	15	±17°	± 17.5°	150, 15 against a battleship	5	± 1.0km	1,5km	± 1°	8°		3	Difficult	Liable to break down
10	120	Linear	Electric	4 x 4 Hor. Interchangeable	15	±17°	±17.5°	150, 20 against a battleship	4	± 0.5km	1km	± 1°	8°		3	Difficult	Ordinary
11	120	Curve	Mechanical	Tr: Paraboloid 1.7m dia. Rec. 1.7m Vertical	11	±25°	± 25°	150, 15 against a cruiser	1.3	± 2km	Research Incompleted	± 3°	Research Incompleted		1	None	Not yet tested
12	75	Warning: Linear Range and Bearing: Sinusoidal		Tr: Paraboloid 1.7m dia. Rec. 1.7m Rotating	11 11	±25°	± 25°	33, 22 against a battleship	1	± 50m	150km	±0.5°	14°		3	None	Liable to break down
13	75	Logarithmic	Electric	Tr: Paraboloid 2m dia. Rec. 2mDouble Ant.(switch)	19 19	± 9°	± 9°	40, 11 against a battleship	1	± 50m	150 m	±0.5°	14°		3	None	Gave some trouble
14	120	Linear	Electric	Paraboloid 0.8 x 1.7m	15	±15°	± 15°	60, 30 against a battleship	1.5	± 500m	1.5km	± 3°	≃±30°		3	Difficult	Gave some trouble
15	120	Linear	Electric	Horn 400mm	13	±19°	± 19°	60, 22 against a battleship	1.5	± 500m	1.5km	± 3°	≃±40°		3	Slight	Gave some trouble
16	75	Linear		Horn 400mm	13	±19°	± 19°	60, 10 against a battleship	1.5	± 500m	1.5km	± 3°	≃±40°	Number of Resistances in use x 1/10	3	None	No trouble
17	75	Linear	Electric	Horn 400mm	13	±19°	± 19°	60, 25 against a battleship	1.5	±100~250m	1.5km	± 3°	≃±40°	Number of Vacuum Tubes in use x 4	3	None	No trouble
18	75	Warning: Linear, Range and Bearing: Sinusoidal		Paraboloid	25	± 7°	± 7°	60, 35 against a battleship	1.5	±100~250m	1.5km	±40°	≃±15°	Number of Magnetron in use x 5	3~4	Slight	No trouble
19	75	Warning: Linear, Range and Bearing: Sinusoidal		Horn, Tr: 1 Rec: 2	15	±15°	± 15°	60, 28 against a battleship	1.5	±100~250m	1.5km	±30°	≃±30°		4	None	No trouble
20	75	Warning: Linear, Range and Bearing: Sinusoidal		Horn, Tr: 1 Rec: 2	20 15	±15° ±20°	± 18° ± 10°	60, 30 against a battleship	1.5	±100~250m	1.5km	±30°	≃±30°			None	No trouble

TABLE III
SHIPBORNE RADAR COUNTERMEASURES

Land-Based and Shipborne Radar Counter Measures

No.	Name	Designation	Object	Research Started	Research Finished	Remarks	Installation	Frequency Band (Wave length)	Receiver: Type	Local Oscillator	Intermediate Frequency	Tubes	Gain	Type of Indication	Antenna: Type	Kind	Gain	Beam Angle Horizontal	Beam Angle Vertical	Spare Parts	No. of Operators	Degree of Operating Difficulty	Maintenance	No.
1	Radar Counter Measure Kai 3	E 27	RCM for meter-wave	6/43	4/44	In use	Surface Ships and Submarines	7.5m~400mc (4m~0.75m)	Single Tuning Superheterodyne	Parallel Wire Single Tuning	14.5mc	Un-955x3 UZ-6C6x9	110db	Aural Visual: For Directional and Repetition Frequency	Directional: Racket-antenna (Rotating Fixed for Surface craft) All-around: Metox-antenna or θ - antenna					Number of Vacuum Tubes in Use x3 Few Replacement Parts	One	None	No trouble	1
2	Radar Counter Measure Model-3		RCM for cm-wave	1/44	4/44	In use	Surface and Submarine (Land)	400mc~10,000mc (0.75m~0.03m)	Crystal Detecto		17.5 ± 3.5mc	UZ-6C6x4 UZ-42x1	110db	Aural Visual: For Directional and Repetition Frequency	Directional: Parabolic Disc Type (Mark-49) (Portable) All-around: Spherical-antenna					Number of Vacuum Tubes in Use x3	One	None	No trouble	2
3	Racket-antenna		RCM for meter-wave	6/43	12/44	In use	Surface and Submarine	4m~0.75m		Receiver Used, Kai-3 (E-27)					Rotating, Fixed	Directional	-3db	30°~50°	30°~60°			None	Liable to Insulation Breakdown	3
4	Metox-antenna		RCM for meter-wave	6/43	12/44	In use	Surface and Submarine	4m~0.75m		Receiver Used, Kai-3 (E-27)					Fixed	All-around	-6db					None	Liable to Insulation Breakdown	4
5	θ - antenna		RCM for meter-wave	6/44	12/44	Not yet used	Surface and Submarine	4m~0.75m		Receiver Used, Kai-3 (E-27)					Fixed	All-around	-6db					None	No trouble	5
6	Mark-49 Antenna		RCM for cm-wave	6/44	12/44	In use	Surface and Submarine, Land	0.80m~0.03m		Receiver Used, Model-3					Portable	Directional	+5db	10°~20°	10°~20°			Slightly Difficult aboard Subs	No trouble	6
7	Spherical Antenna		RCM for cm-wave	3/45	7/45	Not yet used	Surface and Submarine, Land	0.15m~0.03m		Receiver Used, Model-3					Fixed	All-around	-20db					None	No trouble	7

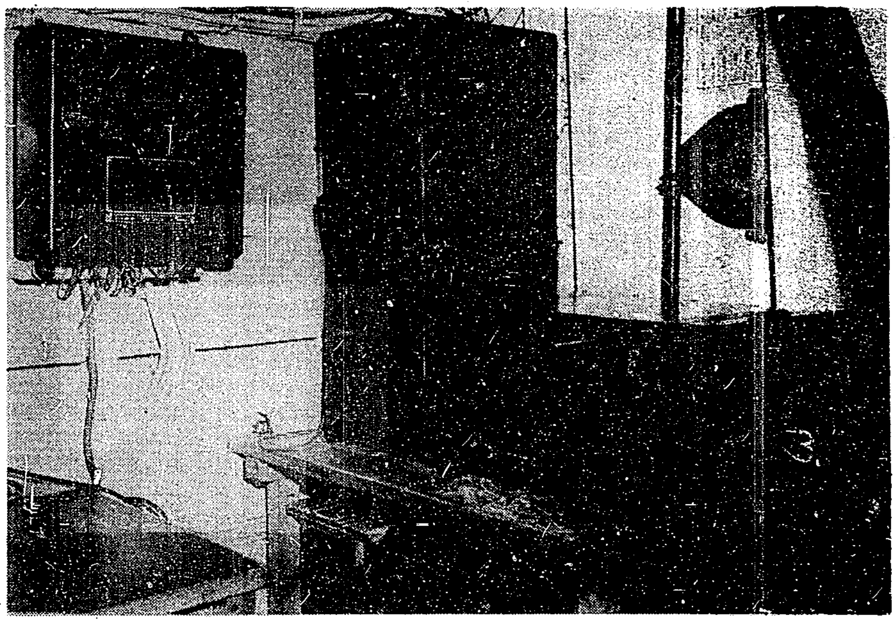


Figure 11

TYPE 3 MARK 1 MODEL 3 RADAR
INSTALLATION IN DD HANAZUKI

Part V
TECHNICAL DATA ON EQUIPMENT

A. General

Table II lists the types of radar equipment in use at the end of the war and their characteristics as well as equipment under development. Only radars in use by the fleet will be discussed in this report and reference is made to the report on experimental radars for data on the other equipments. (NavTechJap Report, "Japanese Experimental Radar", Index No. E-12.)

All equipments in use by the Japanese Navy at the end of the war may be considered obsolete by U.S. Navy standards. The only scope presentation in use was the standard "A" scan with linear and sinusoidal sweeps. Methods of reading ranges varied from mechanical scales to phase shifters and electronic range markers.

The Type 3 Mark 1 Model 3 (13) and the Type 2 Mark 2 Model 1 (21) equipments were the only air search radars in use. The Mark 2 Model 2, 10 centimeter equipments had two modifications in use at the time of the surrender. The Modification 3 radar was installed in submarines for surface search. Modification 417 for surface search and Modification 4S for surface search and fire control were installed in surface vessels.

Table III lists all RCM equipments in use and under development at the end of the war. Both the meter wave (E27) and the centimeter wave (Model 3) receivers were installed in practically all combatant vessels. No electronic jamming equipment was installed or under development for naval vessels.

B. Air Search Radars

1. Type 3 Mark 1 Model 3 (13) Radar

This equipment was adapted for shipboard use from a landbased equipment of the same designation. The only modification accomplished for the shipboard installation was in the antenna and antenna control system. While surface vessels used the same antenna as in the landbased equipment, a special vertical dipole and a YAGI antenna were used in submarines. Examples of shipboard antennas may be seen in Figures 5 and 7. In addition to the mechanical antenna train used on land, a number of the shipboard installations had electrical training systems. This 150 megacycle equipment was very compact and simple in design and operation. Compared with other shipboard radars, it gave very little trouble. The simplicity of the equipment is shown in the block diagram contained in Figure 12.

The transmitter developed a peak power output of 10 kilowatts with two type T-311 tubes connected in a 2C oscillation circuit. A plate voltage of 8000 volts and a grid bias of - 1300 volts was used. The modulater tube (P-560) reduced the bias to zero during oscillation. The pulse rate was 500 per second and the pulse length 10 micro seconds. The receiver and indicator were also of conventional design. The characteristics are completely listed in Table II and complete wiring diagrams are included in Enclosure (E). Instruction books (NavTechJap Document Nos. ND21-6085 and ND21-6086) have been forwarded to WDC. A sample of this equipment was obtained and shipping data is given in NavTechJap Report, "Japanese Electronics - General", Index No. E-28.

2. Type 2 Mark 2 Model 1 (21) Radar

This radar was designed especially for shipboard use. While two subsequent modification were produced with three more under development, the equipment that reached the fleet was never considered equal in reliability and performance to the simple Type 3 Mark 1 Model 3. The trouble was claimed to have been largely due to poor receiver sensitivity that resulted from using acorn tubes as RF Amplifiers at 200 megacycles. The same receiver design was used in all modifications despite adverse service reports. A block diagram is included as Figure 13 and complete wiring diagrams are given in Enclosure (F). The first model of this equipment had a peak power output of 5 kilowatts with a 10 microsecond pulse length and a pulse rate of 1000 per second. The transmitter oscillator utilized two type T-310 tubes in a conventional L-C circuit. A single mattress type antenna was used for transmitting and receiving.

The first modification merely replaced the single antenna with an antenna having two horizontal sets of four elements each for transmitting and two horizontal sets of three elements each for receiving. The second modification replaced the antennas with another single antenna which consisted of three horizontal sets of four elements each.

The third modification was undertaken to adapt the equipment to both air and surface search. The frequency was left at 200 megacycles but the power was increased to 30 kilowatts with a choice of either 6 or 10 microsecond pulses. The pulse rate was reduced to 500 per second. The antenna was to be the same as that used on the Modification 2 except for the addition of lobe switching. Modification 4 and 5 were to accomplish only small changes such as pulse lengths and rates. No installations of Modification 3 and later equipments had been completed at the time of surrender.

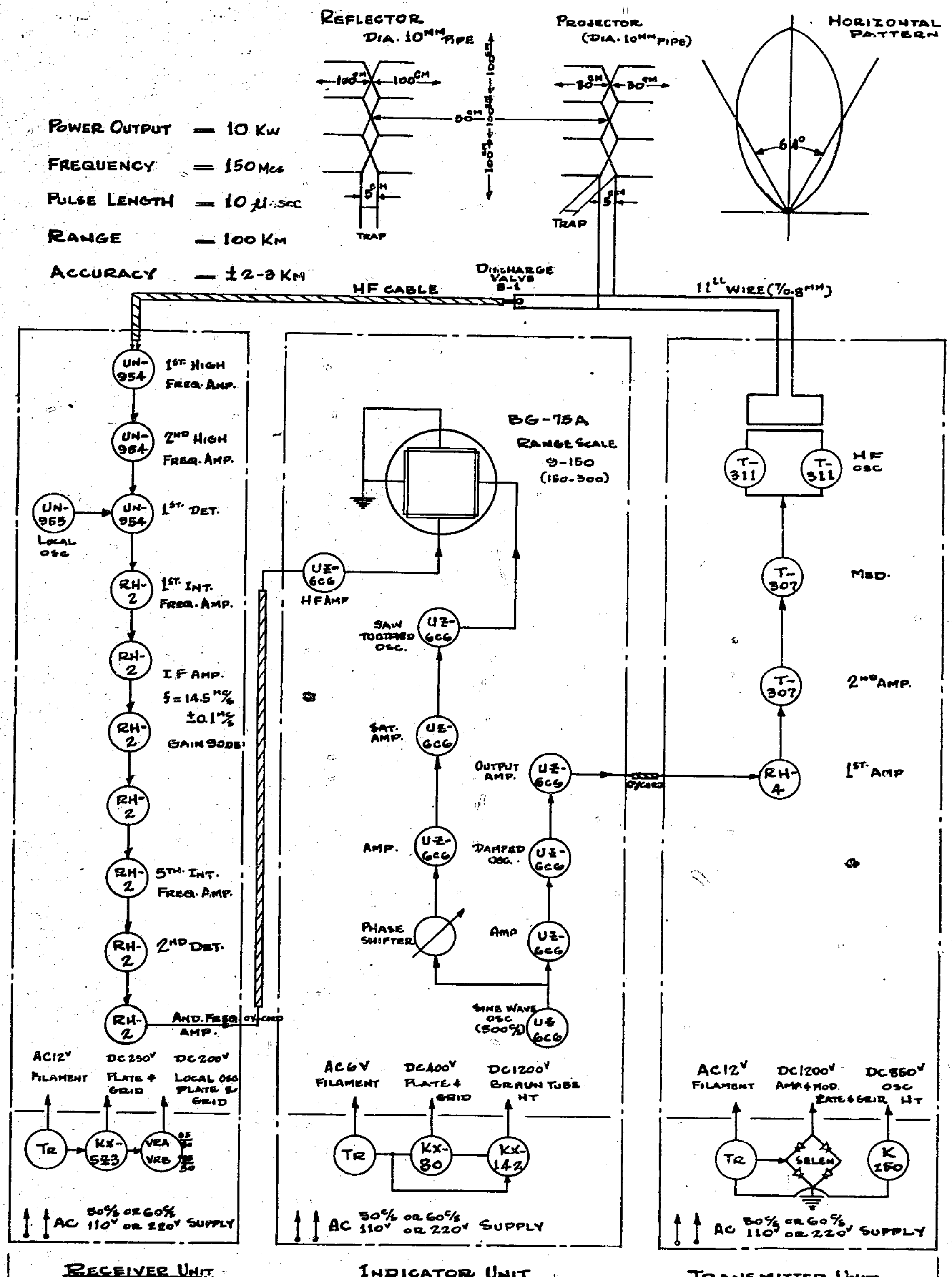


Figure 12

BLOCK DIAGRAM FOR TYPE 3 MARK 1 MODEL 3 RADAR FOR LAND, SHIP AND SUBMARINE USE

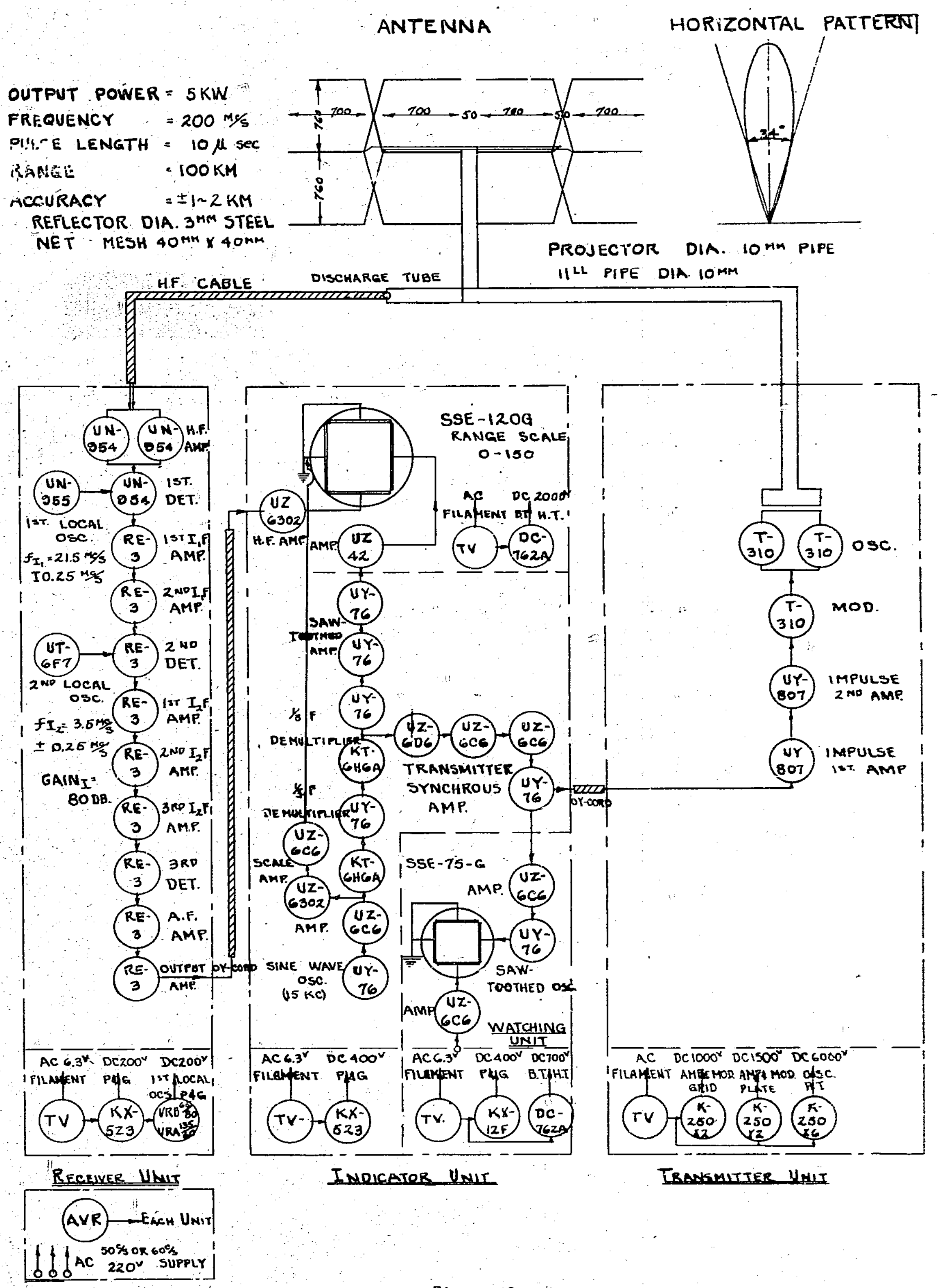


Figure 13

BLOCK DIAGRAM FOR TYPE 2 MARK 2 MODEL 1 RADAR

C. Surface Search and Fire Control Radars

1. Mark 2 Model 2 Modification 4 Radar

Figure 14 shows a block diagram of this equipment. Complete characteristics may be obtained from Table II, while a complete set of wiring diagram is included in Enclosure (G). This 10 centimeter wave equipment was installed in all combatant vessels as either a surface search equipment (Modification 4M) or a combination surface search and fire control equipment (Modification 4S). Larger electro-magnetic horns, a selsyn antenna control system, and additional voltage stabilizers were used in the latter type installations.

This equipment used a water-cooled Type M-312-A magnetron whose filament was made of pure tungsten. The ratings of the tube are as follows:

Filament	10 volts, 19.5 amperes, 195 watts
Emission current	2 amperes
Total anode voltage	11,000 volts
Magnetic field	700 gunses
Antenna output power	2 kilowatt peak
Allowable temperature of anode	60° centigrade
Allowable continuous anode dissapation	500 watts
Oscillation wave length	9,875 ±0.5% centimeter

The plate voltage was 7,000 volts constantly impressed on the anode with a negative pulse of about 5,500 volts applied to the cathode by the modulator. The output of the magnetron was fed through a single tuning stub to a radiation element located in the mouth of the wave guide.

The receiver utilized a superhetrodyne circuit with a crystal detector and a Type M-60-S magnetron as local oscillator. Range tuning was accomplished by varying the field current and fine tuning by charging the cathode voltage of the magnetron. There were five stages of intermediate frequency amplification which were tuned to 14.5 megacycles with a 2 megacycle bandpass. A Type OY 76 tube was used on the second detector with two stages of amplification following. All amplifying stages used the Type UZ 6302 tube. A quartz crystal "retarder" was connected in parallel with the input circuit to the first intermediate frequency stage to produce a delayed pulse for tuning. The total gain of the receiver was claimed to be 120 decibles.

A tuning fork and two Type RH-2 tubes used as an oscillator and a buffer were to supply a constant frequency sine wave of 2.5 kilocycles to the synchronizing circuit, a sweep circuit, and to a phase shifter circuit in the range unit. The synchronizing circuit transformed the sine wave into a negative 120 volt pulse which triggered the modulator. The sweep circuit generated the indicator sweep voltage and a 30 kilocycle electronic range scale. The sinusoidal output of the tuning fork oscillator was also squared up in the phase shifter circuit and used as intensifying pulse for the cathode ray tube.

The other circuits used in this type equipment are considered conventional and specific details may be obtained on all components from the wiring diagrams in Enclosure (H).

The antenna consisted of two electromagnetic horns mounted one above the other. (See Figure 5 for a typical installation.) The upper horn was used for receiving and the lower one for transmission. The gain of the Modification 4S antenna was said to be 13 decibles. Samples of this equipment have been collected and shipping data may be obtained from NavTechJap Report, "Japanese Electronics - General", Index No. E-28.

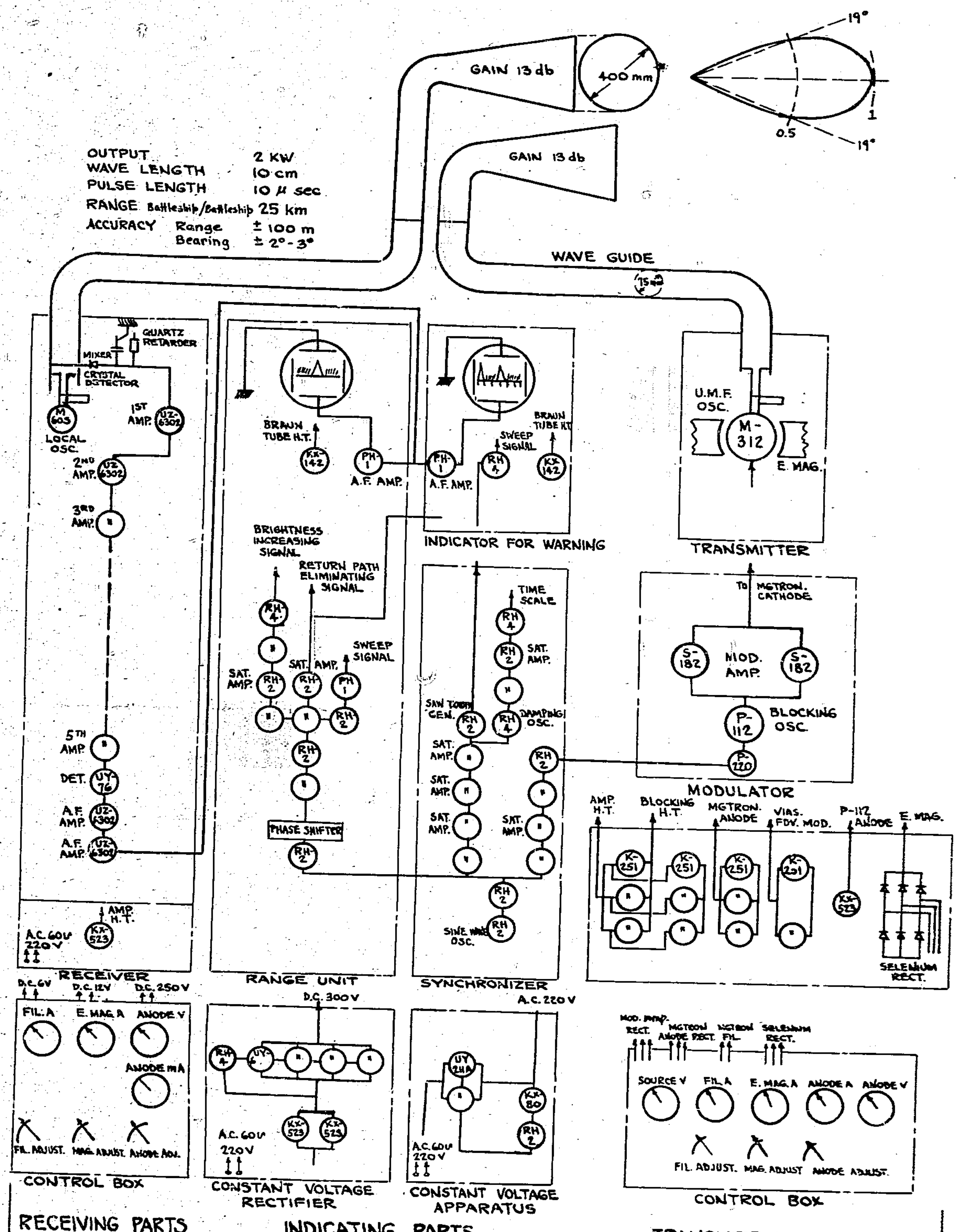


Figure 14

BLOCK DIAGRAM OF MARK 2 MODEL 2 MODIFICATION 4 RADAR

2. Mark 2 Model 2 Modification 3 Radar

This equipment was specially designed for submarines and installed only on them. Electrically it was similar to the Modification 4 equipment, but the mechanical construction was much more compact. Some electrical differences existed in the transmitter, the RF system, the antenna, and the pulse rate, which was only 600 per second. Complete characteristics are contained in Table II and complete wiring diagrams are included in Enclosure (H).

This equipment used a single horn antenna for both transmitting and receiving. The wave guide water seal is described in the installation section of this report. The unusual duplexor and RF system used with this equipment produced a circularly polarized wave, which are detailed in NavTechJap Report, Index No. E-20. The transmitter modulating pulse was also applied to the second of two duplexor tubes used in the deplexor assembly to help protect the receiver crystal. It was found necessary to reduce the fixed transmitter magnetron voltage from 7000 to approximately 5000 volts and to increase the negative modulating voltage accordingly. The noise produced with the higher voltage on the anode blocked the receiver when used with a common transmitting and receiving antenna. A sample of this equipment has been obtained and shipping data may be obtained from NavTechJap Report, Index No. E-28.

D. Radar Countermeasures Equipment

Table III lists the characteristics of the two intercept receivers and their antennas. Wiring diagrams and an instruction book for the Model 3 receiver are contained in NavTechJap Document No. ND22-3007. Wiring diagrams for the Modification 3 (E27) receiver are included in NavTechJap Document No. ND21-6154. Additional information on the antenna designs used may be obtained from NavTechJap Report, "Japanese Antennae". Index No. E-16. Samples of these equipments have been collected and shipping data may be obtained from NavTech-Jap Report, Index No. E-28.

