The Radio Data Book

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Introduction

A wealth of radio information is packed into the pages of this RADIO DATA BOOK. And it is information that will be of value to anyone interested in radio.

There are chapters dealing with the newest information on short waves, including Distance Charts, Time Schedules and Tuning charts.

There are chapters giving details on the building of short-wave sets, adapters and converters. There is also information on building regular broadcast-band receivers and receivers for a.c. or d.c. power lines.

Complete information is also given, in another chapter, for building ultra-short-wave receivers and transmitters. Another chapter deals with antenna systems and antenna tuners for highest efficiency.

There is also a chapter giving information on making and using microphones and preamplifiers followed by a chapter on hearing aids. Another very important consideration, treated fully in the book, is the construction and use of measuring equipment for both Laboratory and Service Bench.

Another section of the book deals with World Station Lists, both for long and short waves.

Here is a book that has been carefully written and compiled by some of the best-known writers in radio. It is a small book but one that "packs a wallop" of just that information so helpful but often so hard to find.

LAURENCE M. COCKADAY

· CONTENTS ·

• CONTENTS •

[CONTINUED]

CHAPTER ONE

Short-Wave First Aids

DURING the past few years, short-wave reception has attained widespread popularity. The possibilities of world-wide broadcast reception, the novelty of hearing terse, dramatic police calls, the human interest inherent in the casual chatter of busy radio amateurs—these are but a few of the outstanding features of short-wave reception that have produced such a remarkable and spontaneous burst of enthusiasm from the many thousands who have just entered the field.

There *are* genuine thrills awaiting the short-wave listener. You can travel across the entire globe while seated in a comfortable living-room chair. You can listen for a while to a cabaret hour from England, then to folk songs from Berlin, opera from Rome, music from Morocco, news flashes from Australia and startling discoveries from Little America! This is not fantasy but an actual possibility!

And, it does *not* require an expert to get results on short waves and it is *not* a trick of magic to tune in many distant stations! All that is required is a good receiver—a number of which are described herein—some common sense, and up-to-date information on short-wave stations, schedules and wavelengths. The latter is supplied monthly in the World Short-Wave Timetable which appears in RADIO NEWS.

How To Tune For Short-Wave Programs

The following information will prove very helpful to the short-wave beginner:

Short-wave tuning is different from broadcast tuning. On the long waves we know almost when and where (on the dials) to find stations, for we grow accustomed to tuning them in day after day. But on a short-wave set we must search for the stations at first and then keep a record of the dial-reading in order to go back and get it later. It is not necessary to keep a written record always, as dial settings on a short-wave set soon get fixed in the mind just the same as on long waves. But you must search for the station at first, and to get it you must tune *when it is on the air!*

Short-wave tuning is different from broadcast tuning. On the long take up much space on the dial. In running up and down the dials you might pass over a distant station dozens of times and never know it is a station unless you happen to stop right on the exact spot where the signal is located. Therefore, you must tune slowly.

The best way for a beginner to proceed is: First spend a few days tuning in local stations, marking down the wavelengths and dial settings, and at the same time learning how to operate the dials and controls on the set. After a number of local stations have been logged, look in an up-to-date station list to learn just what stations are near the same wavelengths as the stations already logged. (Note—Short-wave stations are mostly experimental and change quite often. Be sure your station list is up to date and kept up to date or you will spend much time tuning for stations that are not on the air.) Then, paying particular attention to the time each station is on the air, tune for it near where

43	83	76	90	11	78	71	46	50	41	57	59	55	72	16	15	10	70	10	34	21	46	59	39	66	22	13	103	10	51	25	22	15	63	62	52	46	60	38	MOSCOW, U.S.S.R.
29	113	58	57	49	99	108	57	42	14	83	69	10	85	51	52	47	40	48	31	53	9	41	67	66	63	50	66	44	25	60	57	52	91	82	58	60	51	KHABAROVSK, U.S.S.R.	
23	61	93	74	62	48	63	22	11	65	35	23	56	35	55	57	58	25	62	81	63	54	89	97	16	59	56	66	54	73	56	58	59	99	36	16	25	LOS ANGELES, U.S.A.		
33	53	118	99	42	40	48	4	25	73	25	13	38	29	34	36	40	50	43	79	42	67	101	74	22	36	36	89	37	85	33	36	39	77	22	9	NEW YORK, U.S.A.			
29	55	108	90	49	41	52	7	17	72	26	13	45	28	42	44	47	41	51	82	51	63	99	83	14	45	44	80	43	82	42	44	47	86	25	ST. LOUIS, U.S.A.				
54	31	108	95	54	19	28	28	42	95	6	14	52	11	46	47	52	60	55	96	52	88	121	74	23	41	49	81	52	106	40	43	49	63	CARACAS, VENEZUELA					
104	42	54	68	56	53	38	81	101	79	65	77	61	66	59	57	59	115	56	59	52	91	59	25	85	49	60	70	65	74	53	53	51	CAPETOWN, SOUTH AFRICA						
49	68	87	105	5	63	56	39	51	57	55	50	7	60	4	3	5	77	6	47	4	61	72	38	60	11	4	118	9	66	9	6	GENEVA, SWITZERLAND							
51	62	91	110	11	57	50	37	52	62	49	46	13	54	8	6	11	78	12	53	8	67	77	39	56	5	9	124	15	73	3	MADRID, SPAIN								
51	59	94	113	14	54	47	35	51	66	46	43	15	51	9	9	14	78	15	56	12	70	81	40	54	4	12	120	17	75	LISBON, PORTUGAL									
53	110	32	39	61	117	111	81	65	12	107	94	60	107	67	67	62	53	61	22	61	18	17	58	88	76	64	52	60	MANILA, P.I.										
40	76	87	99	8	68	64	36	45	50	57	49	3	62	7	8	5	78	9	45	12	53	69	44	57	20	5	110	OSLO, NORWAY											
73	61	32	14	113	67	72	87	72	62	75	78	112	69	118	118	113	47	112	71	115	58	46	84	68	118	116	WELLINGTON, NEW ZEALAND												
44	71	88	103	5	65	59	37	48	54	55	49	3	60	3	3	4	72	7	47	8	58	72	41	58	14	HUIZEN, NETHERLANDS													
55	58	92	112	15	52	46	38	54	67	47	45	17	52	12	11	16	81	16	56	12	72	79	38	56	RABAT, MOROCCO														
38	46	100	80	63	33	58	21	25	70	20	11	59	19	56	57	61	38	64	96	62	70	103	92	MEXICO CITY															
82	64	55	75	37	71	55	75	89	58	76	81	42	79	42	40	39	50	36	38	38	70	49	NAIROBI, KENYA																
36	93	18	32	67	107	95	98	82	36	121	110	69	118	74	73	68	66	66	25	69	36	BANDOENG, JAVA																	
35	114	50	48	57	103	117	64	47	12	88	74	55	89	60	60	56	38	56	32	61	TOKIO, JAPAN																		
52	69	83	101	5	65	57	44	55	56	58	54	9	63	9	7	7	80	5	45	ROME, ITALY																			
58	102	42	57	43	108	92	77	70	20	102	92	43	106	49	49	44	70	41	CALCUTTA, INDIA																				
49	73	81	99	2	69	61	44	52	51	61	55	6	66	9	7	4	76	BUDAPEST, HUNGARY																					
28	75	68	51	76	66	82	46	27	50	57	48	71	55	72	74	72	HONOLULU, HAWAII																						
45	73	85	101	3	68	61	40	49	51	58	52	2	63	6	5	BERLIN, GERMANY																							
47	68	89	105	6	62	56	37	49	56	54	48	6	58	2	PARIS, FRANCE																								
45	69	91	106	9	61	58	35	47	55	53	46	6	57	LONDON, ENGLAND																									
56	22	99	83	63	14	29	31	43	99	5	16	63	QUITO, ECUADOR																										
43	74	85	99	5	68	62	39	47	50	58	51	COPENHAGEN, DENMARK																											
40	43	110	90	54	29	42	15	28	83	14	HAVANA, CUBA																												
55	29	98	88	59	15	28	28	42	98	BOGOTA, COLOMBIA																													
43	122	44	50	51	112	112	70	56	NANKING, CHINA																														
13	70	92	78	52	70	69	21	VANCOUVER, CANADA																															
29	56	113	96	43	52	52	TORONTO, CANADA																																
81	12	83	72	61	16	RIO DE JANEIRO, BRAZIL																																	
69	13	90	80	68	LA PAZ, BOLIVIA																																		
48	73	83	99	VIENNA, AUSTRIA																																			
73	72	20	SYDNEY, AUSTRALIA																																				
83	76	PERTH, AUSTRALIA																																					
83	BUENOS AIRES, ARGENTINA																																						
ANCHORAGE, ALASKA																																							

WINNIPEG, MAN.																													
WASHINGTON, D.C.																													126
VANCOUVER, B.C.																												238	118
TULSA, OKLA.																											165	106	96
ST. LOUIS, MO.																										36	179	174	86
SAN FRANCISCO, CAL.																									174	146	81	244	152
SALT LAKE CITY, UTAH																								60	116	92	81	185	96
RALEIGH, N.C.																							183	240	64	97	243	23	136
PORTLAND, ORE.																						239	64	54	173	154	26	236	123
PITTSBURGH, PA.																					218	33	167	227	56	92	220	19	107
PIEDRAS NEGRAS, MEX.																				144	170	138	107	142	91	59	188	154	150
PHOENIX, ARIZ.																			86	183	102	190	51	66	126	93	124	198	138
NEW YORK, N.Y.																		215	173	32	246	44	197	258	188	223	246	21	126
NEW ORLEANS, LA.																	119	132	65	93	207	77	144	193	60	55	220	98	144
MONTREAL, QUE.																141	38	220	189	48	236	73	195	255	98	134	232	39	115
MINNEAPOLIS, MINN.															96	106	102	130	121	74	144	100	99	159	46	63	145	93	39
MIAMI, FLA.														152	143	68	112	200	128	103	272	70	210	261	108	119	283	94	192
MEMPHIS, TENN.													88	70	113	36	197	126	76	67	186	64	125	180	25	34	195	77	110
LOS ANGELES, CAL.												161	237	153	247	169	247	37	113	214	83	224	57	34	159	127	108	230	154
HELENA, MONT.											93	140	227	91	184	166	194	92	140	166	52	188	41	81	124	110	55	185	73
FORT WORTH, TEX.										124	122	45	115	88	155	47	141	86	35	111	162	109	99	146	57	26	177	122	121
DETROIT, MICH.									103	145	198	46	118	54	53	96	49	169	137	21	197	52	149	209	46	81	198	40	86
DES MOINES, IA.								54	66	98	144	49	135	24	104	84	103	115	99	72	148	91	95	155	79	48	153	90	61
DENVER, COL.							61	116	66	124	83	88	174	70	163	109	163	59	82	132	99	147	37	95	79	55	112	149	81
CLEVELAND, O.						123	51	54	106	159	206	64	111	64	49	94	40	176	140	11	208	43	157	218	50	86	208	30	86
CINCINNATI, O.					23	109	51	24	84	151	190	42	87	60	71	72	58	158	118	26	199	40	145	204	32	66	203	40	98
CHICAGO, ILL.				25	32	92	31	24	83	128	175	49	120	35	75	184	72	140	117	41	177	64	126	185	21	60	179	60	73
BOSTON, MASS.			84	74	54	177	115	61	158	205	260	164	128	153	144	137	18	229	191	49	255	61	210	270	104	140	226	55	130
ATLANTA, GA.		94	59	38	56	121	75	60	75	173	195	33	61	92	100	43	76	160	103	53	218	35	159	214	47	67	226	55	131
ALBUQUERQUE, N.M.	127	196	112	124	142	33	83	136	56	86	67	161	170	98	187	103	181	33	57	149	112	157	50	90	93	59	130	165	114

UNITED STATES AND WORLD-WIDE MILEAGE CHART
(See Page 94 For Complete Details)

the local station was heard on the dial. For example, you can easily tune in W2XAF, New York, on 31.48 meters and station VK3ME is just a shade on the dials above it.

Most short-wave stations broadcast in the evening of their own local time. That is why you hear Australia in the morning in New York. Melbourne is fifteen hours ahead of New York time, Berlin is six hours ahead and Honolulu, Hawaii, is 5½ hours later than New York time.

Most short-wave stations are experimental and change wavelengths or schedules often in order to reach certain places they wish to be heard. To wait till you happen to run into them, telling about the changes, would be wasting time. A powerful station may be heard one month and then the next month not be heard at all, simply because they have started operating on a new schedule. The only way in which such information can be gathered in time to be of any help is from a group of listeners, for where one may hear an announcement, hundreds of others may miss it because they are not tuned in at the same time. For this purpose, RADIO NEWS has Official Listening Posts located thruout the world. These posts send monthly reports and from these reports the World Short-Wave Timetables are produced.

Fishing for stations transmitting on the lower wavelengths is made much more productive and is considerably simplified if the listeners know where the various types of stations are to be found. Detailed information concerning the location of regular short-wave broadcast stations will be found in the "World Short-Wave Timetable" which appears monthly in RADIO NEWS. But when the urge comes to wander afield to see what other types of transmissions have to offer, the following list will be of interest. The frequency bands indicated here contain just about everything of any conceivable interest to the short-wave fan. The police, aviation, amateur, experimental and ship telephone bands are all included —certainly a wide enough variety to provide spice for short-wave tuning.

Types of Stations By Frequencies

Frequency in kc.	*Type of Service*
550-1500	Broadcast
1500-1600	Experimental Broadcast Aviation-Police
1600-1700	Television
1704-1708	Aviation
1712	Police
1715-1875	Amateurs, c.w. (code)
1875-2000	Amateurs, 'phone
2000-2300	Television
2316	Aviation
2340-2410	Aviation, ship service, etc.
2410-2430	Police
2440-2470	Police
2470-2490	Aviation
2504-2508	State Police
2610-2650	Aviation
2750-2850	Television
2850-3100	Aviation and Government
3125-3150	Ship 'phone
3155-3265	Government and Aviation
3420-3440	Coast 'phone
3445-3490	Government and Aviation
3490-3495	Experimental
3500-3900	Amateurs, c.w. (code)
3900-4000	Amateurs, 'phone
4110-4130	Aviation
4175-4200	Ship 'phone
4750-4775	Coast 'phone
4795-4800	Experimental
4915-4920	Aviation
5375-5380	Aviation
5565-5695	Aviation and Government
6010-6150	Shortwave Broadcast
6420-6430	Experimental
6400-6480	Coast 'phone
6490-6640	Aviation
6650-6670	Ship 'phone
7000-7300	Amateurs, c.w. (code)
8220	Aviation
8540-8560	Coast 'phone
8650-8660	Experimental
9500-9600	Broadcast
11370-11400	Coast 'phone
11700-11900	Shortwave Broadcast
12330	Aviation
12855-12870	Experimental
13185-13260	Ship 'phone
14000-14150	Amateurs, c.w. (code)

INTERNATIONAL MORSE CODE

1. A dash is equal to three dots.
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to five dots.

A	.—
B	—....
C	—.—.
D	—..
E	.
F	..—.
G	——.
H	....
I	..
J	.———
K	—.—
L	.—..
M	——
N	—.
O	———
P	.——.
Q	——.—
R	.—.
S	...
T	—
U	..—
V	...—
W	.——
X	—.—
Y	—.——
Z	——..
1	.————
2	..———
3	...——
4	....—
5	.....
6	—....
7	——...
8	———..
9	————.
0	—————

Period	.. .. ..
Semicolon	—.—.—.
Comma	.—.—.—
Colon	———...
Interrogation	..——..
Exclamation point	——..——
Apostrophe	.————.
Hyphen	—....—
Bar indicating fraction	—..—.
Parenthesis	—.——.—
Inverted commas	.—..—.
Underline	..——.—
Double dash	—...—
Distress Call	...———...
Attention call	—.—.—
General inquiry call	—.—. ——.—
From (de)	—.. .
Invitation to transmit (go ahead)	—.—
Warning—high power	——..——
Question (please repeat after ....)—interrupting long messages	..——..
Wait	.—...
Break (Bk.) (double dash)	—...—
Understand	...—.
Error	....
Received (O. K.)	.—.
Position report (to precede position messages)	— .—.
End of each message (cross)	.—.—.
Transmission finished (end of work) (conclusion of correspondence)	...—.—

FIGURE 3

Frequency in kc.	Type of Service
14150-14250	Amateurs, 'phone
14250-14400	Amateurs, c.w. (code)
15100-15340	Shortwave Broadcast
16440	Aviation
17080-17120	Coast 'phone
17300-17320	Experimental
17600-17640	Ship 'phone
17750-17810	Shortwave Broadcast
21460-21540	Shortwave Broadcast
22675-22725	Coast 'phone
23100	Experimental
25700	Experimental
26000	Experimental
27100	Experimental
28000-30000	Amateurs, c.w. (code)
34600	Experimental
41000	Experimental
43000-46000	Television
48500-50300	Television
51000-53000	Experimental, Government
51400	Experimental
56000-60000	Amateurs, 'phone
60000-80000	Television
80000-400000	Experimental
400000-401000	Amateurs, c.w. (code)
401000-above	Experimental

Wavelength-Frequency Conversion

Formerly all short-wave enthusiasts thought in terms of wavelengths and receivers, if calibrated at all, were calibrated in wavelengths. Now, however, the trend is definitely toward the use of frequencies rather than wavelengths.

Because of this changing situation it is often found necessary to convert frequency listings to terms of wavelengths and vice versa. A common practice is to divide the known unit into 300,000 to determine the unknown unit. Thus if one knows that a certain broadcast station transmits on 25 meters, and wants to find the frequency, he divides 25 into 300,000 and the answer—12,000—is correct to an accuracy of a fraction of 1 percent. Or if he knows the frequency of this station and wants to find the wavelength, he simply reverses the process, dividing 12,000 into 300,000.

International Call Letters

Call letters of code stations as well as broadcasters heard are of special interest to the short-wave fan because from these it is possible to tell the nationality of the transmitter. Thus any call beginning with K, N or W indicates a station in the United States, its territories or its ships. The larger countries of the world have similar assignments: G for Great Britain, F for France, D for Germany, etc. Smaller countries with fewer transmitters have more limited assignments. Morocco, for instance, is assigned all calls which employ CN as the first two letters. The list of these "International Call Letter Assignments" is given below.

In code transmission the call letters are always preceded by — . . . (de). The letters of the station called are usually repeated 3 times, followed by the letters of the caller, also repeated 3 times, thus: XAB, XAB, XAB de KNL, KNL, KNL, would indicate a U. S. Station calling a Mexican station.

Inasmuch as c.w. (code) transmissions carry further than 'phone or broadcast signals, and as many c.w. stations employ high power, it is possible to log many countries in this way. who either do not have broadcast transmitters or whose broadcast transmitters do not reach out.

Call Signal	Country
CAA-CEZ	Chile
CFA-CKZ	Canada
CLA-CMZ	Cuba
CNA-CNZ	Morocco
COA-COZ	Cuba
CPA-CPZ	Bolivia
CQA-CRZ	Portuguese Colonies
CSA-CUZ	Portugal
CVA-CXZ	Uruguay
CYA-CZZ	Canada
D	Germany

EAA-EHZ	Spain	Q	(abbreviations)
EIA-EIZ	Irish Free State	R	U. S. S. R.
ELA-ELZ	Liberia	SAA-SMZ	Sweden
EPA-EQZ	Persia	SOA-SRZ	Poland
ESA-ESZ	Estonia	SSA-SSZ	Egypt
ETA-ETZ	Ethiopia	STA-SUZ, SVA-SZZ	Greece
EZA-EZZ	Territory of the Saar	TAA-TCZ	Turkey
F	France and colonies and protectorates	TFA-TFZ	Iceland
G	Great Britain	TGA-TGZ	Guatemala
HAA-HAZ	Hungary	TIA-TIZ	Costa Rica
HBA-HBZ	Switzerland	TKA-TZZ	France and Colonies and Protectorates
HCA-HCZ	Ecuador	U	U. S. S. R.
HHA-HHZ	Haiti	VAA-VGZ	Canada
HIA-HIZ	Dominican Republic	VHA-VMZ	Australia
HJA-HKZ	Colombia	VOA-VOZ	Newfoundand
HPA-HPZ	Republic of Panama	VPA-VSZ	British colonies and protectorates
HRA-HRZ	Honduras	VTA-VWZ	British India
HSA-HSZ	Siam	VXA-VYZ	Canada
HVA-HVZ	Vatican City	W	United States of America
HZA-HZZ	Saudi Arabia	XAA-XFZ	Mexico
I	Italy and colonies	XGA-XUZ	China
J	Japan	XYA-XZZ	British India
K	United States of America	YAA-YAZ	Afghanistan
LAA-LNZ	Norway	YBA-YHZ	Dutch East Indies
LOA-LWZ	Argentina	YIA-YIZ	Iraq
LXA-LXZ	Luxemburg	YJA-YJZ	New Hebrides
LYA-LYZ	Lithuania	YLA-YLZ	Latvia
LZA-LZZ	Bulgaria	YMA-YMZ	Free City of Danzig
M	Great Britain	YNA-YNZ	Nicaragua
N	United States of America.	YOA-YRZ	Roumania
OAA-OCZ	Peru	YSA-YSZ	Republic of El Salvador
OEA-OEZ	Austria	YTA-YUZ	Yugoslavia
OFA-OHZ	Finland	YVA-YWZ	Venezuela
OIA-OJZ, OKA-OKZ	Czechoslovakia	ZAA-ZAZ	Albania
ONA-OTZ	Belgium and colonies	ZBA-ZJZ	British colonies and protectorates
OUA-OZZ	Denmark	ZKA-ZMZ	New Zealand
PAA-PIZ	Netherlands	ZPA-ZPZ	Paraguay
PJA-PJZ	Curacao	ZSA-ZUZ	Union of South Africa
PKA-POZ	Dutch East Indies	ZVA-ZZZ	Brazil
PPA-PYZ	Brazil		
PZA-PZZ	Surinam		

Morse Code And The S.W. Listener

Many short-wave broadcast listeners are intrigued by the code transmissions of commercial stations and amateur stations encountered in tuning the short waves. To read code at the speeds normally transmitted is, of course, out of the question unless one has had long practice at it. However, slow-speed sending is often heard when stations are testing or when one is calling another. In either case, the test signal or the call letters of the station called, together with the call letters of the transmitting station, are repeated over and over again, in many cases so slowly that the rankest novice can catch these calls and interpret them with the aid of the code printed herewith. (Figure 3).

How To Convert Foreign Time To Your Local Time

First locate your country, or your section of your country, in the alphabetical list in Figure 4, to find its longitude. Then locate this longitude on line A. Next consult the alphabetical list to determine the longitude of the country whose time you want to find, and locate this longitude on line C. Now lay a ruler or other straight-edge across the chart so that it connects these two points on lines A and C. The point at which it crosses line B shows the time difference between these points. If the hour is preceded by a plus sign, add this figure to the time in your locality. If a minus sign is shown, deduct the hours.

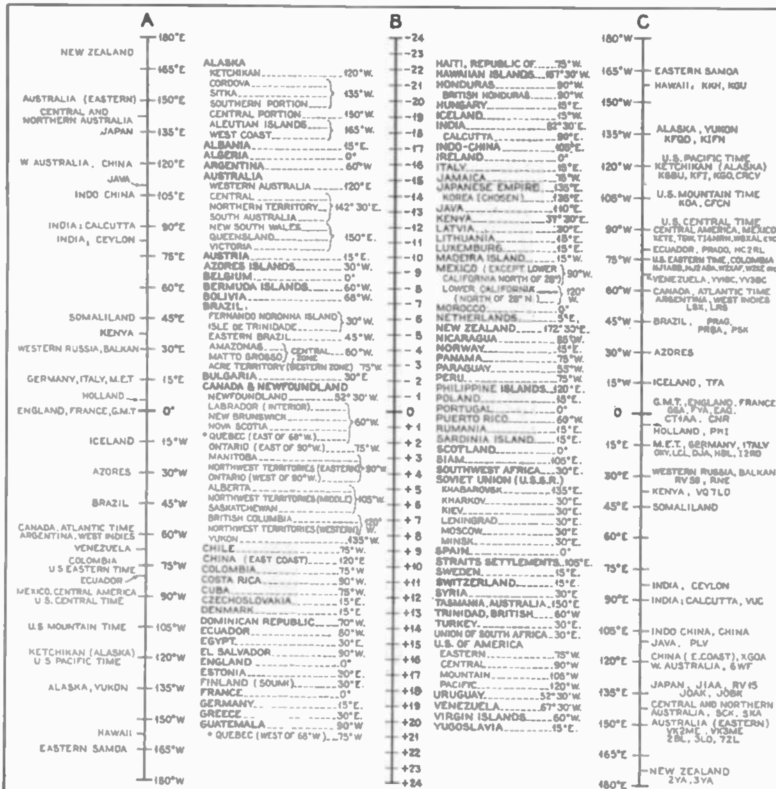


FIGURE 4

From the foregoing it is evident that the use of this chart represents an utterly simple method of accurately determining the time in any part of the world, corresponding with that in any other part. If desired, a strip of cardboard may be employed in place of a ruler, pivoting one end on line A in a position corresponding to one's own location so that the straight-edge may be swung through an arc sufficiently long to reach all points on line C. This will still further simplify the use of the chart.

CHAPTER TWO

Short-Wave Adapters and Converters

THE short-wave receiver, in its highest development, is the most efficient method of receiving short waves. This is because every component can be especially designed for its particular short-wave purpose, rather than depending on parts and circuits, the short-wave efficiency of which may be impaired by the fact that they are not intended for this use. It does not follow, however, that a good converter or adapter such as described here will not give better short-wave results than only a fairly good short-wave receiver.

A short-wave adapter obtains its power from the broadcast receiver and utilizes part of the broadcast receiver circuit. It is usually connected to the broadcast receiver by removing the detector tube and insert-

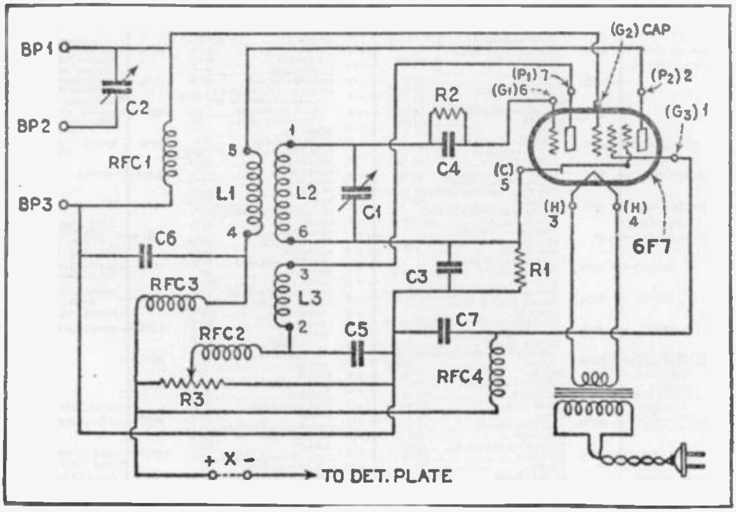


FIGURE 5

Above is the circuit for a single-tube short-wave adapter.

ing a plug in its place. The tubes ahead of the detector, generally known as the radio-frequency tubes, are not utilized, although they are lighted when the short-wave adapter is in operation. This is the simplest means for the radio fan to get into the short-wave field.

Next in simplicity is a short-wave converter which, like the adapter, is used in connection with the broadcast-band receiver. However, unlike the adapter, it utilizes all tubes and circuits of the set. What the converter actually does is to change the short wave into a long wave, within the tuning range of the receiver, which then amplifies it throughout the various circuits just as if it were a broadcast-band signal.

How To Build A S.W. Adapter

The single-tube short-wave adapter provides a very simple method of short-wave reception. Such an adapter can be made by almost any fan—and those who are not mechanically inclined have recourse to the local radio serviceman, who will build it for a very small cost.

The circuit of such an adapter is shown in Figures 5 and 6. Figure 5 is the schematic diagram, as preferred by those having some experience in radio construction. Figure 6 is a picture diagram in which the

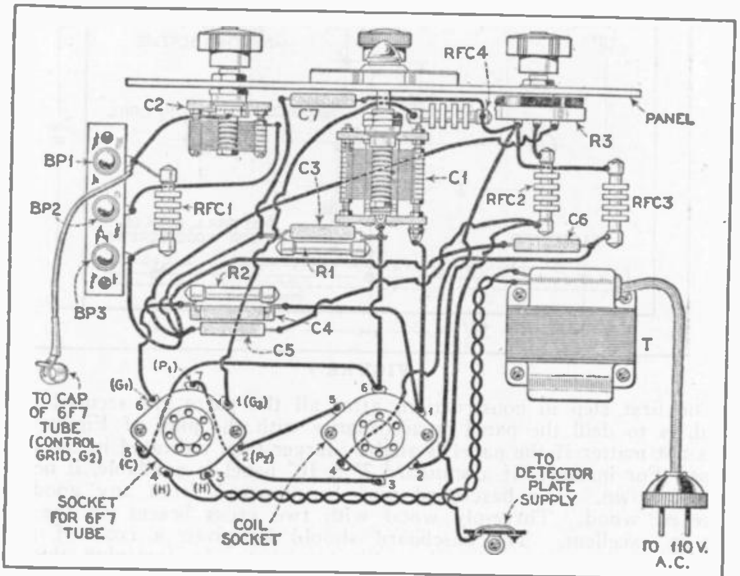


FIGURE 6

parts and the manner of their interconnection will be more apparent to the beginner. In both diagrams, the labels and letters refer to the same parts, which can be identified on the following parts list.

List of Parts

2 National 6-prong sockets
4 National radio-frequency choke coils (RFC1, RFC2, RFC3, and RFC4), type 100
1 Lynch 1-watt resistor, 350 ohms (R1)
1 Lynch 5-megohm grid leak (R2)
1 variable potentiometer, 0 to 50,000 ohms (R3)
1 National 100 mmfd. variable condenser (C1), type SE100
1 National dial, type BM-C
1 National 50 mmfd. variable condenser (C2), type ST50
4 by-pass condensers, .1 mfd. (C3, C5, C6 and C7)
1 grid condenser, .0001 mfd. (C4)

1 5- to 6-volt filament-lighting transformer (T)
1 National grid-grip, type 24
4 binding posts
15 feet hook-up wire
Busbar wire, 20 feet
Miscellaneous hardware, screws, washers, etc.
1 aluminum panel, 6½" by 10" (or 7" by 10")
1 baseboard, 6" by 9"
1 tube base
Small piece of bakelite strip for binding posts
National plug-in coils for bands desired, type R-39, series 10 (L1, L2 and L3)

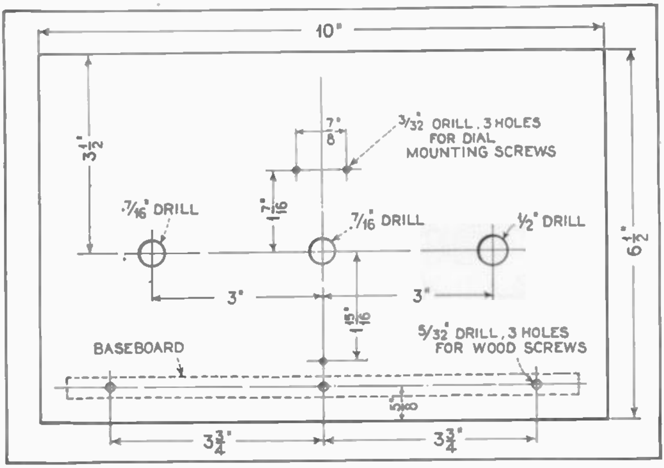


FIGURE 7

The first step in construction, after all the parts are secured and at hand, is to drill the panel in accordance with the plan of Figure 7. It does not matter if the panel is slightly larger than indicated in the dimensions. For instance, if a standard 7" x 10" panel is available, it need not be cut down. The baseboard may be prepared from any good solid piece of wood. Three-ply wood with two cross braces on the under side is excellent. The baseboard should be given a coat of shellac (orange looks better than the white variety). In fastening the baseboard to the panel, be careful to use small screws so as not to split the wood—particularly when ply-wood is used. These screws are not subjected to much strain, the main panel support being supplied by the condenser C1 mounting. This condenser should be the first instrument mounted, in accordance with the detailed drawing of Figure 8.

Next, study the general layout as shown in the picture wiring diagram, Figure 6, the layout, Figure 9, and the top view photograph, Figure 10.

It is important that all parts be laid out exactly as shown. After the main tuning condenser, C1, the parts are best mounted in the following order: binding-post strip; sockets; filament transformer, T, condenser, C2, and the volume control, R3.

Start with the wiring before mounting additional parts, and connect condenser C2 across binding-posts BP1 and BP2. Now mount and connect condenser C3 and C4. Use bus-bar wire here in order to make these parts self-supporting. (The top view photo, Figure 10, will show where

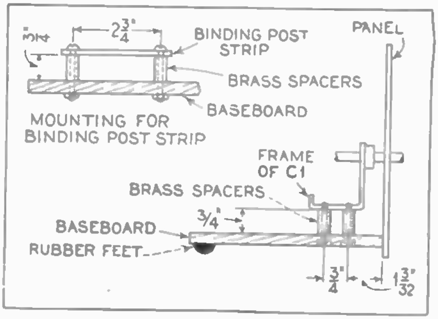


FIGURE 8

it is desirable to use the bus-bar rather than the flexible hook-up wire). Solder a 7-inch lead to BP1 for the grid cap. Resisters R1 and R2 are next connected by means of their semi-flexible pigtails which also hold them rigidly in place. The socket connections should now be completed, and chokes RFC1 and RFC2 mounted and connected by means of their pigtails. Mount and wire the remaining connections.

For the sake of habit, it will be desirable to connect the volume control, R3, so that volume increases as it is turned to the right—or clockwise. With the volume control in place, and looking at it from the back of the panel, the wire from the right-hand lug should lead to BP3. The center lug is connected to RFC2, and the remaining lug as shown on the diagrams.

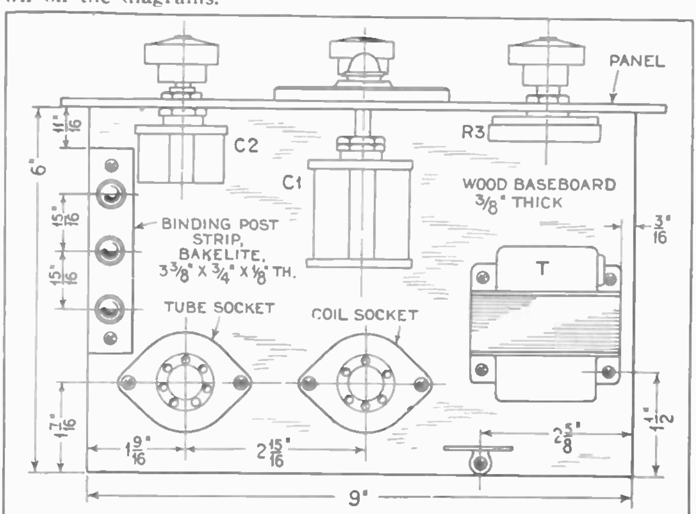


FIGURE 9

All joints must be soldered—and soldered cleanly. If possible, use rosincore solder—and nothing else. This will not be difficult if the joints are good and clean. If you must use a paste, clean the joints, after soldering, with denatured alcohol, being sure to wipe off all surplus paste. Have your iron clean, well tinned and sufficiently hot.

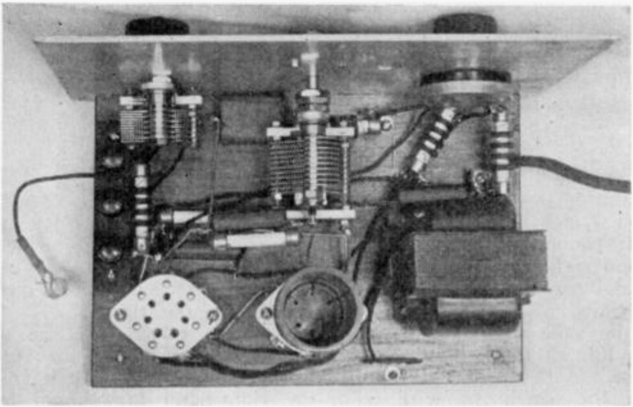


FIGURE 10

The wiring should be checked and double-checked against Figures 5 and 6.

To mount the dial, pry off the hub cap with a small screw-driver. Loosen the screw in the hub so that the dial will slip over the condenser shaft. Secure dial to the panel by means of the three small screws *from the back of the panel.* Turn the condenser plates on C1 all the way *out*, and adjust the dial to zero. Now tighten the set-screw against the shaft and replace the hub cap. While the dial has 200 divisions, only 150 divisions will be used over a 270-degree rotation.

It will be necessary to provide some means of connecting the adapter to the receiver. The most convenient way of doing this is by a plug which can be substituted for the detector tube. Secure a base from a burned-out detector tube or any other tube having the same kind of base. Break the bulb, and clean out the base. Locate the plate prong by reference to the drawing, Figure 11—looking at the bottom of the base (prongs toward you). Hold a hot soldering iron against this prong until the solder melts, remove the old lead, and force through, from the top, a short length of bare wire. Clip off the portion that sticks through the bottom of the prong and cover with a drop of solder. Clean the prong with a nail file, being careful to remove any trace of solder that might prevent insertion into the socket. Now solder a flexible lead to the bare wire—as far down in the base as you can get. This lead should be long enough to reach from the adapter to the radio broadcast receiver. Fill the tube base with sealing wax.

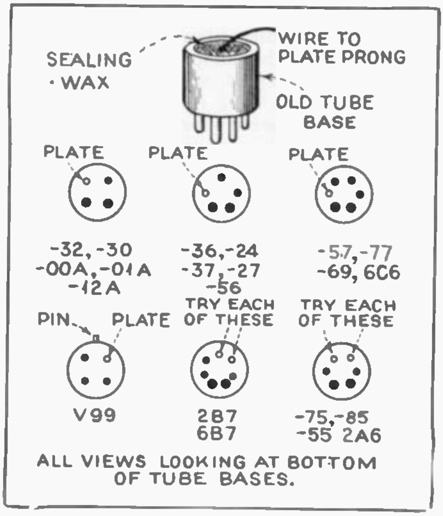


FIGURE 11

The free end of this lead is connected to the post on the adapter marked "to detector plate."

The adapter is now ready for operation. Place a type 6F7 tube in the corner socket of the adapter. In the remaining socket, plug in a coil covering the wave range desired. This can be determined by referring to the tuning curves in Figure 12. For instance, if you want to receive a station transmitting on say 39 meters—10 megacycles—you will receive this on the coil having the red identification line on the upper rim—with the condenser tuned close to 95.

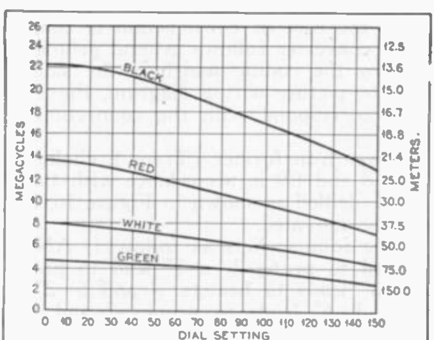


FIGURE 12

Remove the detector tube from the broadcast receiver and substitute the adapter plug. Disconnect the antenna from the receiver and connect it to either BP1 or BP2 on the adapter. If you have a long aerial—over seventy-five feet—the adapter will probably work best when the lead-in is connected to BP2. If it is connected to BP1, condenser C2 will not be used. Now run a wire from the ground post on the receiver to BP3. *Be sure and leave the ground connected to the receiver also.* Turn on the receiver and plug in the power line on the adapter (or switch on the battery if this source is employed for lighting the 6F7 tube).

Turn the volume control, R3, slowly to the right. At a point fairly close to full "on," a click should be heard, and a hiss will be audible in the loudspeaker from then on. The adapter is now oscillating. Radio telephone stations will always be received loudest just *before* (to the left of) the "click." When the adapter is oscillating, reception will be accompanied by a whistle, which will change in pitch as the adapter is tuned. Satisfactory reception cannot be had in this condition, but it is often very helpful in locating weak stations. As the volume control is backed down from the point of oscillation, it will be necessary to retune slightly. When using a long antenna, reception can occasionally be improved by discovering an optimum adjustment on the antenna condenser, C2. Aside from these points, tuning is effected exactly as it is on the broadcast receiver.

If the adapter will not oscillate, and you are satisfied that it is correctly constructed and wired, it is probably because insufficient voltage is being supplied through the detector plug. This will usually happen when the detector tube in the broadcast receiver is coupled to the audio amplifier through a resistance, or a diode is used as a detector. In such instances, a 45- to 90-volt B battery should be inserted in the adapter plug lead at X in Figure 5. Be sure the plus and minus terminals (positive and negative, respectively) are connected as shown.

How To Build A 2-Tube S.W. Converter

If you possess a high-grade broadcast receiver, a converter of this type represents an economical method of obtaining excellent short-wave reception—even when the cost of construction is considered.

Construction of the converter follows general principles. The parts will be readily identified by the coding which is the same in the parts list, in Figure 13 and in the picture wiring diagram, Figure 14. The numbers on the sockets, etc., correspond with the connections shown in Figure 14.

First mount the power transformer (Trans.), choke (X), binding posts and condensers C4, C8 and C9 in accordance with the layout of Figures 14 and 15. The panel, drilled as shown in Figure 16, is next in line. The switch, S, may now be mounted.

Connect leads to the four sockets as follows: ANTENNA SOCKET—an 8″ and a 3″ lead to prong 3—a 3″ lead to prong 4. 2A7 TUBE SOCKET—twisted 12″ leads to heaters, 4 and 5—2″ lead to prong 6—an 8″ lead to prong 3—6″ leads to prongs 2 and 8 and a 4″ lead to prong 7. TYPE-80 SOCKET—10″ twisted leads to filaments, prongs 1 and 2—10″ leads to plates, 3 and 4. OSCILLATOR SOCKET—4″ leads to prongs 1, 2 and 4 and a 6″ lead to prong 3.

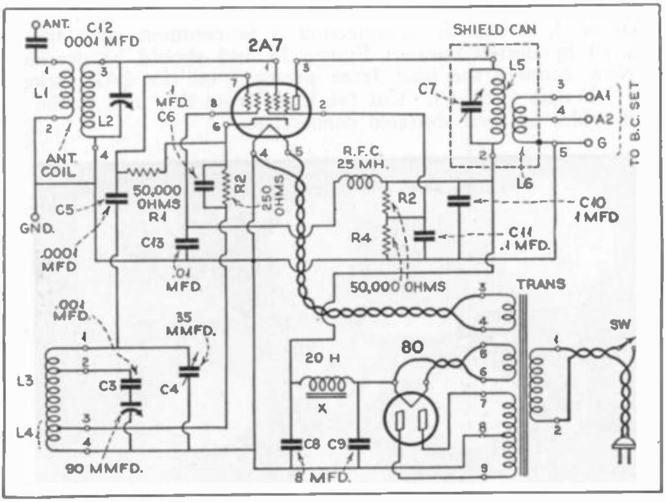
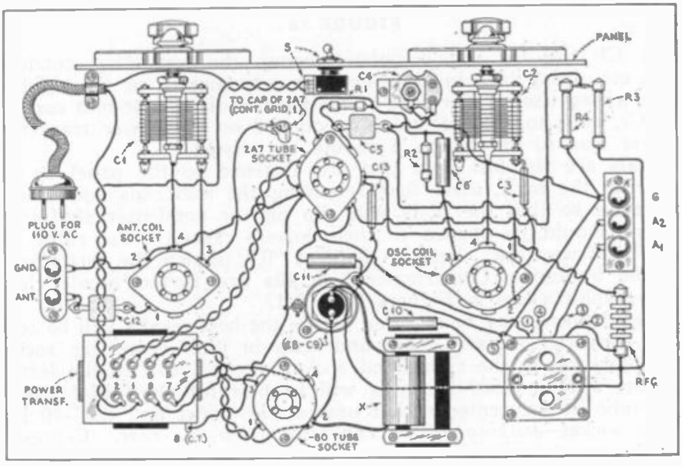


FIGURE 13

Connecting these leads before the sockets are mounted will facilitate making the connections. Mount the sockets. The connections to L5 and L6, the output unit, are now in order and should also be made before

FIGURE 14

Pictorial Wiring Diagram



mounting. An 8" lead should be soldered to connection 2, and 4" leads to connections 3, 4 and 5. Connection 5 is common with the shield can, indicated by dotted lines in Figure 13 and should be grounded as shown. Now connect the lead from prong 3 on the 2A7 socket, and mount the I-F unit (L5-L6). Cut the leads from this unit to the proper length and solder to their destined connections.

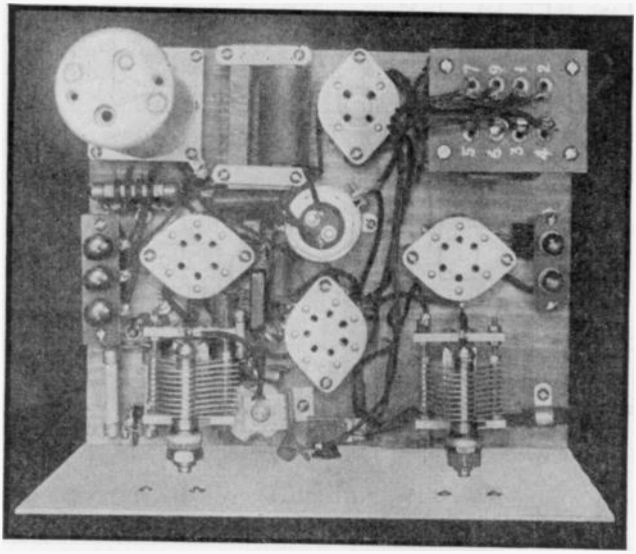


FIGURE 15

Mount C1 and C2 and complete wiring—the remaining condensers, resistors, etc., being held in place by their own pigtails or the rigidity of the short wiring itself. The case of the electrolytic double-unit condenser, C8 and C9, runs to ground and connection 8 on the power transformer. The power lead to the switch S should be twisted.

The dials are the last item and are fastened to the panel by small screws from the back, after first removing the hub caps and loosening the setscrews so that the dials will slip on the condenser shafts. The condensers should be opened to their lowest capacity—the rotor plates swung all the way out. Set the dials at "0," tighten the setscrews and replace the hubcaps. Constructional details are further made clear in the photographic views in Figures 15 and 17.

Some adjustment may be required before the best results will be secured with the converter. Insert tubes and coils in their respective sockets—the oscillator coil in the right-hand socket, the r.f. coil in the left-hand socket (the 4000 to 7500 kc. coils will be best for the initial attempt), the 2A7 tube in the center socket nearest the panel and the -80 in the remaining socket—*looking at the converter from the rear.* Connect antenna and ground to the indicated posts. Connect post G to the ground

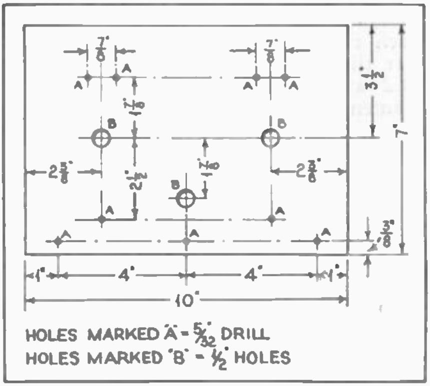
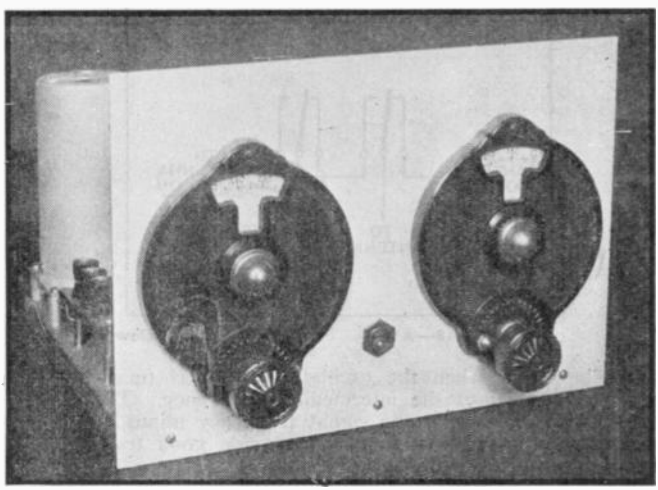


FIGURE 16

post on your broadcast receiver and A1 to the antenna post. Plug in the power supply and turn on both converter and receiver.