ENCLOSURE (A)

PHOTOGRAPHS OF MARK 2 MODEL 2 MODIFICATION 4S AND TYPE 3 MARK 1 MODIFICATION 3 RADAR INSTALLATION ON DD HANAZUKI

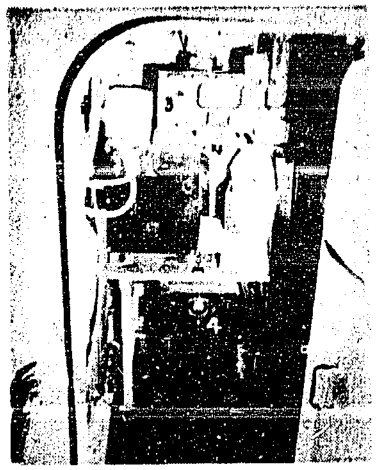


FIGURE 1(A)

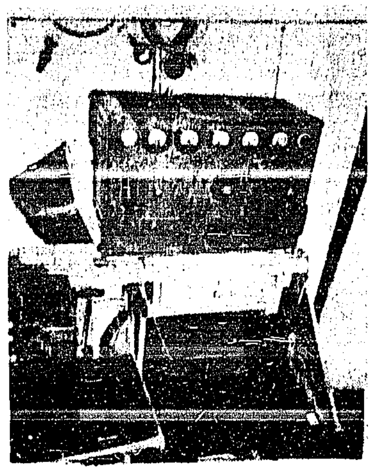


FIGURE 2(A)

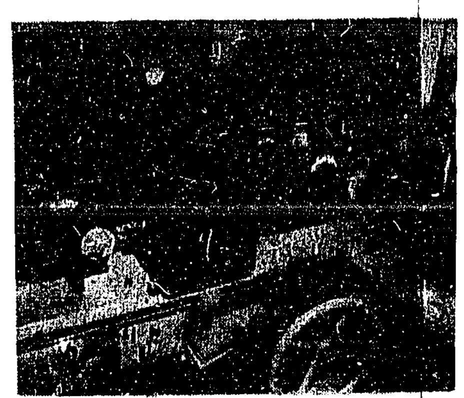


FIGURE 3(A)

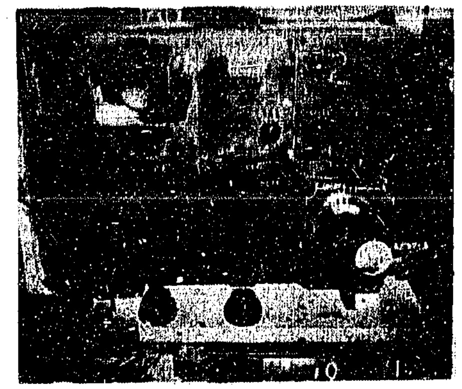


FIGURE 4(A)

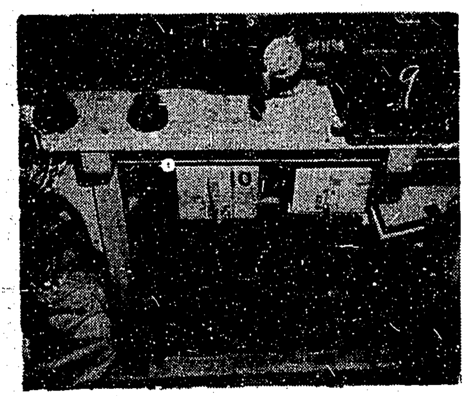


FIGURE 5(A)

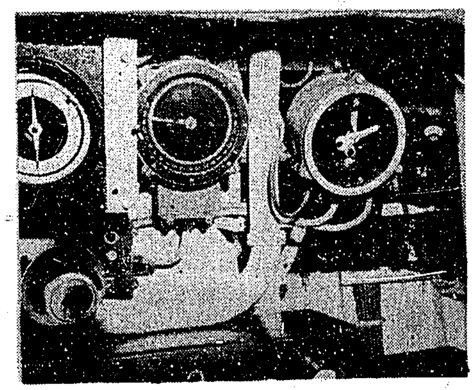
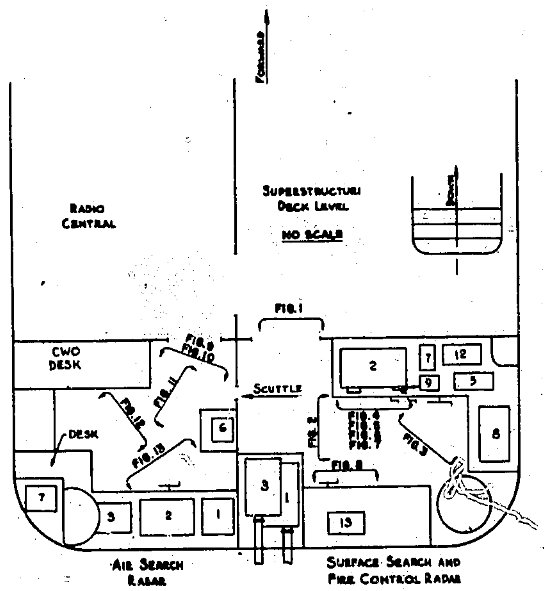


FIGURE 6(A)



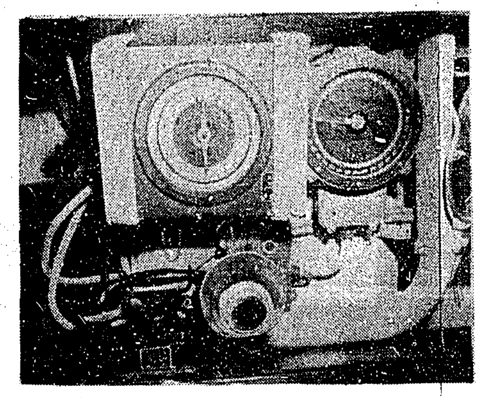


FIGURE 7(A)

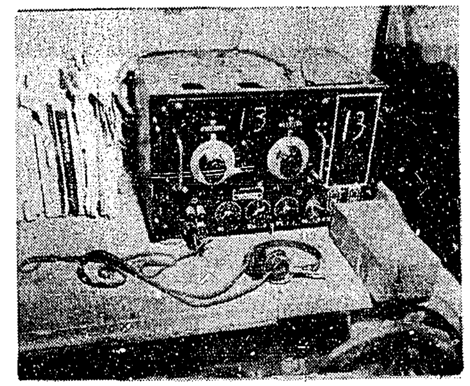


FIGURE 8(A)

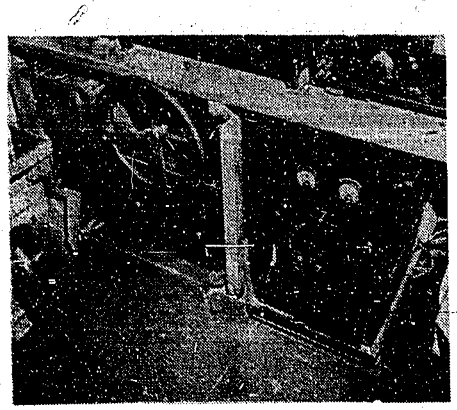


FIGURE 9(A)

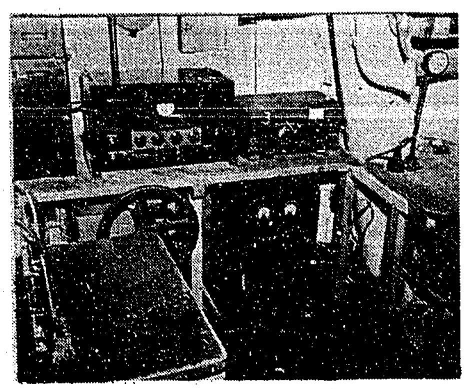


FIGURE 10(A)

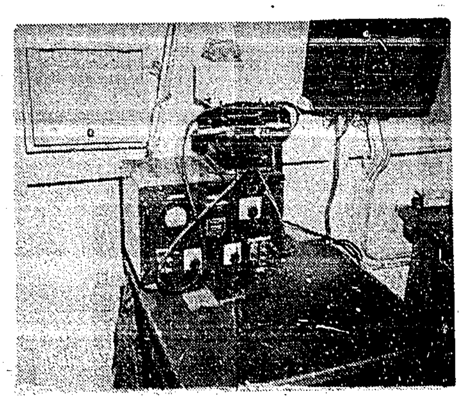


FIGURE 11(A)

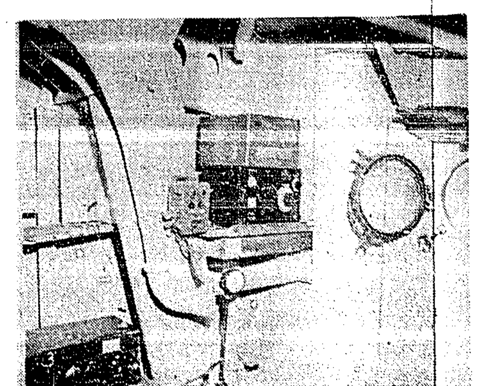


FIGURE 12(A)

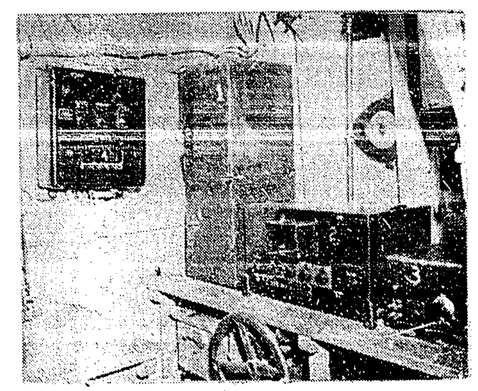


FIGURE 13(A)

ENCLOSURE (B)

PHOTOGRAPHS OF MARK 2 MODEL 2 MODIFICATION 4 RADAR INSTALLATION ON CV KATSURAGI

FIGURE 1(B)

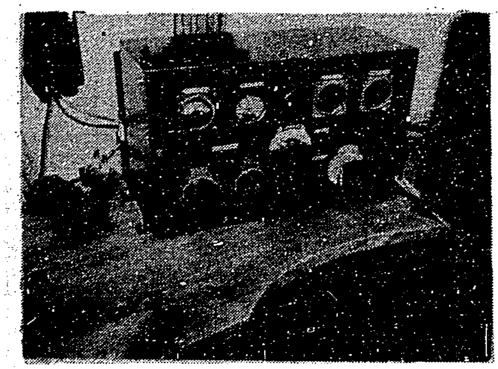
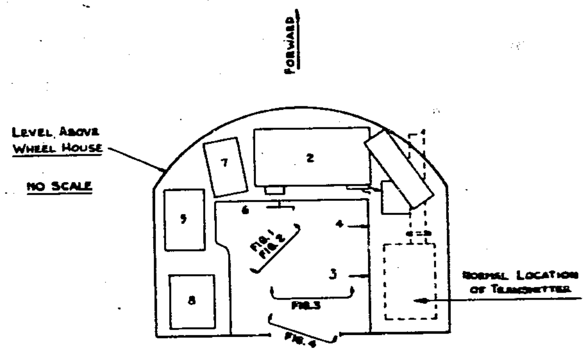


FIGURE 2(B)



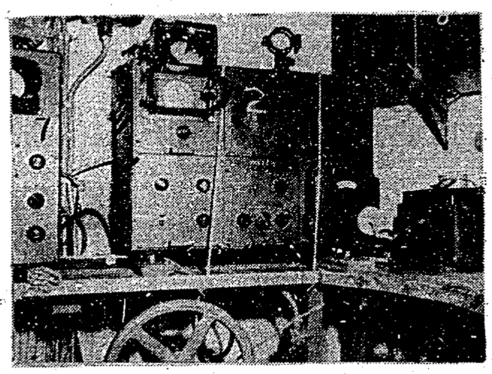


FIGURE 3(B)

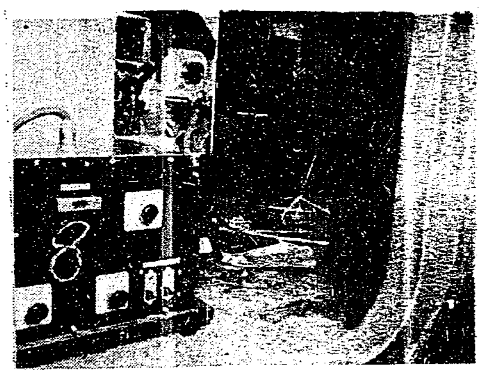
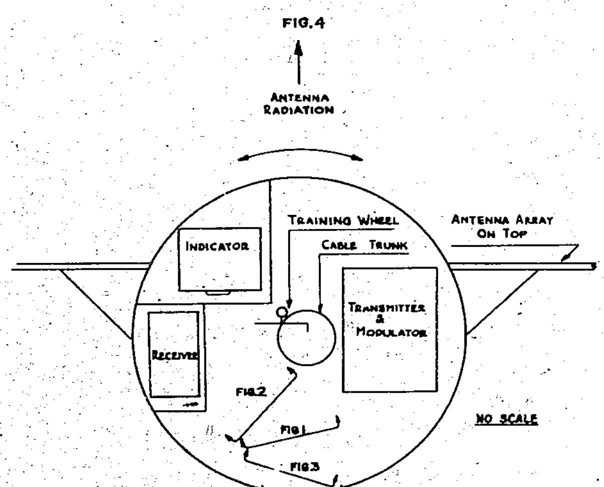


FIGURE 4(B)

ENCLOSURE (C)

PHOTOGRAPHS OF TYPE 2 MARK 2 MODEL 1 MODIFICATION 3 RADAR INSTALLATION ON CV KATSURAGI



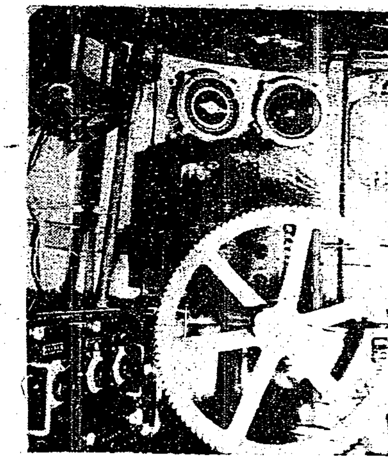


FIGURE 1(C)

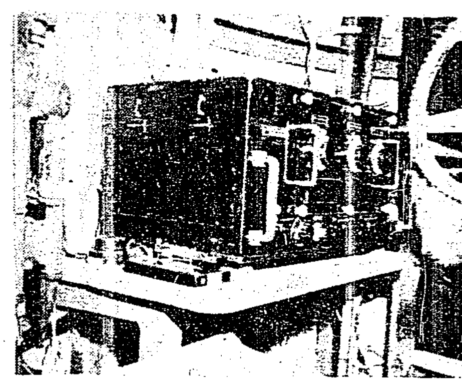


FIGURE 2(C)

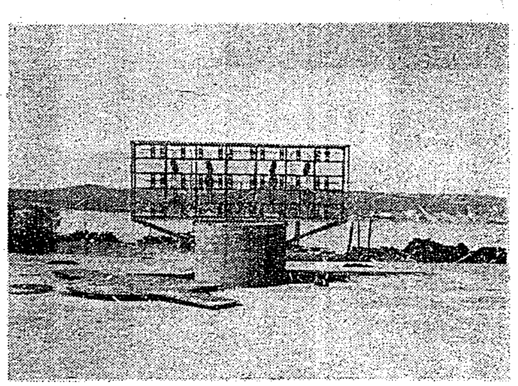


FIGURE 4(C)

COMPLETE UNIT RETRACTABLE INTO FLIGHT DECK

FIGURE 3(C)

ENCLOSURE (D)

PHOTOGRAPHS OF TYPE 3 MARK 1 RADAR INSTALLATION ON CV KATSUR

FIGURE 1(D)

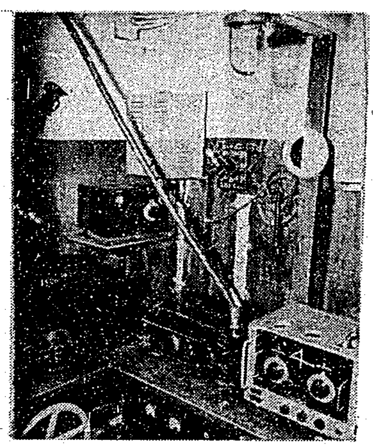
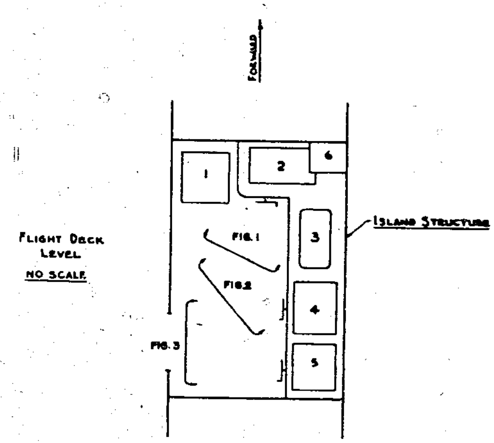


FIGURE 2(D)

FIGURE 3(D)

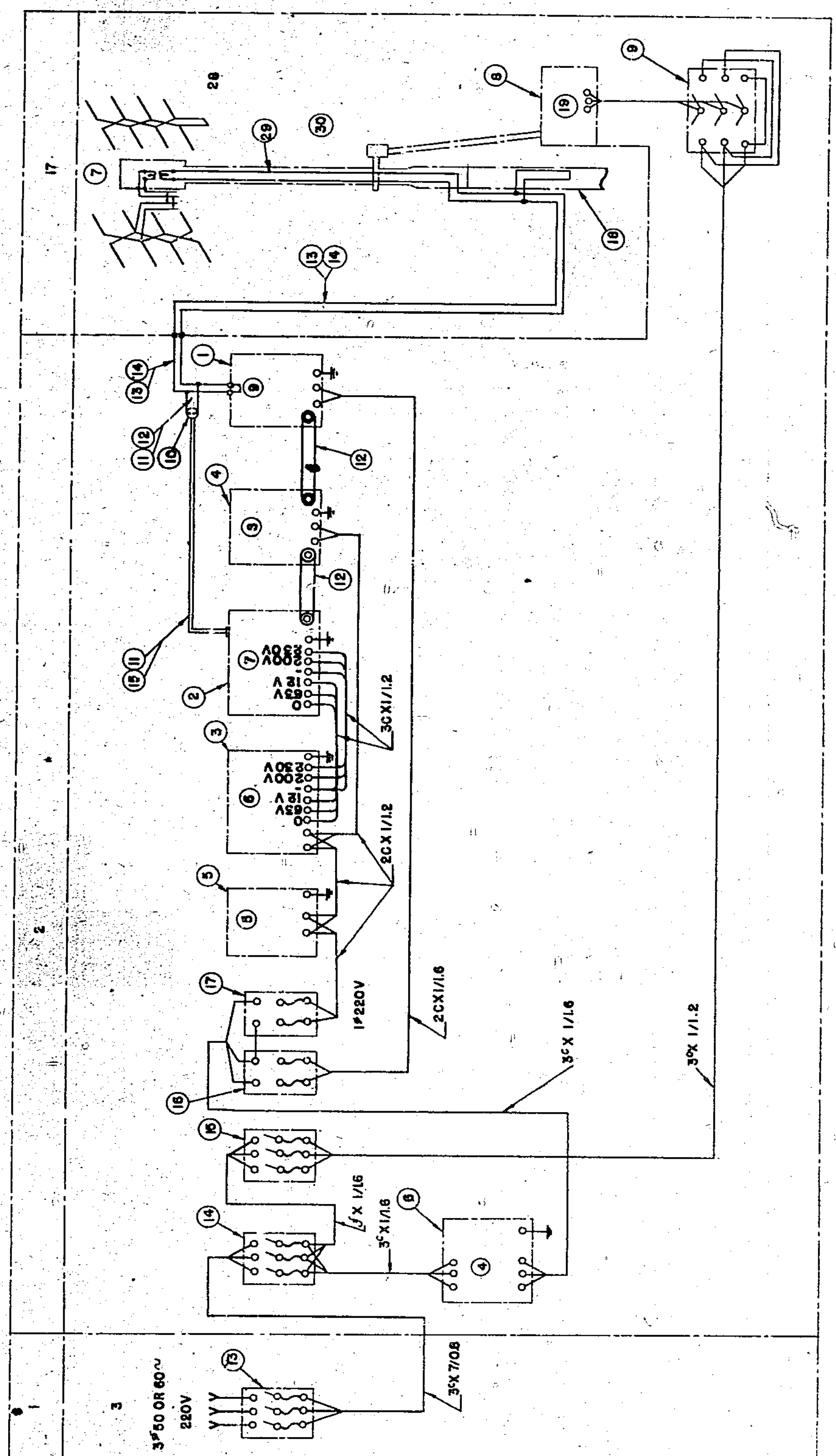


ENCLOSURE (E)

WIRING DIAGRAMS OF TYPE 3 MARK 1 MODEL 3 RADAR

LIST OF DIAGRAMS

ENCLOSURE (E), continued



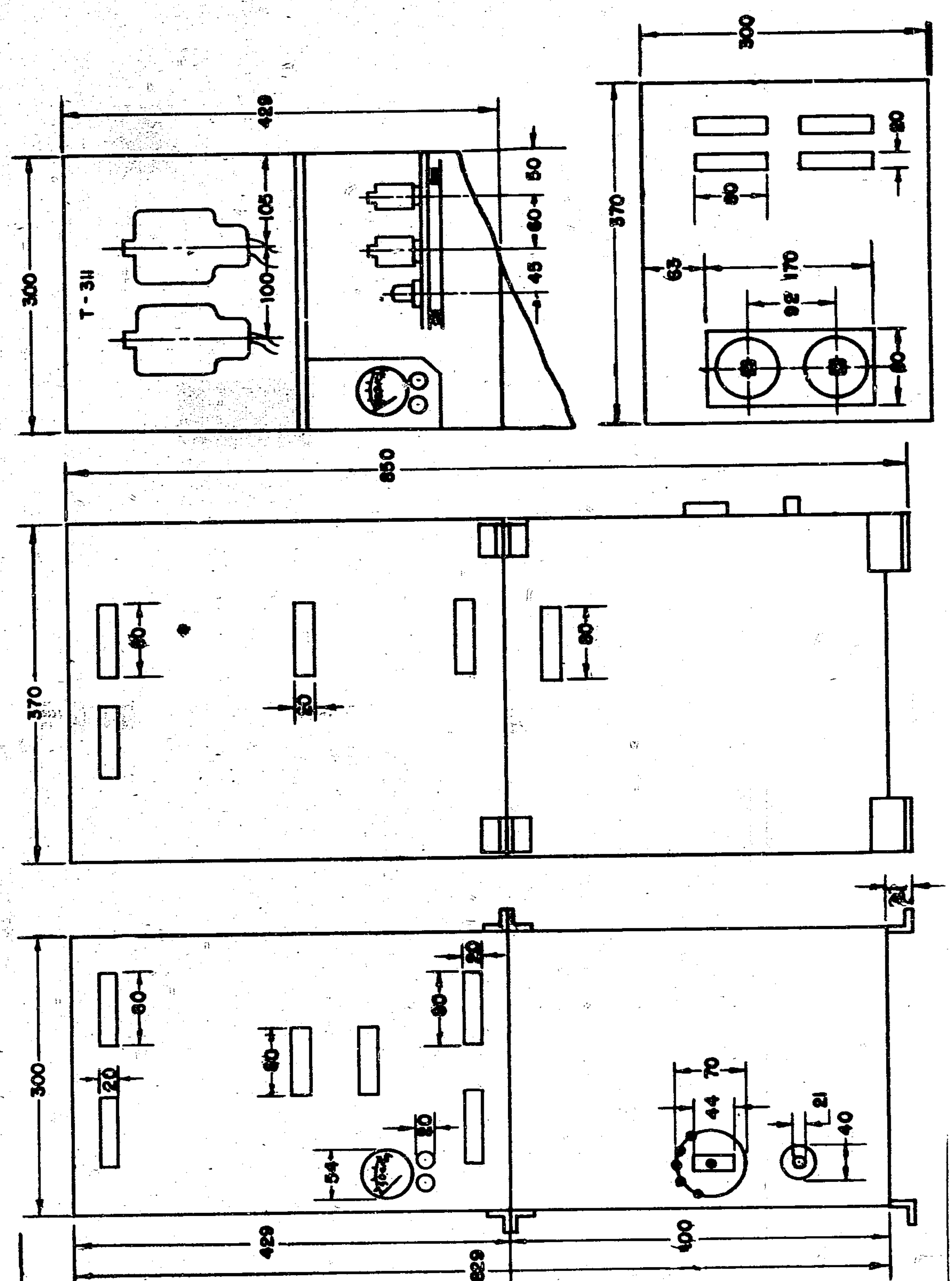
TYPE 3 MARK 1 MODEL 3 RADAR
Overall Hook-Up Diagram

ENCLOSURE (E), continued

LIST OF PARTS USED IN TYPE 3 MARK 1 MODEL 3 - OVERALL CIRCUIT DIAGRAM

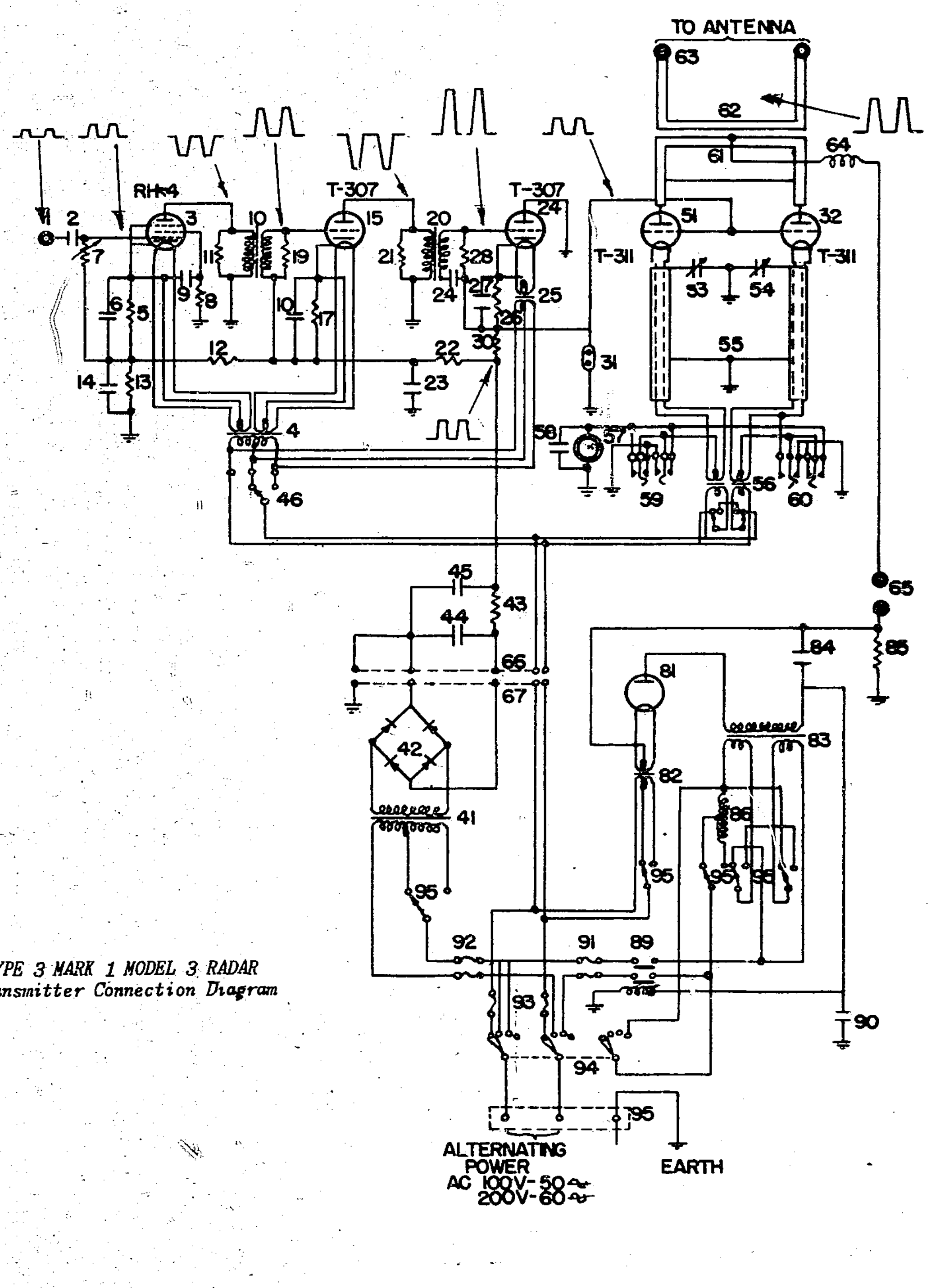
Number	Item	Number	Item
1	Power room	17	Antenna
2	Radar room	18	Antenna for ship
3	Power room (shipboard)	19	Antenna rotating mechanism
4	Automatic voltage regulator	20	Fixed with a ½ h.p. electric motor
5	Wave meter	21	Reversible switch (controller form)
6	Rectifier for receiving set	22	Cord
7	Receiving set	23	Tripod circuit switch breaker
8	Indicator	24	Double pole switch
9	Transmitter	25	Wooden pole
10	Special discharge tube	26	The rest
11	Conductor is 4mm in diameter	27	Radiator
12	Interval of two lines is 23mm	28	Reflector
13	Conductor is 4mm in diameter	29	Outer pipe of 150mm inside diameter Conductor of 4mm diameter Two lines of 60mm interval
14	Two lines is 50mm in interval		
15	High frequency cable		
16	HADO = peak of a wave or surge or undutate resistance 230	30	Conductor of 2.4mm diameter (7/0g) or two lines of 30mm interval