Tune the receiver to some frequency between 500 and 600 kc.—a frequency upon which, in normal operation, no station can be heard. Turn the volume control full on. Now adjust the output unit by means of C7, using a non-metallic neutralizing wrench. Adjust for the loudest hiss in the loudspeaker. After the loudest hiss point is reached—or if no definite hiss adjustment is noted—tune C1 a degree at a time, and while on each degree, tune C2 over its entire range. A station will shortly be

FIGURE 17



heard. Tune in as loudly as possible on C1. Now adjust C7 carefully, retuning C2 for each change in the output unit. Note the loudness of the signal, and shift the wire connected to A1 on the converter to A2. Readjust C7 and C2 without touching C1. Connect the lead from the broadcast receiver antenna post permanently to either A1 or A2—whichever connection gave the best signal. If it was A1, you will of course have to readjust C7 and C2.

With the signal tuned in to maximum as indicated above, check the readings on the two dials. If they are not the same adjust C4 by means of the non-metallic screwdriver until they read identically. (If the difference in readings is considerable, see if there is not another point C2, closer to the reading on C1, where the station can be received. Do not touch C1. If such a point exists, start from here when adjusting C4). The readings may vary slightly over different portions of the dials. An exceedingly delicate (and therefore rather impractical adjustment for the beginner) would be necessary on C7 to provide exact tracking.

If a whistle is heard on all stations, it is due to the fact that the *broadcast receiver* is tuned to a frequency on which a nearby or powerful broadcast station is transmitting. Readjusting the broadcast receiver, C7 and C4, will eliminate this annoyance.

The operator may notice that some stations can be received on rather widely separated adjustments of C2—a possibility that was implied in the above directions for adjusting C4. This is due to the fact that the

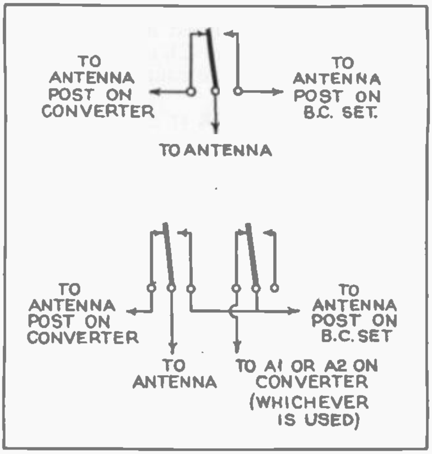


FIGURE 18—Above **FIGURE 19—Below**

signal will be heard when the oscillator circuit is tuned to the signal frequency *plus or minus* the intermediate frequency. The proper oscillator frequency, however, is the signal frequency minus the intermediate frequency. Only this adjustment will provide good tracking and complete wave coverage.

A switch may be conveniently provided to throw the antenna from converter to broadcast receiver — for short- or long-wave reception respectively. The most simple arrangement is shown in Figure 18. This can be used in almost all instances. However, if a slight loss of volume on broadcast reception is noted, the switching system of Figure 19 can be employed, which removes L6 from across the broadcast receiver primary. The power switch on the converter should of course be turned off when the broadcast receiver is being used alone.

Parts List

1 aluminum or bakelite panel, size 7" x 10"
1 baseboard, size 8" x 10"
1 4 prong socket (for the —80 tube)
2 6-prong sockets (for the coils)
1 7-prong socket (for the 2A7 tube)
2 National SE-90, 90 mmfd. variable tuning condensers (C1 and C2)
1 National air padding condenser, 35 mmfd., type W35 (C4)
1 mica condenser, .001 mfd. (C3)
2 mica condensers, .0001 mfd. (C5 and C12)
3 paper condensers, .1 mfd. (C6, C10 and C11)
1 two-section Hi-Farad electrolytic condenser, 8 mfd. per section (C8 and C8)
1 mica condenser, .01 mfd. (C13)
3 Lynch pigtail 1-watt, 50,000-ohm resistors (R1, R3 and R4)
1 Lynch pigtail 1-watt, 250-ohm resi tor (R2)
1 National I. F. output transformer, type C (L5, L6 and C14) (Condenser included)
1 National 2.5 mh. r.f. choke, type 100 (RFC)
1 20-henry choke coil (X)
1 power transformer for a type —80 rectifying tube and a 2.5-volt heater secondary (Trans.)
5 binding posts
1 switch (S)
1 National grid-grip (for connection to top of 2A7 tube)
2 National type VB-C dials
1 coil flexible hook-up wire
Miscellaneous hardware, etc.—screws, nuts and bolts, bakelite strips for binding posts, washers or short lengths of tubing for the mounting of raised parts
1 type 2A7 tube
1 type —80 rectifying tube
Coil sets covering the desired frequency bands

Five sets of standard coils are available. They are the National type CAO, CBO, etc.; for the oscillator coils, and CAD, CBD, etc., up to CED for the detector coils. The middle letter indicates the frequency range: A indicates 11,500-20,000 kc.; B, 7000-12,000 kc.; C, 4000-7500 kc.; D, 2400-4300 kc.; E, 1500-2600 kc. The oscillator coils differ from the r.f. coils as may be observed by inspecting the diagram, Figure 13, and are therefore not interchangeable.

CHAPTER THREE

Tested Short - Wave Receivers

A Beginner's S.W. Receiver

HERE is a short-wave receiver operable from power lines or batteries, which is so simple that anyone can build it, regardless of their mechanical ability or experience. As a matter of fact, we start with the assumption that the reader's practical acquaintance with things electrical is limited to fixing a floor plug or replacing a fuse.

Read the instructions at least twice before attempting to build the receiver. Study the circuit diagrams, layout drawings and photographs. Figure 20 is the a.c. set wiring diagram drawn with the conventional

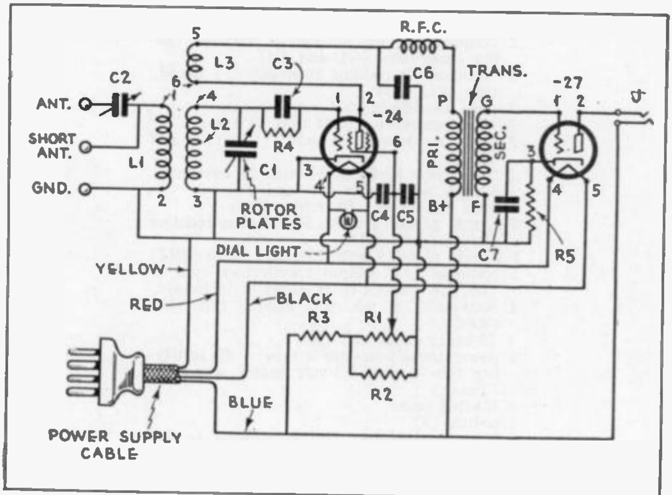


FIGURE 20

radio symbols. Figure 21 is a picture diagram of the same which will probably be of greater significance to the beginner. Figure 22 is the schematic diagram of the battery set. Compare these drawings and endeavor to identify the various parts in Figures 20 and 22. They carry the same labels as in Figure 21 and in the parts list (except for changes in the battery set).

The first step in actually building the short-wave set is to drill the holes in the front panel in accordance with the layout of Figure 23. While the parts list calls for an aluminum panel, considerable latitude in size (larger) and material may be permitted in the construction of a beginner's first receiver. Hard rubber or bakelite make excellent panels, but even clean, dry plywood can be used. The panel is mounted on the base-board, which may be made from any convenient slab of wood. Here, too, the constructor may vary somewhat from the mechanical procedure indicated in the illustrations. The panel can be mounted by means of small angle brackets, obtainable in any hardware store, or, if the base-board is thick enough, the panel can be screwed directly to its front edge. While "feet" contribute to the appearance of the completed job, they are of course not essential.

When the panel and base-board have been joined, mount the condenser C1, jack (J), resistor R1, the dial and the pilot light. The legs sup-

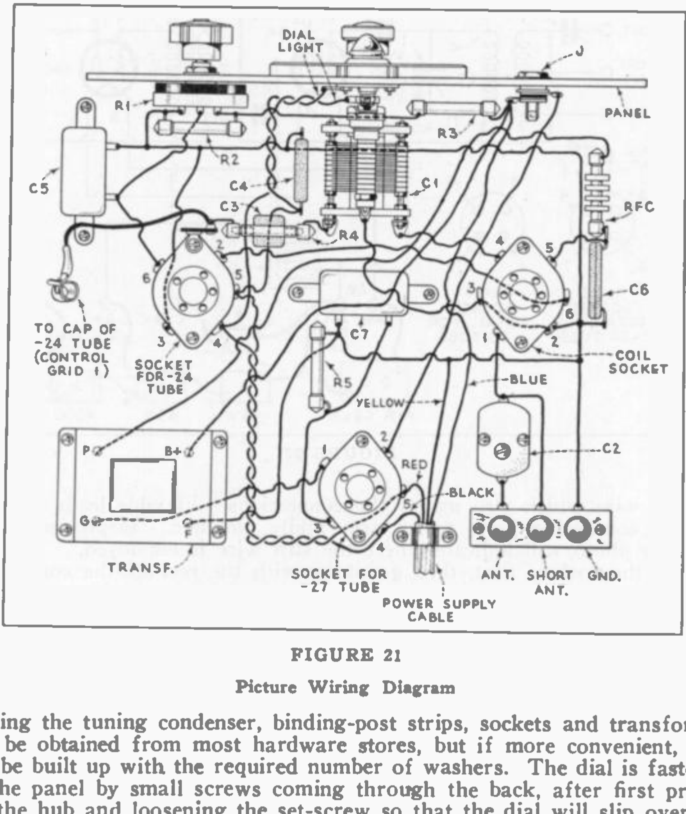


FIGURE 21

Picture Wiring Diagram

porting the tuning condenser, binding-post strips, sockets and transformer can be obtained from most hardware stores, but if more convenient, they can be built up with the required number of washers. The dial is fastened to the panel by small screws coming through the back, after first prying off the hub and loosening the set-screw so that the dial will slip over the tuning condenser shaft. Move the rotor as far out as it will go—that is, counter-clockwise—and set the dial on zero. Now tighten the set-screw and replace the hub-cap. When the condenser is turned all the way to the right, the dial should show the one hundred and fiftieth division. (Though there are 200 dial divisions, only three-quarters of them are used with a 270° condenser.)

The dial light is connected in parallel with the heater of the tube—that is, two wires (which should be twisted as shown in Figures 21 and 24) run from the two heater connections, 4 and 6, to the pilot light.

Now mount C4, the sockets and binding-post strips. The remainder of the parts are mounted as they are wired, being held in place by the

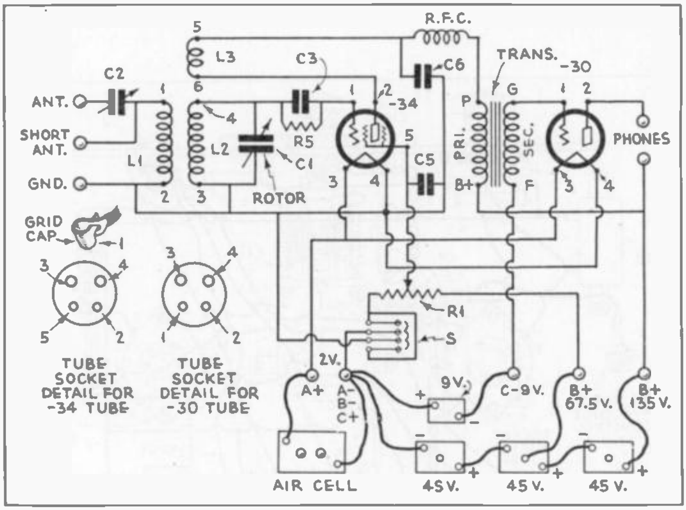


FIGURE 22

bus-bar wire which also makes the connections. Flexible leads are used only in connecting parts which are rigidly mounted. Inspection of the top-view photo will indicate where the stiff wire is employed.

Wire the sockets first, then go along with the rest of the connections in any order of sequence you please. Twist all heater leads as shown in Figures 21 and 24. The numbers in Figures 20, 21, and 22 identify just where the connections are made on the coil and tube sockets. The transformer connections are initialed as indicated. Be sure to connect the rotor plates of C1 to the wire running to the ground post.

The color-code of the power cable must be followed as indicated. Care should be exercised in wiring the volume control exactly as shown in Figure 21. If the outside connections are reversed, the volume will increase as the knob is turned backwards.

Further constructional details will be evident from the picture diagram, Figure 21, and the top-view photograph, Figure 24. While these illustrations were made from the a.c. version, the changes in the battery set are so slight that they may still be used as a guide.

In the battery set, switch S is mounted in place of the jack, J, on the

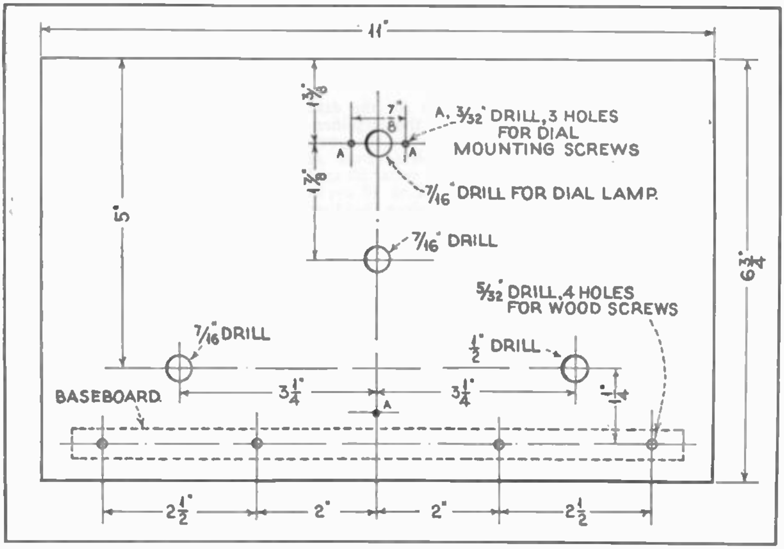


FIGURE 23

panel. Be sure to make this connection exactly as shown. A misplaced wire here would still permit the switch to turn "on and off" the filament of the -34 tube, but would result in the rapid drain of half the B battery through the volume control 1.

If the dial light is used, *make certain that it is the .06 ampere type,* otherwise the air-cell battery may be discharged in a short time. The correct bulb can be identified by the *pink* glass bead supporting the filament. The additional binding posts required in the battery set may be conveniently mounted on a strip at the back of the base-board.

Parts List

The following parts will be used in the a.c.-operated receiver:

One aluminum panel, size 7" x 11"
One National 6-prong socket
C1—National 100 mmfd. variable tuning condenser, type SE100
C2—Fixed-variable 70 mmfd. variable condenser (screw-driver adjustment)
R1—50,000-ohm potentiometer
R2—Lynch 2-watt 5000-ohm pigtail resistor
R5—Lynch 2-watt 2000-ohm pigtail resistor
R3—Lynch 2-watt, 10,000-ohm pigtail resistor
R4—Lynch 5-megohm pigtail grid leak
RFC—National radio-frequency choke coils, type 100
Two National 5-prong sockets (for tubes)
One National 6-prong socket
One National 4-conductor power cable
J—Telephone receiver jack
Three binding posts
One National VBC dial
Trans.—National amplifying transformer, type S101
C3—Mica grid condenser, .0001 mfd.
C4—By-pass condenser, .01 mfd.
C5, C7—By-pass condensers, .5 mfd.
C6—Mica by-pass condenser, .00025 mfd.
L1, L2, L3—National plug-in coils for the wave ranges desired
One bakelite strip for mounting binding posts
Miscellaneous screws, hardware, etc.
One coil flexible hook-up wire
One package bus-bar wire
One National grid grip, type 24 (for connection to top of tube)

Accessory List

In addition to the above parts used in the actual construction of the short-wave set, the following accessories should be acquired:

One type —24 tube for the detector
One type —27 for the amplifier
One type —80 tube for the power supply
One National complete power supply, type 5880-AB, for 110 volts, 60 cycles, or type 5880-AB-25 for 25 to 40 cycles
One telephone receiver head-set—2000 to 4000 ohms (with plug)

If the battery set is constructed, the following parts and accessories will be eliminated: C4, R2, R3, R4, 2 six-prong sockets (for the tubes), the type -24 tube, the type -27 tube, the type -80 tube, the telephone jack (J), the 'phone plug, the power supply plug and the power supply.

Extra Parts List

Taking the place of these a.c. parts in the battery set are:

Two National 4-prong sockets (for the tubes)
Seven additional binding posts
S—Double-pole, single-throw toggle or jack switch
R5 (Figure 22)—Lynch 10-megohm grid leak.

One type —34 tube
One type —30 tube
One Eveready air-cell battery
Three 45-volt, center-tapped B batteries
One 9-volt C battery

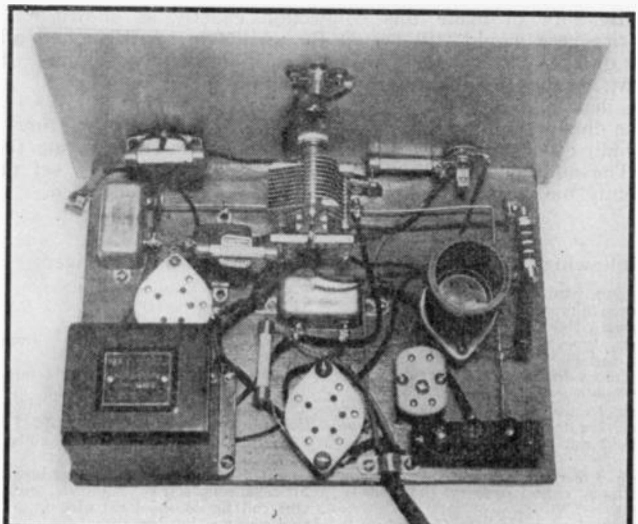


FIGURE 24

The same coils are used in both the a.c. and d.c. models, and the following is a list of those in which the beginner will be most interested. The colors refer to the stripe on the face of the rim by which they are readily identified.

Coil Types and Ranges

No. 11—black—13.5 to 25 meters—daytime, long-distance reception
No. 12—red—23 to 41 meters—miscellaneous broadcasting
No. 13—white—40 to 70 meters—long-distance night broadcasting
No. 14—green—65 to 115 meters—amateurs, airplane
No. 15—blue—115 to 200 meters—police broadcasts

The tuning curves of four of the most popular coils are illustrated in Figure 25. Do not try to buy these parts directly from the manufacturer.

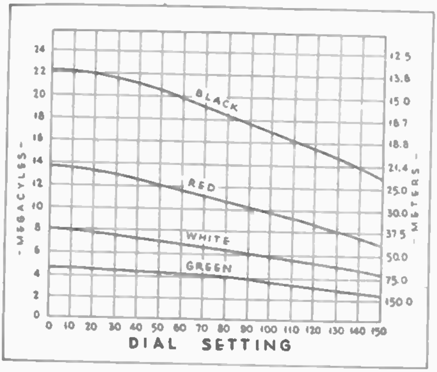


FIGURE 25

turer. If you live in the city, you will have little difficulty in locating a convenient source of supply. Any radio serviceman can direct you to a store handling parts—and in most cases he will be glad to get them for you himself. If you prefer to purchase direct by mail, look through the advertising section of RADIO NEWS. You will find several radio parts houses who will send you their catalogs. These firms are reliable and their prices are cheap as possible for the designated parts.

A 2-Tube Short-Wave Receiver

With the advent of the new 53 and 19 "twin" tubes, a new field of design has been opened to the short wave experimenter. Each of these tubes contains two separate triode class B tube-elements enclosed in a single envelope, making them ideal for small and portable apparatus. Furthermore, since the amplification factor and the power output is rather high, as compared with the ordinary run of triodes, a receiver using a combination of either a 53 or a 19 as a detector and first audio amplifier, and a 47 or a 33 as an output tube, will operate a speaker at a good level of volume on most short wave stations.

The receiver described here utilizes one type 19 as a regenerative detector and first audio amplifier, and one type 33 as an output tube. The detector portion is conventional in every respect, standard parts being used throughout. The first audio-frequency stage is transformer coupled, using a 3-to-1 ratio audio transformer. The output stage is resistance coupled. With this type of coupling plenty of amplification is obtained for operation of a speaker and at the same time the avoidance of a second audio transformer reduces cost and saves space. The set is built up on an aluminum chassis and panel and is designed to fit a wood or metal cabinet 6 inches high, 6 inches deep, and 10 inches long, inside dimensions.

Practically all of the insulation in the radio-frequency portion is of isolantite or other ceramic material. The tuning condenser shown in

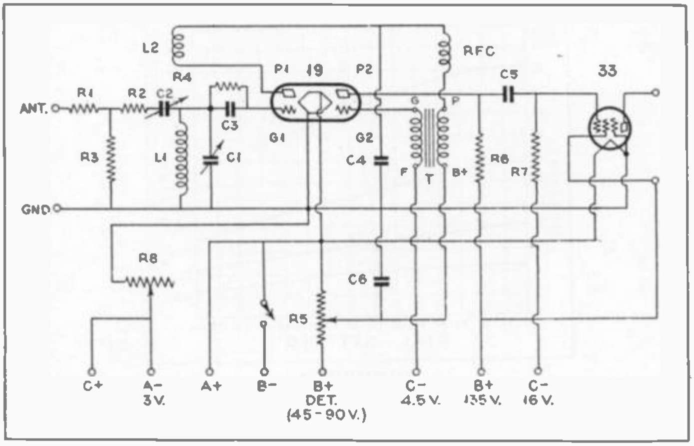


FIGURE 26

the photographs has been changed for one with isolantite insulation, the Hammarlund type MC-140M. Contrary to the usual procedure, the detector and coil sockets are not mounted directly on the chassis but are supported above it by small brass bushings, thus improving efficiency. As shown in the photographs, nearly all of the wiring is underneath the chassis. With the exception of the antenna resistance network and the coupling condenser, *all r.f. wiring is above the chassis; all low frequency and battery wiring is under the chassis.* This type of construction not only improves the general appearance of the receiver, but actually helps to prevent body capacity, instability and other undesirable effects by keeping the r.f. currents from the audio-frequency amplifier.

The reader is advised to study the drawing of the detector socket until the connections are thoroughly understood. Use plate No. 1 (P1) and the grid No. 1 (G1) of the 19 tube for the detector portion of the

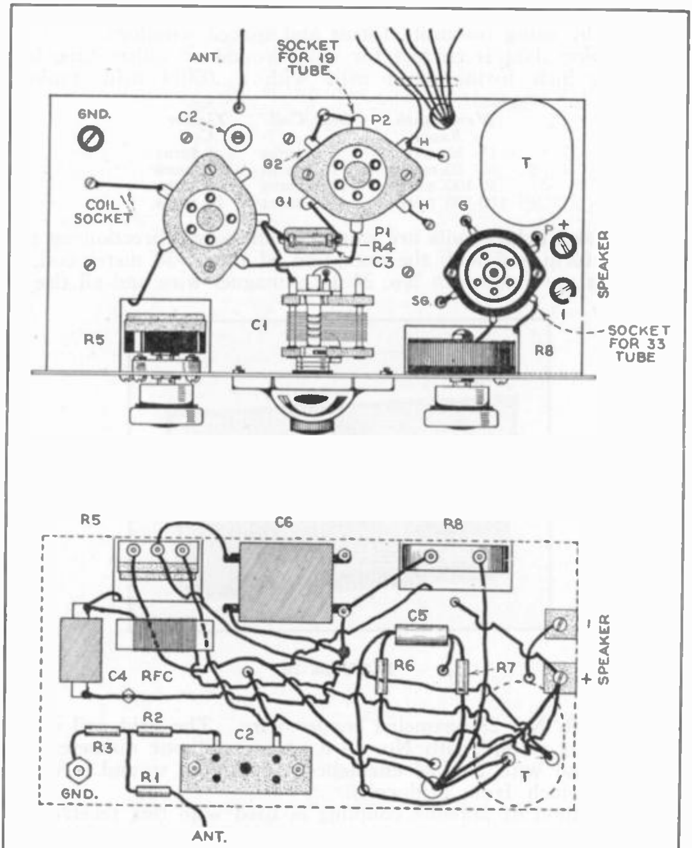


FIGURE 27

tube; plate No. 2 (P2) and grid No. 2 (G2) for the audio-frequency portion. It may be necessary to shield grid No. 2 to prevent r.f. from entering this portion of the tube; this is easily done by simply running the grid lead through a short piece of copper tubing and then grounding this tubing to the chassis.

The chassis and panel are not depended upon for a common return conductor. Instead all negative wiring is soldered to machine screws which protrude through the chassis and these screws are then "bonded" together by a common bus wire under the chassis.

The coils for this receiver may be any of the standard types or they may be wound by the experimenter himself. The writer used ordinary

5 prong tube bases for the coils shown. Their efficiency can be improved considerably by using isolantite forms and spaced windings.

The following data is correct for coils wound on either tube bases or standard 1½ inch forms when used with a .00014 mfd. tuning condenser:

Wavelength Range	*Grid Coil*	*Tickler Coil*
15- 30 meters	3½ turns	5 turns
30- 50 meters	7½ turns	6 turns
50-100 meters	18½ turns	10 turns
100-200 meters	44½ turns	16 turns

Both grid and tickler coils are wound in the same direction on the tube base or coil form and with the exception of the 15-30 meter coil, all the grid windings are made with No. 24 d.c.c. magnet wire and all the ticklers

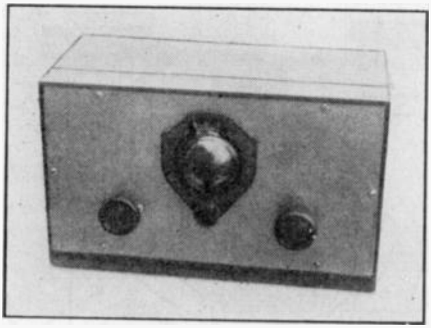


FIGURE 28

are wound with No. 28 enameled copper wire. The grid coil of the 15-30 meter coil is wound with No. 18 d.c.c., spaced one diameter, and the tickler is wound with No. 24 enamelled wire, close wound. All ticklers are spaced 1/16 inch from grid coils.

A novel method of antenna coupling is used with this receiver. Three fixed resistors are arranged to form a "T pad" network in connection with the usual compression type mica antenna series condenser, C2. The chief advantage of this particular type of coupling is the almost complete elimination of "dead spots" from the tuning range. In fact, the receiver can usually be tuned through the complete coverage of each coil without having to manipulate the antenna coupling condenser or the regeneration control—and still employ plenty of antenna coupling!

If a transposed doublet antenna is to be used, it is best to arrange an "H pad" rather than that shown, in order to utilize the full benefit of this system. The series resistor values are 400 ohms each; the shunt resistor is 500 ohms.

The construction of this receiver is so simple that a further detailed description is unnecessary. The schematic circuit in Figure 26 and the picture wiring diagram in Figure 27 will provide all necessary constructional information even for the novice.

An outstanding feature of this receiver which will be particularly appreciated by experienced short wave fans, will be the extremely smooth control of regeneration. As the regeneration control, R5, is advanced the point of oscillation is approached gradually with the result that maximum sensitivity may be obtained without the usual sudden plopping over into oscillation. In reception of c.w. signals, the same action is obtained with a smooth and gradual approach to the point of non-oscillation.

With a potentiometer used for control of regeneration as it is in this receiver there is a small current drain from the B battery at all times, whether the receiver is tuned "on" or "off." Where heavy duty B batteries are employed this current drain is not especially important because it amounts to less than 1 milliampere. However, where standard or midget B batteries are used and especially if the detector plate voltage is 90 or 105, this loss will mean somewhat shortened battery life. In such cases it will be advisable to connect a switch in the B— lead as indicated by the "X" in Figure 26. This may either be a separate switch or may be one which is mounted on, and operated by the rheostat, R8. The latter arrangement is recommended because the switch operation then becomes automatic. The purpose of the switch is to break the B battery circuit when the set is turned off so this continuous slow leakage of B current through R5 is eliminated.

List of Parts

C1—Hammarlund Type MC-140M Midget condenser .00014 mfd.
C2—Compression type condenser (neutralizing type)
C3—Fixed condenser, .0001 mfd.
C4—Fixed condenser, .002 mfd.
C5—Fixed condenser, .01 mfd.
C6—By-pass condenser, 1 mfd., paper type
L1, L2—(see text)
R1—½ watt resistor, 400 ohms
R2—½ watt resistor, 400 ohms
R3—½ watt resistor, 500 ohms
R4—½ watt resistor, 4 megohms
R5—Regeneration control, 0 to 100,000 ohms potentiometer, insulated shaft type
R6—2 watt resistor, 250,000 ohms
R7—½ watt resistor, 100,000 ohms
R8—Filament rheostat, 20 ohms
RFC—R.F. choke 2½ millihenries
T—Audio frequency transformer
One Eby "Low loss," six prong socket (for 19 tube)
One Eby "Low loss," five prong socket (for coils)
One base-mounting type, five prong socket (for 33 tube)
One Aluminum sheet, size 7 x 10 inches
One Aluminum sheet, size 6 x 10½ inches (for panel)
One type 19 tube and one type 33 tube
Necessary dial, knobs, coils, wire, speaker, batteries, etc.

The Radio News "Dragnet"

Outstanding features of the RADIO NEWS "Dragnet" are as follows: Three-tube performance with two tubes; Strictly a non-"blooper"; Eliminates the usual irregular and critical control of regeneration; Brings in world-wide short-wave programs; Provides comfortable headphone volume even on far distant stations; A given station will always come in at the same dial setting; Costs slightly over $8.00 for parts, exclusive of coils, tubes and batteries.

Before going into the constructional details of the receiver it may be well to briefly analyze the circuit of Figure 30. RFC is an 8 millihenry r.f. choke which was selected, after trying different values of resistance and also smaller chokes, because it was found to provide somewhat greater signal strength. This choke is connected to the C battery, and the condenser C9 is employed to by-pass the battery. C1 is included in the antenna circuit solely as a safeguard to prevent shorting the C

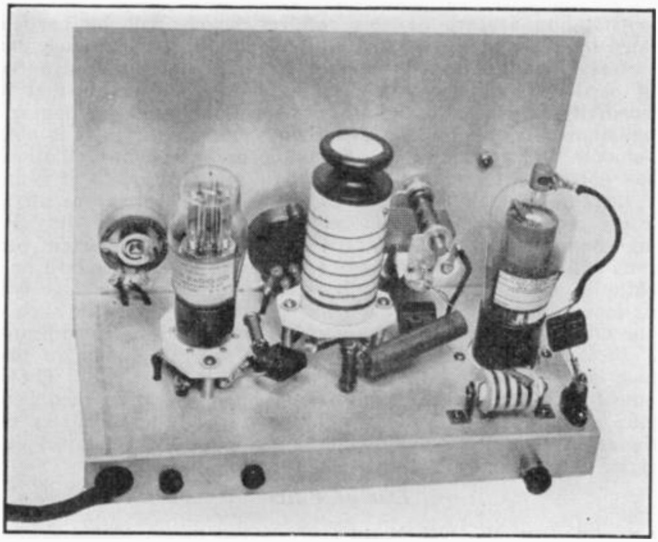


FIGURE 29

battery through the choke should the antenna lead inadvertently contact the chassis.

This choke provides the imput to a -34 tube. This is a high gain, variable-mu r.f. pentode of the 2-volt type.

The output of the -34 is tuned by means of the coil L1 and condenser C2.

The rest of the detector circuit is conventional until we get to the plate circuit, where we find a "pi" type r.f. filter which consists of the resistor R6 and the condensers C6 and C7.

The output of the detector section of the 19 tube is coupled to the grid of the second section by condenser C5, with R3 and R4 as the coupling resistors. R2 is a 100,000 ohm potentiometer employed to control regeneration.

It should be noted that the on-off switch SW is of the d.p.s.t. type. This is necessary because unless the B battery circuit is broken as well as the filament circuit, the B battery will slowly drain off through the potentiometer R2, even when the filaments are turned off.

The plug-in coils employed in this receiver are of the home-made variety with winding specifications as given in Figure 32 and 33. Following the idea of using extremely high-grade insulation throughout, Hammarlund Isolantite forms were employed.

The Hammarlund forms used in the coils covered in the specifications of Figure 32 are 1½ inches in diameter and are of the 4-prong type. If the constructor makes his own coils it is important that the forms he uses be of this same diameter, otherwise the ranges will be different than those shown in the table.

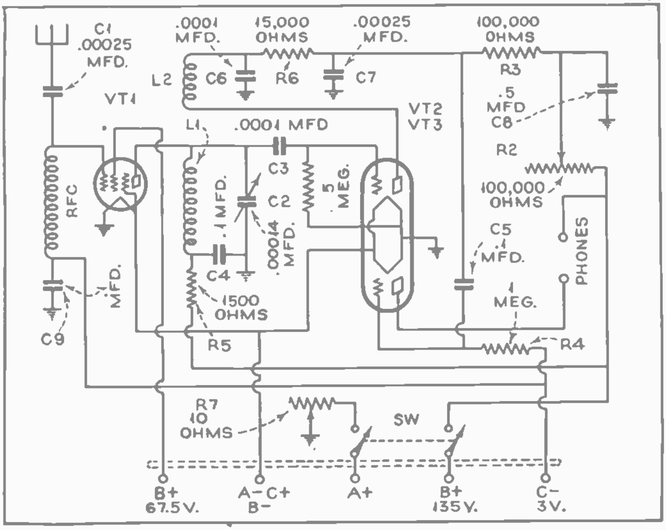
In general it will be noted that the ticklers employed are somewhat smaller than usual. This is done in order to permit the use of higher plate voltage with resulting higher detector output. For best results, the ticklers should be of such size that the regeneration control potentiometer can be operated in a well advanced position.

The coils covered in Figure 32 provide plenty of overlap. At first glance it may seem that the overlap between coils 1 and 2 is unnecessarily large but this is intentional. The greatest sensitivity is obtained when using relatively little tuning capacity in the tuned circuit. To provide best operation, therefore, it is desirable that the coil ranges be so selected that the most desired stations will come in at low settings of the tuning condenser. In the case of coil No. 1, the range is 15.8-28.0 meters. Thus the 16 and 19 meter short-wave broadcast stations will be tuned in with a highly favorable inductance capacity ratio. The 25-meter stations, on the other hand, would come in near the top of the dial where efficiency would be less. For this reason the range of coil No. 2 is made to include the 25-meter band close to its high-frequency end and the 30- and 31-meter bands as well. The 50-meter stations are also well down on the dial of coil range No. 3.

By disregarding this factor of efficiency it would be possible to cover from 16 meters to 200 meters with 4 coils instead of the 5 employed but the sacrifice of efficiency involved is not believed to be worth while.

The coil socket is mounted on bushings to keep the coil well up from the metal chassis. The 19 tube socket is similarly mounted, but in this case the purpose is to avoid carrying r.f. leads underneath the chassis. Insofar as possible all r.f. wiring is kept above the chassis and all a.f.

FIGURE 30



or d.c. wiring below the deck. This makes for short leads in the r.f. circuits and helps to isolate the r.f. circuits from the others.

So far as the constructional details are concerned there is little that can be said which would add to the information provided by the photo-

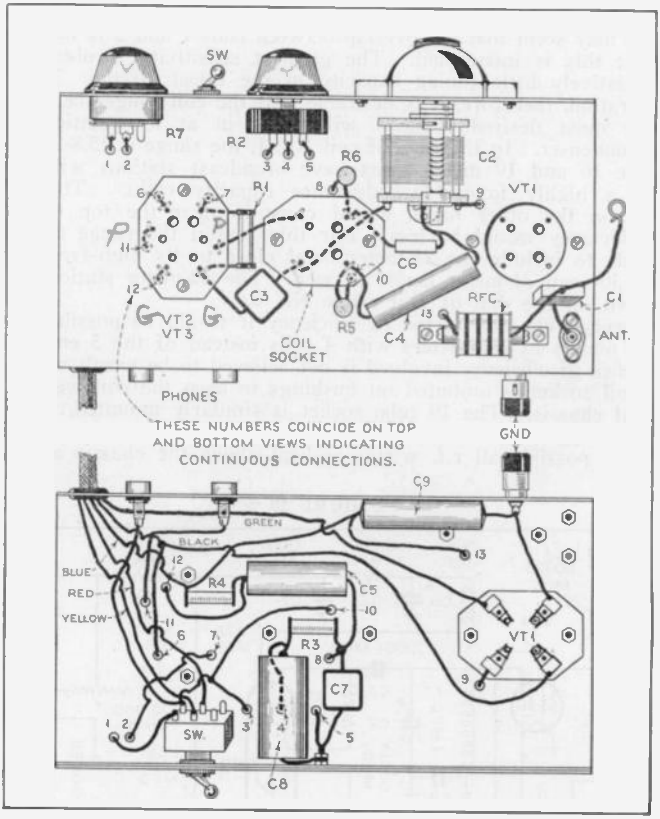


FIGURE 31

graphs, the chassis specifications (Figure 34) and the picture wiring diagram (Figure 31). It is not absolutely essential that the panel and chassis be of metal. The metal does, however, eliminate body capacity and provide general shielding, and for that reason is considered worth while, especially as the cost of the aluminum is low.

One or two pointers concerning the wiring may be helpful to the novice who builds this set. For instance, it is advisable to mount all parts on the base and to wire them as far as possible before attaching the panel.

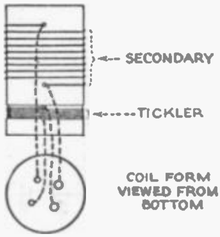


FIGURE 32—Right

FIGURE 33—Above

Blueprints — For constructors who prefer to work from blueprints, a set has been prepared on the Radio News "Dragnet" and is available to readers at a nominal price of 25c.

COIL DATA

	Secondary Turns	Tickler Turns	Frequency	Wavelength
No. 1	6	6	19000-10700	15.8- 28.0
No. 2	10	7	13000- 6610	22.5- 45.4
No. 3	18	9	7230- 3830	41.5- 78.3
No. 4	30	12	4150- 2250	72.2-133.3
No. 5	50	20	2380- 1220	126.0-245.8

Wire Sizes:

No. 22 double silk covered wire is used for all secondary windings except No. 5 and this is No. 28 d.s.c.

No. 28 d.s.c. wire is used for all ticklers

Spacing Between Ticklers and Secondaries:

No. 1 coil—3/16 inch
No. 2 coil—1/8 inch
No. 3 coil—1/8 inch
No. 4 coil—3/32 inch
No. 5—1/8 inch, tickler wound in 2 layers

Secondary Turns Spacing:

Coils 1, 2 and 3 are space wound to make secondary winding 1½ inches long. Coils 4 and 5 are wound without spacing.

Wires of suitable length should be soldered to the terminals of the sockets for the coil and the type 19 tube before mounting these sockets, then, in mounting them, thread through the holes in the chassis the wires that are intended to go beneath this base. Wires of adequate length should also be soldered to the rheostat terminals before the panel is mounted on the base. With these precautions the wiring will be found easy.

The "Dragnet" is designed for battery operation. Two standard dry cells are employed for the filament supply, a 4½ volt C battery and three 45 volt B blocks. Heavy duty B blocks are not necessary inasmuch as the plate current drain is only a few milliamperes.

The R. N. "Dragnet," a name selected because of the demonstrated ability of this little receiver to drag in just about everything on the air, will be found extremely smooth in operation and absolutely stable.

List of Parts

C1, C7—Aerovox type 1467 miniature fixed condensers, .00025 mfd.
C2—Hammarlund MC-140M, 140 mmfd. midget "Midline" condenser
C3, C6—Aerovox type 1467 miniature fixed condensers, .0001 mfd.
C4, C5, C9—Aerovox cartridge type by-pass condensers, .1 mfd., 200 volts.
C8—Aerovox cartridge type by-pass condenser, .5 mfd., 200 volts
L1, L2—Plug-in coils wound on 4 prong forms (see text)
R1—5 megohm pigtail type resistor, ½ watt
R2—Centralab potentiometer, 100,000 ohms
R3—100,000 ohm pigtail type resistor, ½ watt

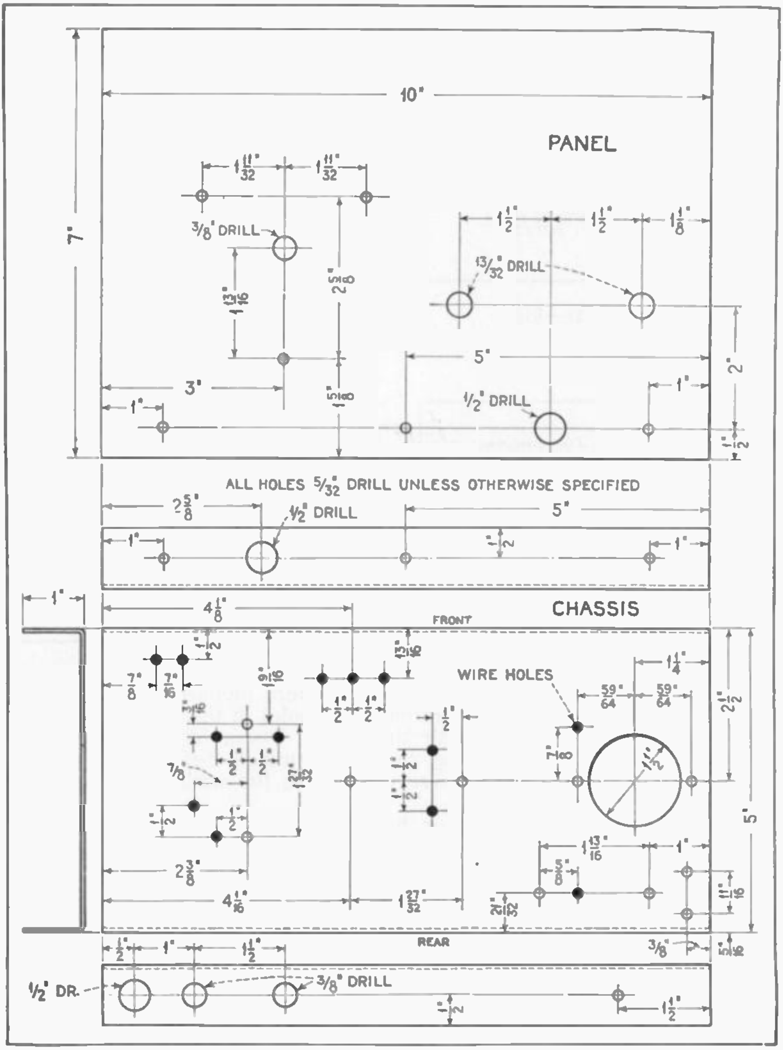


FIGURE 34

The panel and chassis for the Radio News "Dragnet" should be cut, bent and drilled in accordance with the dimensions given here.

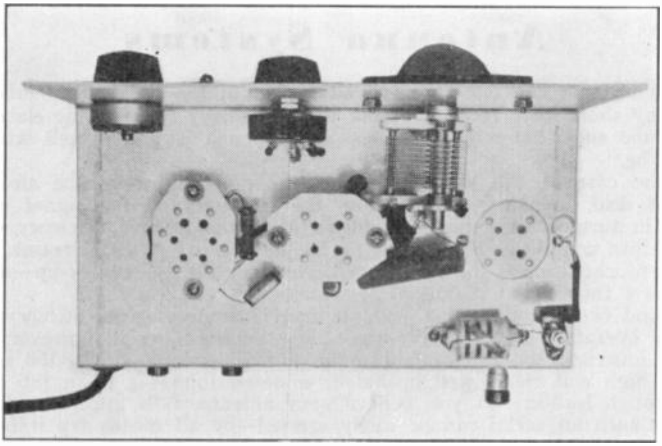
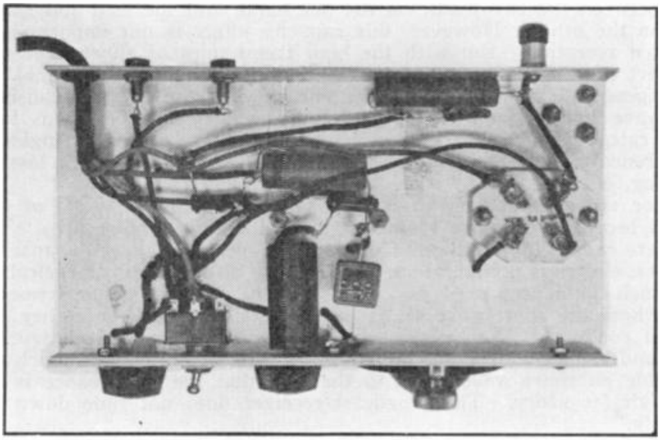


FIGURE 35

R4—1 megohm pigtail type resistor, ½ watt
R6—15000 ohm pigtail type resistor, ½ watt
R7—Yaxley "Junior" rheostat, 10 ohms, with knob
R.F.C.—Hammarlund type CH-8, r.f. choke 8 millihenry
2—Hammarlund type S-4 Isolantite 4 prong sockets (1 for coil, 1 for Type —34 tube)
1—Hammarlund type S 6 Isolantite 6 prong socket (for type 19 tube)
SW—1 Toggle switch, d.p.s.t.
1—Kurtz-Kasch vernier dial, 2¾ inch
1—Midget porcelain stand-off insulator, 13/16 inch high, (used for antenna terminal)
2—Insulated 'phone tip jacks
1—binding post (for ground terminal)
1—5-Wire color coded battery cable, length optional
1—Rubber grommet (for protecting battery cable where it passes through rear
1—1½ inch bakelite knob (for R2)
Aluminum panel and base (see Figure 34)

FIGURE 36



CHAPTER FOUR

Antenna Systems

IN no instance can one take full advantage of the possibilities inherent in any short-wave receiver—from the elementary types to the elaborate multi-tube super-heterodynes—unless the antenna is pretty well what it should be.

In the case of the simple receiver—the one- and two-tube affairs—a great deal necessarily depends on the character of the signal input, which in turn is an antenna problem. And the greater efficiency engineered into complicated receivers, as the number of tubes increases, cannot be touched unless the signal well overrides the noise pick-up—which again is a function of the aerial system.

A good broadcast antenna will, in many instances, give entirely satisfactory operation with a short-wave set. Such an aerial, however, will almost invariably be a reasonably long outside antenna—75 to 150 feet—swung high and clear, well insulated, soldered joints—a clean job from tip through lead-in. If you believe your antenna falls into this class—or that such an aerial can be easily erected—by all means try it before experimenting with the somewhat more complicated types. An exception to this advice is in apartment houses, where, regardless of how well the lead-in may be installed, it will be practically certain to run through a noise-infested area.

Broadcast antennas, which will not give good short-wave results, are those employing noise-reduction systems designed for operation between 200 and 600 meters and, in most cases, indoor aerials. (Again, an exception. Indoor aerials sometimes give good results in rural districts. But in such cases, an outdoor antenna is easily erected, and advantage should be taken of the superior results accompanying an open installation.)