ENCLOSURE (E), continued



TYPE 3 MARK 1 MODEL 3 RADAR
Exterior View of Transmitter
Dimensions are mm

ENCLOSURE (E), continued



TYPE 3 MARK 1 MODEL 3 RADAR
Transmitter Connection Diagram

ENCLOSURE (E), continued

LIST OF PARTS USED IN TYPE 3 MARK 1 MODEL 3 RADAR TRANSMITTER CONNECTION DIAGRAM

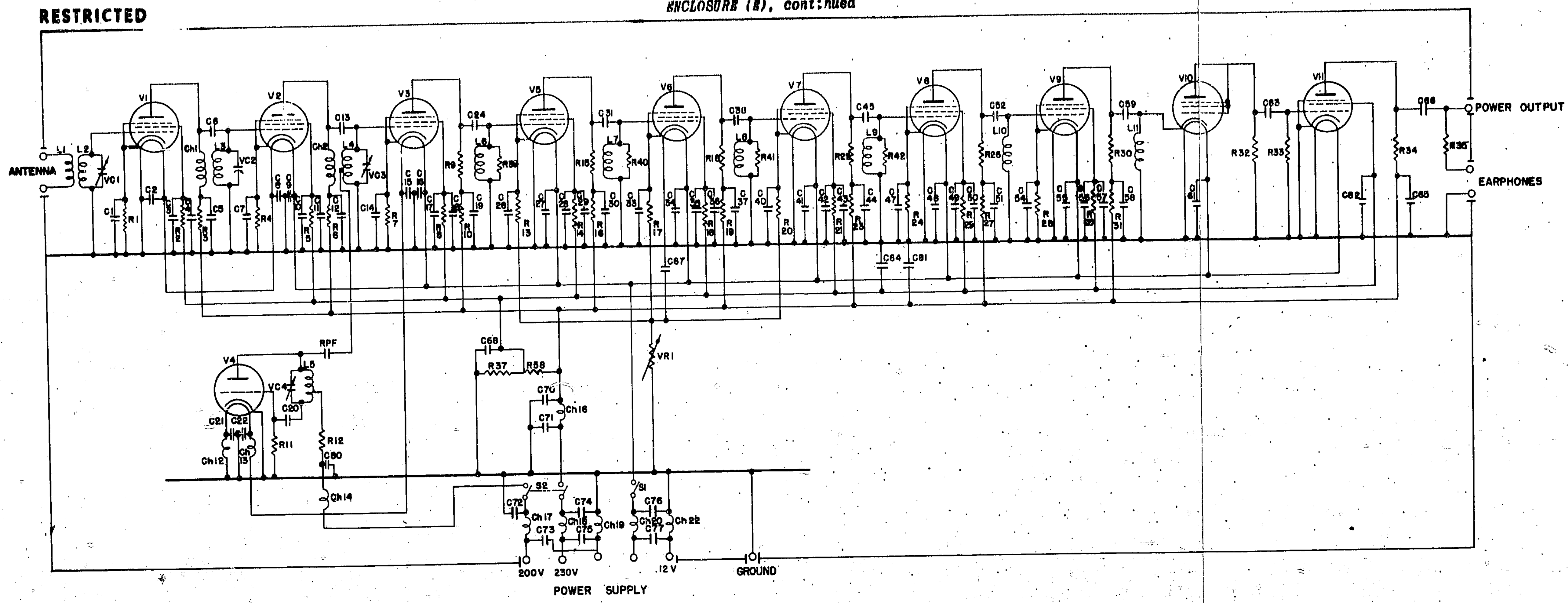
Number	Item	Model & Type	Note
1	Input terminal	Naval service type	Single pole plug
2	Connection condenser	Mica	10,000 $\mu\mu$F
3	First amplifying tube	RH-4	
4	Filament heat transformer (bias)		9 VA 220 110/12V 12V
5	Cathode inclination resistance	C-2	10 KΩ
6	Cathode by-pass condenser	OP-654	2FF 1000V (oil impregnated paper)
7	Control grid resistence	NV-200-S	50 KΩ
8	Screen grid resistence	C-2	200 KΩ
9	Screen by-pass condenser	OP-652	1 μF 1000V (oil impregnated paper)
10	Output transformer	TF Model I	300 T = 300 T
11	Wing resistance	C-2	10 KΩ
12	Voltage drop resistance	C-5	200 KΩ
13	Voltage drop resistance	C-3	100 KΩ
14	Voltage by-pass transformer	OP-654	2 μF 1000V (oil impregnated paper)
15	Second amplifying tube	T-307	
17	Cathode inclination resistance	C-2	10 KΩ
18	Cathode by-pass condenser	OP-656	2 μF 3000V (oil impregnated paper)
19	Control grid resistance	C-2	10 KΩ
20	Output transformer	TF Model I	300 T = 300 T
21	Wing resistance	C-2	10 KΩ
22	Voltage drop resistance	C-5	30 KΩ
23	Voltage by-pass condenser	OP-656	2 μF 3000V(oil impregnated paper)
24	Modulator	T-307	
25	Filament amplifying tube		6 VA 220 110/12V

ENCLOSURE (E), continued

Number	Item	Model & Type	Note
26	Cathode inclination resistance	C-2	20 KΩ
27	Cathode by-pass condenser	OP-656	2 μF 3000V (oil impregnated paper)
28	Control grid resistance	C-2	10 KΩ
29	Direct current prevention condenser	OP-658	0.1 μF 3000V (oil impregnated paper)
30	Grid series resistance	C-2	20 KΩ
31	Glow tube		
41	Power transformer		
42	Serenium rectifier		
43	Smooth resistance	C-2	
44	Smooth condenser	OP-656	2 μF 3000V (oil impregnated paper)
45	Smooth condenser	OP-656	2 μF 3000V (oil impregnated paper)
46	Power switch		
51	Oscillating tube	T-311	
52	Oscillating tube		
53	Filament by-pass condenser		
54	Filament by-pass condenser		
55	Filament closed circuit coil		
56	Filament heating transformer		156 VA105 105/12V 12V
57	Wing ammeter	Service type Model 7	D.C. 50MA
58	Wing by-pass condenser	D-1250	1000 μF (porcelain)
59	Wing switch	No. 92	A
60	Wing switch	No. 92	A
61	Wing closed circuit coil		
62	Antenna connection coil		
63	Antenna terminal		included in No. 62
64	High frequency choke coil		
65	High pressure terminal		

ENCLOSURE (E), continued

Number	Item	Model & Type	Note
66	Connection terminal board		
67	Connection terminal board		
81	Wing power rectifier tube		
82	Filament heating transformer		18 VA 220 110/5V
83	Power transformer		500 VA 110 110/7000V
84	Smooth condenser	OP-606	0.5 μF 20 KV (oil pregnated paper)
85	Load resistance	C-5	1 M Ω x 6
86	Inductive coil		0.015H, 0.06H
87	(Absent)		
88	(Absent)		
89	Overload relay		
90	Overload by-pass condenser	OP-655	1 μF 3000V (oil pregnated paper)
91	Safty fuse		Electric service type No. 302 Model II
92	Safty fuse		Electric service type No. 302 Model II
94	Power off-on switch		
95	Terminal board		



TYPE 3 MARK 1 MODEL 3 RADAR
Receiver Wiring Diagram

ENCLOSURE (E), continued

LIST OF PARTS USED IN TYPE 3 MK1 MODEL 3 RADAR RECEIVER WIRING DIAGRAM

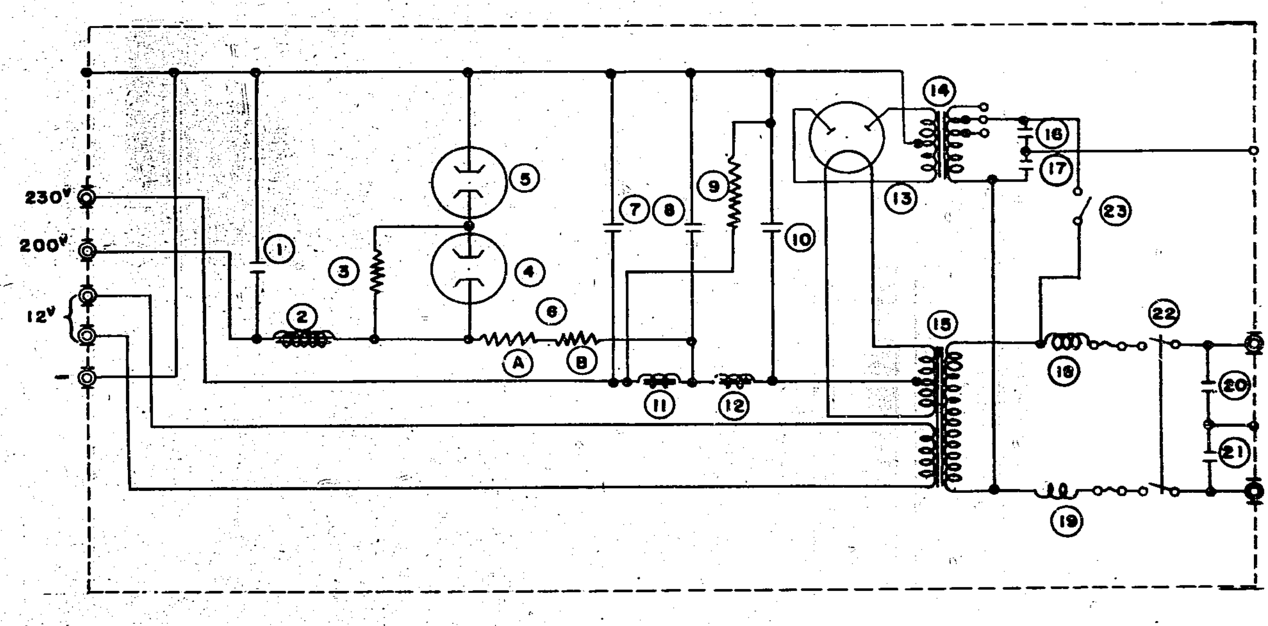
Designation	Rating	Model
C1	100 PF ±10%	B-12
C2	0.01 μF ±20%	2
C3	0.01 μF ±20%	2
C4	0.5 μF ±20%	Mark Ro
C5	0.01 μF ±20%	2
C6	50 PF ±10%	B-12
C7	100 PF ±10%	B-12
C8	0.01 μF ±20%	2
C9	0.01 μF ±20%	2
C10	0.01 μF ±20%	2
C11	0.5 μF ±20%	Mark Ro
C12	0.01 μF ±20%	2
C13	50 PF ±10%	B-12
C14	100 PF ±10%	B-12
C15	0.01 μF ±20%	2
C16	0.01 μF ±20%	2
C17	0.01 μF ±20%	2
C18	0.5 μF ±20%	Mark Ro
C19	0.01 μF ±20%	2
C20	10 PF ±10%	B-10
C21	0.01 μF ±20%	2
C22	0.01 μF ±20%	2
C23	2 PF ±10%	Pz-10
C24	50 PF ±10%	B-12
C26	0.01 μF ±20%	2
C27	0.01 μF ±20%	2
C28	0.01 μF ±20%	2
C29	0.5 μF ±20%	Mark Ro
C30	0.01 μF ±20%	2
C31	50 PF ±10%	B-12
C33	0.01 μF ±20%	2
C34	0.01 μF ±20%	2
C35	0.01 μF ±20%	2
C36	0.5 μF ±20%	Mark Ro
C37	0.01 μF ±20%	2
C38	50 PF ±10%	B-12
C40	0.01 μF ±20%	2
C41	0.01 μF ±20%	2
C42	0.01 μF ±20%	2
C43	0.5 μF ±20%	Mark Ro
C44	0.01 μF ±20%	2
C45	50 PF ±10%	B-12
C47	0.01 μF ±20%	2
C48	0.01 μF ±20%	2
C49	0.01 μF ±20%	2
C50	0.5 μF ±20%	Mark Ro
C51	0.01 μF ±20%	2
C52	50 PH ±10%	B-12
C54	0.01 μF ±20%	2
C55	0.01 μF ±20%	2
C56	0.01 μF ±20%	2
C57	0.5 μF ±20%	Mark Ro
C58	0.01 μF ±20%	2
C59	50 PF ±10%	B-12
C61	0.01 μF ±20%	2
C63	0.5 μF ±20%	Mark Ro
C64	0.01 μF ±20%	2
C65	4 μF ±20%	Mark I

ENCLOSURE (E), continued

Designation	Rating	Model	Designation	Rating	Model
C66	0.5 µF ±20%	Mark Ro	R16	2 KΩ ±10%	D-0.25
C67	4 µF ±20%	Mark I	R17	0.3 KΩ ±10%	D-0.25
C68	0.5 µF ±20%	Mark Ro	R18	10 KΩ ±10%	D-1
C70	0.01 µF ±20%	2	R19	2 KΩ ±10%	D-0.25
C71	0.01 µF ±20%	2	R20	0.3 KΩ ±10%	D-0.25
C72	0.01 µF ±20%	2	R21	2 KΩ ±10%	D-0.25
C73	0.01 µF ±20%	2	R22	10 KΩ ±10%	D-1
C74	0.01 µF ±20%	2	R23	2 KΩ ±10%	D-0.25
C75	0.01 µF ±20%	2	R24	0.3 KΩ ±10%	D-0.25
C76	0.01 µF ±20%	2	R25	2 KΩ ±10%	D-0.25
C77	0.01 µF ±20%	2	R26	10 KΩ ±10%	D-1
C80	0.01 µF ±20%	2	R27	2 KΩ ±10%	D-0.25
C81	0.01 µF ±20%	2	R28	0.3 KΩ ±10%	D-0.25
C82	0.01 µF ±20%	2	R29	2 KΩ ±10%	D-0.25
R1	0.5 KΩ ±10%	D-0.25	R30	10 KΩ ±10%	D-1
R2	2 KΩ ±10%	D-0.25	R31	2 KΩ ±10%	D-0.25
R3	2 KΩ ±10%	D-0.25	R32	10 KΩ ±10%	D-1
R4	0.5 KΩ ±10%	D-0.25	R33	100 KΩ ±10%	D-0.25
R5	2 KΩ ±10%	D-0.25	R34	2 KΩ ±10%	D-2
R6	2 KΩ ±10%	D-0.25	R35	50 KΩ ±10%	D-1
R7	1 KΩ ±10%	D-0.25	R36	2 KΩ ±10%	D-0.25
R8	2 KΩ ±10%	D-0.25	R37	5 KΩ ±10%	20 W
R9	10 KΩ ±10%	D-1	R38	5 KΩ ±10%	20 W
R10	2 KΩ ±10%	D-0.25	R39	30 KΩ ±10%	D-0.25
R11	50 KΩ ±10%	D-0.25	R40	30 KΩ ±10%	D-0.25
R12	2 KΩ ±10%	D-0.25	R41	30 KΩ ±10%	D-0.25
R13	0.3 KΩ ±10%	D-0.25	R42	30 KΩ ±10%	D-0.25
R14	2 KΩ ±10%	D-0.25	S1	T-Type Snap Switch	
R15	10 KΩ ±10%	D-1	S2	T-Type Snap Switch	

ENCLOSURE (E), continued

Designation	Rating	Model	Designation	Rating	Model
V1	UN - 954		V9	RH - 2	
V2	UN - 954		V10	RH - 2	
V3	UN - 954		V11	RH - 2	
V4	UN - 955		VC1	PF ±15%	
V5	RH - 2		VC2	PF ±15%	
V6	RH - 2		VC3	PF ±15%	
V7	RH - 2		VC4	PF ±15%	
V8	RH - 2		VR1	5 KΩ $\pm^{20\%}_{10\%}$	NV35c



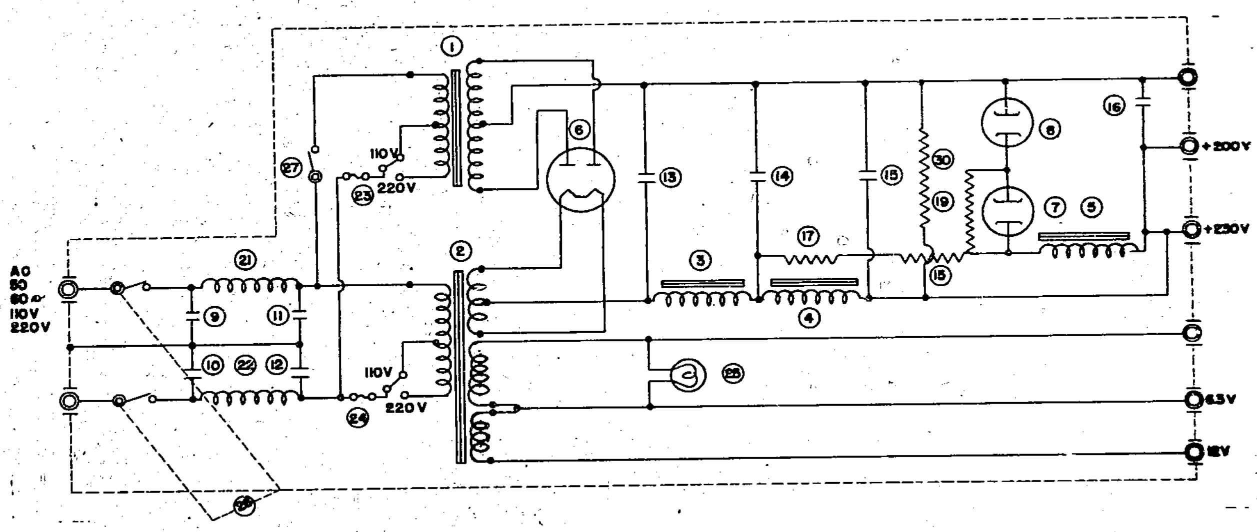
TYPE 3 MARK 1 MODEL 3 RADAR
Wiring Diagram of Receiver Rectifier (Old Type)

ENCLOSURE (E), continued

LIST OF PARTS USED IN TYPE 3 MARK 1 MODEL 3 RADAR
WIRING DIAGRAM OF RECEIVER RECTIFIER (OLD TYPE)

Number	Item
1	Condenser with magnetic terminals
2	Choke coil
3	Resistor
4	Constant voltage discharge tube
5	Constant voltage discharge tube
6	Resistor
7	Condenser
8	Condenser
9	Resistor
10	Condenser
11	Choke coil
12	Choke coil
13	Rectifier
14	Transformer (for the use of low tension)
15	Transformer (for the use of high tension)
16	By-pass condenser
17	By-pass condenser
18	High frequency choke coil
19	High frequency choke coil
20	By-pass condenser
21	By-pass condenser
22	Filament circuit breaker
23	Vane circuit breaker

ENCLOSURE (E), continued

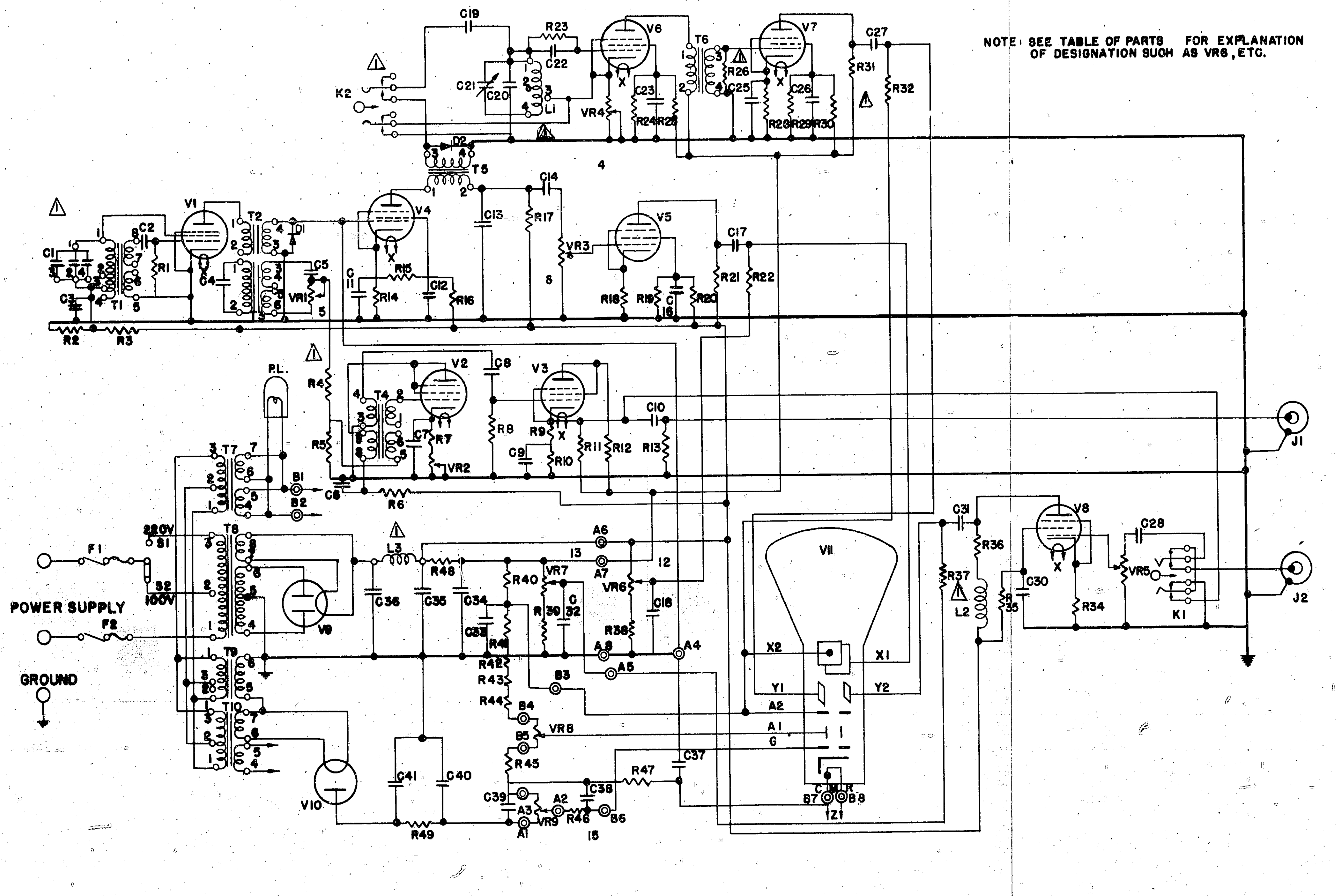


TYPE 3 MARK 1 MODEL 3 RADAR
Wiring Diagram of Receiver Rectifier (New Type)

LIST OF PARTS USED IN TYPE 3 MARK 1 MODEL 3 RADAR WIRING DIAGRAM OF RECEIVER RECTIFIER (NEW TYPE)

Number	Item
1 - 2	Power supply transformer
3 - 5	Low frequency choke coil
6	Vacuum tube
7 - 8	Low-voltage discharge tube
9 - 12	Mica condenser (Naval standard, type Z)
13 - 16	Paper condenser (Naval standard, type C-1)
17 - 18	Fixed resistance (Type 15 HC HINOMOTO-form)
19 - 20	Fixed resistance (B 20-Type, RIKEN-form)
21 - 22	High frequency choke coil
23	Fuze (Safe carrying capacity)
24	Fuse
25	Identification lights
26	Power supply circuit breaker (2 poles)
27	Power supply circuit breaker (Single pole)

NOTE: SEE TABLE OF PARTS FOR EXPLANATION OF DESIGNATION SUCH AS VR6, ETC.



TYPE 3 MARK 1 MODEL 3 RADAR
Schematic Diagram of Indicator (C-Model 1)

ENCLOSURE (E), continued

LIST OF PARTS USED IN TYPE 3 MARK 1 MODEL 3 RADAR (C - MODEL 1 INDICATOR SYSTEM)

Designation	Name	Rating	Type-Model	Quantity
	I. Types of Vacuum Tubes			
V1	VZ - 6C6 Vac. Tube	F63vP250V		1
V2	VZ - 6C6 Vac. Tube	F63vP250V		1
V3	VZ - 6C6 Vac. Tube	F63vP250V		1
V4	VZ - 6C6 Vac. Tube	F63vP250V		1
V5	VZ - 6C6 Vac. Tube	F63vP250V		1
V6	VZ - 6C6 Vac. Tube	F63vP250V		1
V7	VZ - 6C6 Vac. Tube	F63vP250V		1
V8	VZ - 6C6 Vac. Tube	F63vP250V		1
V9	KX - 80, Rectifier Tube	F5V 2A		1
V10	KX - 142, Rectifier Tube	F2-5V,1-75A		1
V11	BG - 75-A Cathode Tube	F2-5V,2.1A		1
P1	Type E Bulb	10 V		1
	II. Types of Coils Used			
T1	Master Oscillator-Transformer		211-RM-42	1
T2	Pulse Transformer		253-SF-3	1
T3	Coupling Transformer		201-SG-55	1
T4	Non-Coupling, Blocking Oscillator Transformer		201-SG-16	1
T5	Pulse Transformer		206-FB-12	1
T6	Pulse Transformer		206-FB-12	1
T7	Power Supply Transformer		504-SZ-17	1
T8	Power Supply Transformer		500-SL-44	1
T9	Power Supply Transformer		502-SA-53	1
T10	Power Supply Transformer		502-SA-52	1
L1	Scale Frequency Coil		P.B.-2077	1
L2	Compensation Coil		AG-13	1
L3	Filter Choke Coil		404-SK-10	1
L4	Filter Choke Coil		404-SK-10	1

ENCLOSURE (E), continued

Designation	Name	Rating	Type-Model	Quantity
	III. Miscellaneous Parts			
J1	Concentric Cable Plug			1
J2	Concentric Cable Plug			1
D1	D-278 Rectifier			1
D2	D-278 Rectifier			1
K1	406-N Key			1
K2	406-N Key			1
S1	Power Supply Switch	220V5A		1
S2	Power Supply Change Over Switch			1
F1	Safety Fuse	220V-1A 100V-2A	Navy Model 1	1
F2	Safety Fuse	220V-1A 100V-1A	Navy Model 1	1
	IV. Types of Condensers			
C1	Master Oscillator Condenser 917-N4325	(1-2)0 124 µF (1-4)0025(1-3) 0.0025 µF	917-N4000	1
C2	Coupling Condenser	0.1 µF 1 KV	M-60	1
C3	By-Pass Condenser	1 µF 2 KV	KOD-1020	1
C4	Timing Condenser	0.1 µF 1 KV	M-60	1
C5	Phasing Condenser	0.0005 µF 1KV	M-60	1
C6	By-Pass Condenser	1 µF 2 KV	KOD-1020	1
C7	Blocking Oscillator Condenser	0.015 µF 1 KV	M-60	1
C8	Coupling Condenser	1.000 µF 1 KV	76-K	1
C9	By-Pass Condenser	1 µF 2 KV	KOD-1020	1
C10	Coupling Condenser	0.1 µF 1 KV	M-60	1
C11	By-Pass Condenser	1 µF 2 KV	KOD-1020	1
C12	By-Pass Condenser	1 µF 2 KV	KOD-1020	1
C13	Saw Tooth Wave Condenser	0.005 µF 1 KV	M-60	1
C14	Coupling Wave Condenser	0.005 µF 1 KV	M-60	1

ENCLOSURE (E), continued

Designation	Name	Rating	Type-Model	Quantity
C16	By-Pass Wave Condenser	1 μF 2 KV	KOD-1020	1
C17	Coupling Wave Condenser	0.1 μF 1 KV	M-60	1
C18	By-Pass Wave Condenser	1 μF 2 KV	KOD-1020	1
C19	Coupling Wave Condenser	500 PF 1 KV	16-K	1
C20	Range Scall Oscillator Condenser	1000 200 100PF	76-K	3
C21	Small Type Variable Condenser	100 PF	MOD-80432	1
C22	Coupling Condenser	100 PF 1 KV		
C23	By-Pass Condenser	0.05 μF 1 KV	M-60	1
C25	By-Pass Condenser	0.05 μF 1 KV	M-60	1
C26	By-Pass Condenser	0.05 μF 1 KV	M-60	1
C27	Coupling Condenser	0.1 μF 1 KV	M-60	1
C28	Coupling Condenser	1 μF 2 KV	KOD-1020	1
C30	By-Pass Condenser	1 μF 2 KV	KOD-1020	1
C31	Coupling Condenser	0.1 μF 1 KV	M-60	1
C32	By-Pass Condenser	1 μF 2 KV	KOD-1020	1
C33	By-Pass Condenser	1 μF 2 KV	KOD-1020	1
C34	Filter Condenser	4 μF 2 KV	KOD-4020	1
C35	Filter Condenser	4 μF 2 KV	KOD-4020	1
C36	Filter Condenser	4 μF 2 KV	KOD-4020	1
C37	Coupling Condenser	0.1 μF 3 KV	M-63	1
C38	By-Pass Condenser	1 μF 2 KV	KOD-1020	1
C39	By-Pass Condenser	1 μF 2 KV	KOD-1020	1
C40	Filter Condenser	0.5 μF 4 KV	KOD-540	1
C41	Filter Condenser	0.5 μF 4 KV	KOD-540	1