The long-wave noise-reduction systems usually employ a twisted transmission lead-in, or a shielded cable. There is a pronounced condenser effect between the two leads, on the one hand, and the lead and shielded cable on the other. However, this capacity effect is not important with broadcast reception. But with the high frequencies of short-wave work, the effect of capacity may be considered as shorting out the signal.

Our general comment against the efficiency of the twisted lead-in for short-wave work should not be held condemnatory of all systems falling in this category as there are several types which are especially engineered, in reference to correct length and impedance, to minimize such losses by balancing, etc.

Indoor antennas are unsatisfactory from the point of view of noise. This is because the entire system is located within a noise area. These noises are caused by radiations from vacuum cleaners, violet ray machines, elevators, electrical refrigerators, incinerators, oil furnaces, dial telephones, etc. Such appliances need not necessarily be used in the apartment or home where the short-wave set is installed. The interference they cause is often conducted, like "wired wireless," by telephone and electric light wires, and radiated all along the route. Noise interference is much more noticeable on short waves, due to the fact that the disturbance is of a very high frequency. The broadcast receiver does not tune down to it efficiently.

The noise level on s.w. foreign stations should be less, than that accompanying long-distance reception on the long-wave band. If you believe you are being bothered by more than the normal amount of back-ground noise, it is a good idea to consult someone experienced with short-wave reception, for his opinion.

Using a broadcast antenna, the background noise can be reduced somewhat by lengthening the aerial. Always assuming that the antenna is out of the noise area, this will increase your signal pick-up more than the noise pick-up. Adding more feet to the aerial will, of course, increase the

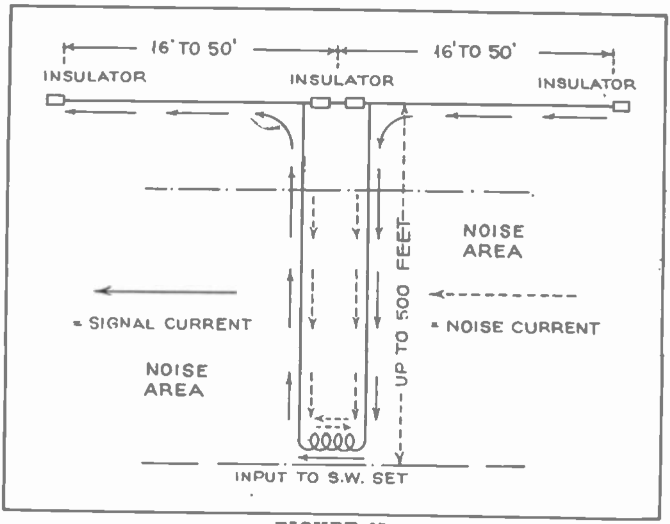


FIGURE 37

capacity between aerial and ground. This capacity acts as a small condenser across the antenna primary in the receiver which may boost its natural wavelength to an undesirable degree. In such cases it is necessary to put a small condenser in the lead-in, close to the set. This should be preferably of the variable air-dielectric type—the so-called midget or trimming condenser—having a maximum capacity of from 35 to 90 microfarads.

Lengthening the aerial may also result in broad tuning. This may be explained by the fact that with the short antenna the volume control is turned higher for a given output from a certain station. Practically all volume-control systems increase regeneration to some extent as the control is turned up. And increased regeneration is accompanied with improved selectivity.

If the complaint of poor reception on the broadcast antenna is other than noise, the trouble probably is with the short-wave set itself—not the antenna. However, if background noise is excessive, the only cure is recourse to a noise-reduction antenna system.

What we really mean by noise reduction is the increase in the signal-to-noise ratio. As implied above, this can be accomplished in either one or a combination of two ways—by increasing the signal pick-up and by decreasing the noise pick-up. This may be illustrated by an ideal problem.

We assume that our antenna picks up only signal and the lead-in picks up both signal and noise. (The ordinary lead-in picks up quite a bit of signal.) If we substitute a lead-in which picks up nothing at all, we shall have increased our signal-to-noise ratio enormously! Of course we shall have lost a bit of signal strength, due to the elimination of lead-in pick-up, but the volume control can now be turned up to compensate this. However, if the sensitivity of the set is insufficient to make up for this loss, we can increase the length of the antenna—which is usually a good idea, unless a particular length is desired, as will be mentioned farther on.

As predicated, the problem just considered is an ideal one. In actual practice the situation is as follows: The antenna pick-up on a given signal may have a signal-to-noise ratio of say fifteen to one, while the lead-in has a *noise-to-signal* ratio of perhaps thirty to one. The combination may well result in the noise being much louder than the signal, and reception is impossible. We now install a lead-in which picks up practically no noise, nor signal, and the result is we have a signal-to-noise ratio of fifteen to one. If we wish, we may lengthen the aerial, compensating the loss in signal pick-up by the lead-in—probably without material change in the signal-to-noise ratio. However, if the aerial is extended toward a noise area, the signal-to-noise ratio will naturally be lowered, and if away from a noise area, the ratio will be increased.

The transmission line provides a form of lead-in which picks up neither signal nor noise, which is economical, easy to install and widely used for short- and all-wave reception. Its noise-reduction qualities are effective as high as 600 meters.

"Doublet" Antennas

Inspection of Figure 37 will indicate the manner in which the transmission line functions. This illustrates the "doublet" antenna—so named because of the two equal stretches of aerial on each side of the double lead-in. We shall assume that at a given instant a signal current is induced in the antenna which follows the direction of the arrows drawn in solid lines. This current goes *down* one lead-in, through the antenna primary of the receiver, and *up* the other lead-in, following along its original direction on the left-hand portion of the horizontal wire. Noise pick-up by the antenna will follow a similar course and be heard in the receiver. If the antenna is well located, the noise impulses will be very weak in comparison with the signal. In other words, we have a high signal-to-noise ratio.

The very powerful noise impulses in the section indicated as "noise area," through which the lead-in passes, will take the same direction, *in both lead-ins*, as indicated by the dotted arrows. Meeting in the antenna primary, they neutralize (buck each other) and become non-existent as far as the receiver is concerned. Similarly, any signals picked up by the lead-ins will have no effect on reception.

The parallel leads are placed close together so that they receive impulses of identical strength. If one wire were to pick-up a stronger impulse than the other, it would force itself through the primary against the bucking action of the weaker impulse picked up by the other wire, and noise would be heard. The leads must not be placed too close together, or the capacity will be increased to the extent where losses will occur, as mentioned in the case of long wave noise reduction systems used for high frequency work. The leads are usually spaced about three inches.

It is a general practice to transpose the transmission line every two to three feet—that is cross it, as shown in Figure 38—by means of trans-

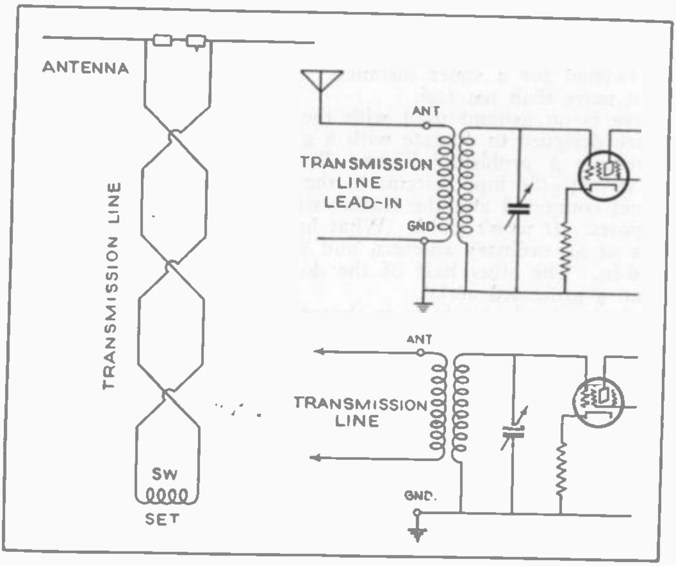


FIGURE 38—Left
FIGURE 39—Upper Right FIGURE 40—Lower Right

position blocks. This provides the most convenient mechanical method of keeping the lead-ins perfectly spaced, and in some instances may contribute slightly to noise reduction. For example, if the transmission line is run close to another wire which may be a conductor of noise impulses, an appreciable variation in field strength may exist across the three inch space between the transmission wires. This means that one wire will receive a stronger impulse than the other, and noise will be heard. But if the leads are transposed, each wire will receive the stronger impulse at different points on the way down, thus re-establishing the necessary balance.

Transposition—or parallel feeding—should be carried out as close to the short-wave receiver as possible. Where the transmission leads enter the

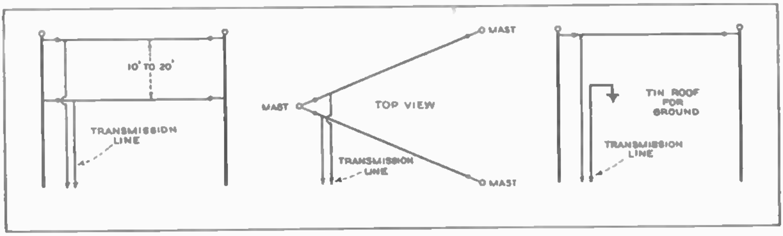


FIGURE 41

house, lightning arresters may be installed—one in each lead. If it is inconvenient to continue the transposition within the house, the leads may be twisted for a short distance. The shorter the better—and certainly not more than ten feet.

As there is no ground used with the transmission line, and most receivers are designed to operate with a ground, coupling to the set sometimes presents a problem. Figure 39 shows the conventional antenna primary circuit—the input circuit to the short-wave set—used often with the ground connected and the transmission lines run to the antenna and ground posts. *It won't work.* What happens is one-half of the doublet functions as an ordinary antenna, and one transmission lead as an ordinary lead-in. The other half of the doublet is useless—it being nothing more than a grounded aerial.

The solution to the problem is shown in Figure 40. Here the ground has been isolated from the transmission line circuit, but remains connected to the rest of the receiver. In the better short-wave sets, provision is made for the correct connection to a transmission line lead-in. Some receiver manufacturers supply noise-reduction antenna kits with their products with full directions for installation, which, needless to say, should be followed carefully, before experimenting with the systems described in this article. (In the majority of instances, however, the recommended antenna will be the doublet with transposed lead-in.)

There are on the market coupling devices which permit the transmission line to be employed with receivers not originally designed for the purpose, without making any change in the set itself, and permitting the ground to the connected to the usual ground post.

The doublet antenna receives best signals arriving at right angles to the direction in which it is stretched. For example, if it is desired to favor stations to the east and west, the antenna should be strung north and south. However, the directional possibilities are not of sufficient importance to take precedence over the more important consideration of erecting the antenna *free and clear of obstructions and as remote as possible from a local noise area.*

Two arms of the doublet are run in a straight line—being broken only in the center by the insulator. The efficiency of such an aerial, on a given wavelength, bears a direct relationship to its length. Preference will be shown to signals, the wavelength of which is twice the total length of the horizontal portion. Also, due to the harmonic relationship, signals the wavelength of which is equal to the length of the doublet will be similarly peaked. For instance, if particularly good reception is desired on the 50 meter stations, the antenna should be 25 meters—82 feet— long. This aerial will also give "pepped up" signals on 25 meters. Excellent (normal) reception will be had between peaks.

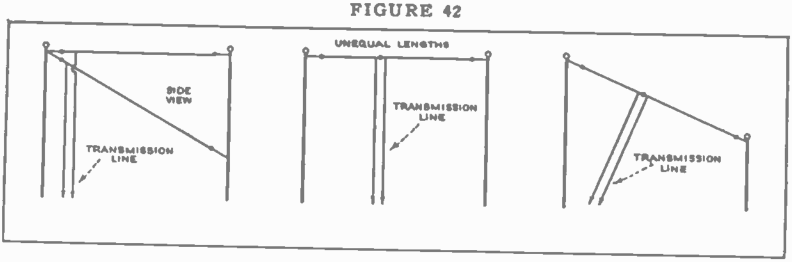
There is no necessity for sticking to the straight doublet design when using the transmission line lead-in. Several convenient variations are shown in Figures 41 and 42. Of course, as departure is made from the doublet type, an antenna and counter-poise combination is approached, and the directional and peaked characteristics of the doublet are lost.

A Homemade Shielded Lead-In System

If the lead-in could in some way be kept from picking up any signals regardless of its length, the antenna could be placed out of the field of any local disturbances, thereby preventing it from receiving any of the so-called man-made static. One method of doing this is to connect the antenna and receiver with a shielded low-impedance line. This requires a step-down transformer at the aerial and a step-up transformer at the set. In experiments, that and a few other similar methods were tried, but were dropped due to the high cost of the shielded wire and to the fact that if any great length of lead-in was used, the shield had to be grounded in two or more places. The method finally accepted is shown in Figure 43. Two insulated wires are twisted together and used for the lead-in. At the antenna end of this line one of the wires is cut about six inches short and the other is fastened to the aerial. The receiver end connects to two similar primaries in series. The secondary feeds into the receiver in the customary manner. The theory is that one lead carries signal plus the disturbing noise, while the other carries only noise; the noise cancels out in the primary circuit, leaving only the desired signal. In Figure 43, L1 and L2 are the primaries, L3 the secondary, and S is an electrostatic shield to prevent any capacity coupling between the primaries and the secondary. C1 and C2 are a fixed and a trimmer condenser respectively; their purpose will be explained later.

The method of measuring the attenuation of lead-in pick-up is as follows: A dummy lead-in about fifty feet long is fastened to the coils the same as in Figure 43, but a single-pole, single-throw, anti-capacity switch is connected in at the point SW. The wires at the far end of the line are connected together and to the high side of a signal generator. The other side of the generator is returned to ground. A receiver is put on the output of the eliminator. The amount of attenuation of unde-

FIGURE 42



sired signal is the ratio of the sensitivity of the receiver with SW open and the sensitivity with SW closed.

The coil is shown in Figure 44 and the winding data of the coil used is as follows: The winding form can be either a cardboard tube or wood cylinder 1½ inch long and ⅝ inch in diameter. The secondary is

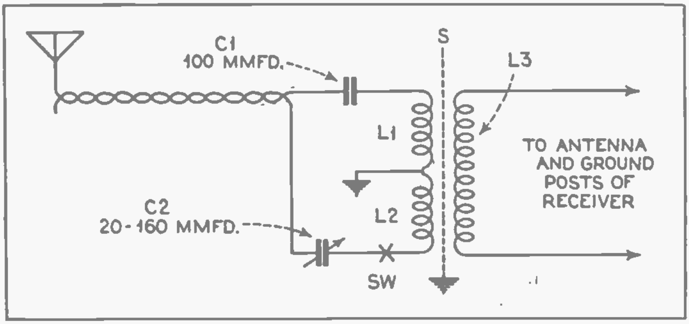


FIGURE 43

wound on first and consists of 450 turns of No. 33 enamelled wire. The winding length of this coil is 1 inch and it is insulated between layers with about .001 inch paper. Over the secondary is placed a winding of insulating paper .003 inch thick. The electrostatic shield is placed on next. This consists of a strip of tinfoil 1½ inches wide and just long enough so that the two ends will lack meeting by about a sixteenth of an inch. *This shield should not be a closed circuit.* Over the shield is placed more insulation .003 inch thick. The two primaries are now wound on. They consist of 75 turns each of No. 33 enamelled wire. The two windings must be identical and equidistant from the center of the form, and, as the winding will run slightly over one layer, the only way to do this is to start the winding of each primary from the center and work outwards. The secondary leads are brought out from one side of the coil, and the primary and shield leads from the other.

L1, when tuned by the antenna capacity, resonates within the broadcast band, making it necessary to place C1, a 100 mmfd. condenser, in series with it. C2 is put in the other lead to make both circuits symmetrical. With the above values and on an average antenna, L1 and L2 will resonate at about 1800 kc. The adjustment of C2 is not dependent upon the length of the lead-in nor on the capacity of the antenna, making it possible for the manufacturer to adjust it before the device leaves the factory.

It is important to keep the primary leads well shielded from the secondary leads, because if there is any capacity coupling between the two windings, the adjustment of C2 for maximum cancellation will vary as the receiver is tuned from one end of the band to the other.

Probably the best way to adjust the device when no signal generator is available is to run the double lead-in to within a few feet of the antenna but not connected to it. The receiver is then tuned to a weak station and C2 adjusted so the signal is at a minimum. The lead-in is then connected to the antenna.

Unshielded portions of the receiver, the variable condenser and the grid leads will pick up nearly as much noise as the lead-in itself. The most effective way to prevent this is to construct a steel box to line the inside of the cabinet and enclose the entire chassis, with openings left, of course, for the dial and for ventilation. With this shielding it was found possible to place the set in the field of a strong r.f. signal without receiving any of it.

A line interference filter design is shown in Figure 45. The two coils are wound in the same direction and placed side by side in inductive relation to each other. The entire unit is mounted in a small metal can. This filter will in some cases work better without a ground, depending on the type of interference; but an increase in hum will result in most cases when the ground is eliminated.

On a completely shielded receiver with all the above devices it was possible to eliminate nearly all interference. Under actual measurement, the attenuation of lead-in pick-up was 65 db. and the attenuation of antenna signal varied only between 5 db. and 10 db.

By way of explanation it may be well to add here that the antenna system described (or any other special lead-in system) will prove beneficial only where the field of interference embraces the lead-in but not the antenna—or where the antenna is in a relatively weak field of interference as compared with that in which the lead-in is located. Obviously if a

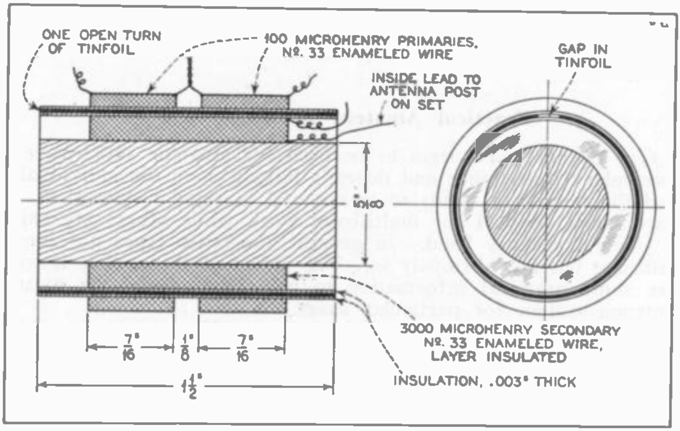


FIGURE 44

Constructional details of the coil for the shielded lead-in system.

source of interference is general and covers an entire neighborhood so that no matter where the antenna proper is placed it will still be within the field of interference, no amount of attention to the lead-in will eliminate the trouble. But, on the other hand, a system such as that described here will oftentimes greatly reduce noise even though the noise is found over a large area, because in many cases such noise may be carried along and radiated from light or power wires. If the antenna is placed a fair distance from such interference carrying wires, then its pick-up of the interference will naturally be less. If the lead-in system is one

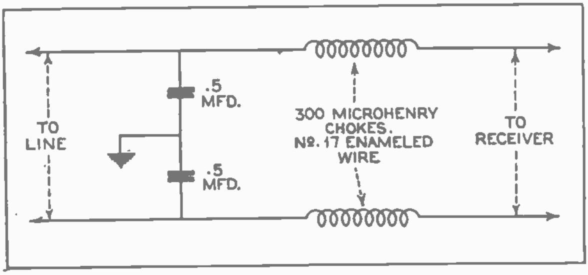


FIGURE 45

which cannot introduce the interference into the receiver, even though the lead-in may run in rather close proximity to the trouble-making power wires, the overall effect will be a considerable reduction of noise.

In general, wherever there is present noise interference other than atmospheric static, an antenna system such as the one discussed here will be well worth trying.

Practical Amateur Aerial Design

The type of antenna system to be used for amateur short-wave work is of secondary importance and depends largely upon the individual location and the frequency bands to be covered in regular operation. Some types are easily adapted for multi-band work while others are suited to only a single frequency band. In general, the latter types are somewhat more efficient but not obviously so. The object of this article is to bring together some practical information to help in choosing the most suitable antenna system for particular cases.

Better efficiency usually results in using a Hertz antenna (½-wave wire in free space) than when using the ¼-wave Marconi type which must have a good ground system or a large counterpoise. (In this latter type every inch of wire in the system radiates energy, so that a rather small percentage is radiated by the uppermost parts of the antenna which do the business.) The horizontal Hertz, on the other hand, is entirely *up-in-the-air* so it becomes obvious why the efficiency is better. And, of course, this applies equally well to signals coming in. Antenna systems for single-waveband operation will be first considered.

Simple Half-Wave Antenna

The simple half-wave antenna diagrammed in Figure 46 is a split doublet, each side being one quarter wave-length long. The length of each half equals 0.78 times the wavelength or $\frac{468}{(2 \times \text{freq. (mc.)})}$. It is ideal for portable work at any frequency and does a first class job for both transmitting and receiving. The transmission line used to couple this doublet to the transmitter or receiver need not be tuned and can be of any length provided its impedance is correct. Forms of rubber-covered, twisted lampcord provide a suitable impedance match.

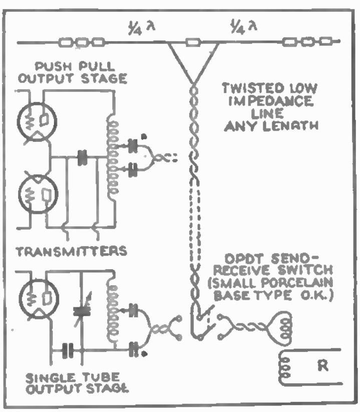
"Giant Killer" feeder wire is intended especially for this purpose. Its impedance is slightly higher than that at the center of the antenna (about 75 ohms) so that it should be fanned somewhat when connecting to either side of the center insulator to be theoretically correct. This type of antenna is suited only to the waveband (fundamental) for which it is cut or any *odd* harmonic thereof. On *even* harmonics a voltage (and impedance) maximum appears at the center and cannot be matched to (is virtually short-circuited by) a 75-ohm line. When used for receiving, the line will have no pickup and, therefore, a maximum signal-to-noise ratio will result. The line is magnetically coupled to the receiver by means of a small primary coil; to the transmitter across a few turns of the last plate-tank coil or coupled same as receiver. Bear in mind the necessity for sufficient insulation in the twisted line when used for transmitting.

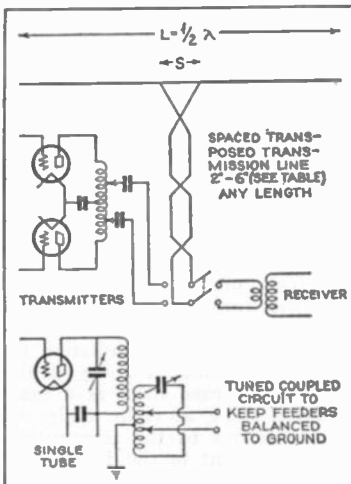
FIGURE 46—Below

This diagram shows a simple, half-wave, split-doublet antenna.

FIGURE 47—Right

Showing spaced transmission line fanned at the antenna.





WIRE SIZE	SPACING	LINE IMPEDANCE	S
14 12	4½" 6"	600	0.25L
14 12	2" 3"	500	0.20L
LYNCH HI-MHO (LIGHT)	LYNCH TRANS-POSITION BLOCKS	450	0.18L

A Spaced Transmission Line

Another method of feeding a half-wave Hertz is to use a spaced transmission line fanned at the antenna so that the impedance of the line equals that of a part of the antenna across which the line is connected. See Figure 47. The length of this antenna and the distance between the wires are quite critical. The length equals $\frac{463}{\text{freq. (mc.)}}$ feet. The distance (S) equals one-quarter the antenna length for a 600-ohm line, and decreases as the line impedance goes down. See table in Figure 47. A transposed line may be used and is particularly desirable for reception. The line should be perpendicular to the antenna for at least ¼ wavelength and should be terminated in such a manner at the transmitter so that it is balanced to ground. Transposition blocks make an easy and efficient job of the feeder. In putting up this type of antenna, the wire should be several percent too long and should be cut about one percent at a time, observing the performance after each cut. Fixed coupling to the transmitter (or an oscillator) should be used so that the loading effect of the antenna might be seen on the plate (or grid) milliammeter. When the doublet length is correct, it will have a maximum load effect.

A Single-Wire Feeder Antenna

A third type of antenna for single-band operation is the single-wire feeder affair shown in Figure 48. The length of the antenna is roughly the same as the previous type but had better be determined by experiment, as previously explained. The feeder should be connected one-seventh the length off the center and must run at right angles for proper operation. There must be no sharp bends in this feeder or there will be reflection losses and line radiation. This type is less suitable for reception than either of the foregoing systems because the line is not so free from pick-up.

In the foregoing antennas, properly designed and constructed, there should be no radiation or pick-up on the feeder and any length at all may be used. If no radiation or pick-up takes place in the feeder, the half-wave antenna is doing all the work, which is exactly what we want. And in this case there is a marked directionality, best transmission or reception being at right angles to the line of the antenna. In adjusting these antennas to the transmitter, the plate meter must be used as the antenna current in the feeders is very low and is not necessarily a true indicator of power taken by the antenna proper. Start with a minimum of coupling and gradually bring it up, always retuning the plate-tank condenser, until the tube is properly loaded. It is possible to use any of these types as a Marconi antenna for lower frequencies, tying the two feeders together. In a pinch this means may also be used on odd harmonics of the Marconi quarter-wave fundamental but, at best, is a makeshift job.

The single-wire-feed antenna of Figure 48 may be used for all amateur frequencies but does not perform as well on harmonics as on the fundamental frequency. This is because there is a mis-match between antenna and feeder on harmonics. It is possible to compromise and improve harmonic operation but usually at the expense of fundamental efficiency. The feeder is usually moved further from the center of the antenna. The feeder radiates, standing waves appear and there are losses all

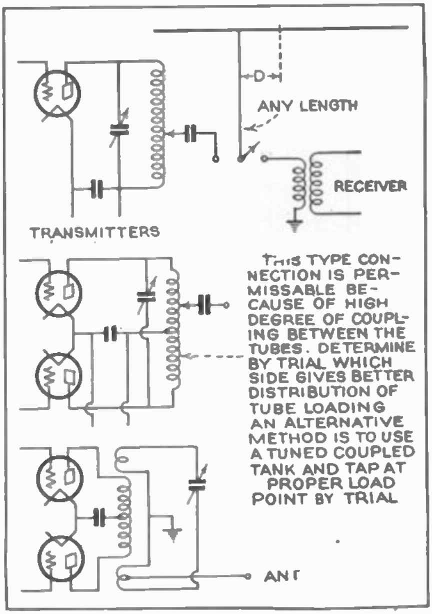


FIGURE 48

around. Nevertheless, many hams like this method because of its utter simplicity and obtain good results with it. It should be cut for the lowest frequency band to be used or, if this demands too great a stretch, Marconi operation may be used on the highest wavelength, the antenna being cut for one band lower.

An All-Band Antenna

A second all-band antenna may be procured by simply cutting any single wire (plus lead) into a half-wavelength for the lowest frequency band to be used. Operation with a ground may also be used as above. This is really a voltage-feed type with a feeder of zero length. The end of the antenna is plenty "hot" and should therefore be hung close to the plate on the tank coil. A separate tank of low capacity (to reduce losses) may be coupled to the plate tank and the antenna hung on to that. A ground is sometimes used at the other end of this coupled circuit. However, some losses are bound to appear as the antenna comes into the shack and into the vicinity of other apparatus. Not only that but there is a strong field around the antenna which may be a nuisance —affecting neutralizing, paralizing the receiver, etc. Of course, the entire length of wire radiates so that a lot of energy may be wasted before it gets to the high part of the system. The length should be adjusted

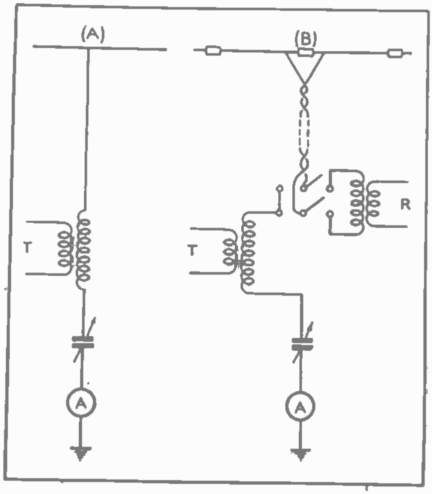


FIGURE 49

experimentally as with previous systems because the antenna proper, coming into the shack, is subject to all kinds of influences which might affect the fundamental, or natural frequency. This antenna is equally good on *all* harmonics because the ends of an antenna are always maximum voltage points (Figure 49).

A Zeppelin Antenna

A third type, permitting many-band operation is the old, reliable "Zepp," (Zeppelin) which is about the easiest antenna to resonate because a certain amount of tuning may be done right at the transmitter or receiver. See Figure 50. A half-wave antenna is used with quarter-wave feeders. This might be considered a full-wave affair with half a wavelength "folded," so that a point of maximum current comes right at the feeder end. This is a true current-fed antenna, the losses appearing in the previous voltage-fed system being entirely absent here. Although the feeders must be a quarter-wavelength long, electrically, much leeway is possible by loading or cutting with parallel or series-tuning condensers. When multi-band operation is desired, a compromise in length must be made to accommodate tuning to the various harmonics, the most reasonable length being a little under three-eighths wavelength. This is not at all critical, compared to the chopping of the flat tops for this family of antennas, but should be quite close. This limitation of feeder length which appears here for the first time in this series of antenna systems, might be worse were it not for the fact that the feeders may be bent or folded to add length. Again, the half-wave flat-top might well be

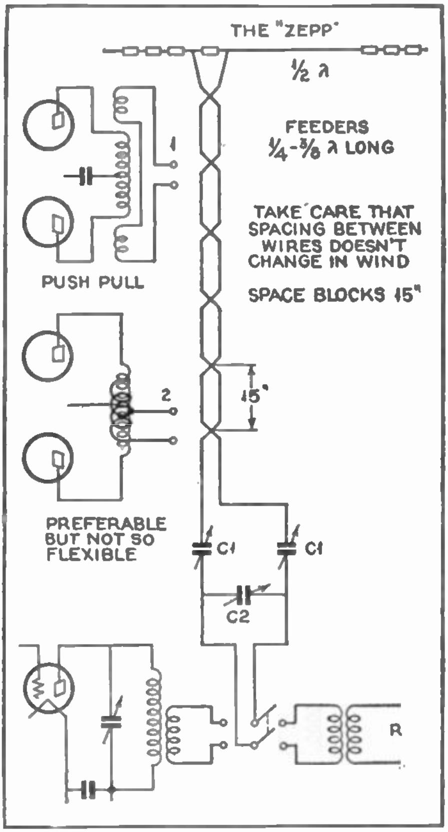


FIGURE 50

cut too long and chopped although this is less important with the Zepp than with most of the other types. Most hams do not get a proper balance of feeder currents so the feeders do some radiating. Even so, the results obtained usually justify this old favorite. It is because some leeway is possible that they don't take the necessary pains to do a perfect job. This is really an unbalanced system, but it does a lot toward improving the signal-to-noise ratio, especially when transposed feeders are used. However, in our opinion, the following antenna is really the ace of all wave receiving aerials.

A Balanced "Split" System

Figure 51 shows another very flexible system, this time a balanced "split" arrangement that resembles the first shown doublet, but which is really a one-and-a-half-waye antenna with two half-wave parts, folded as feeders. Since a current maximum exists in the center of the antenna we need half-wave feeders this time, to get back to another current maximum for current feed. Again, compromising in feeder length for the sake of the harmonic family, the feeders should be the same length as in the Zepp.

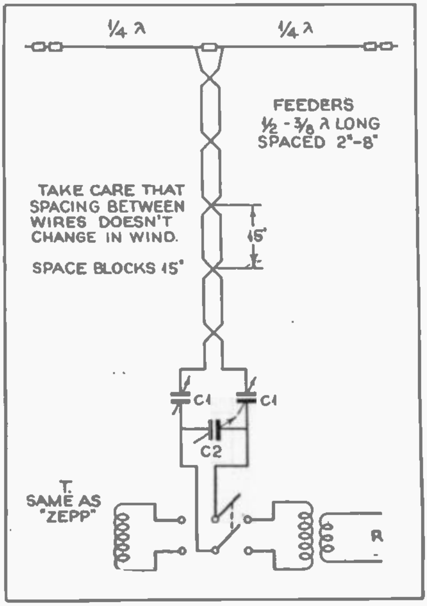


FIGURE 51

This will allow tuning to all bands in a similar manner. In both this type and the Zepp, the full voltage of the antenna appears on the feeders, so that the spacers must be first-class insulators and of low dielectric constant. When a transposed line is used this antenna is excellent for reception, although tuning *must be used!* This is the most versatile aerial of the whole bunch for multi-band use and will cover a large part of the short-wave spectrum.

To correct a common fallacy, solid wire has not the lowest high-frequency resistance but, rather, a sort of cable made of insulated wires, tightly twisted together, presents a much lower resistance than the equivalent solid wire.

The Radio News "Tenatuner"

Much is heard about the advantages to be obtained through tuning the antenna used for DX reception but there seems to be very little definite information available as to the extent of the improvement thus obtainable or on suitable equipment for tuning the antenna. A study of this subject has been made in the RADIO NEWS Laboratory and the antenna tuning unit developed from this study is described herewith for the benefit of DX fans who may be interested—and let it be said here that every DX fan can profitably take advantage of the improved DX reception provided by such a unit.

To illustrate the value of the unit, Figure 52 is made up from actual measurements made in the Laboratory. These measurements were made

Freq. KC.	*Ant. Direct*	*Ant. Tuned*	*Improvement in Output, Decibels*
600	1 v.	7.25 v.	17.2
800	1 v.	5.5 v.	14.8
1000	1 v.	4.3 v.	12.7
1200	1 v.	4.5 v.	13.1
1500	1 v.	1.8 v.	5.1

FIGURE 52

using a standard commercial receiver and an ordinary outdoor antenna approximately ninety feet long. The voltage measurements were obtained from a meter connected across the speaker. The signal was obtained from a completely shielded, modulated oscillator which was coupled to the antenna, and the output of which was completely independent of changes in antenna tuning. At each frequency the oscillator and receiver were tuned exactly and then the oscillator output cut down until the receiver output meter showed a reading of one volt with the receiver connected directly to the antenna in the normal manner. Then without changing any of the adjustments the antenna tuner was inserted between the antenna and the receiver and was tuned to resonance. The output meter was again read and gave a definite measure of improvement brought by the antenna tuner circuit. Thus it is seen that at 600 kilocycles the receiver output was multiplied 7.25 times or the equivalent of 17.2 decibels. At the other frequencies in the broadcast band, the gain was smaller, being only 1.8 times at 1500 kilocycles or the equivalent of 5.1 decibels.

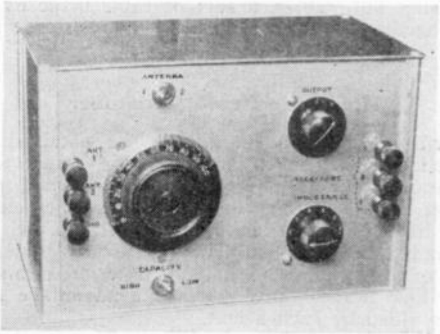


FIGURE 53

The average improvement for the entire broadcast band is seen to be slightly less than five times or the equivalent of fourteen decibels. Briefly, what this all means is that very weak DX signals which ordinarily could not be brought up to audibility with the receiver alone can be increased

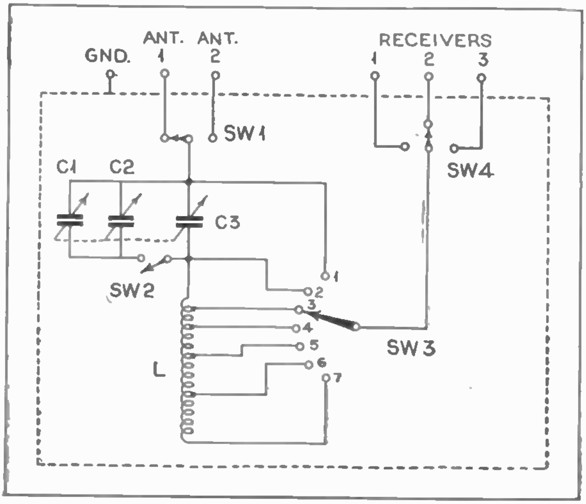


FIGURE 54

to a point far above the threshhold of audibility through the simple expedient of tuning the antenna.

Nor is this the only advantageous feature offered by antenna tuning. It is a known fact that internal noise in a receiver originates almost

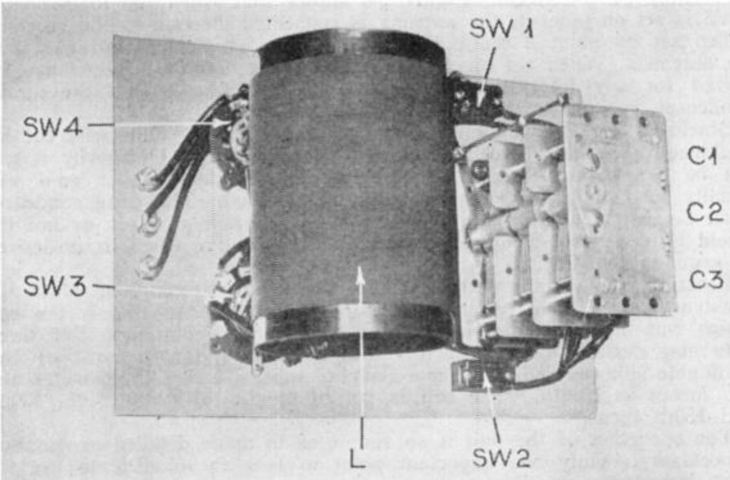


FIGURE 55

entirely in the first tube. Therefore, if a signal can be picked up, as it is when the antenna is tuned, before going into this first tube the ratio of signal-to-noise will be more favorable and in effect the noise level of the receiver will be materially reduced.

Where a short antenna is used the gain provided by tuning it is tremendous. In the above tests, for instance, a gain ratio of 24 was obtained at 600 kilocycles and 4.6 at 1500 kilocycles, or an average gain of approximately 14 (23 decibles) for the broadcast band. These measurements were obtained when the 90 foot outdoor antenna was replaced with a 20 foot indoor antenna. Thus where conditions necessitate the use of a short antenna, the unit described here will result in a degree of effectiveness approximating that of a much longer untuned antenna.

The "Tenatuner" consists basically of a tapped coil and a variable condenser in series between the antenna and the receiver. It is desirable to have a variable condenser with a maximum capacity of approximately 1000 mmfd. for this purpose but such good condensers are hard to obtain and for that reason an inexpensive three-gang condenser is employed in this unit. When all three condensers are in the circuit, the total capacity is somewhat in excess of 1000 mmfd. but provision is made, by means of the switch SW2, for cutting out two of these sections.

The switches SW1 and SW4 are refinements inasmuch as they permit two antennas and up to three receivers to be used and interconnected in any combination desired simply by throwing switches. Many DX fans have two antennas and two or three receivers which they use interchangeably and the switching arrangement provided in the Tenatuner will permit all of these to be permanently connected, and switching from one to another accomplished instantaneously.

A study of the circuit, Figure 54, shows that when the main switch SW3 is set on point 1, the antenna is connected directly to the receiver. When set on point 2 the tuning condenser is connected in series with the antenna. When set on points 3 to 7 the amount of inductance required for any frequency is cut into the circuit and, with the tuning condenser, constitutes the antenna tuning circuit.

Shielding of the entire unit is of course important. Otherwise the inductance L would provide undesirable direct pick-up. Ordinarily it will not be necessary to ground this shield and in fact higher gain will usually be obtained if the unit is left ungrounded. The gang condenser must be insulated from the shield—this is desirable whether or not the shield is to be grounded and is of course imperative where it is desired to ground the shield.

Practically all of the parts employed are standard, many of which the constructor will have on hand. The only exception to this is the coil which was especially designed and made for the Tenatuner. For those who may desire to construct this coil, it consists of 150 turns of No. 24 double silk covered wire on a Bakelite tube, 3 inches in diameter and 4½ inches in length. The coil is tapped at the 5th, 20th, 50th, 100th, and 150th turns.

The operation of the unit is so simple as to make detailed explanation unnecessary. Only one important point to bear in mind is to use the least inductance possible to reach resonance at any given frequency. This means that insofar as possible SW2 should be closed to place the three condensers in parallel and the coil tap selected which will permit keeping as much of this condenser capacity in the circuit as possible. The desirability of this is borne out in the tests described above. At 600 kilocycles with SW3 set at tap 6, the gain ratio obtained was 7.25. Setting SW3 on tap 7, and returning the condenser to resonance, provided a gain ratio of only 5.3. Thus by using more of the inductance than was necessary approximately 1/3 of the gain was sacrificed.

List of Parts

- C1, C2, C3—Trutest 3-gang condenser, 365 mmfd. each section, ¼-inch shaft.
- L—Trutest special "Tenatuner" coil (see text for winding data).
- SW1—Toggle switch, s.p.d.t.
- SW2—Toggle switch, s.p.s.t.
- SW3—Yaxley rotary tap switch, 7 point.
- SW4—Yaxley rotary tap switch, 3 point.
- 1—Aluminum box shield 9 inches long, 5 inches wide, 6 inches high.
- 1—Bakelite dial, 2½ inches diameter.
- 6—Eby binding posts with insulating washers.
- Hook-up wire, screws, nuts, hardware.

Multiple Antenna System

Here is an inexpensive multiple antenna system, actually installed in an apartment house, which provides efficient reception to four receivers from a single aerial.

The accompanying diagram, Figure 56, shows the circuit and the value of parts necessary in making the various coils and condenser combinations to which the leads are tapped for the different sets. All coils are wound in the same direction on the one coil form. The diameter of the form is not critical and can be from two to three inches.

A hard rubber, bakelite or cardboard tube can be used for the coil form. For protection and appearance the coil and condensers should be

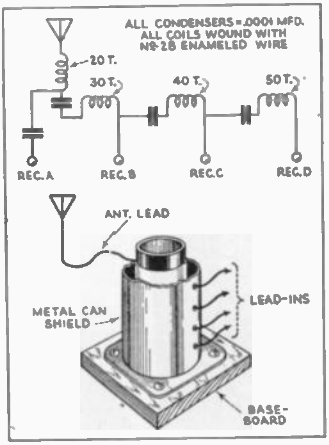


FIGURE 56

mounted in a metal can as shown. The completed unit can be mounted directly at the antenna lead-in or on the window sill adjacent to the first receiver.

Unique Indoor Antenna

A 30-foot length of twisted pair (lamp cord), connected as shown here, makes a surprisingly effective antenna for use with a.c. receivers. As will be noted in Figure 57, the end of one wire is connected to a

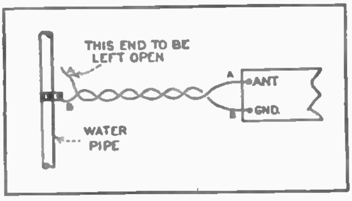


FIGURE 57

water pipe and the other end of this wire to the ground post on set. One end of the other wire is connected to the receiver antenna post and the other end left unconnected.

This antenna system works on the "ground loop" principle. The water pipe, ground and the a.c. line (which is always grounded somewhere along its span) constitute three sides of a large loop. When the water pipe is connected to the ground post on the set, the loop is indirectly completed. The second wire in the twisted pair couples the loop to the antenna post of the set by virtue of the capacity between the two wires of the pair.

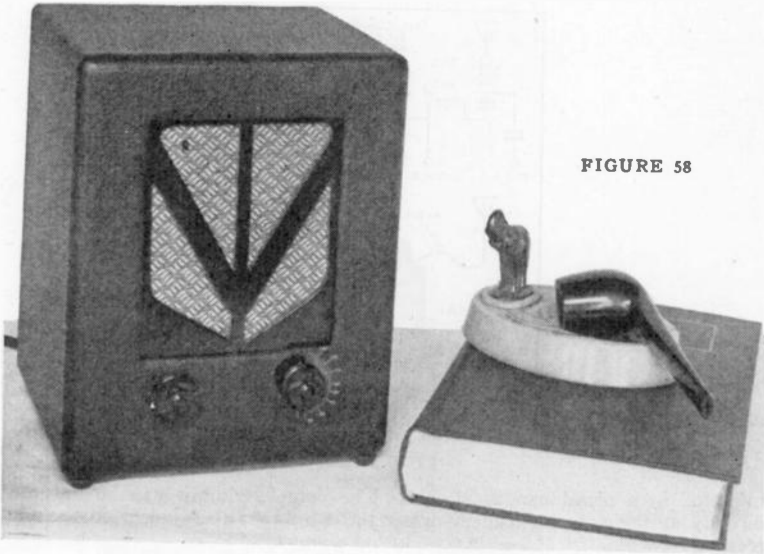


FIGURE 58

CHAPTER FIVE

Midget Broadcast Band Receivers

A 3-Tube A.C.-D.C. Compact

THIS three-tube compact universal receiver actually provides excellent 4-tube performance, due to the use of new 12A7 combination pentode-rectifier tube. Its compactness is indicated by the overall dimensions of the leatherette-covered case—7¾ inches high by 6¼ inches wide by 5¾ inches deep.

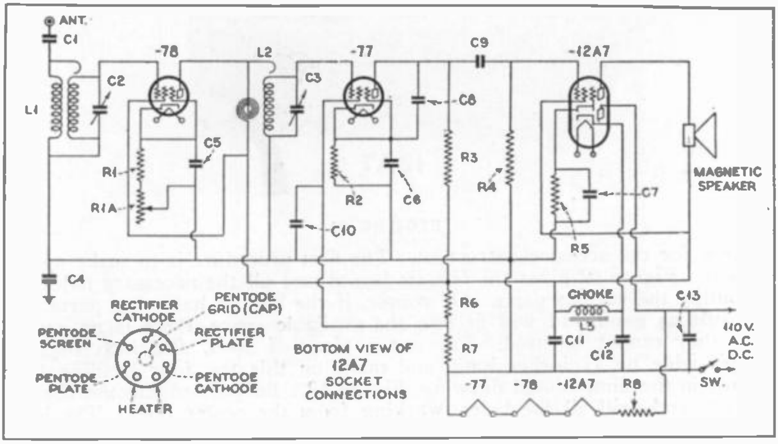
The receiver uses standard parts and the wiring is not at all complicated, as the constructor will notice by referring to the circuit diagram, Figure 59. The receiver employs a tuned radio-frequency circuit utilizing one -78, one -77 and the aforementioned 12A7 tube. This new 12A7 tube contains in one envelope a power pentode, having the same characteristics as the type -38 tube and a rectifier with characteristics similar to those of the 1V rectifier. Thus this tube plays the dual rôle of output tube and rectifier. The constructor will find the prong lay-out for this new 12A7 in Figure 59.

By further reference to the circuit diagram, it will be seen that the antenna is connected to the primary winding of the antenna coil through a .002 mica condenser, C1, shown mounted on the speaker bracket in Figure 60. The purpose of this condenser is to prevent the possibility of receiving a shock if the antenna wire and an external ground are touched simultaneously. It will also be noted that all parts are insulated from the chassis, for the same reason. The returns of the r.f. coils and by-pass condensers are made to the variable condenser frame, and this condenser is insulated from the chassis by a thin sheet of varnished cambric. The screws fastening the condensers to the chassis are insulated by a small piece of cambric sleeving placed over the screws and bakelite washers on each side of the chassis. Control of volume is accomplished by varying the bias on the -78 tube. This volume control also carries the on-off switch.