V. Types of Variable Resistors

Designation	Name	Rating	Type-Model	Quantity
VR1	Phasing Variable Resistor	500 K Ω	NV-35-B	1
VR2	Blocking Oscillator Variable Resistor	20 K Ω	NV-35-B	1
VR3	Time Axis Amplitude Resistor	500 K Ω	NV-35-B	1
VR4	Graduated Cylinder Resistor	3 K Ω	NV-35-B	1

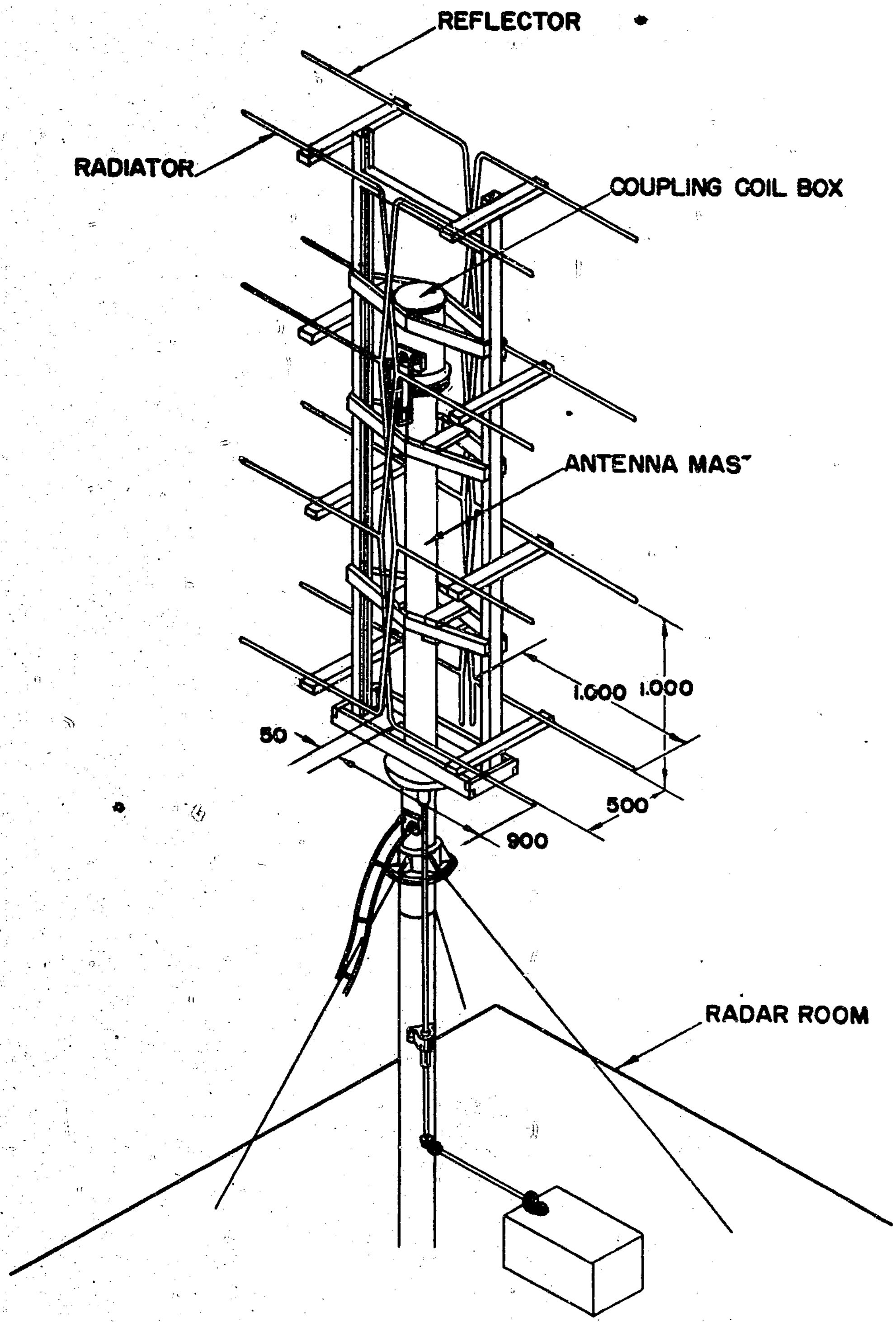
ENCLOSURE (E), continued

Designation	Name	Rating	Type-Model	Quantity
VR5	Signal Input Resistor	10 K Ω	NV-1	1
VR6	Horizontal Adjustor Resistor	500 K Ω	NV-B	1
VR7	Vertical Adjustor Resistor	500 K Ω	NV-B	1
VR8	Focus Adjustor Resistor	100 K Ω	NV-B	1
VR9	Degree of Illumination Adjustor Resistance	100 K Ω	NV-B	1
	VI. Types of Fixed Resistors			
R1	Grid Leakage Resistor	10 K Ω	C-2	1
R2	Screen Grid Voltage Divider Resistor	50 K Ω	C-2	1
R3	Screen Grid Voltage Divider Resistor	50 K Ω	C-2	1
R4	Grid Divider Resistor	25 K Ω	C-2	1
R5	Grid Divider Resistor	10 K Ω	C-2	1
R6	Anode Series Resistor	100 K Ω	C-2	1
R7	Blocking Oscillator Cathode Resistor	100 K Ω	C-2	1
R8	Grid Leakage Resistor	50 K Ω	C-2	1
R9	Catnode Resistor	5 K Ω	C-2	1
R10	Bias Resistor	20 K Ω	C-2	1
R11	Voltage Divider Resistor	100 K Ω	C-2	1
R13	Coupling Resistor	500 K Ω	C-2	1
R14	Bias Resistor	20 K Ω	C-2	1
R15	Voltage Divider Resistor	100 K Ω	C-2	1
R16	Voltage Divider Resistor	50 K Ω	C-2	1
R17	Saw Tooth Wave Nascent Resistor	500 K Ω	C-2	1
R18	Bias Resistor	1 K Ω	C-2	1
R19	Voltage Divider Resistor	50 K Ω	C-2	1
R20	Voltage Divider Resistor	20 K Ω	C-2	1
R21	Anode Resistor	50 K Ω	C-2	1

ENCLOSURE (E), continued

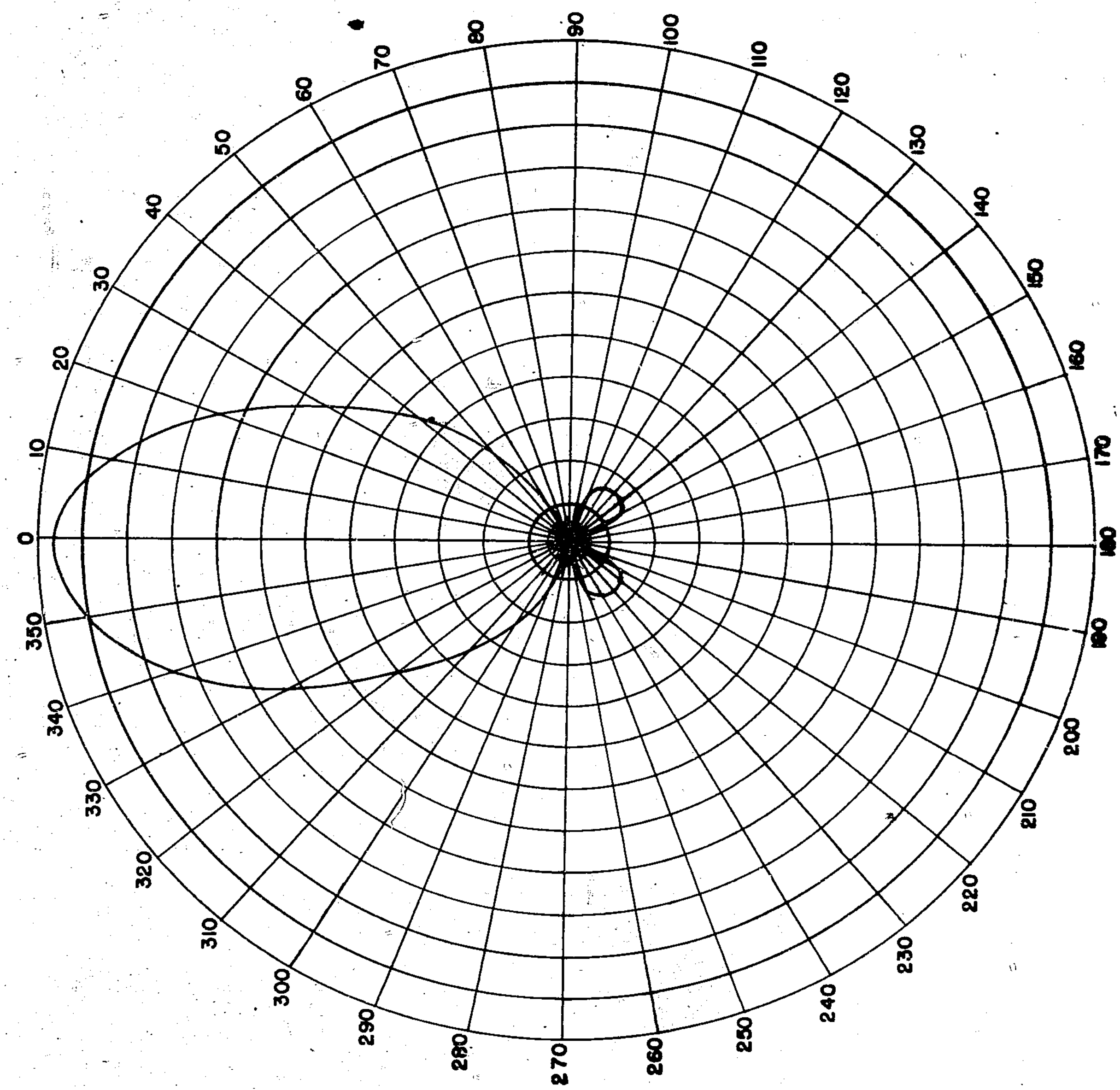
Designation	Name	Rating	Type-Model	Quantity
R22	Coupling Resistor	500 KΩ	C-2	1
R23	Grid Leakage Resistor	100 KΩ	C-2	1
R24	Voltage Divider Resistor	50 KΩ	C-2	1
R25	Voltage Divider Resistor	50 KΩ	C-2	1
R26	Resistor	10 KΩ	C-2	1
R28	Bias Resistor	100 KΩ	C-2	1
R29	Voltage Divider Resistor	50 KΩ	C-2	1
R30	Voltage Divider Resistor	50 KΩ	C-2	1
R31	Anode Load Resistor	2 KΩ	C-2	1
R32	Coupling Resistor	100 KΩ	C-2	1
R34	Bias Resistor	2 KΩ	C-2	1
R35	Screen Grid Resistor	50 KΩ	C-2	1
R36	Anode Resistor	25 KΩ	C-2	1
R37	Coupling Resistor	500 KΩ	C-2	1
R38	Voltage Divider Resistor	250 KΩ	C-2	1
R39	Voltage Divider Resistor	250 KΩ	C-2	1
R40	Voltage Divider Resistor	250 KΩ	C-2	1
R41	Voltage Divider Resistor	500 KΩ	C-2	1
R42	Voltage Divider Resistor	300 KΩ	C-2	1
R43	Voltage Divider Resistor	300 KΩ	C-2	1
R44	Voltage Divider Resistor	100 KΩ	C-2	1
R45	Voltage Divider Resistor	200 KΩ	C-2	1
R46	Coupling Resistor	100 KΩ	C-2	1
R47	Coupling Resistor	100 KΩ	C-2	1
R48	Filter Resistor	100 KΩ	C-2	1
R49	Filter Resistor	5 KΩ	C-2	1

ENCLOSURE (E), continued



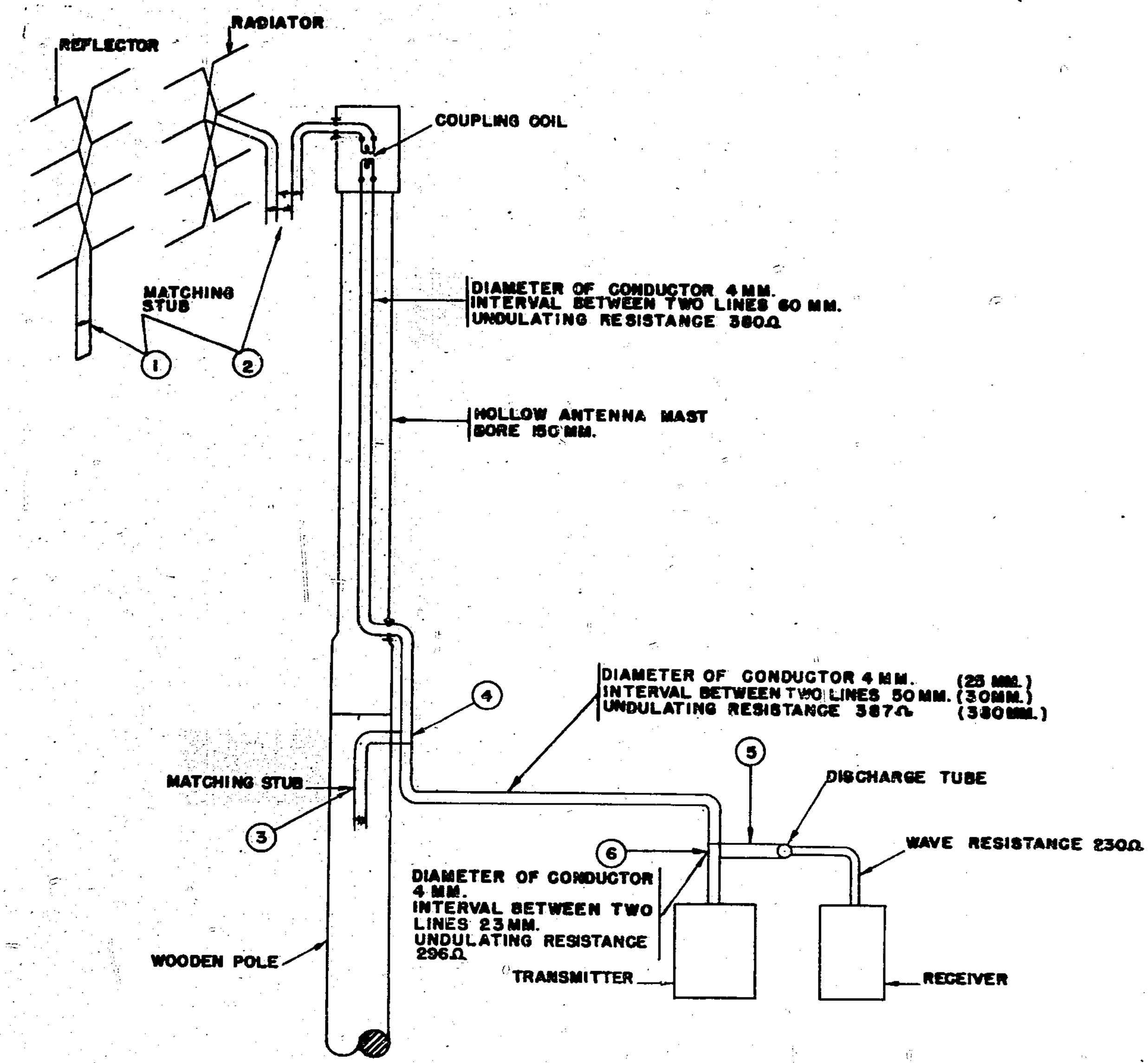
TYPE 3 MARK 1 MODEL 3 RADAR
Construction of the Antenna

ENCLOSURE (E), continued



TYPE 3 MARK 1 MODEL 3 RADAR
Antenna Directivity Pattern

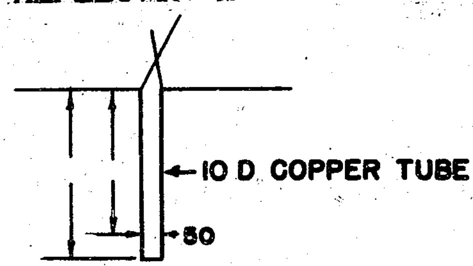
ENCLOSURE (E), continued



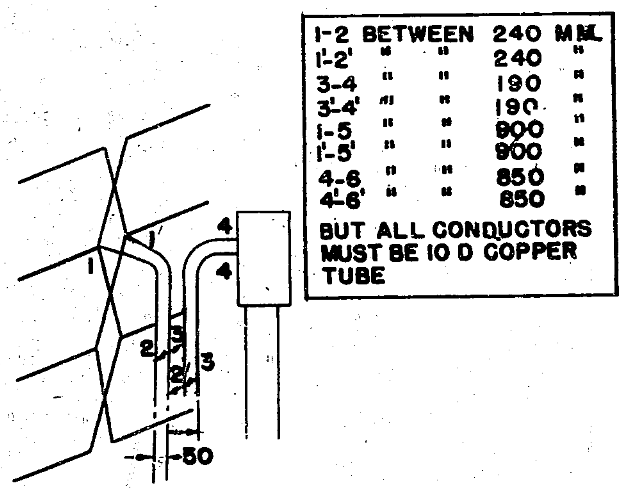
TYPE 3 MARK 1 MODEL 3 RADAR
Schematic Diagram of Antenna

ENCLOSURE (E), continued

REFLECTOR MATCHING LINES



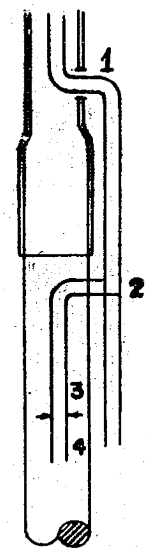
RADIATOR MATCHING LINES



TYPE 3 MARK 1 MODEL 3 RADAR

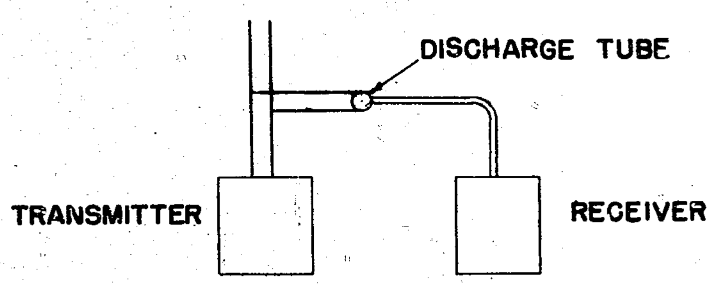
ENCLOSURE (E), continued

FEEDER LINE MATCHING LINES



1	INSULATOR	-2	BETWEEN	920	MM
2	" "	-3	" "	150	"
3	" "	-4	" "	150	"

RECEIVING CIRCUIT BRANCHING POINTS



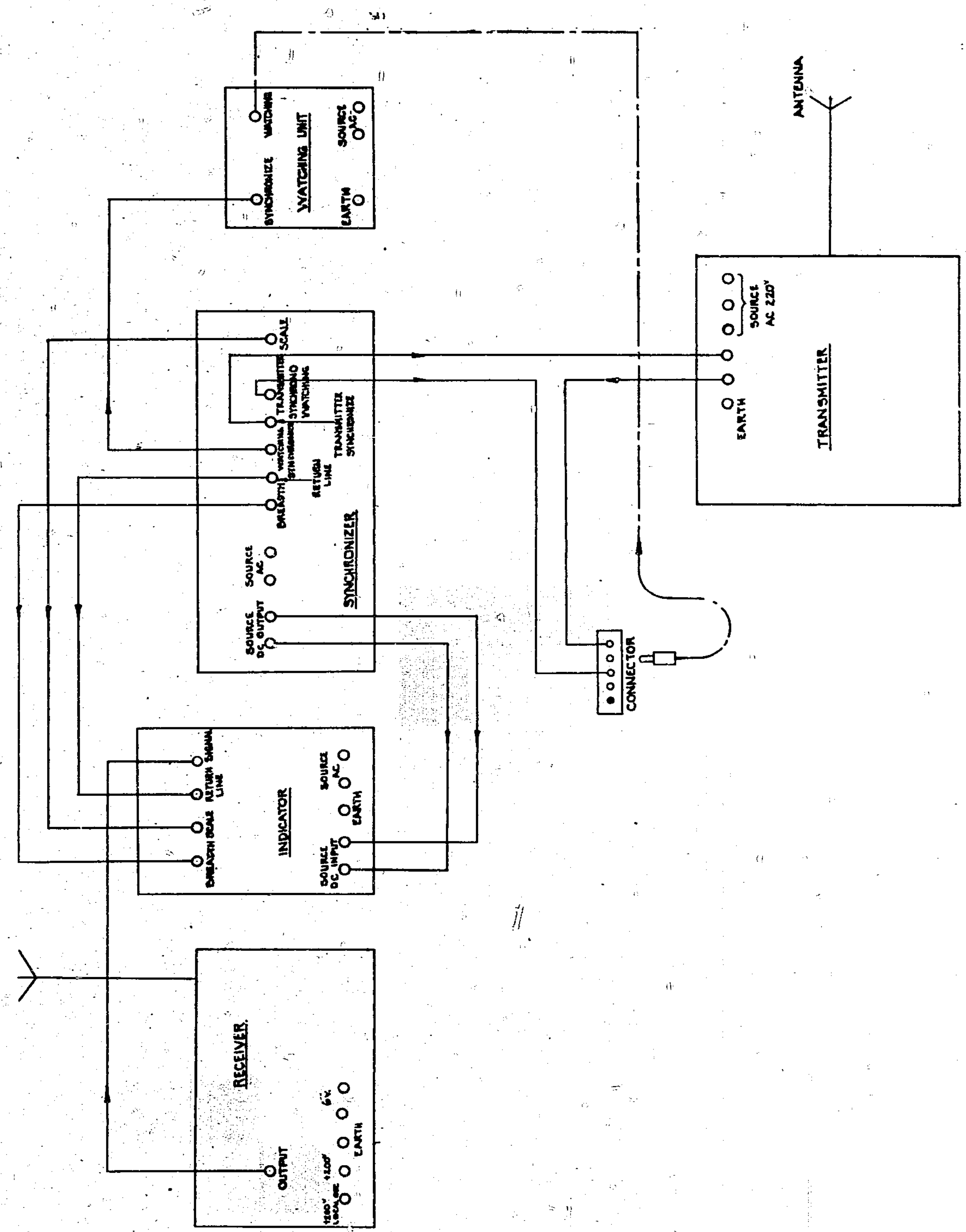
TYPE 3 MARK 1 MODEL 3 RADAR

ENCLOSURE (F)