The antenna coil, L1, is located on top of the chassis, mounted on a bracket fastened to the back of the loudspeaker. The r.f. coil, L2, is mounted under the chassis, in back of the variable condenser. Particular care must be taken to have these two coils connected to their respective variable condenser sections as directly as possible. The detector circuit is conventional, employing a type -77 tube to provide high sensitivity. The screen voltage for this tube is obtained from the voltage divider resistors R6 and R7. The detector is resistance-coupled to the grid circuit of the 12A7 through resistors R3 and R4 and condenser C9. The magnetic speaker is connected directly in the plate circuit of the 12A7 as shown. The detector and output tubes are biased by resistors R2 and R5 respectively. C6 and C7 serve to by-pass these bias resistors, to obtain best quality. If the builder doesn't care too much for bass reproduction, these two condensers can be ¼ or ½ mfd. each, but for best reproduction it is suggested that 5 mfd. electrolytics be used. These 5 mfd. electrolytic condensers may be either single units or combined in one container. They are low-voltage units, rated at 25 volts, hence are very compact in size.

The filter choke, L3, is mounted under the chassis and can be readily seen in Figure 61. This choke is a very compact one with 500 ohms rated resistance. It is supplied with an upright mounting bracket so that it can easily be mounted on the chassis.

FIGURE 59



The filter condenser is also very compact, and is shown in Figure 60, at the front, right in back of the speaker.

The filament-reducing resistor, R8, of 250 ohms, is incorporated right in the line cord which is known as a "heater line cord." These cords are obtainable in various lengths and resistance values and it is suggested that the cord be as long as possible, at least 6 feet, and 10 feet if procurable. There is considerable heat dissipated in this line cord, and the longer it is the cooler it will be in use.

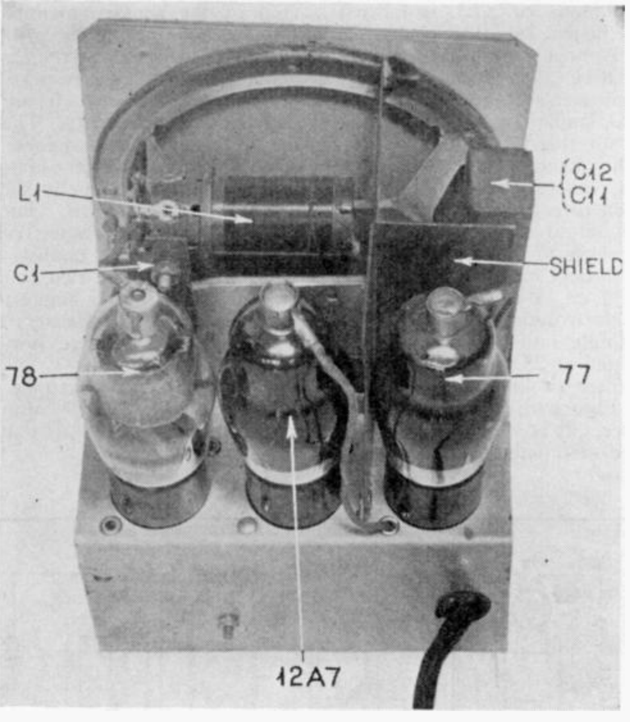


FIGURE 60

Now for the actual construction. The first procedure is to make up the chassis. Figure 62 gives the chassis layout and all the necessary holes for mounting the various parts. Of course, if the builder has other parts that are just as good and will fit into the available space, there is no reason why they cannot be used. Lay out a piece of steel, .042 inch thick, 5 inches wide by 11 inches long, and mark on this the four bending lines shown in the dimensional drawing, Figure 62. Before bending the chassis, lay out and drill all the holes, working from the center lines. The large cut-out for the speaker can best be made by drilling around its outline with a small drill, then chiseling out the enclosed piece and filing the edges smooth. The holes marked F are for passing through the connecting wires and should use steel grommets if possible, but for the great majority of us who cannot use such things the next best thing is to just make very sure that the edges of these holes are smooth, so that they cannot cut the insulation of wires going through them.

After all the holes have been drilled in the chassis, and it has been bent up in its final shape it should be plated. Cadmium is suggested, although a dull chromium may also be used. However, some plating should be used, to avoid future rusting.

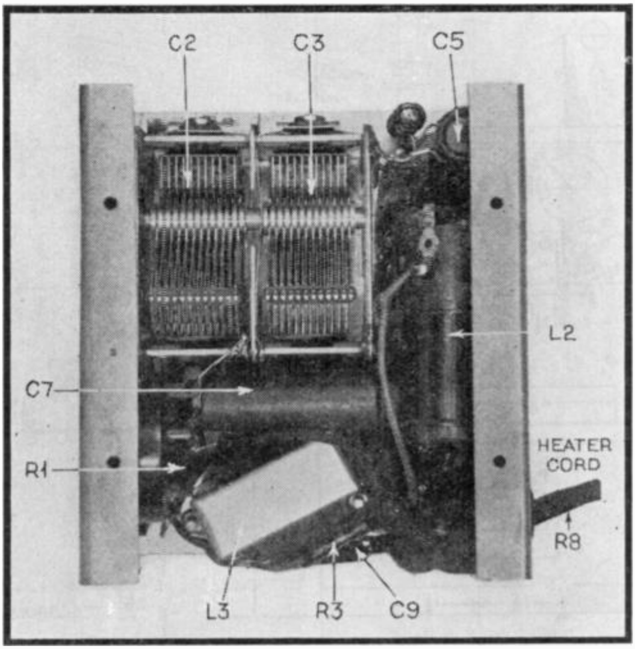


FIGURE 61

The drawing, Figure 63, shows the construction of the shield which is placed between the -77 and 12A7 tubes, as shown in Figure 60. Figure 63 also shows the speaker bracket dimensions. The spade bolts used on the shield are the same as used on variable condensers and coil shields by many manufacturers and can be obtained from any variable condenser manufacturer. These two shields should also be plated like the chassis.

When the chassis is completed and the parts are ready to assemble, the rest is comparatively easy. The variable condenser is first mounted under the chassis, taking the precautions mentioned before to insure its insulation from everything else. After it is in place it is suggested that its insulation be checked by means of a continuity meter. Next the loudspeaker is mounted in place. A word of caution is necessary here. Be sure that the assembly bench is scrupulously clean of all magnetic particles, otherwise these particles are liable to get into the speaker and ruin its performance. The volume control is next assembled on the chassis fol-

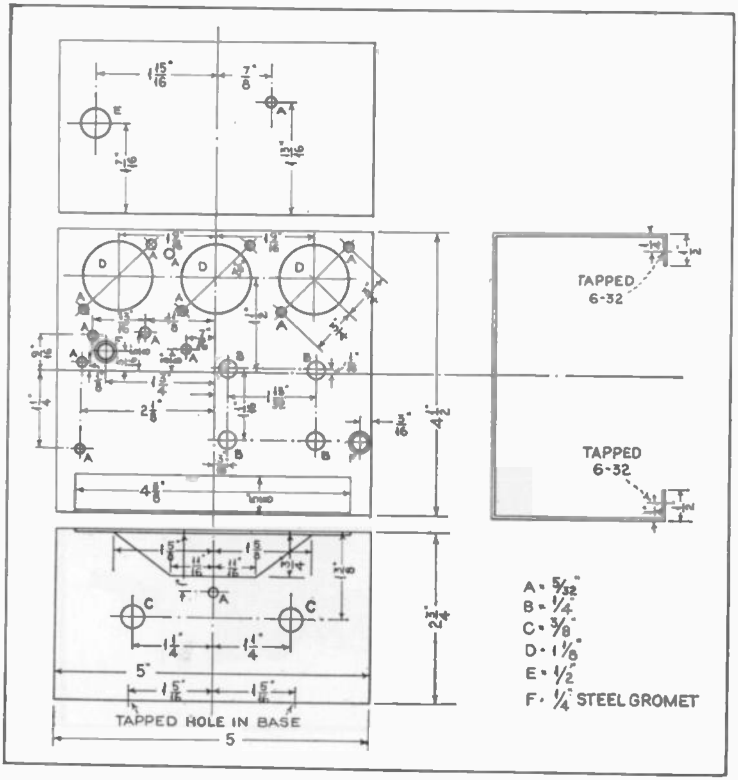


FIGURE 62

lowed by the choke and the sockets. The filter condenser block is mounted on top of the chassis, the antenna coil and antenna condenser are mounted on the loudspeaker frame and the r.f. coil is fastened under the chassis in back of the variable condenser. Resistances are mounted on their own leads and as directly as possible, as also are the smaller by-pass condensers. The dual .5 mfd. condenser block, C6 and C7, is mounted directly on the back of the variable condenser.

After the set is all wired up, check over all connections carefully, then plug it into the line. First check the voltages, to make sure all values are correct. There should be about 100 volts on the plate and screen of the -78 and 12A7, about 10 volts on the 12A7 cathode and about 4 volts on the -78 cathode on full volume.

Once the set is working, the alignment procedure is simple. Pick out

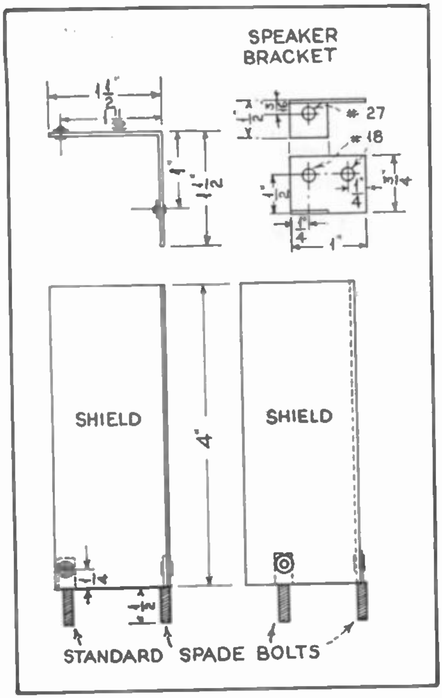


FIGURE 63

some station near 1500 kc. and adjust both compensators on the variable condenser, with the volume control reduced, until the signal is loudest.

If in operation the receiver tends to be unstable at the high-frequency end, it can be materially remedied by mounting a strip of copper about 2½ inches long by 1¼ inches wide at the grid end of the antenna coil. This shield can be fastened to the speaker frame and the tube shield as shown in Figure 60.

List of Parts

C1—Mica condenser, .002 mfd.
C2, C3—General Instrument 2-gang condenser, type 1450, each section 365 mmfd., clockwise rotation, low non-extending end plates, low extended shield, compensating condensers on short side

C4, C5—Tubular type 2-section paper condenser, .1 mfd., 200 volts
C6, C7—Electrolytic condensers, 5 mfd., 25 volts
C8—Mica condenser, .0005 mfd.
C9—Paper condenser, .02 mfd., 200 volts
C10—Paper condenser, .05 mfd., 200 volts
C11, C12—Electrolytic 2-section condensers, 4 mfd., 175 volts, mounting holes space 1⅜ inch
C13—Paper condenser, .1 mfd., 200 volts
L1—Sickles antenna coil
L2—Sickles radio-frequency coil
L3—Kenyon filter choke, 30-henry, 500 ohms, type KC500
R1—Carbon resistor, 400 ohms, ½ watt
R1A—Centralab rheostat, 200,000 ohms
R2—Carbon resistor, 20,000 ohms, ⅛ watt
R3—Carbon resistor, 250,000 ohms, ⅛ watt
R4—Carbon resistor, 500,000 ohms, ⅛ watt
R5—Carbon resistor, 1,000 ohms, ⅛ watt
R6, R7—Carbon resistors, 50,000 ohms, ⅛ watt
R8—Ohmite 250-ohm heater line cord, 10 feet long
SW—Power switch on volume contro', R1A
2 six-prong wafer sockets
1 seven-prong wafer socket
1 tube shield and speaker bracket
1 metal chassis
1 leatherette-covered cabinet, 7¼ inches high by 6¼ inches wide by 5¼ inches deep outside dimensions
1 Best 5-inch magnetic type loudspeaker, 8500 ohms for a single 12A7 type tube

The condensers and resistors can be of any reliable manufacture.

A "Super Six" Midget

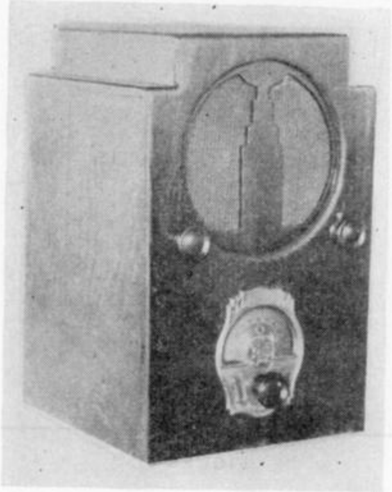


FIGURE 64
Front view of the receiver.

The physical size and high amplification factors of the new -50 series tubes suggested the design of a real midget receiver. Heretofore most midget sets have been midget in performance as well as size. The high gain obtainable in intermediate stages with the type -58 tube, however, promised a receiver that would stand up with the larger models as to performance while still retaining the advantages of small size.

A type -58 tube is used in the first stage as a combination r.f. amplifier and frequency changer. Ordinarily, the gain in this stage is very low, but by the incorporation of a new principle the amplification is made considerable. It will be noticed that the type -56 tube used in the oscillator is coupled to the frequency-changer stage through a coil inserted in the suppressor-grid lead. Thus the r.f. from the oscillator swings this grid both positive and negative with respect to the cathode. During the positive part of the r.f. cycle a condition exists in the -58 tube much like that necessary for oscillation, and it will be remembered that in an Armstrong super-regenerative circuit a very high effective amplification is obtained by using this principle. Thus considerable extra gain is obtained over this stage by driving the suppressor grid at the oscillator rate than would have been the case had the cathode been modulated as in the usual arrangement. The fact that this is done at an r.f. rate some 250 kilocycles above the station frequency prevents the circuit from becoming unstable, as it is a well-known fact that, as in super-regenerative action, a vacuum tube can be operated at much higher than oscillating voltages by supplying this voltage in short pulses such that the tube does not have time to go into oscillation between positive and negative pulses.

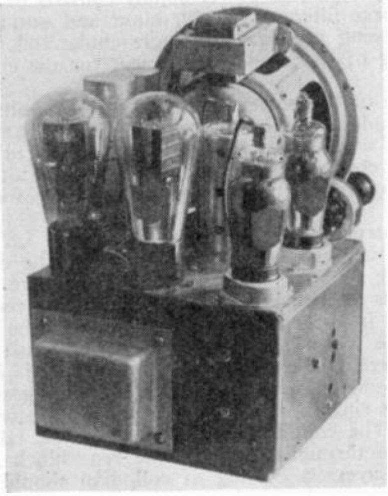


FIGURE 65

The use of a -58 in this stage also greatly reduces interference due to cross modulation by strong local stations. As would be expected, the selectivity lies almost entirely in the intermediate stages. The first r.f. stage tunes quite broadly, and for this reason little difficulty will be encountered in lining up the oscillator and r.f. stages for tracking purposes.

The volume control is a combination of antenna shunt and grid bias. A great number of systems were experimented with, but this control proved the best when it was applied to the cathode and suppressor grids of both the r.f. stage and the intermediate stage. It was found necessary to use the antenna shunt combination in order to reduce the signal strength to prevent overloading. It works very well, partially because the -58 tube is of the remote cut-off type, the mu of the tube decreasing from around 1500 to as low as 50 when the negative grid bias is increased. This reduces the amplification in the intermediate stage where it is the most effective in reducing volume.

A second type -58 is used in this stage, having both input and output tuned. Very thorough shielding is necessary if this stage is to be operated without oscillation, but with proper precautions an exceedingly high gain will be obtained. It is this amplification which accounts for the performance of the set despite the small size of the chassis.

A type -57 tube is used in a tuned input, grid-bias second detector circuit for both gain and quality of reproduction. The plate circuit is loaded with the conventional low-pass filter consisting of an r.f. choke and two by-pass condensers. This increases the gain obtainable in this stage greatly and so betters the overall performance of the receiver.

The pentode -47 stage is the usual type, feeding into an output transformer with the proper impedance to give maximum gain with best quality of reproduction. The power supply consists of a type -80 rectifier feeding a brute-force filter of 8 mfd. input and output, the field of the dynamic speaker being used as the single choke coil. This results in a considerable saving of space and is sufficient for the current requirements of the set.

The full voltage of the power supply, some 260 volts, is applied to the -58's and the pentode. The oscillator and detector are supplied through dropping resistors, while the screens also are operated at a lower potential. The by-pass condensers shown are necessary, all unnecessary parts having been eliminated in the preliminary tests before the parts were definitely placed in the chassis.

In case the constructor wishes to make his own i.f. transformers, and the ones described are considerably smaller than the commercial models, complete details are given in Figure 67. The coils are wound on a winding form which fits the chuck of a hand drill for convenience. Two paper washers are placed in the winding form to prevent the wire from coming in contact with the wood blocks. A paper ring must then be prepared on the dowel to serve as the "core" for the coil. This is done by winding several turns of bond or writing paper and securing the end with some Duco cement. This ring should be free to slip off the winding form dowel when completed. The coil is then scramble-wound, taking care to bring out the inside wire through a slot in the rear block before starting to wind. Every few layers, a coating of collodion should be applied to the coil. This mixture can be made by dissolving some clear celluloid in acetone. When the coil has been wound, the end block is removed and a further coating of collodion is applied to the coil. It is then allowed to dry thoroughly before using.

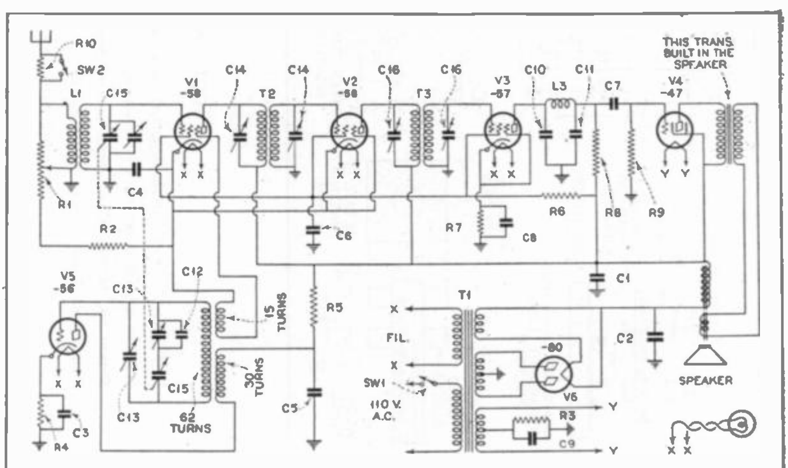
Four of these coils must be made for the two transformers. A piece of dowel is cut to length and the coils slipped over the end. When the supporting bus-bar has been driven in solidly and bent over, the unit may be fastened to the tuning condenser by soldering the bus-bar to the two opposite terminal lugs. This results in extremely strong construction with a minimum of space taken up. When all of the wires have been connected, the coils may be spaced one-half inch apart and dipped in paraffin to prevent the absorption of moisture. The shield can should then be placed over the completed transformer and cut off at the bottom so as to leave about a ¼-inch clearance at the top of the can. This is necessary in order to reduce the size of the can to proper dimensions in order to allow its mounting inside the chassis. Some care should be taken that the bus-bar used for supporting the wooden dowel does not touch the shield can, and a paper lining placed inside the shield can will prevent any possibility of a short-circuit which would be disastrous to the -80 tube and filter circuit.

The antenna coil (Figure 68) consists of a 1¼-inch form wound with a primary and a secondary. The primary has 20 turns of No. 28 enameled wire and the secondary 110 turns of the same kind of wire. It is fitted with a bracket as shown in Figure 68. After the coil has been wound to suit, it should be dipped in paraffin or otherwise covered with a moisture-proof substance to prevent the absorption of moisture.

The oscillator coil (Figure 69) is somewhat more difficult to construct, and the directions must be adhered to if the tuning condensers are to track when completed. It consists of two coils wound separately. The inner winding is on the standard 1¼-inch form and consists of 62 turns. The outer coil is wound on a paper form which just fits around the first coil and consists of two windings, one of 30 turns and the other of 15. Number 28 enameled wire is used for these coils. The 30-turn winding is used as the regeneration coil while the 62-turn section is the tuned portion of the oscillator circuit. The 15 turns serves as the oscillator coupling coil.

The entire coil unit is mounted on a Hammarlund screw type dual condenser, 10-70 mmfds., C13. One section of this condenser is used across

FIGURE 66



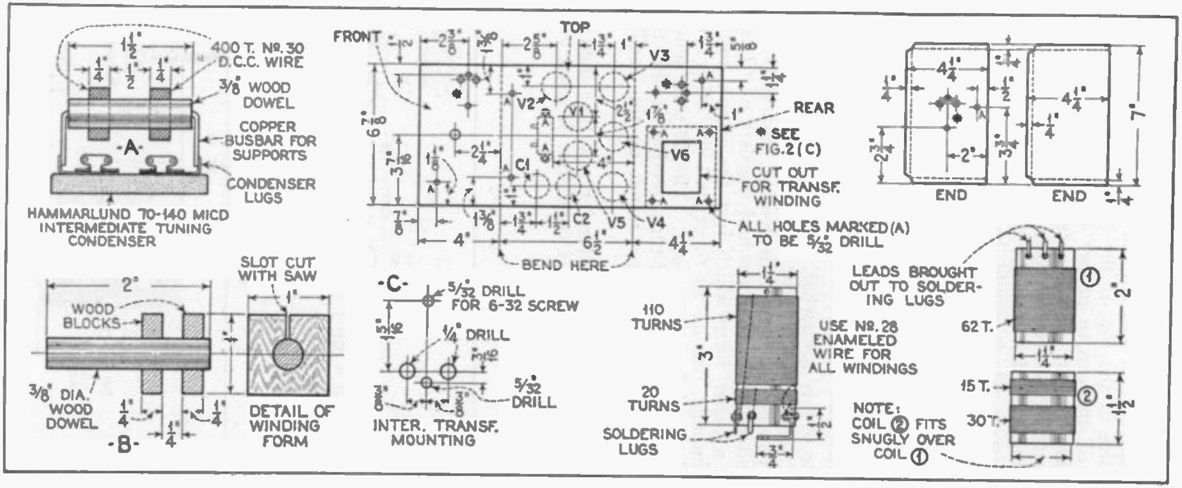


FIGURE 67, 68, 69 and 70

COIL AND CHASSIS CONSTRUCTION

In Figure 67, shown at the left, (a) shows section of completed transformer, (b) form employed in preparing coils and (c) the specifications for i.f. mounting and adjustment holes to be provided in front and rear walls of chassis. Figure 68, shown in the lower center, gives specifications for antenna coupling coil. Figure 69, shown in the lower right hand corner, shows details of oscillator coupler. From the dimensions given in Figure 70, upper center and right hand corner, readers will be able to duplicate the author's chassis.

the oscillator coil as a trimmer, the other section across the padding condenser as a trimmer.

A certain amount of care must be taken in assembling the parts in their proper order, as it will be noticed that much of the set is inaccessible. Hence a few suggestions will be given as to those parts which must be mounted first in order to avoid trouble. It will be found advisable to mount the power transformer temporarily and write down a list of all connections which cannot be reached when it is in place. These include the -80 socket, the pentode socket and some terminals on the -56 socket. Remove the transformer and mount the sockets and shield can bases, as these parts use the same mounting screws. Connect the grid return resistor (R9) on the -47 from grid to ground, directly under the power transformer. The filaments should be wired and leads left of sufficient length to reach the proper terminals of the power transformer.

The screen-grid by-pass condenser, the detector by-pass and cathode resistor will all mount under the first intermediate transformer which in the photographs is located next to the tuning condenser. Leads should then be soldered on all socket connections which will be covered by the power transformer, including a grid lead to the pentode. The plate of the pentode can be connected to the output transformer, as can the suppressor grid. The filter condensers can be mounted and partially wired in.

As soon as the power transformer is placed, make all of the filament connections, -80 plate leads and center-tap to ground connections. This will finish the wiring of the power transformer. The intermediate transformers can now be placed and wired as far as possible, leaving generous leads to any connection which it is not possible to make at the time. The antenna coil and tuning condenser can now be mounted, the former on one of the mounting screws for the first filter condenser and the latter by the single-hole mounting nut on the shaft. The high-voltage lead from the filter circuit is brought up to an insulated screw shown in the center of the chassis fastened onto the power transformer mounting bolt. It carries two solder lugs, and the oscillator resistor and detector plate resistor have one end each soldered directly onto these lugs. The last unit to be mounted is the oscillator coil, and all connections to it must be made with flexible leads soldered to the proper connections before placing it.