WIRING DIAGRAMS OF TYPE 2 MARK 2 MODEL I RADAR

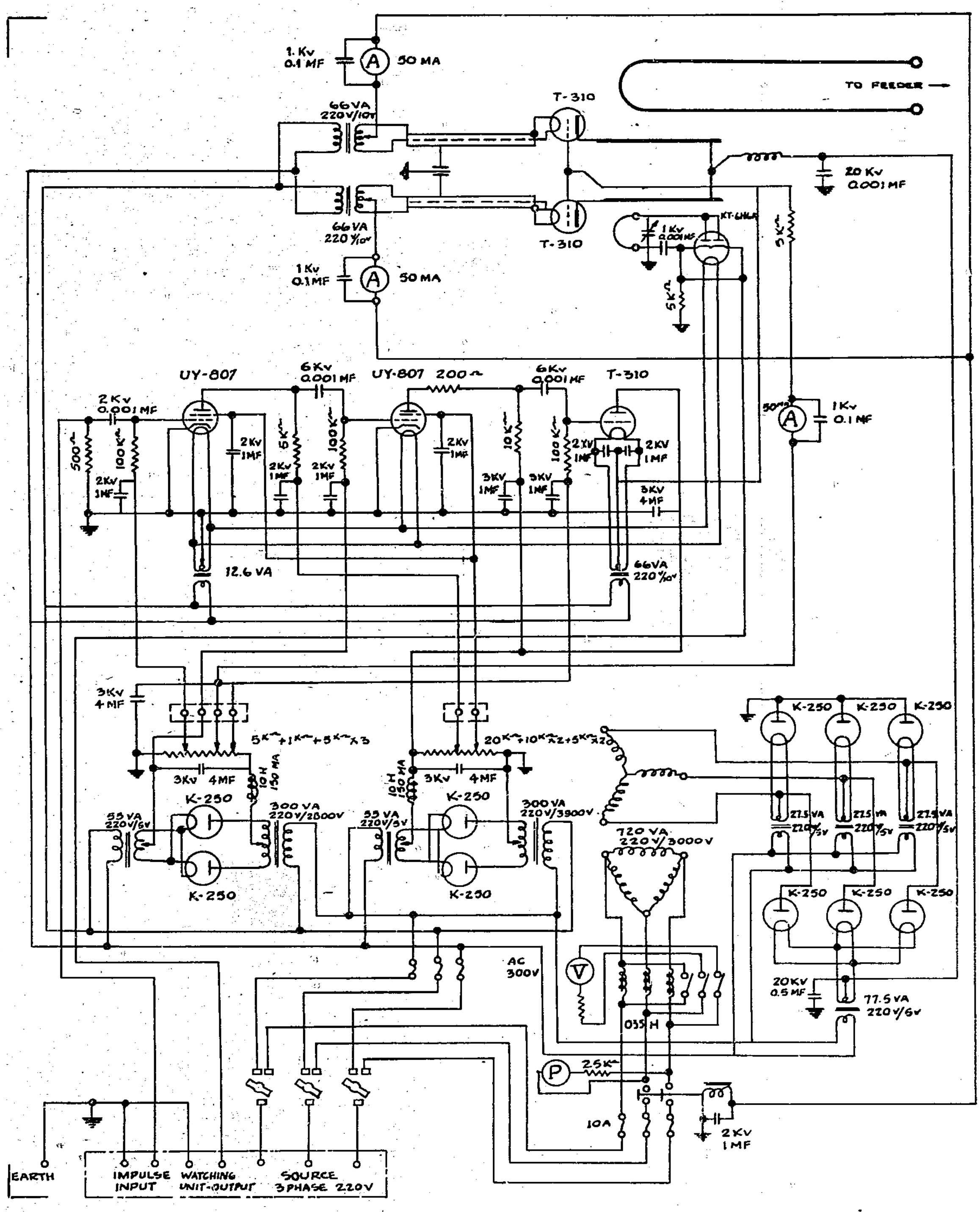
LIST OF DIAGRAMS

ENCLOSURE (F), continued

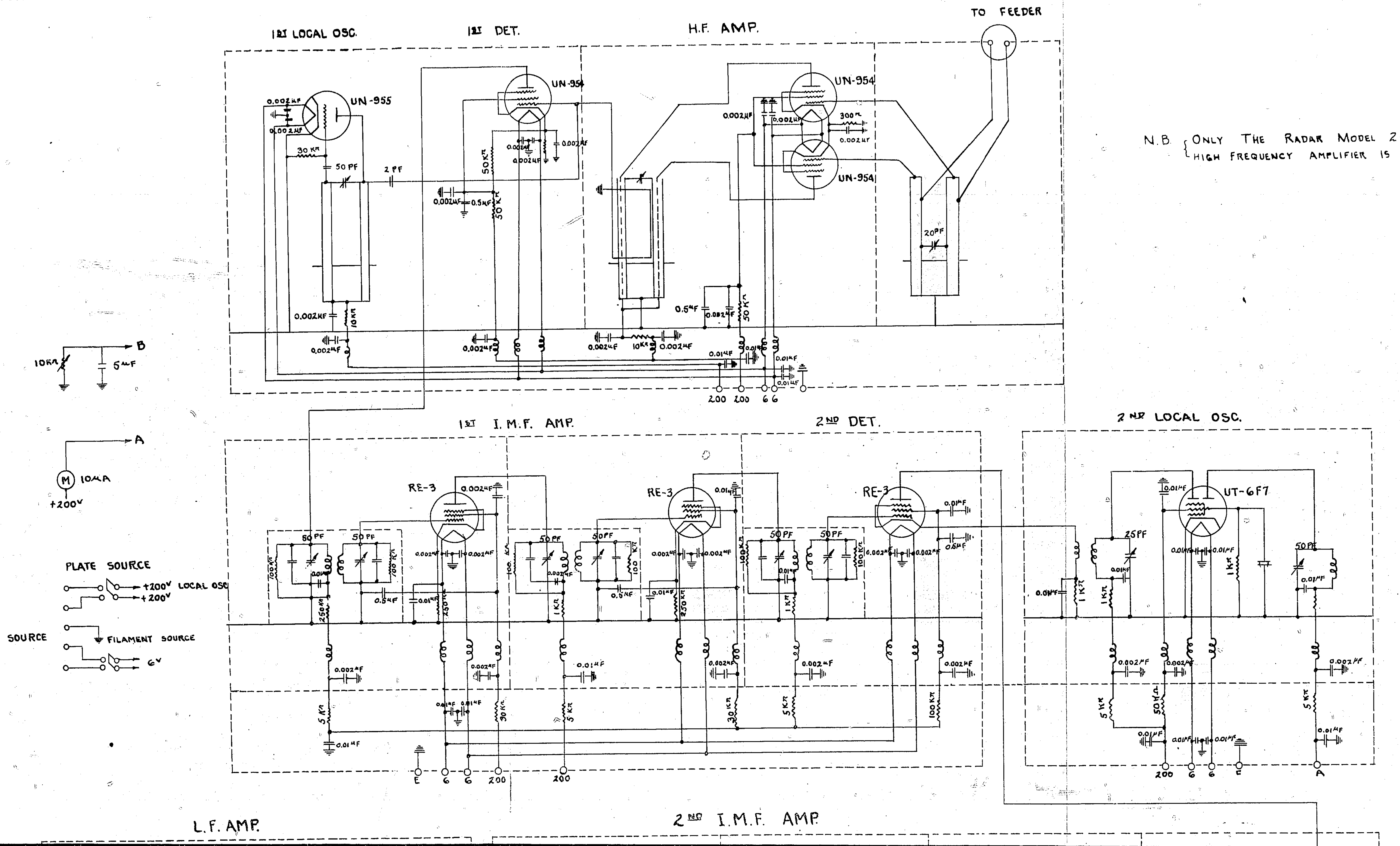


TYPE 2 MARK 2 MODEL 1 RADAR
Connection Diagram Between Units

ENCLOSURE (F), continued

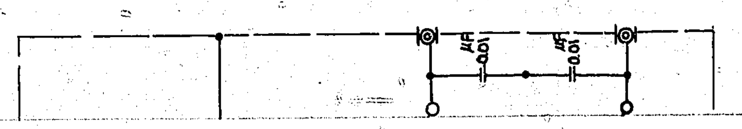


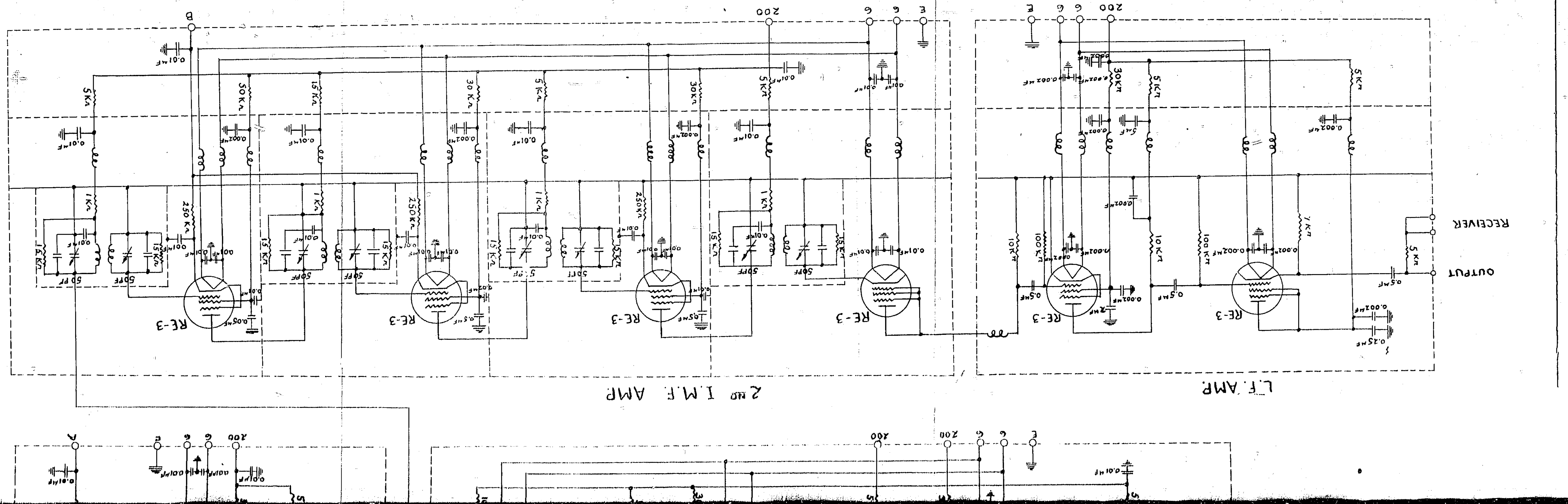
Transmitter Connection Diagram



N.B. { ONLY THE RADAR MODEL 2-11 HIGH FREQUENCY AMPLIFIER IS SINGLE TUBE (UN-954)

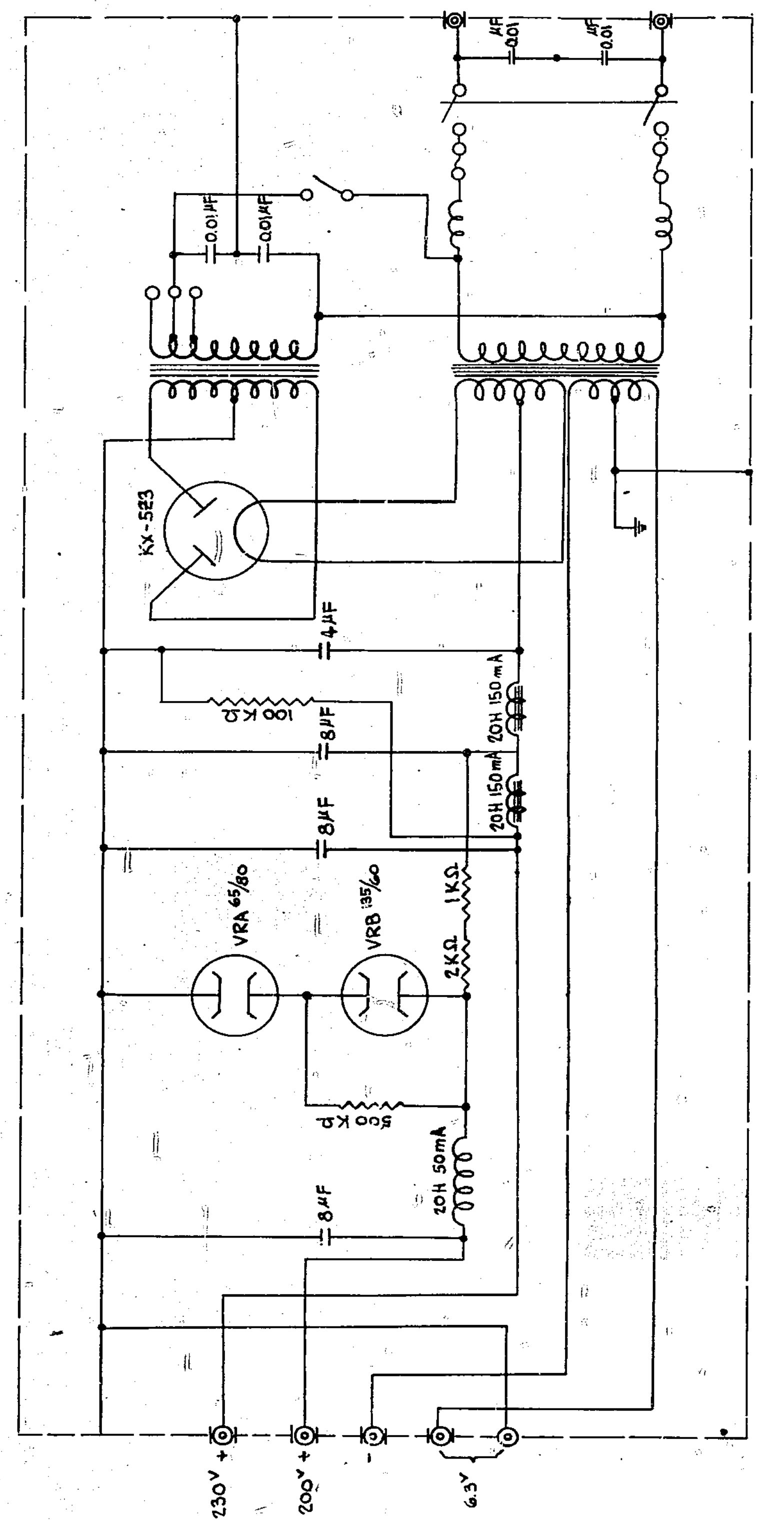
ENCLOSURE (F), continued





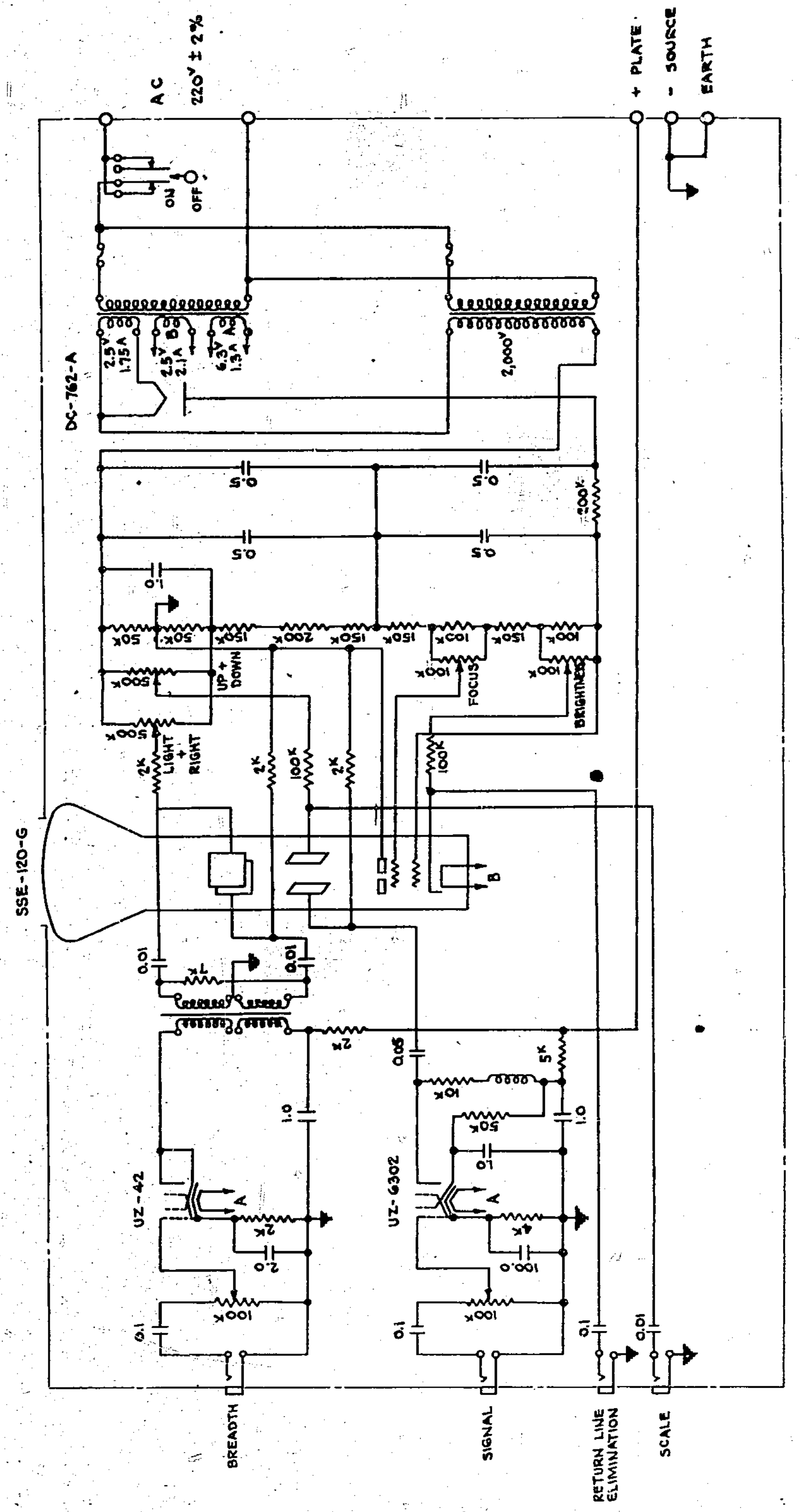
TYPE 2 MARK 2 MODEL 1 RADAR
Receiver Connection Diagram

ENCLOSURE (F), continued



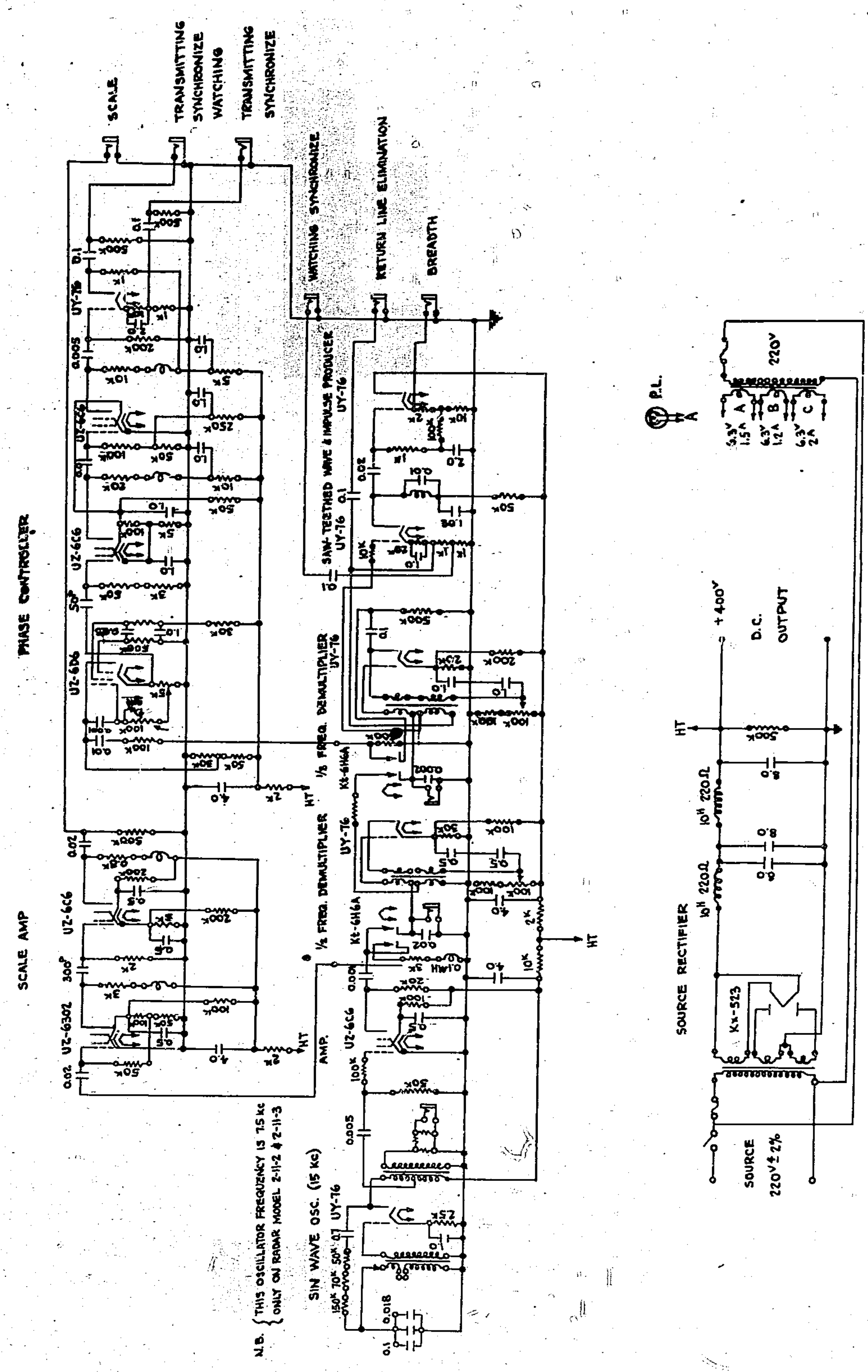
TYPE 2 MARK 2 MODEL 1 RADAR
Rectifier for Receiver Connection Diagram

ENCLOSURE (F), continued



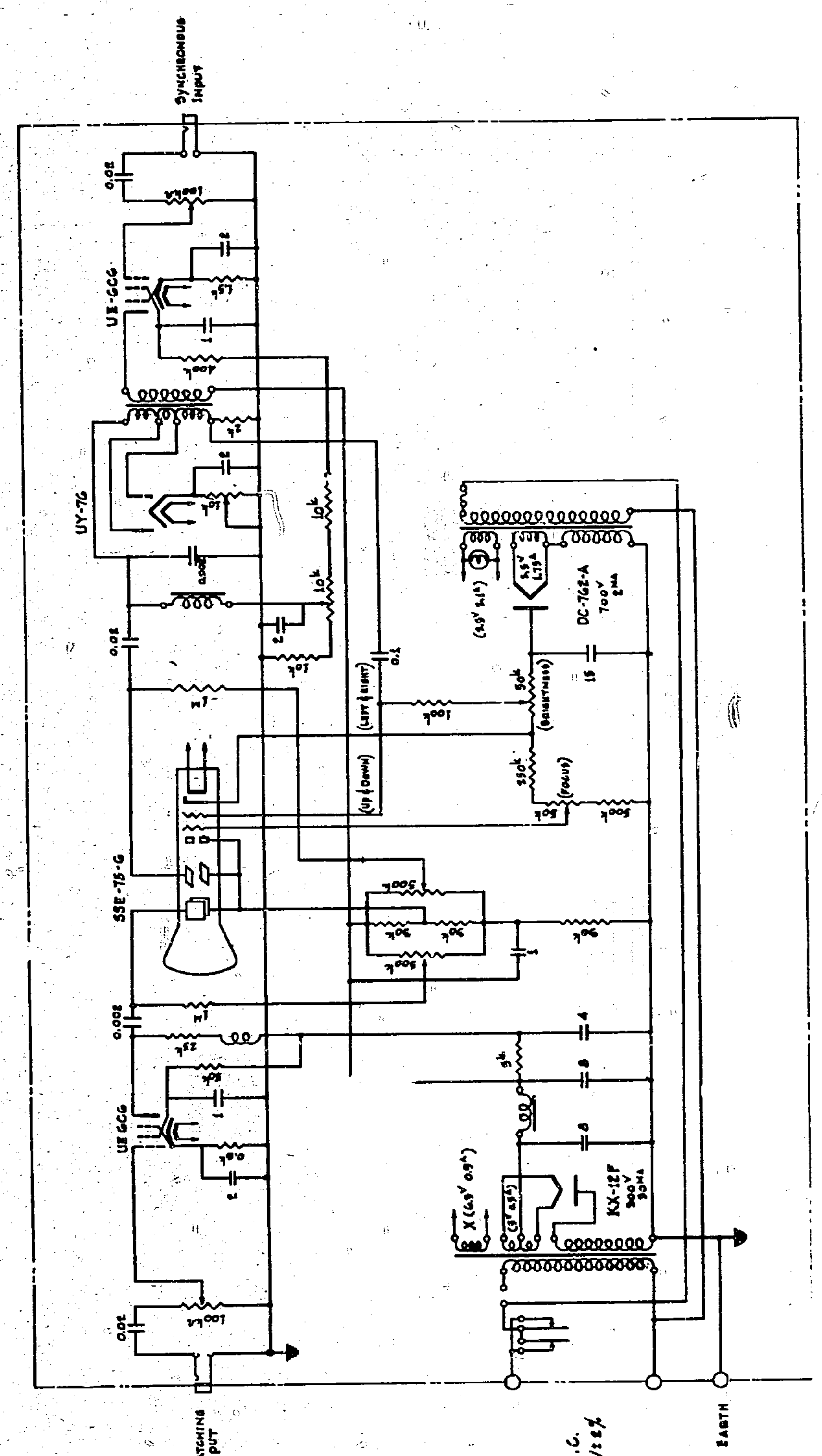
TYPE 2 MARK 2, MODEL 1 RADAR
Indicator Connection Diagram

ENCLOSURE (F), continued



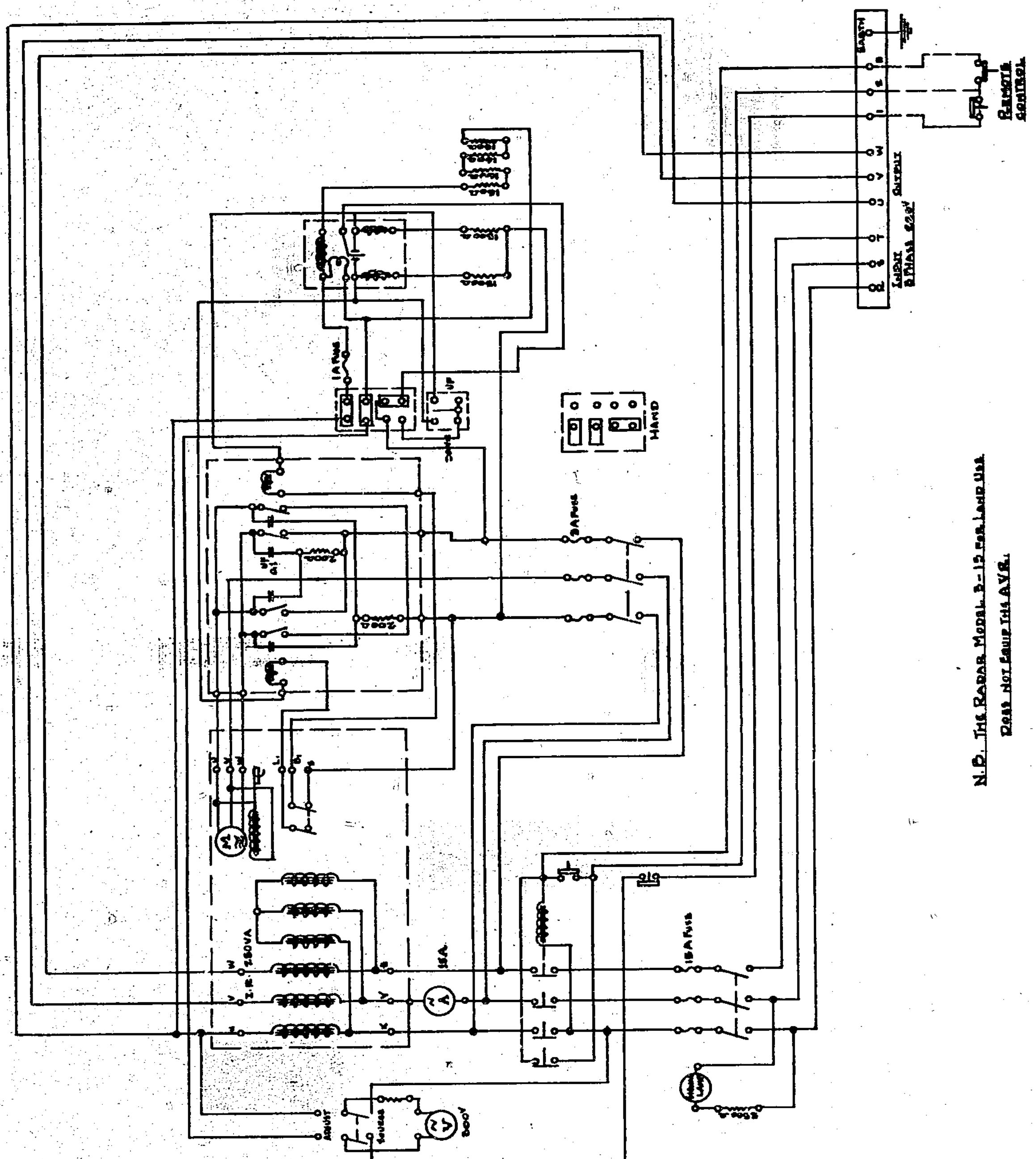
TYPE 2 MARK 2 MODEL 1 RADAR
Synchronizer Connection Diagram

ENCLOSURE (F), continued



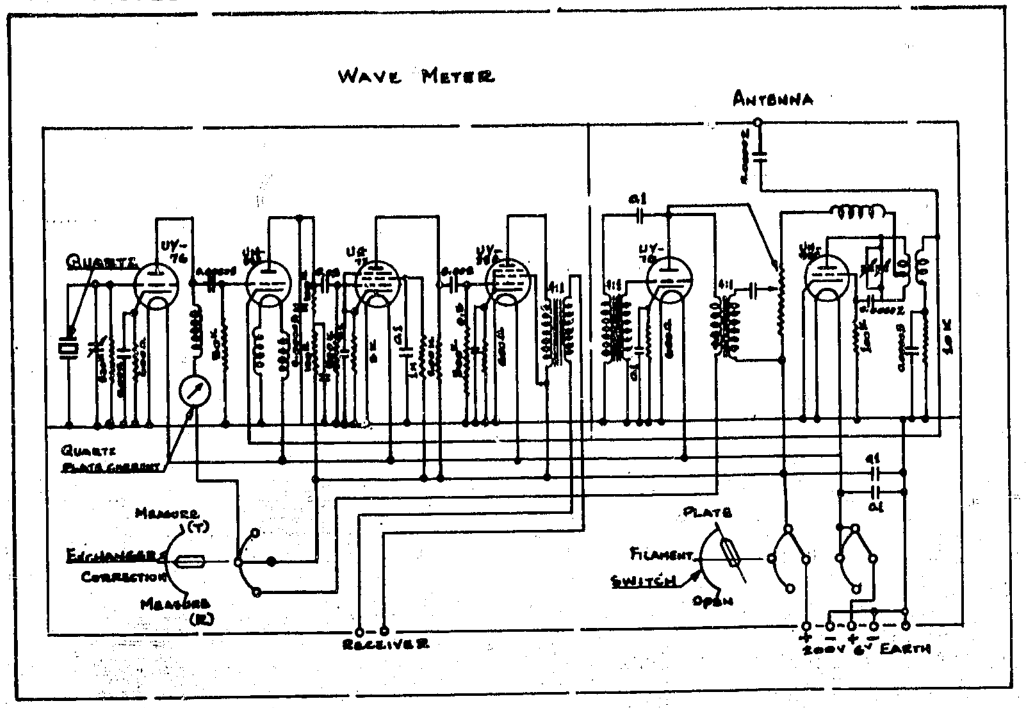
TYPE 2 MARK 2 MODEL 1 RADAR
Watching Unit Connection Diagram

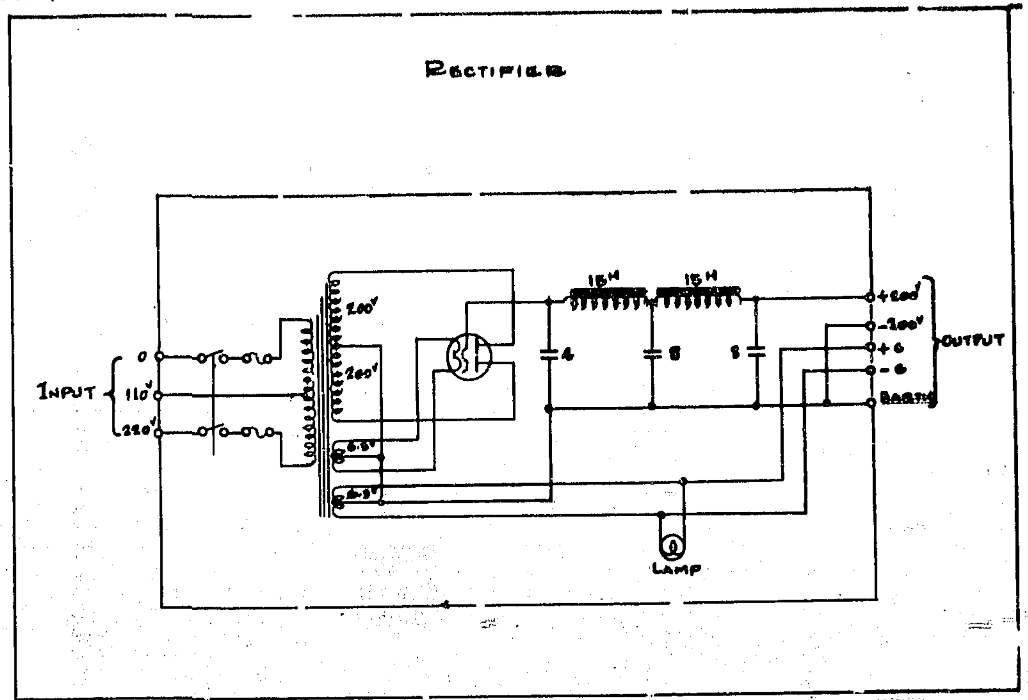
ENCLOSURE (F), continued



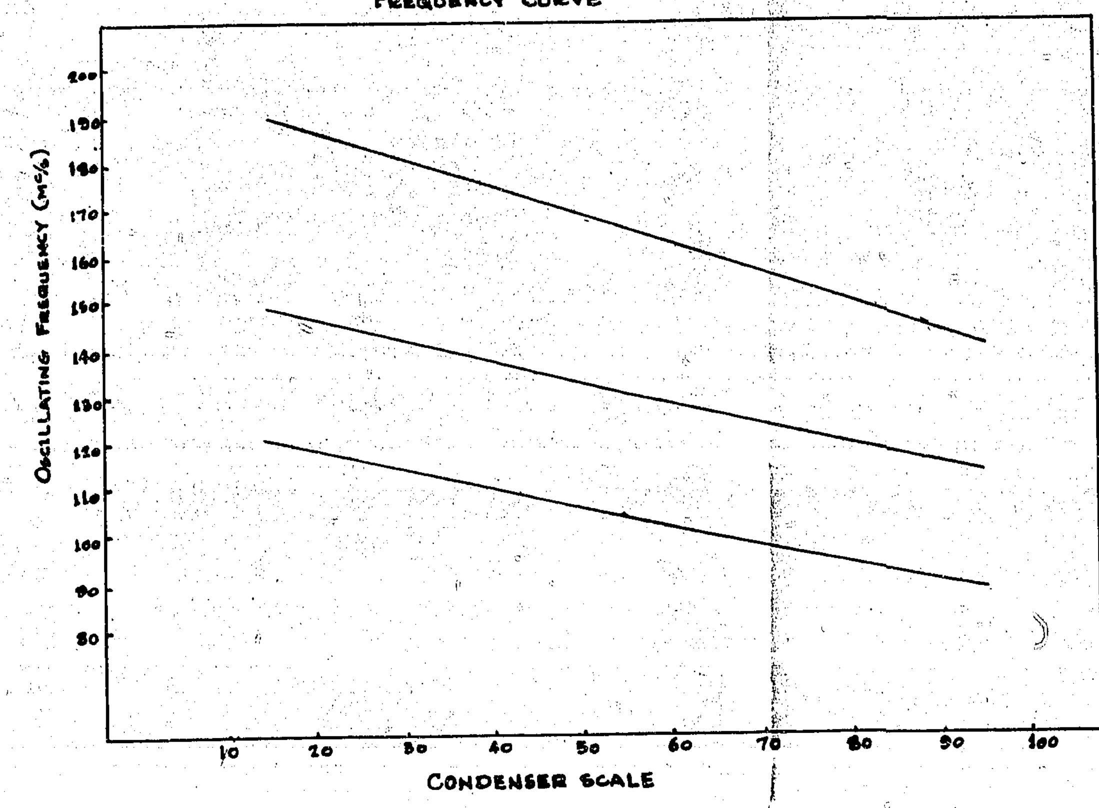
N.B. The Radar Model 3-15 for Land Use Does Not Equip the A.V.R.

TYPE 2 MARK 2 MODEL 1 RADAR
Automatic Voltage Regulator





WAVE METER

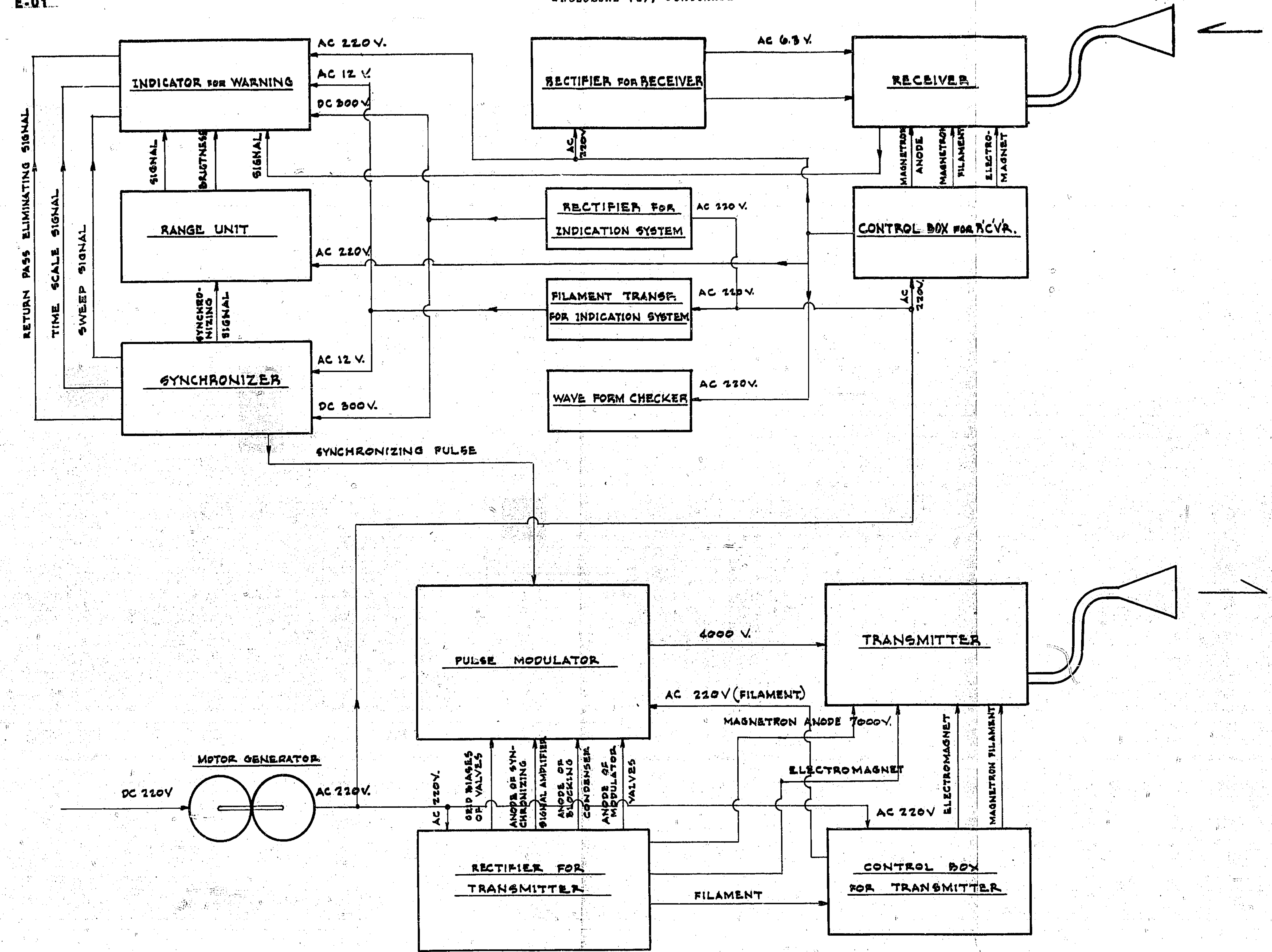


N.B. The Radar Model S-13 for Land Use Does Not Equip The Wave Meter.

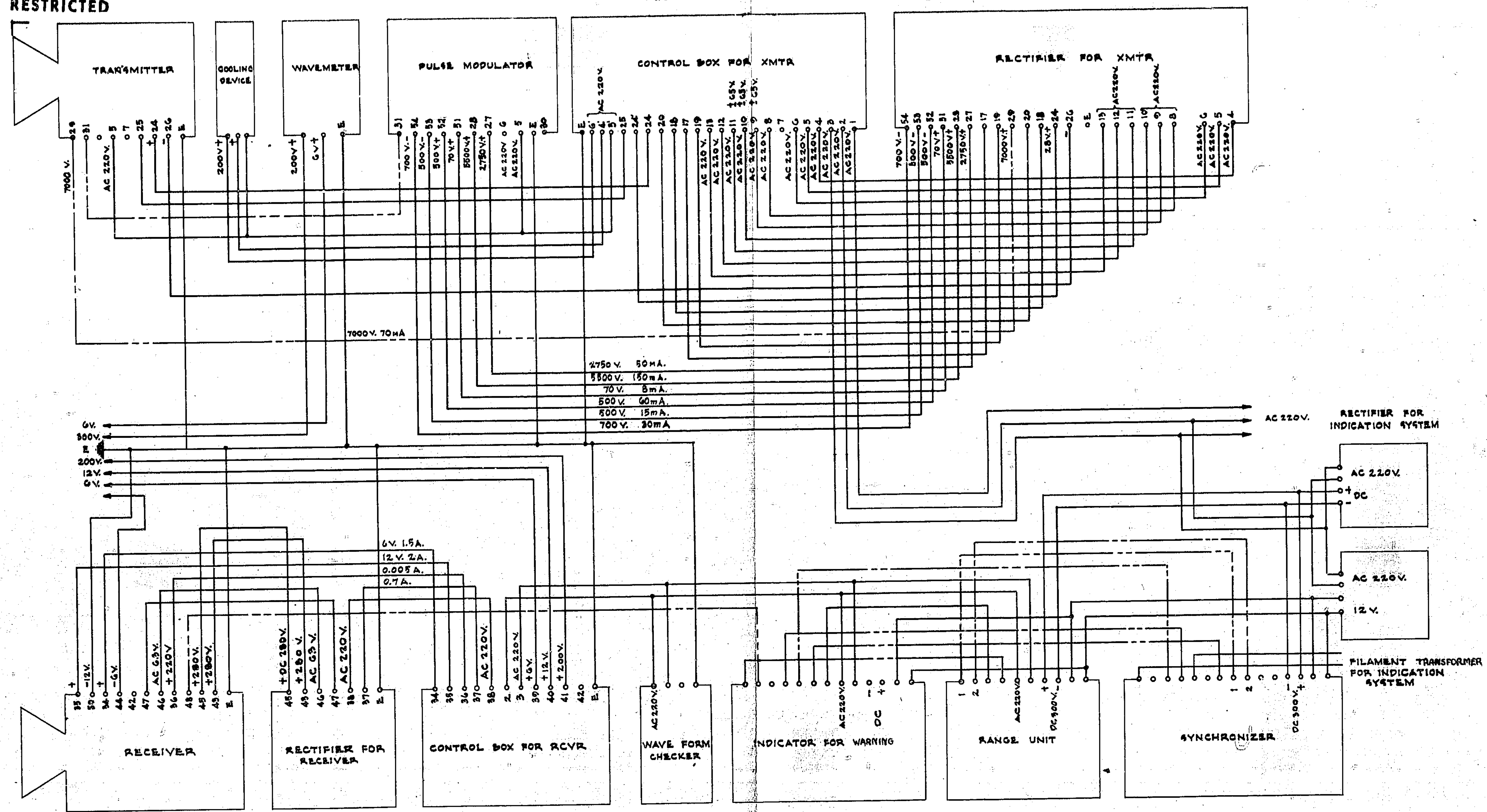
ENCLOSURE (G)

WIRING DIAGRAMS OF MARK 2 MODEL 2 MODIFICATION 4 RADAR

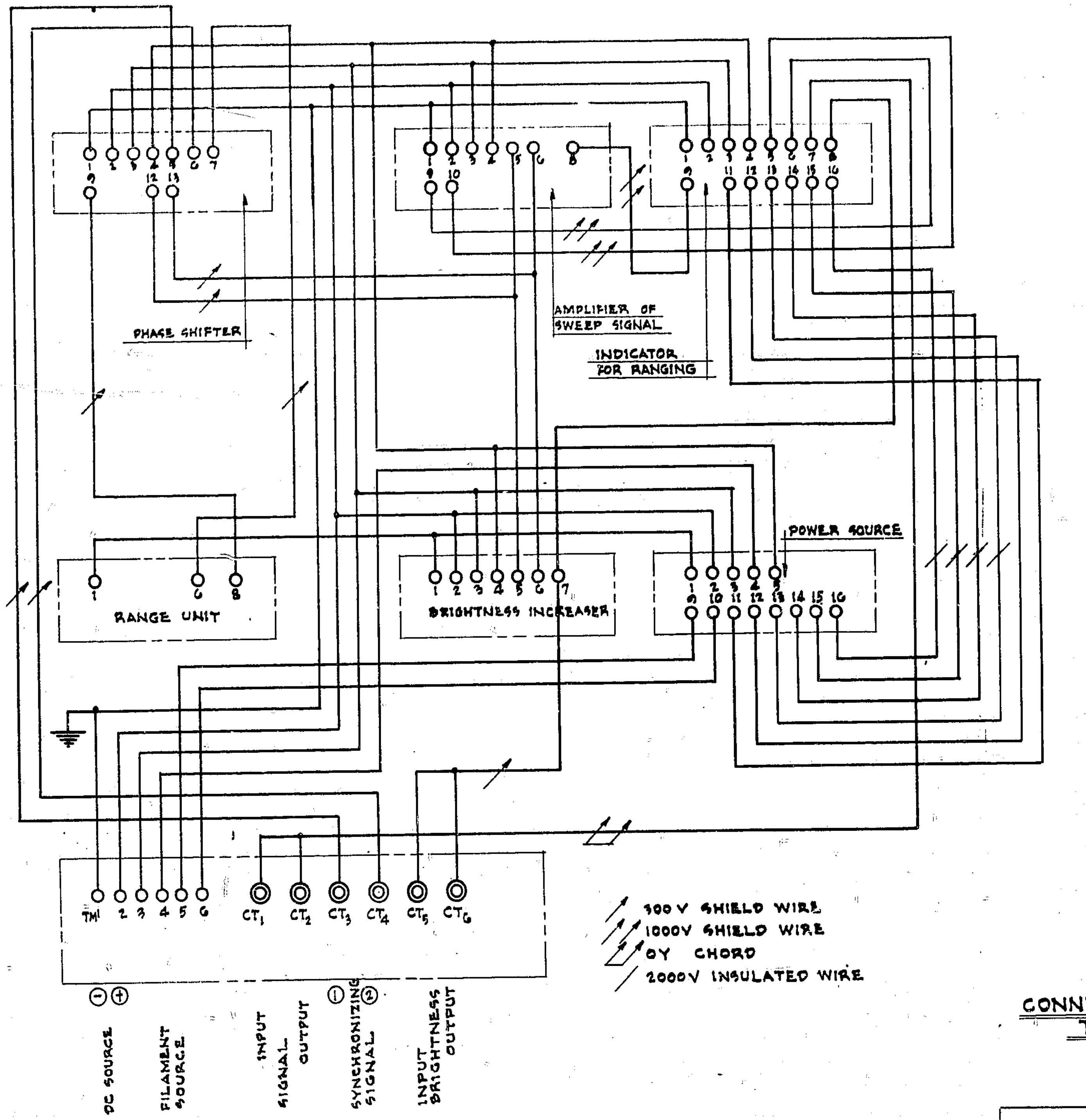
LIST OF DIAGRAMS



MARK 2 MODEL 2 MODIFICATION 4 RADAR
Block Diagram

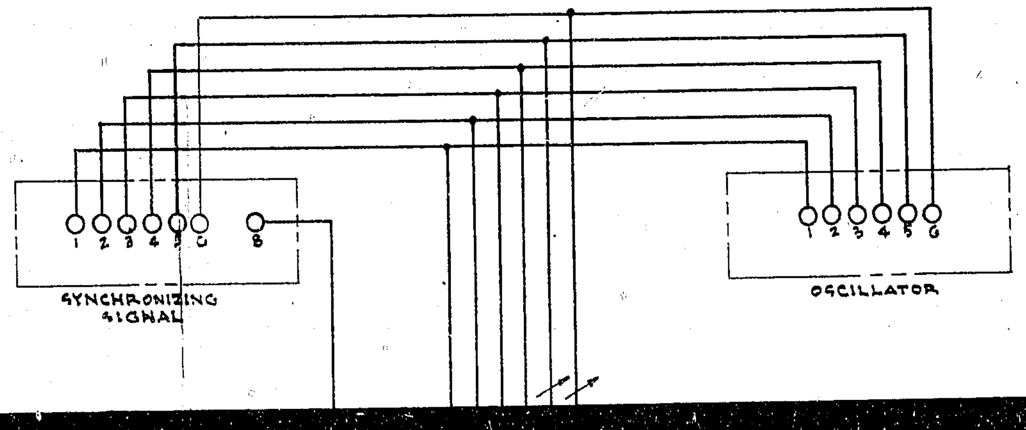


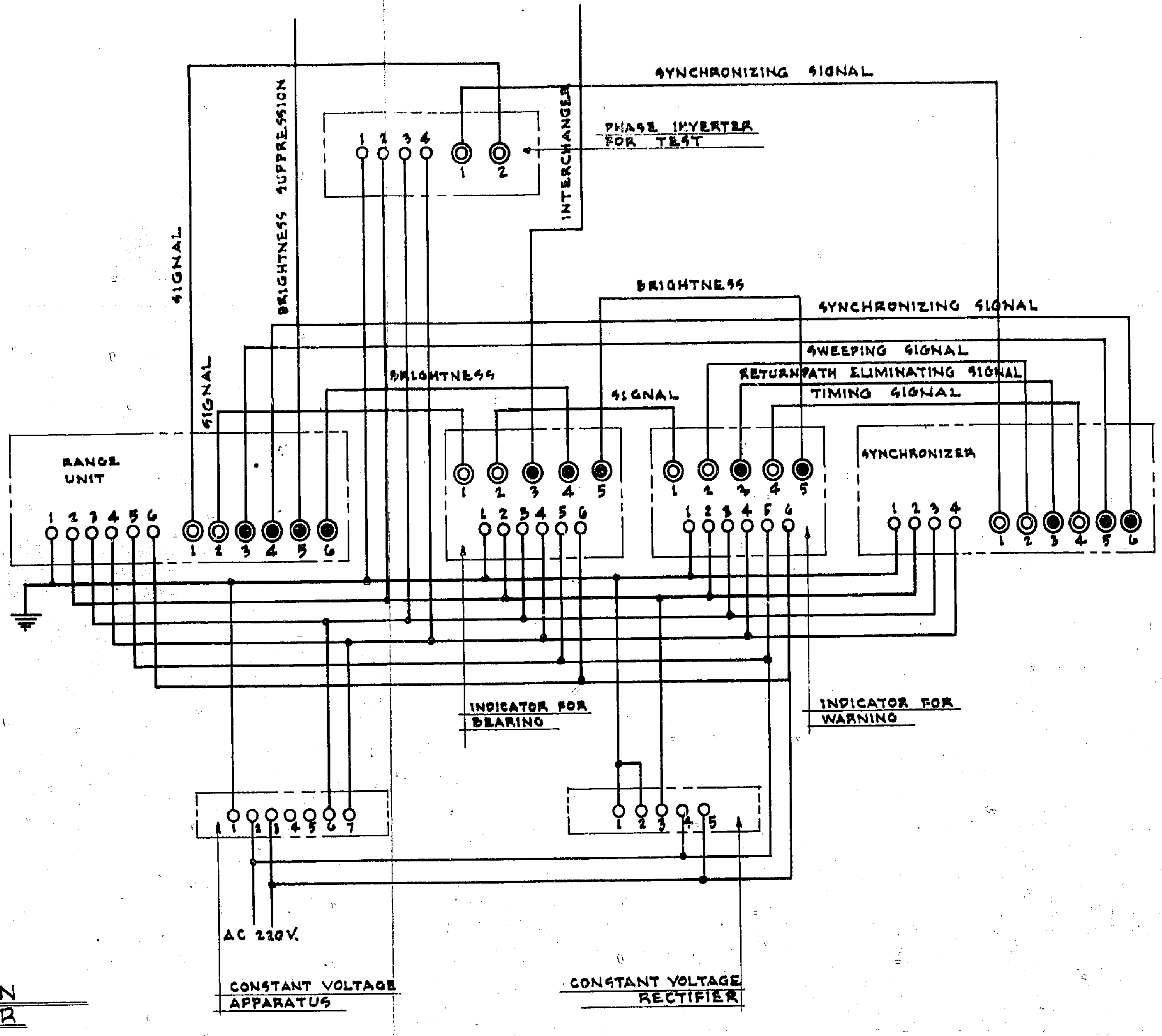
MARK 2 MODEL 2 MODIFICATION 4 RADAR
Wiring Diagram



CONNECTION DIAGRAM BETWEEN TERMINALS OF RANGE UNIT

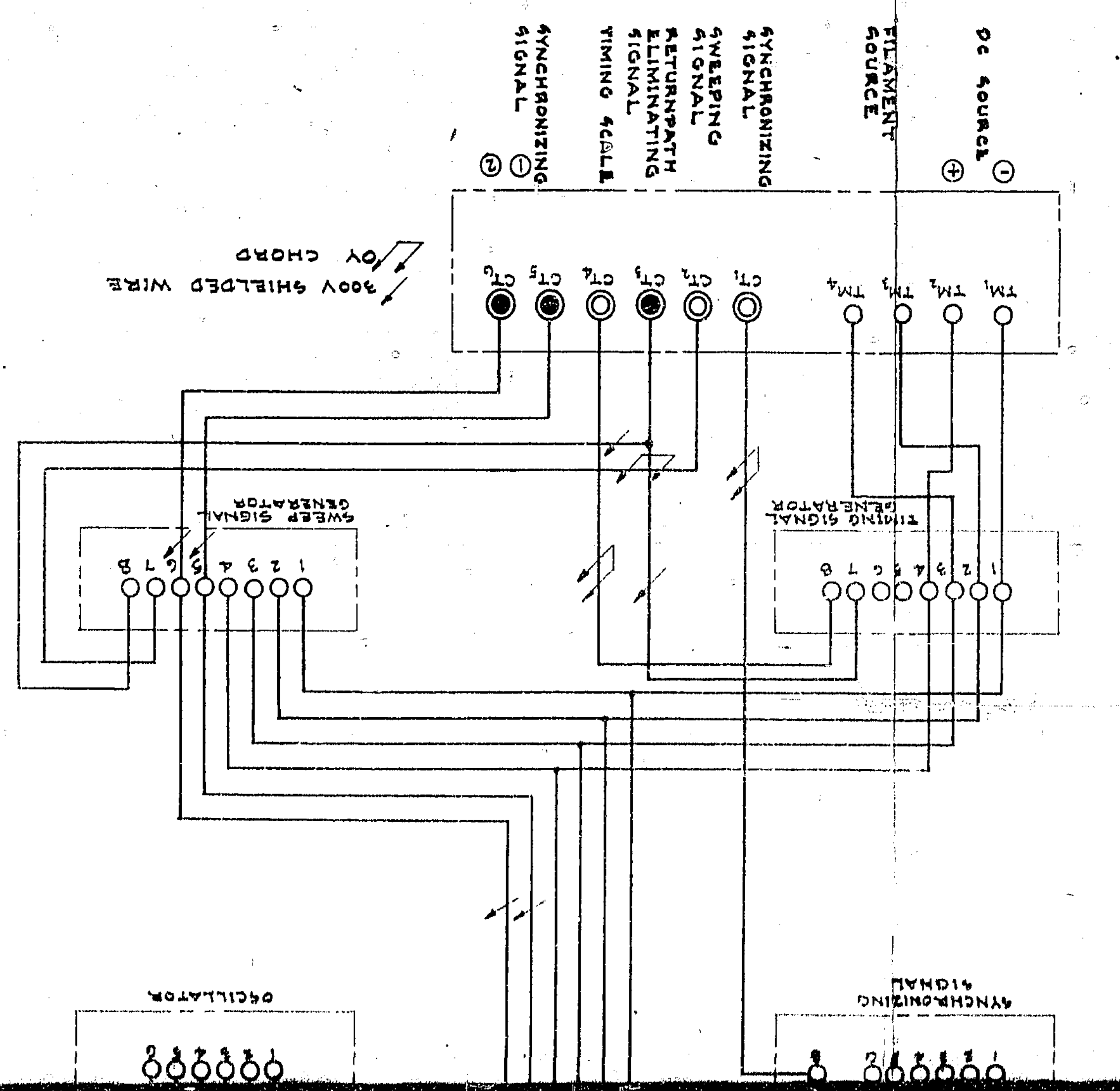
CONNECTION DIAGRAM BETWEEN TERMINALS IN SYNCHRONIZER





GENERAL CONNECTION OF INDICATION SYSTEM (SS213-B)

ENCLOSURE (G), continued



MARK 2 MODEL 2 MODIFICATION 4 RADAR
Connection Diagrams for Range Unit,
Synchronizer and Indication System

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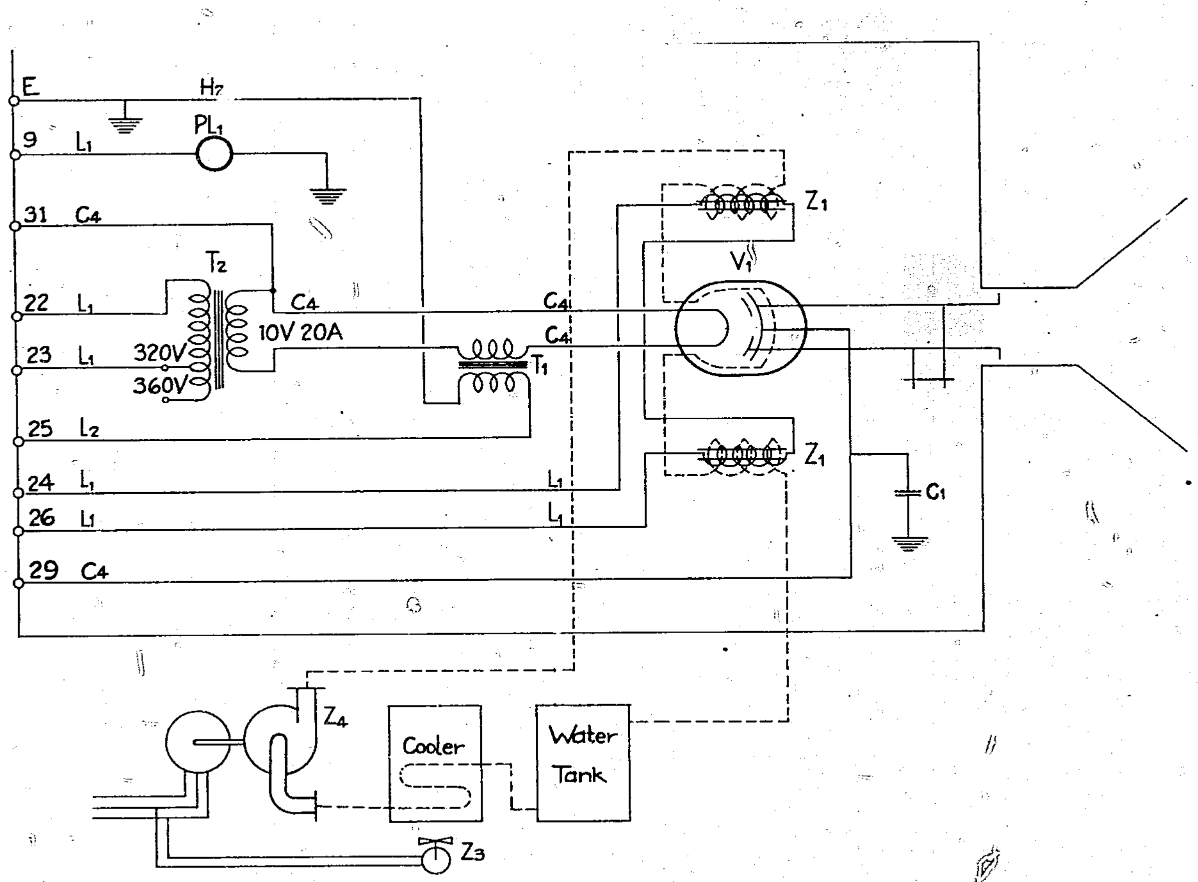
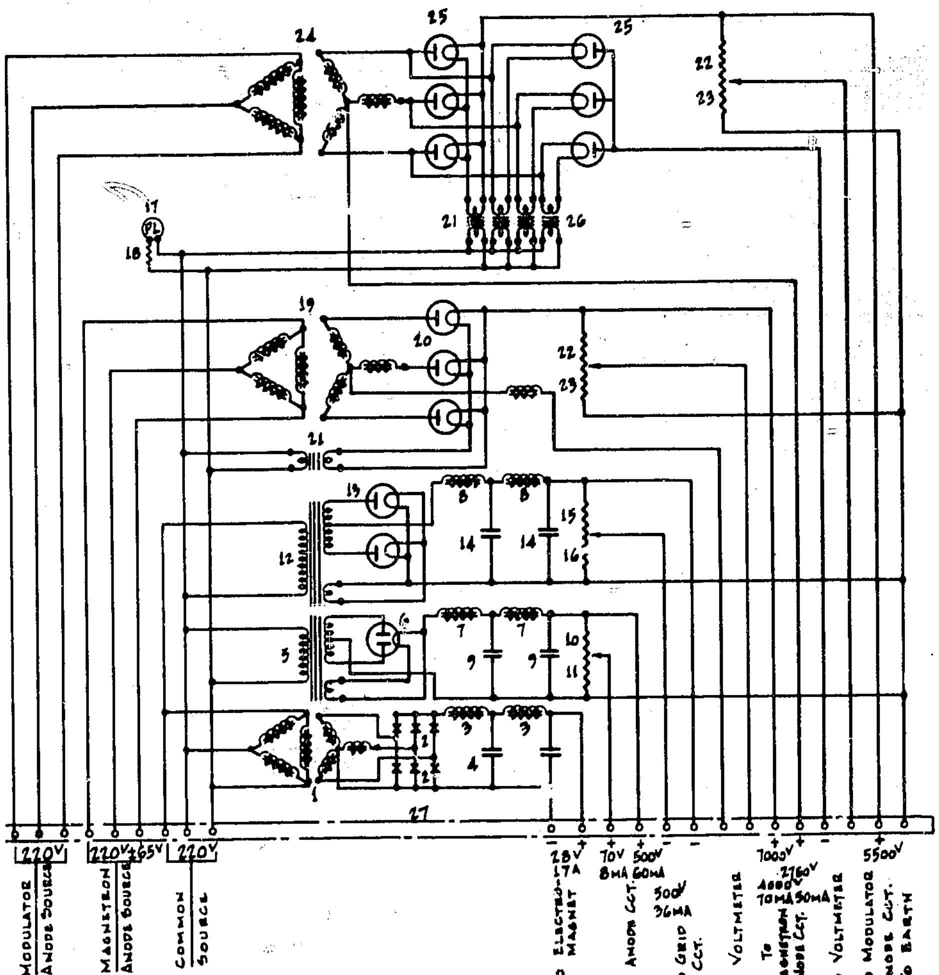
ENCLOSURE (G), continued



C_1	Oil Filled Condenser	1	2uF, TVDC20kV
PL_1	Pilot Lamp	1	24V 0,11A
T_1	Current Transformer	1	50~15VA, TVAC10kV
T_2	Cathode Heating Transformer	1	Pr. 200V & 220V, Sec. 10V 20A, TVAC10kV
V_1	Magnetron	1	M-312
Z_1	Electromagnet	1	16mmDSC2500T×2 (8,9Ω×2)
Z_3	Electric Fan	1	70l/sec, AC220V, 50~/s
Z_4	Cooling Pump	1	16,5l sec, AC220V, 50~/s

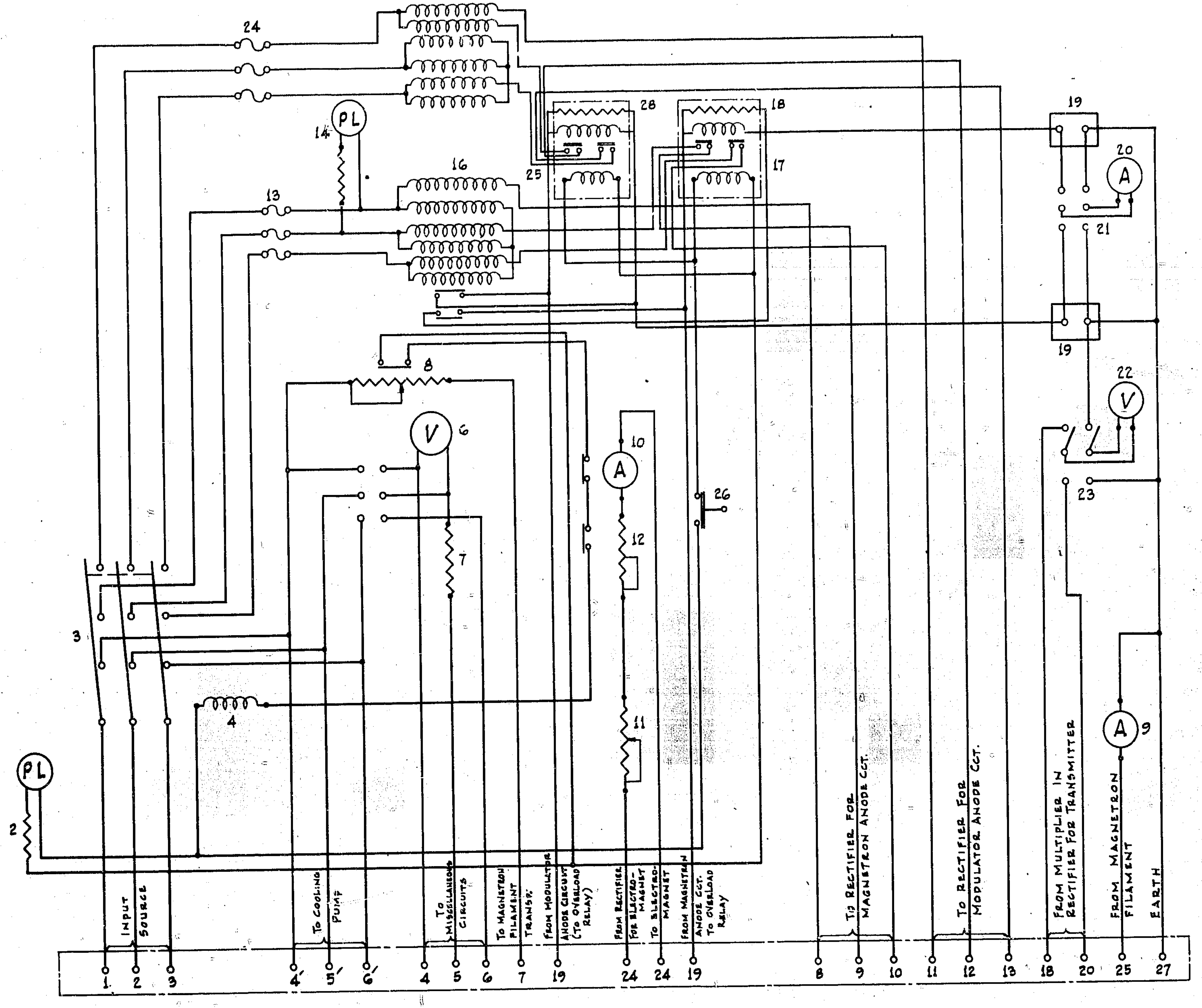
MARK 2 MODEL 2 MODIFICATION 4 RADAR
Transmitter

ENCLOSURE (G), continued



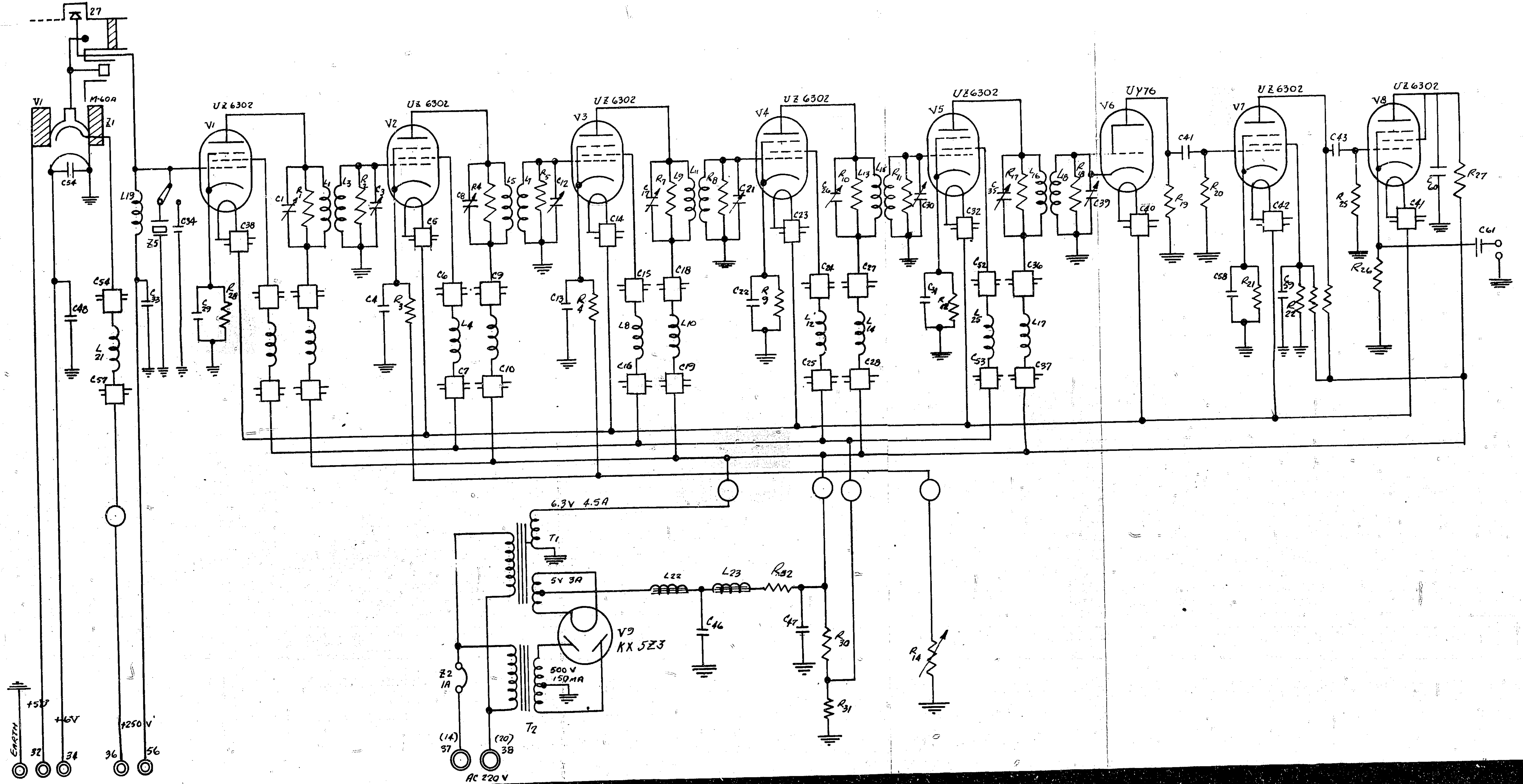
No.	NAME OF PARTS	RATING	NUM
1.	POWER TRANSFORMER FOR ELECTROMAGNET	60VA	1
2.	CUO RECTIFIER FOR ELECTROMAGNET	29V 0.9A	1
3	SMOOTHING CHOKE COILS FOR ELECTROMAGNET	30mH	2
4	SMOOTHING CONDENSERS FOR ELECTROMAGNET	100pF	2
5	POWER TRANSFORMER FOR PLATE SOURCE OF P112	95VA	1
6	RECTIFIER TUBE FOR PLATE SOURCE	KX523	1
7	SMOOTHING CHOKE COILS FOR PLATE SOURCE	20H	2
8	SMOOTHING CHOKE COILS FOR GRID SOURCE	6H	2
9	SMOOTHING CONDENSERS FOR PLATE SOURCE	4μF	2
10	BLEEDER RESISTANCE FOR PLATE SOURCE		1
11	(Do)		1
12	POWER TRANSFORMER FOR GRID SOURCE		1
13	RECTIFIER TUBES FOR GRID SOURCE		2
14	SMOOTHING CONDENSERS FOR GRID SOURCE		4
15	BLEEDER RESISTANCE FOR GRID SOURCE		1
16	(Do)		1
17	PILOT LAMP OF HIGH VOLTAGE		1
18	SERIES RESISTANCE OF PILOT LAMP		1
19	POWER TRANSFORMER FOR MAGNETRON ANODE SOURCE	770VA	1
20	RECTIFIER TUBES FOR MAGNETRON ANODE SOURCE		3
21	FILAMENT TRANSFORMER		1
22	MULTIPLIER RESISTANCES OF MAGNETRON ANODE VOLTMETER		1×2
23	(Do)		1×2
24	POWER TRANSFORMER FOR PLATE SOURCE OF MODULATOR TUBES		1
25	RECTIFIER TUBES FOR PLATE SOURCE OF MODULATOR TUBES		6
26	FILAMENT TRANSFER FOR PLATE SOURCE OF MODULATOR TUBES		3
27	TERMINALS		23

MARK 2 MODEL 2 MODIFICATION 4 RADAR
Connection Diagram of Rectifier for Transmitter



ITEM No	NAME OF PART		No. REQ'D
1	PILOT LAMP OF IRY SOURCE		1
2	SERIES RESISTENCE OF PILOT LAMP	2500Ω	1
3	SWITCH	250V	1
4	LIMIT-SWITCH RELAY		1
5	FUSE		1
6	VOLTMETER FOR SOURCE	300V	1
7	MULTIPLIER OF ABOVE METER		1
8	ADJUSTABLE RESISTANCE OF MAGNETRON FILAMENT CURRENT		1
9	AMMETER FOR FILAMENT CURRENT	30A	1
10	AMMETER FOR ELECTRO-MAGNET CURRENT	2A	1
11	ROUGH ADJUSTABLE RESISTANCE OF ELECTRO-MAGNET CURRENT		1
12	FINE ADJUSTABLE RESISTANCE OF ELECTRO-MAGNET CURRENT		1
13	FUSES OF MAGNETRON ANODE CIRCUIT	250V 5A	3
14	PILOT LAMP OF HIGH TENSION		1
15	SERIES RESISTANCE OF ABOVE LAMP	2500Ω	1
16	VOLTAGE REGULATOR OF MAGNETRON ANODE CIRCUIT	200VA	1
17	OVERLOAD RELAY OF ABOVE CIRCUIT	75MA	1
18	SHUNT RESISTANCE OF ABOVE RELAY		1
19	SHUNT OF MILLIAMMETER (20)		2
20	MILLIAMMETER FOR MAGNETRON ANODE CURRENT & MODULATOR ANODE CURRENT	200MA	1
21	INTERCHANGE SWITCH		1
22	VOLTMETER FOR MAGNETRON ANODE & MODULATOR ANODE	10kV	1
23	INTERCHANGE SWITCH		1
24	FUSES FOR MODULATOR ANODE CIRCUIT	250V 5A	3
25	OVERLOAD RELAY OF ABOVE CIRCUIT	200MA	1
26	RECOVERING BUTTON		1
27	TERMINALS		1
28	SHUNT RESISTANCE	550Ω	1

MARK 2 MODEL 2 MODIFICATION 4 RADAR
Circuit Diagram of Control Box for Transmitter


UZ 6302
UY76
M-60A
KX 5Z3
6.3V 4.5A
5V 3A
500 V
150 mA
EARTH
+250 V
+6V
AC 220 V
(14)
(20)
32
34
36
56
37
38

TRANSFORMER FOR PILOT LAMP			
FILAMENT CURRENT METER			
ANODE VOLTAGE METER (COMMON WITH CRYSTAL CURRENT METER)			
ANODE CURRENT METER			
ELECTROMAGNET CURRENT MTR.			
SWITCH			
INTERCHANGE SWITCH			
PILOT LAMP			
FILAMENT CURRENT CONTROL RESISTANCE			
SERIES RESISTANCE			
SERIES RESISTANCE			
BLEEDER RESISTANCE FOR ANODE VOLTAGE CONTROL			
BLEEDER RESISTANCE			
ELECTROMAGNET CONTROL RESISTANCE			
SERIES RESISTANCE OF ELECTROMAGNET			

V1	LOCAL OSCILLATOR	M-60-A	1
V2	I.F. AMPLIFIER	UB-6302	1
V3	"	"	1
V4	"	"	1
V5	"	"	1
V6	2nd DETECTOR	UY-76	1
V7	A.F. AMPLIFIER	UB-6302	1
V8	"	"	1
V9	RECTIFIER	KX-583	1
V10	I.F. AMPLIFIER	UB-6302	1
C1	I.F. TUNING CONDENSER	NBC 5P	1
C3	" "	"	1
C4	CATHODE BIPATH CONDEN.	0.002μF	1
C5	CHOPATH CONDENSER	0.1μF	1
C6	"	"	1
C7	"	"	1
C8	I.F. TUNING CONDENSER	NBC 5P	1
C9	CATHODE BIPATH CONDEN.	0.1μF	1
C10	" " "	"	1
C12	I.F. TUNING CONDENSER	NBC 5P	1
C14	CHOPATH CONDENSER	0.1μF	1

C13	CATHODE BIPATH CONDENSER	0.002μF	1
C11	CHOPATH CONDENSER	0.1μF	1
C16	" "	"	1
C17	I.F. TUNING CONDENSER	NBC 5P	1
C18	CHOPATH CONDENSER	0.1μF	1
C19	" "	"	1
C21	I.F. TUNING CONDENSER	NBC 5P	1
C22	BIPATH CONDENSER	0.002μF	1
C23	CHOPATH CONDENSER	0.1μF	1
C24	" "	"	1
C25	" "	"	1
C26	I.F. TUNING CONDENSER	NBC 5P	1
C27	CHOPATH CONDENSER	0.1μF	1
C28	" "	"	1
C29	BIPATH CONDENSER	0.002μF	1
C30	I.F. TUNING CONDENSER	NBC 5P	1
C31	BIPATH CONDENSER	0.002μF	1
C32	CHOPATH CONDENSER	0.1μF	1
C33	" "	"	1
C34	CONDENSER	10PF	1
C35	I.F. TUNING CONDENSER	NBC 5P	1
C36	CHOPATH CONDENSER	0.1μF	1
C37	" "	"	1
C38	" "	"	1

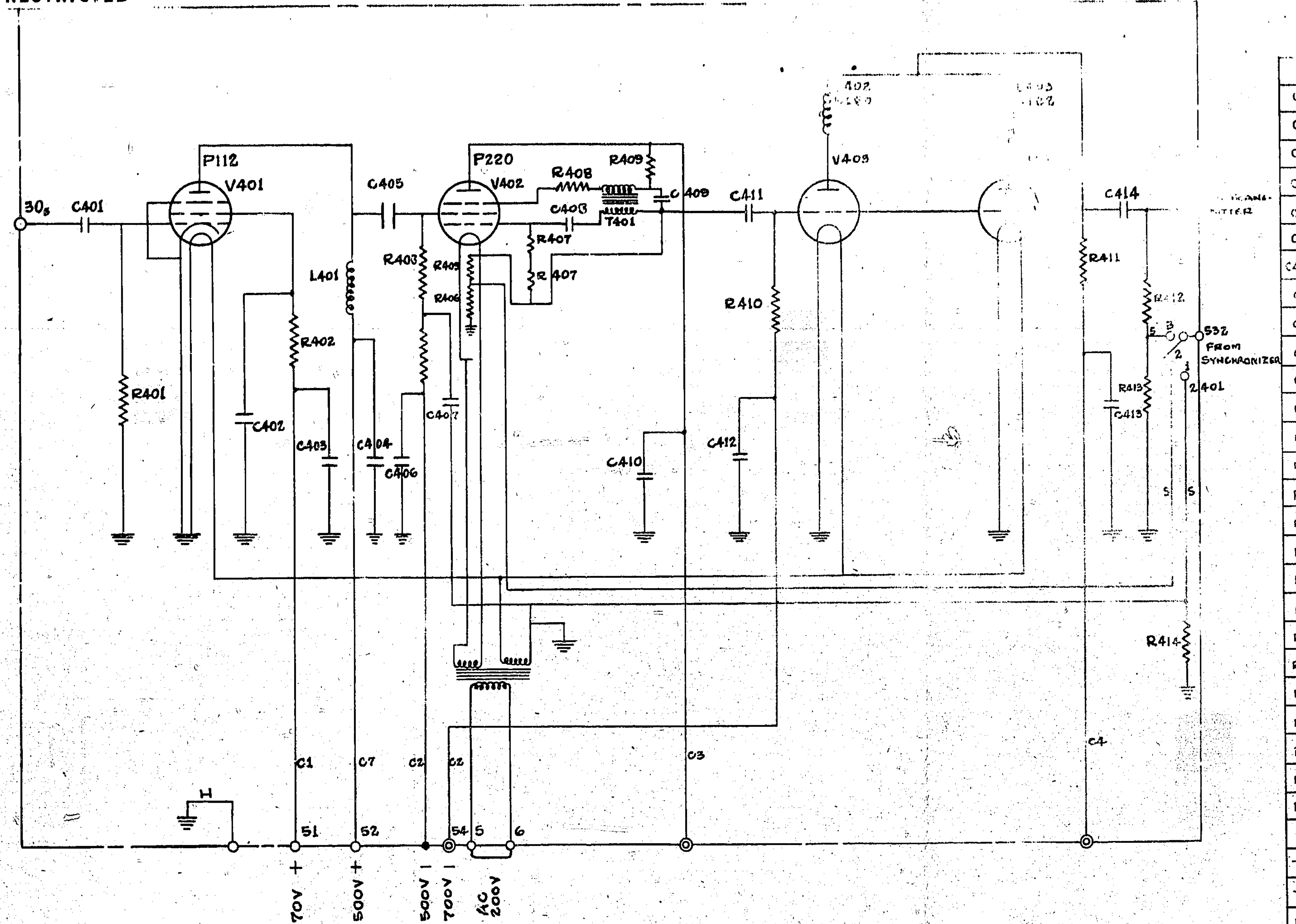
C39	I.F. TUNING CONDENSER	NBC 5P	1
C40	CHOPATH CONDENSER	0.1μF	1
C41	COUPLING CONDENSER	0.05μF×2	1
C42	CHOPATH CONDENSER	0.1μF	1
C43	COUPLING CONDENSER	0.05μF×2	1
C44	CHOPATH CONDENSER	0.1μF	1
C46	SMOOTHING CONDENSER	2μF×4	1
C47	" "	"	1
C48	BIPATH CONDENSER	100μF	1
C49	CHOPATH CONDENSER	0.1μF	1
C50	" "	"	1
C51	" "	"	1
C52	" "	"	1
C53	" "	"	1
C54	BIPATH CONDENSER	0.002μF	1
C55	CHOPATH CONDENSER	0.1μF	1
C56	" "	"	1
C57	" "	"	1
C58	BIPATH CONDENSER	0.5μF	1
C59	" "	"	1
C60	" "	"	1
C61	COUPLING CONDENSER	0.05μF×2	1

R1	DAMPING RESISTANCE	1/4L 8KΩ	1
R2	" "	"	1
R3	BIAS RESISTANCE	1/2C 140Ω	1
R4	DAMPING RESISTANCE	1/4L 8KΩ	1
R5	" "	"	1
R6	BIAS RESISTANCE	1/2C 140Ω	1
R7	DAMPING RESISTANCE	1/4L 8KΩ	1
R8	" "	"	1
R9	BIAS RESISTANCE	1/2C 140Ω	1
R10	DAMPING RESISTANCE	1/4L 8KΩ	1
R11	" "	"	1
R12	BIAS RESISTANCE	1/2C 140Ω	1
R14	VOLUME CONTROL	S-LINEAR	1
R17	DAMPING RESISTANCE	1/4L 8KΩ	1
R18	" "	"	1
R19	LOAD RESISTANCE	1/2C 10KΩ	1
R20	GRID LEAK	1/2C 100KΩ	1
R21	LOAD RESISTANCE	1/2C 140Ω	1
R22	BLEEDER RESISTANCE	1/2C 100KΩ	1
R23	" "	1/2C 70KΩ	1
R24	LOAD RESISTANCE	1/2C 4KΩ	1
R25	GRID LEAK	1/2C 100KΩ	1

R26	LOAD RESISTANCE	1/2C 1KΩ	1
R27	ANODE RESISTANCE	1/2C 4KΩ	1
R28	BIAS RESISTANCE	1/2C 140Ω	1
R30	LOAD RESISTANCE	NH10 6KΩ	1
R31	" "	"	1
R32	" "	NH10 2KΩ	1
L1	I.F. TUNING COIL		1
L2	" " "		1
L3	" " "		1
L4	" " "		1
L5	" " "		1
L6	" " "		1
L7	" " "		1
L8	" " "		1
L9	" " "		1
L10	" " "		1
L11	" " "		1
L12	" " "		1
L13	" " "		1
L14	" " "		1
L15	" " "		1

L16	I.F. TUNING COIL		1
L17	" " "		1
L18	" " "		1
L19	LOAD COIL	50MH	1
L20	I.F. TUNING COIL		1
L22	SMOOTHING CHOKE	120MA20H	1
L23	" "	"	1
T	POWER TRANSFORMER	150W	
Z2	FUSE		
Z1	ELECTROMAGNET		1
Z3	CRYSTAL DETECTOR		1
Z4	SWITCH		1
Z5	QUARZ RETARDER		
T1	TERMINAL OF ELECTROMAGNET		
T2	FILAMENT TERMINAL		
T3	ANODE TERMINAL		
T4	POWER TERMINAL		
T5	" "		

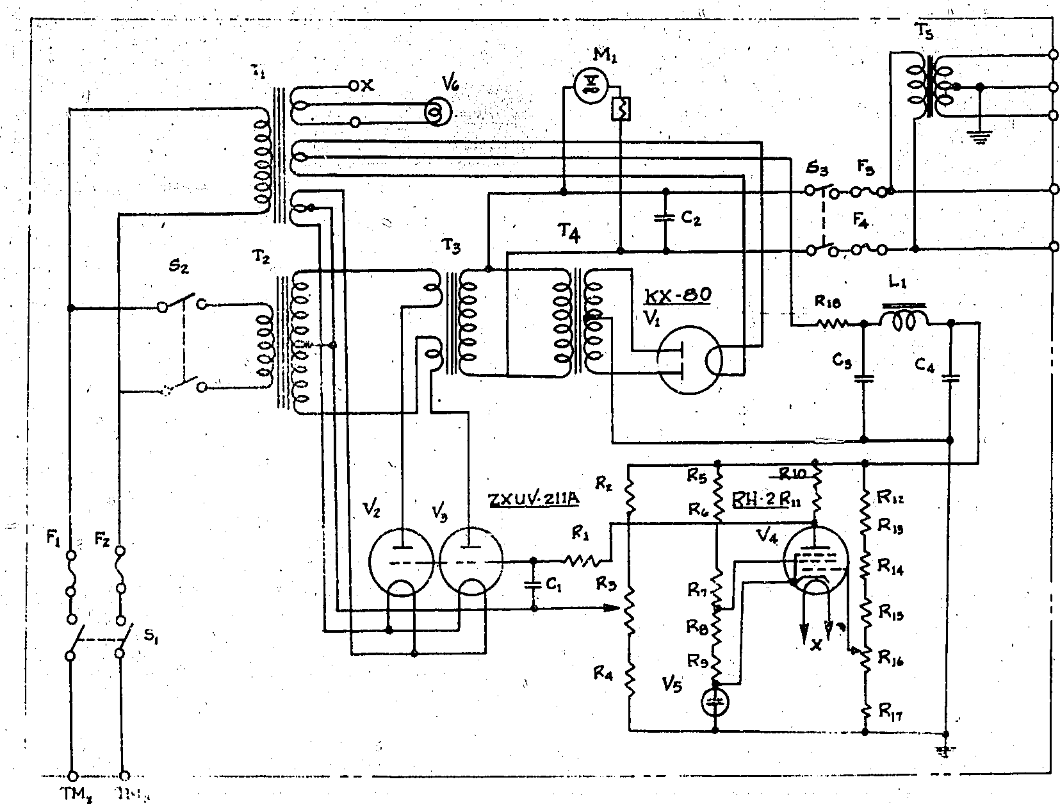
MARK 2 MODEL 2 MODIFICATION 4 RADAR
Connection Diagram of Receiver



C401	COUPLING CONDENSER	0.02 µF 1KV
C408	"	1000 pF 25 KV
C405	"	0.001 µF 5 KV
C409	BIPATH CONDENSER OF SUPPRESSOR GRID	0.05 µF 5 KV
C411	COUPLING CONDENSER	0.2 µF 5 KV
C407	"	0.05 µF 2 KV
C402, C403	BIPATH CONDENSER OF SCREEN GRID	0.05 µF 1 KV OIL FILLED
C406	BIPATH CONDENSER OF CONTROL GRID	0.05 µF 3 KV
C 412	"	0.05 µF 5 KV
C414	COUPLING CONDENSER	2 µF 20 KV
C 410	BIPATH CONDENSER OF ANODE	4 µF 10 KV
C413	"	2 µF 20 KV
R 401	GRID RESISTANCE	50 KΩ
R 402	SCEEN-GRID RESISTANCE	5 KΩ
R 404	GRID RESISTANCE	10 KΩ
R403	"	200 KΩ
R407		50 KΩ
R414	STABILIZING RESISTANCE	100 KΩ
R 405	CATHODE RESISTANCE	5 KΩ
R406	"	400 Ω
R 409	SUPPRESSOR GRID RESISTANCE	5 KΩ
R410	GRID RESISTANCE	10 KΩ
R408	SERIES RESISTANCE	2 KΩ
R411	ANODE RESISTANCE	1 KΩ x 2
R412	OUTPUT RESISTANCE	2 KΩ x 2
R413	"	100 Ω
T 401	OSCILLATION TRANSF.	
T402	FILAMENT TRANSF.	PR. 200 V. SEC. 10 V. 4A. 12V 1-4A.
L 402	CHOKE COIL IN ANODE CCT.	
L 401		1 H 60 mA 6 KV
L402 L403		
V401	AMPLIFIER TUBE	P-112
V 402	BLOCKING OSCILLATION TUBE	P-220
V 403	AMPLIFIER TUBE	S-182
V 404		

MARK 2 MODEL 2 MODIFICATION 4 RADAR
Connection Diagram of Pulse Modulator

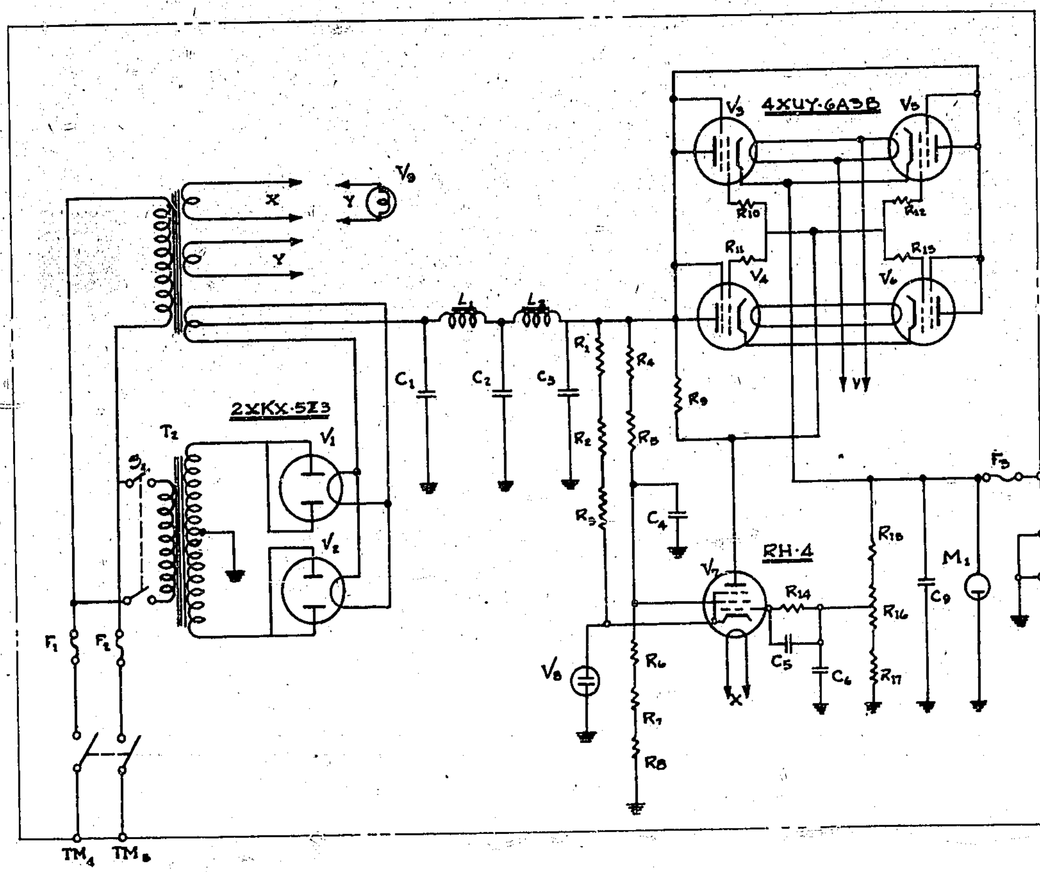
ENCLOSURE (G), continued



V1	RECTIFIER TUBE	KX-80	1	
V2	CONTROLLED VALVE	UV-211A	1	
V3	"	"	1	
V4	CONTROLLING VALVE	RH-2	1	
V5	CONSTANT VOLTAGE DISCHARGE TUBE	VRA 135/30	1	
V6	PILOT LAMP		1	10V, 0.18A
T1	FILAMENT TRANSF.		1	200V/10.5V, 10.5V, 12V.
T2	POWER TRANSF.		1	200V/2000V+2000V.
T3	COUPLING TRANF.		1	1000V×2/220V.
T4	POWER TRANSF. FOR CONTROLLING CCT.		1	220V/500V+500V.
T5	STEPDOWN TRANSF.		1	220V/12V.
L1	SMOOTHING CHOKE COIL		1	20 H 30mA
R1	GRID RESISTANCE		1	20KΩ
R2			1	10KΩ
R3	BLEEDER RESISTANCE		1	50KΩ
R4			1	30KΩ
R5			1	5KΩ
R6			1	5KΩ
R7	BLEEDER RESISTANCE		1	5KΩ
R8			1	5KΩ
R9			1	5KΩ
R10	SERIES RESISTANCE		1	20KΩ
R11	OF CONTROLLING VALVE		1	30KΩ
R12			1	5KΩ
R13			1	10KΩ
R14			1	20KΩ
R15	BLEEDER RESISTANCE		1	20KΩ
R16			1	10KΩ
R17			1	20KΩ
R18			1	500Ω×3
C1			1	1KV 2uF
C2			1	1KV 8uF
C3			1	2KV 4uF
C4			1	2KV 4uF
M1	OUTPUT VOLTMETER		1	250V AC
F1			1	3A
F2	FUSES		1	3A
F3			1	3A
F4			1	3A
TM1			1	
TM2			1	
TM3			1	
TM4			1	
TM5			1	
TM6			1	

MARK 2 MODEL 2 MODIFICATION 4 RADAR
Constant Voltage Apparatus

ENCLOSURE (G), continued



V1	RECTIFIER TUBES	KX-5Z3	1	
V2		"	1	
V3		UY-6A3B	1	
V4	CONTROLLED TUBES	"	1	
V5		"	1	
V6		"	1	
V7	CONTROLLING TUBE	RH-4	1	
V8	CONST. VOLTAGE DISCHARGE TUBE	VRA	1	
V9	PILOT LAMP		1	10V 0.18A
T1	FILAMENT TRANSF.		1	
T2	POWER TRANSF.		1	
L1	SMOOTHING CHOKE COIL		1	
L2	"		1	
R1			1	10KΩ
R2			1	20KΩ
R3			1	- KΩ
R4			1	" KΩ
R5	BLEEDER RESISTANCES		1	5KΩ
R6			1	- KΩ
R7			1	" KΩ
R8			1	15KΩ
R9	SERIES RESIST. OF CONTROLLING TUBE		1	100KΩ
R10			1	200KΩ
R11	STABILIZING RESIST.		1	- KΩ
R12			1	- KΩ
R13			1	- KΩ
R14	GRID LEAK OF CONTROLLING TUBE		1	" KΩ
R15			1	30KΩ
R16	BLEEDER RESISTANCES		1	25KΩ
R17			1	- KΩ
C1			1	2KV 8uF
C2	SMOOTHING CONDENSERS		1	" "
C3			1	" "
C4			1	1KV 0.5uF
C5	BY PASS CONDENSERS		1	" "
C6			1	" "
C7			1	- 8uF
M1	OUTPUT VOLTMETER		1	800V DC
F1				3A
F2	FUSES		1	3A
TM1				EARTH
TM2				"
TM3	TERMINALS			+DC 800V
TM4				AC 200V
TM5				AC 200V

MARK 2 MODEL 2 MODIFICATION 4 RADAR

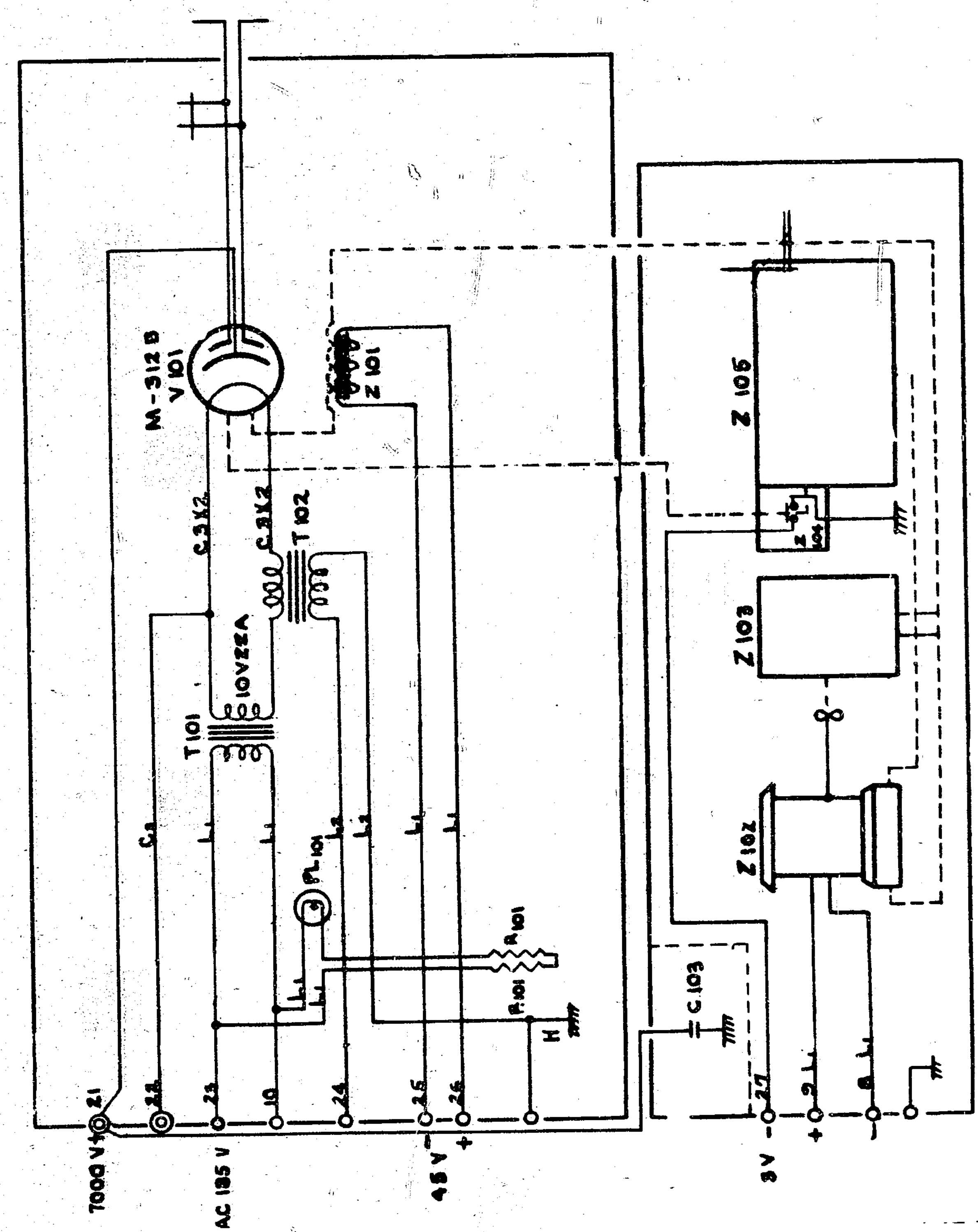
Constant Voltage Rectifier

ENCLOSURE (H)

WIRING DIAGRAMS OF MARK 2 MODEL 2 MODIFICATION 3 RADAR

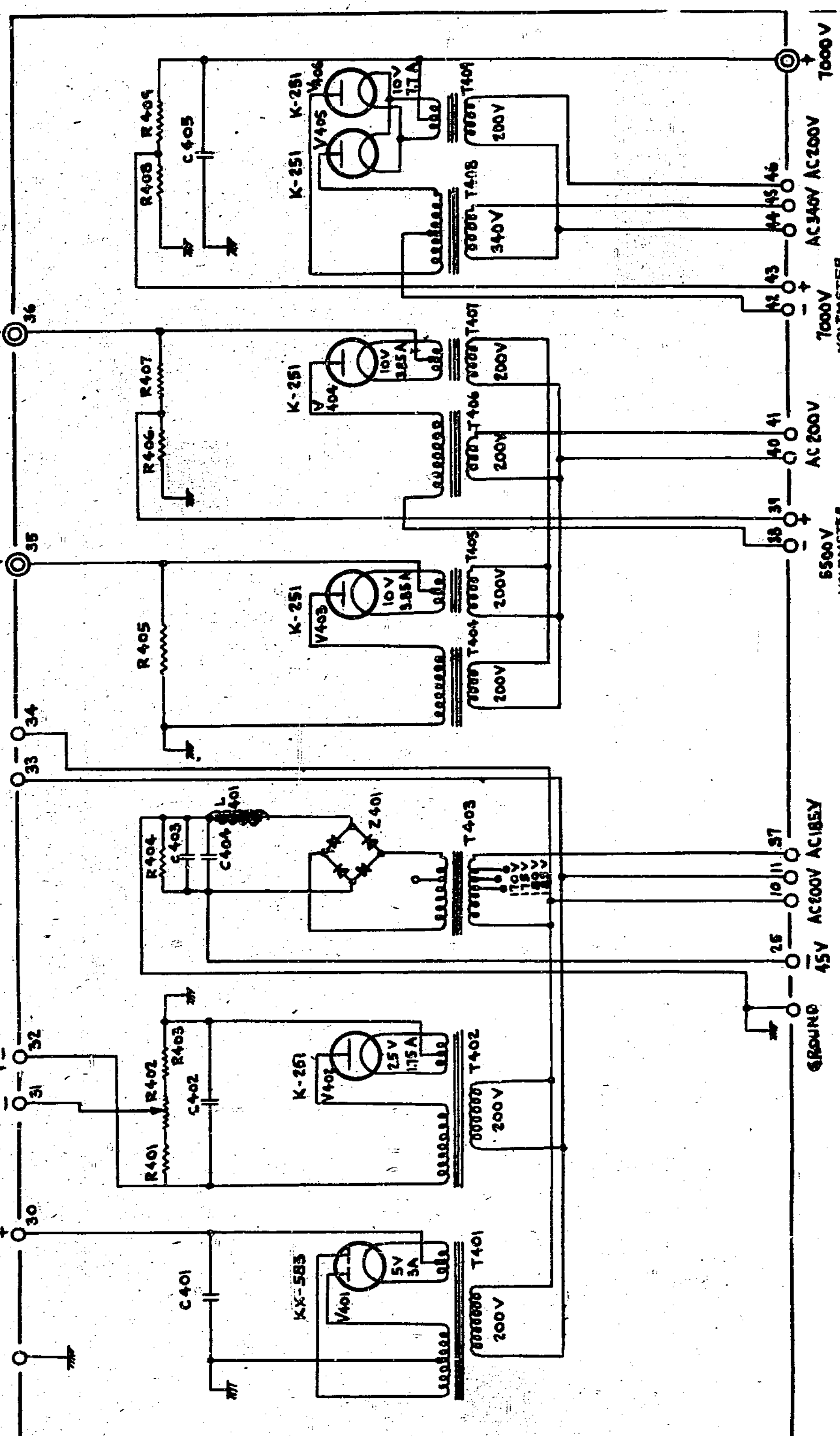
LIST OF DIAGRAMS

ENCLOSURE (H), continued



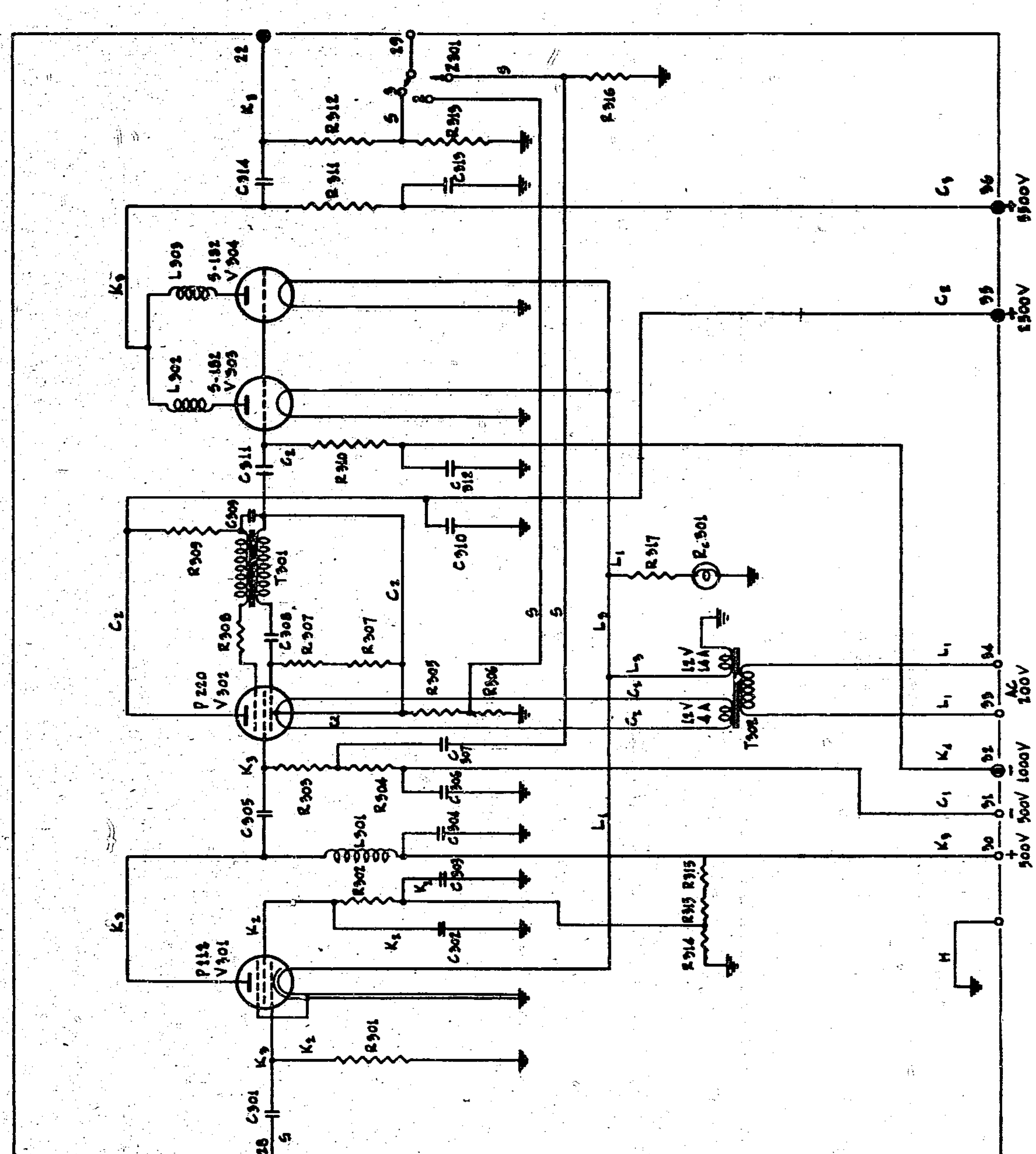
MARK 2 MODEL 2 MODIFICATION 3 RADAR Transmitter and Water-Cooling System

ENCLOSURE (H), continued



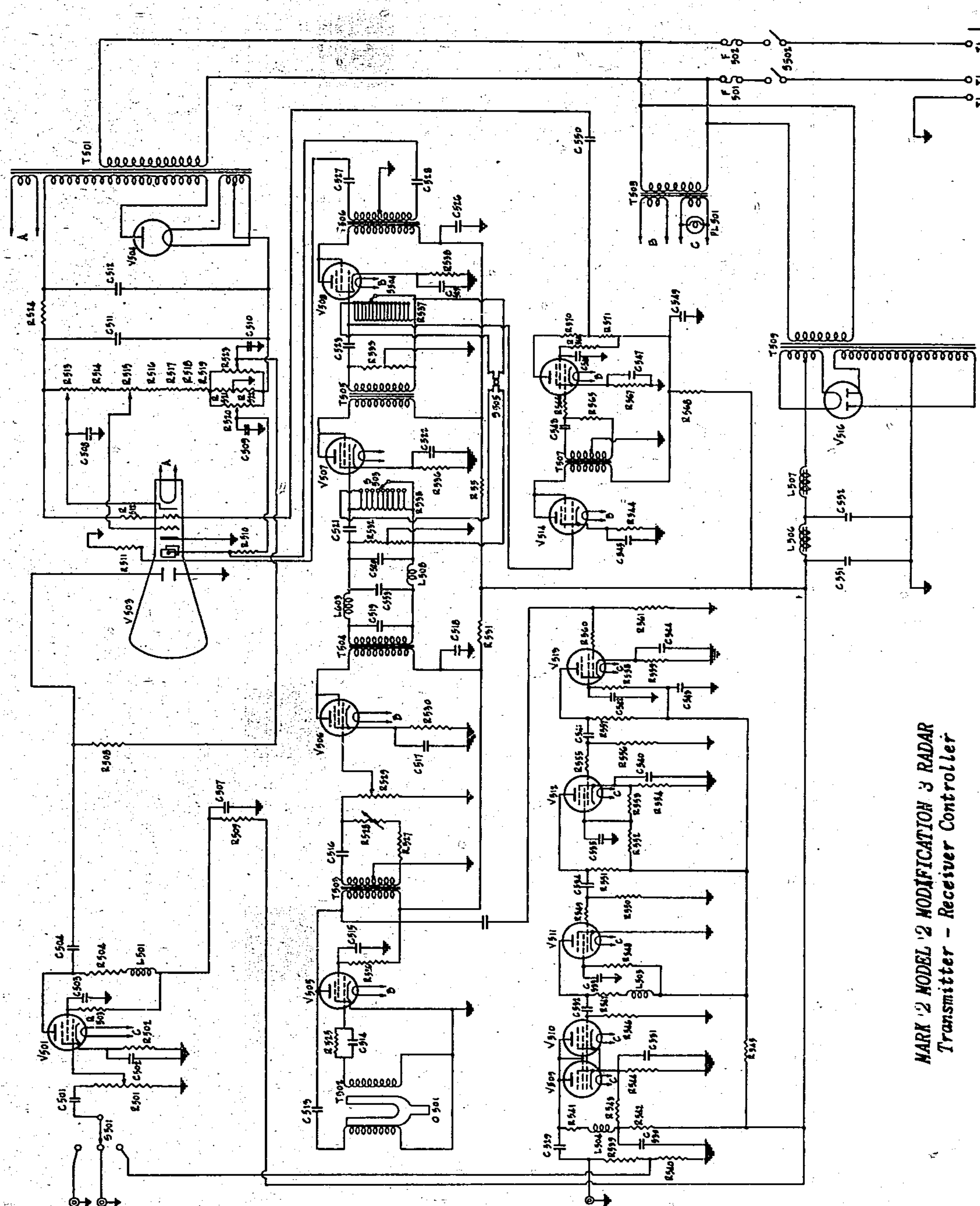
MARK 2 MODEL 2 MODIFICATION 3 RADAR
Transmitter Rectifier

ENCLOSURE (H), continued

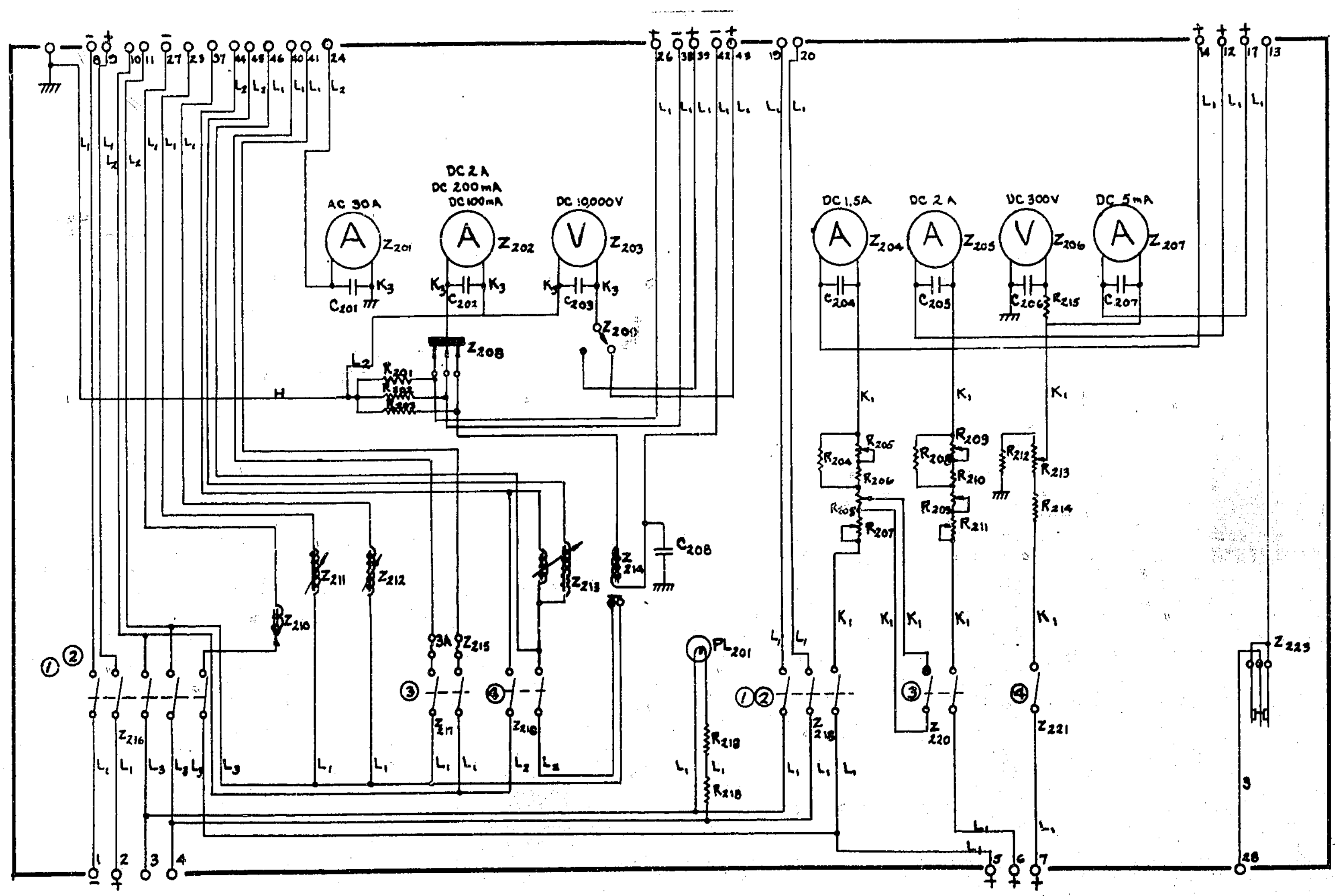


MARK 2 MODEL 2 MODIFICATION 3 RADAR
Impulse Modulator Circuit

ENCLOSURE (H), continued



MARK 2 MODEL 2 MODIFICATION 3 RADAR
Transmitter - Receiver Controller



MARK 2 MODEL 2 MODIFICATION 3 RADAR
Indicator System Circuit