Turning the set upright, the volume control may be mounted and the resistor in the cathode circuit fastened between it and the by-pass condenser. The local-long distance switch (SW2) goes on the other side, its resistor being mounted in a vertical position directly above it. The grid clips can now be soldered on, and when the dial and dial light have been fastened in place the set is ready for adjusting.

The tuning condensers should be set to pick up some local station at the high-frequency end of the dial. The intermediate tuning condensers should then be screwed all the way in and backed off about two turns. In this way they are all set at about the same point. With the volume control at maximum, rotate the oscillator trimming condenser back and forth. This condenser screw is reached through a hole in the chassis on the left side looking from the front. If this adjustment will not give results, try rotating the tuning dial a little to either side and repeating the procedure. If none of these are effective, turn all intermediate tuning condensers in half a turn and proceed as before. Should this prove ineffective, the set will have to be serviced to determine whether all tubes have the proper voltage and current.

When a signal is located, rotate the tuning condenser for maximum volume and readjust the oscillator trimmer. The intermediate tuning

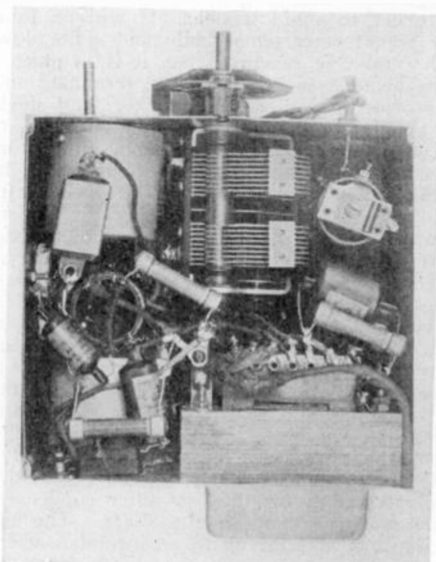


FIGURE 70

condensers should now be adjusted separately for the loudest signal. Next tune down to the low-frequency end of the dial and adjust for maximum volume, using the trimmer for the padding condenser and the antenna trimmer. It may be found that the high end will then be a little off, and it may be necessary to readjust the intermediate frequency a little in order to make the set track over the entire dial.

It will be found that local stations will come through with such strength that it is not possible to control them with the volume control even in the off position. Hence, for the constructor who lives in a large city where there may be one or more powerful stations, a local-long distance switch has been added which places about 1800 ohms in the antenna. This value may be determined experimentally and depends a great deal on the location. The selectivity will be found to be comparable to that obtained from a two or three-stage t.r.f. receiver, and on locals it is usually much better. Image frequency will not give as much trouble as might be expected. Clear reception has been obtained on stations all over the United States over a period of a week. The receiver was taken to Lawrence, Kansas, and tested with an antenna strung around the moulding of a small room. A station was received on practically every point on the dial, including all of the Chicago stations, KFI, WLW and all of the more powerful long-distance stations.

List of Parts

C1, C2—Potter dry electrolytic condensers, 8 microfarads, 450 volts
C3—Potter Master by-pass condenser, .006 microfarad, 450 volts
C4—Shielded by-pass condenser, .25 microfarad
C5, C6, C7—Potter Master by-pass condenser, .1 microfarad, 450 volts
C8—Potter Master by-pass condenser, .25 microfarad, 450 volts
C9—Potter Master by-pass condenser, .5 microfarad 450 volts
C10, C11—Mica condensers, .0005 mfd.
C12—Mica condenser, .002 mfd.
C13—Hammarlund i.f. tuning condenser, dual type, 10-70 mmfd.
C15—Radio Condenser Company compact double-section tuning condenser, .000375 mfd.
C14, C16—Hammarlund intermediate tuning condenser, dual type, 70-140 mmfd.
L1—Antenna coil (see text)
L2—Oscillator coil (see text)
L3—85 millihenry r.f. choke coil
R1—Clarostat 1000-ohm potentiometer with switch
R2—300 ohm I.R.C. resistor
R3—500-ohm I.R.C. resistor
R4—1000-ohm I.R.C. resistor
R5—20,000 ohm I.R.C. resistor
R6—75,000-ohm I.R.C. resistor
R7—30,000-ohm I.R.C. resistor
R8—250,000-ohm I.R.C. resistor
R9—1-megohm I.R.C. resistor
R10—Fixed resistor, 1800 ohms
T1—Stancor power transformer, small type, with core dimensions 4 inches by 3⅛ inches; windings as follows: 700-volt center-tapped, 5 volts at 2 amp.; 2.5 volts at 1.75 amp. center tapped, 2.5 volts at 4 amp.
T2, T3—I.F. transformers (see text)
Utah 6-inch dynamic speaker with 2500-ohm field, equipped with output transformer to match single —47 tube
3 Eby wafer sockets, 6 prongs
2 Eby wafer sockets, 5 prongs
1 Eby wafer socket, 4 prongs
3 ICA midget shields for —50 series tubes
2 coil shields, 2-inch diameter
3 grid clips
1 Crowe midget dial with moving spotlight
Aluminum for chassis, wire, solder, screws, etc.

The Junior DX'er

The receiver described here, has definitely proven its ability to bring in innumerable distant stations on the broadcast band right through the heart of the evening while local stations are going full swing.

The rather surprising sensitivity of the receiver is accounted for by the care exercised in its design and in the use of the newest types of pentodes throughout. An unusual feature that very largely accounts for the excellent selectivity is the dual-tuned preselector circuit employed.

This emphasis on the sensitivity and selectivity of this little receiver should not be taken as indicating that these are the only features it offers. The power detection, with the power pentode resistance-coupled to this detector, operate to provide most pleasing tone quality which is adequately maintained by the dynamic speaker employed. On the whole, the receiver is such that its performance should satisfy experienced radio fans, yet it is one which will present no constructional difficulties to the merest novice—a fact which will be confirmed by a glance at the wiring diagram and the photographs. Last, but by no means least, the entire kit, including parts, chassis, tubes, speaker and cabinet, costs well under $25.00.

The circuit of the receiver as shown in Figure 72 has been designed for high efficiency, economy of parts and tubes, and maximum simplicity. One of the new -57 pentodes is used as a combined first detector and oscillator. In this arrangement, the control grid is connected in the usual manner to a tuned circuit, with a preselector (band-pass selector), L1, ahead of it to provide the necessary selectivity. The primary of the

FIGURE 71

oscillator coil, L2, is in series in the plate circuit, so that the tuned secondary of this coil is magnetically coupled to the plate circuit. This tuned oscillator circuit determines the frequency of the generated oscillations, these being 175 kc. higher than the frequency of the incoming signal. The tuned primary circuit of the first i.f. transformer, L3, is also in series in the plate circuit.

Single-dial control is accomplished through the use of a three-gang, .000365 mfd. (each section) variable condenser. Two sections of this condenser are in the circuits of the signal-frequency band selector. The remaining section tunes the oscillator circuit.

The volume-control potentiometer, R1, performs the dual function of increasing the control grid bias on V2 and grounding the antenna—that is, when reducing volume—and vice versa. This ingenious type of volume control is smooth and even.

The i.f. transformers, L3 and L4, are peaked at 175 kc. The single i.f. stage uses a type -58 variable-mu pentode which effectively reduces cross-modulation and modulation distortion. A -57 type pentode tube is used as the second detector. Power detection is employed. This tube is resistively coupled to the output pentode (type -47), thus insuring tone fidelity. A 50,000-ohm resistor in the cathode circuit provides the proper detector bias. Phonograph jacks are provided at J1 and J2. These are ordinarily shorted by a small piece of bus-bar wire which is removed when the audio portion of the receiver is to be used in conjunction with a phonograph pick-up.

A single power transformer, T2, furnishes the high voltage for the rectifier tube plates, the 5-volt rectifier filament voltage and also a filament voltage of 2.5 volts for the four pentodes. Due to the fact that the two -57 tubes and the -58 tube are of the cathode type, whereas the -47 tube is of the direct-heater type, it is possible to use a single filament winding to supply all four tubes. In other words, the negative bias voltage on the -47 tube does not affect the other three cathode heater tubes.

The 1800-ohm speaker field, L5, takes the place of an audio choke. Combined with the two electrolytic condensers C12 and C13, it acts as an adequate filter system. The output transformer T1, with 7000-ohm impedance primary to match the -47 tube, is an integral part of the dynamic speaker. The "on-off" switch, SW, is controlled by the same knob as the volume-control potentiometer, R1.

The complete receiver is housed in a shaded two-tone cabinet, finished in American walnut. An illumined full-vision dial is used. The cabinet houses not only the receiver, but also a high-quality midget dynamic speaker which gives lifelike, full-rounded tones. In addition, there is provision for using the a.c. line as the antenna instead of outdoor or indoor aerial.

Constructional Directions

First, mount the five sockets and the special preselector mounting socket, as shown in the top view illustration (Figure 73). In mounting sockets V1, V2 and V3, fasten shield bases at the same time. Next mount the three-gang condenser about ¾ inch back from the edge of the chassis. The power transformer is mounted as shown at T2.

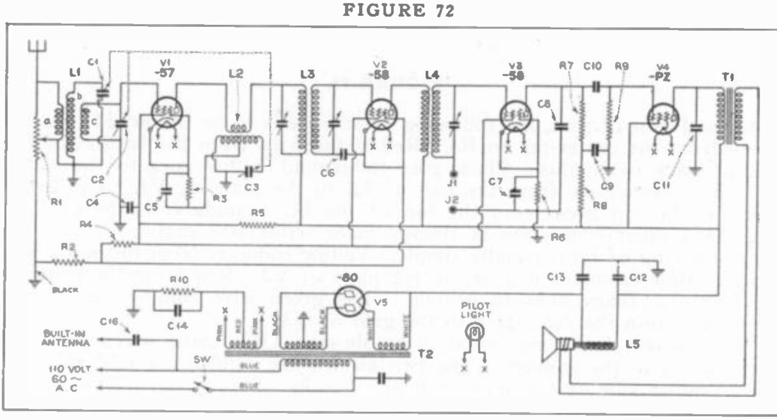
The dual electrolytic condenser is mounted in an inverted position. Then the combination oscillator, the first i.f. transformer and the second i.f. transformer are fastened in place. Finally the preselector is mounted.

The combined volume control and switch is mounted at the front chassis wall. The twin jacks are mounted at the rear of the chassis.

The chassis is now turned upside down and condenser C15 is fastened to the bottom by means of a small strap. All other parts on the underside of the chassis are soldered in place during the process of wiring, in most cases being soldered to the terminal of the particular tube socket with which they function (Figure 74).

Starting with the wiring, the filament circuits of the four pentodes are wired in first. These are all in parallel across the two heavy pink wires of the power supply transformer. The pilot light is wired in at this

FIGURE 72



time to the same filament line. This light is fastened to the top of the three-gang condenser. The filament of the rectifier tube may be wired in next, to the two heavy white wires of the power transformer. The rectifier plates are then connected to the two thin black wires coming out of the transformer on the same side as the heavy pink wires.

Leaving the power supply circuit for the time being, the preselector is now wired in. The top coil is the primary and this is wired to the antenna and volume control at one end and to the ground at the other. The coil close to this is the first tuned secondary. This is wired to condenser C1. The coil at the bottom, separated by ¾ inch from the others, is the second tuned circuit. This is wired to condenser section C2.

The grid circuits are wired next, then plate circuits, then cathodes, negative returns and by-pass condensers. In wiring in the combined oscil-

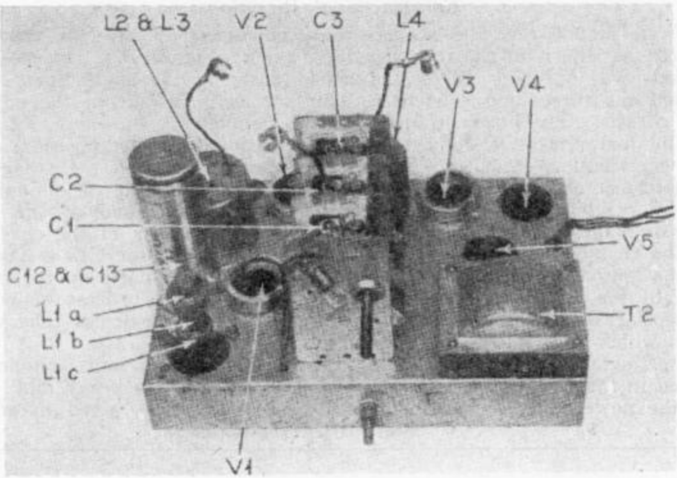


FIGURE 73

lator and first i.f. coil, the following color code is to be followed: Yellow goes from the center-tap to R3. Red is the wire from the bottom of the i.f. primary to B plus. Black goes to ground. Blue goes to the stator of C3. Green goes from the end of L2 to the plate of V1. The green wire at the top goes from the top of the i.f. secondary to the grid of V2. The other connection is already made within the case.

The wiring of L4 is equally simple. Yellow connects from the secondary to J1. Blue from the primary to the plate of V2. Red from the primary to B plus. Black goes to ground. The green wire coming out of the top goes from the secondary to the grid of V3.

The speaker leads are wired in as shown. Only three wires go from the chassis to the speaker. The two electrolytic condensers C12 and C13 shunt either side of the speaker field. Finally, the primary of the power transformer is wired in series with the switch on the volume control.

Condensers C15 and C16 are wired in at this time. This completes the wiring.

In testing and adjusting the set, the first step is to peak the intermediate-frequency transformers to 175 kc. The first i.f. transformer has two tuned circuits, whereas the second transformer only has a tuned secondary. An oscillator may be used, although it is possible to make this adjustment on a broadcast signal.

The next step is to balance the three equalizing condensers on the three-gang tuning condenser. This adjustment should be made first on a station at the lower end of the dial and then on one at the upper end.

To use the receiver with the "built-in" antenna, connect the brown spotted wire to the blue antenna wire. Connect the black wire to ground if this is available. A ground is not absolutely essential. For maximum

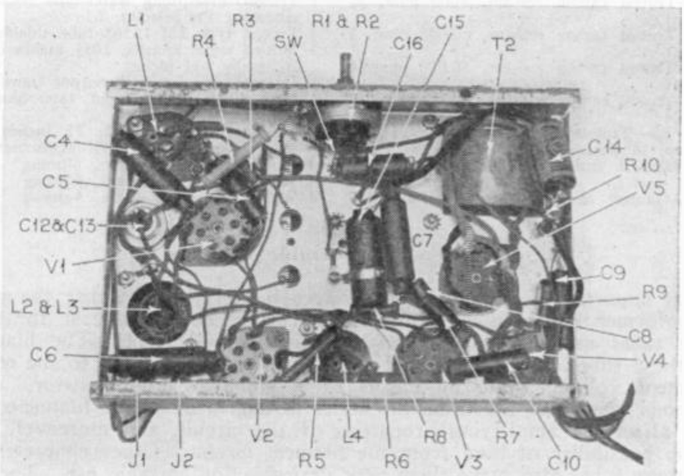


FIGURE 74

distance, however, a good aerial and ground are recommended.

Although the above directions may sound a bit complicated, this set has been thoroughly worked out in advance and even a beginner will experience no trouble in assembling it, wiring it and obtaining excellent results. If there is any difficulty in controlling oscillations, these may be eliminated by shunting condenser C2 with a 500,000 ohm resistor.

As explained above, the power transformer and the various coils are all color-coded, so that only a color blind person could make a mistake in wiring in these parts.

List of Parts

C1, C2, C3—Trutest, 3-gang shielded variable condenser, .000365 mfd. each section, with three equalizing condensers attached.

C4, C6, C7—Cornell "cub" cartridge condenser, .1 mfd., 200 volt

C5—Cornell "cub" cartridge condenser, .002 mfd., 600 volt

C8—Cornell "cub" cartridge condenser, .002

mfd., 600 volt
C9—Cornell "cub" cartridge condenser, .00025 mfd., 600 volt
C10—Cornell "cub" cartridge condenser, .01 mfd., 600 volt
C11—Cornell "cub" cartridge condenser, .001 mfd., 600 volt
C12, C13—Trutest dry electrolytic dual condenser, Type D3335 (C12—8 mfd.) (C13 4 mfd.)
C14—Cornell "cub" cartridge condenser, .5 mfd., 200 volt
C15—Cornell "cub" cartridge condenser, .01 mfd., 600 volt
C16—Cornell "cub" cartridge condenser, .02 mfd., 600 volt
R1—10,000 ohm Potentiometer with 300 ohm resistance R2, and equipped with Switch—Sw1
R3—Trutest carbon resistor, 4000 ohm, ½ watt
R4—Trutest carbon resistor, 60,000 ohm, 1 watt
R5—Trutest carbon resistor, 50,000 ohm, 1 watt
R6—Trutest carbon resistor, 50,000 ohm, ½ watt
R7, R8—Trutest carbon resistors, 250,000 ohm, ½ watt
R9—Trutest carbon resistor, 500,000 ohm, ½ watt
R10—Trutest carbon resistor, 500 ohm, ½ watt
L1—Trutest Pre-Selector Coupler
L2, L3—Composite Oscillator (L2) and 175 k.c. 1st Intermediate Frequency Transformer (L3).
L4—2nd Intermediate Frequency Transformer, peaked at 175 kc.
L5, T1—See dynamic speaker, below
T2—Trutest Power Supply Transformer, 350 volts each side of center-tap, with 5 volt and 2½ volt filament windings
J1, J2—Eby Twin "Phono" Jacks, type 2M13030
V1, V3—Arcturus type —57 pentode tubes
V2—Arcturus type —58 variable-mu pentode
V4—Arcturus type Pz power output pentode
V5—Arcturus type —80 full-wave rectifier
1 Trutest direct-drive full vision dial with pilot light
1 Trutest Five-prong wafer-type socket for mounting Pre-Selector, L1
3 Trutest type 2M 13265 tube shields
1 Drilled metal chassis, 10⅛ inches by 6¾ inches by 1¾ inches
1 Dynamic speaker with output transformer, 7000 ohms primary and 1800 ohm field coil
1 Walnut-finished cabinet, 15 inches high, 12 inches wide, and 7½ inches deep
3 Wafer type tube sockets, 6-prong
1 Wafer type tube socket, 5-prong
1 Wafer type tube socket, 4-prong

An A.C.-D.C. Portable Receiver

An important feature of this receiver lies in the fact that the power transformer has been eliminated, thus cutting down the cost for parts. The tubes used are of the quick-heating, cathode type. The filaments of the 5 tubes are in series and the line voltage is reduced to the correct filament voltage value by means of a suitable series resistor. Since cathode type tubes are used, the series arrangement of the filaments does not affect the amplifying properties of the circuit, and moreover, there is no possibility of hum from the filament circuit. Other characteristics of these tubes also make them very desirable for portable use. They are rugged and their filament current is only .3 ampere. Since they are connected in series, this value (.3 ampere) represents the total filament current drain.

As shown in Figure 76 a tuned radio-frequency circuit is employed having one stage of tuned r.f., an untuned second r.f. stage, a tuned detector using grid-leak rectification and a single audio stage. Variable-mu -39 type pentode tubes are used in the two r.f. stages and the detector. The antenna coupler is lateral-wound with Litz wire and combines high efficiency with great accuracy. Impedance coupling is used between the r.f. stages. A tuned impedance is used to couple the second r.f. stage and the detector. Both the secondary of the antenna coupler and the impedance are tuned by sections of a small two-gang variable condenser. Resistance coupling is used between the detector and the audio output stage. This stage uses a -38 type output pentode. This tube permits the use of a pentode screen-grid tube as an audio amplifier, giving high gain without distortion. with low signal input. Furthermore, the -38

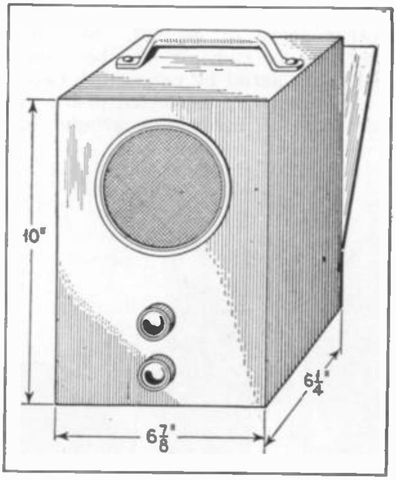


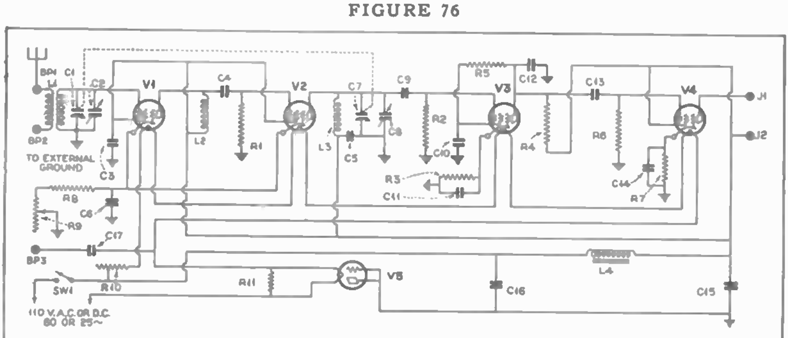
FIGURE 75

works exceedingly well with a plate voltage as low as 90 volts, and this characteristic is highly advantageous where the maximum available voltage happens to be 110 instead of 115 volts.

Rectification is obtained through the use of a -71-A tube, by tying the plate and grid together, thus making the tube into a two-element half-wave rectifier. Since the filament current drain of the -71-A tube is slightly less than that of the other tubes, this is equalized by shunting the filament terminals of the -71-A with a 50-ohm resistor. Hum is eliminated through the use of a small audio choke, by-passed at either end by cardboard type electrolytic condensers.

The circuit (Figure 76) presents a number of other interesting features. Provision is made for any one of four aerial arrangements. First, it is

FIGURE 76



possible to use simply a piece of stranded wire about ten to fifteen feet in length, with no other aerial or ground. Second, conventional aerial, and ground to a water pipe or radiator may be used. Third, the electric light line may be used as an aerial by connecting two of the three binding posts together, with a ground wire connected to the ground post. Fourth, the electric light line may be used as a ground in connection with a

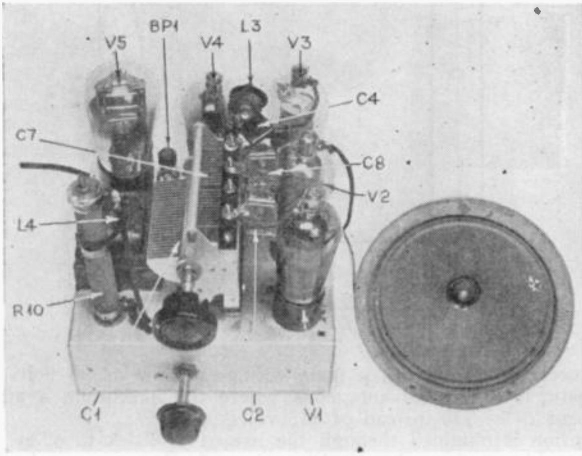


FIGURE 77

short aerial. Naturally, the first method is the most convenient, and this is the one which is used most frequently. To prevent short circuits, the negative side of the line is not grounded to the chassis, but is brought out to a binding post through a .0005 mfd. condenser.

Volume is controlled by means of a potentiometer in the cathode return circuit of the two r.f. pentodes. A smooth, even control is obtained. The voltage-reducing resistance in the filament circuit is an adjustable 300-ohm wire-wound resistor, adjusted to about 280 ohms by means of the sliding contact.

Construction Data

The chassis is only 6 inches by 5½ inches by 2 inches high. Light-gauge aluminum, say 14 to 16-gauge, is the most suitable. This may be obtained drilled for the sockets and the audio choke mounting.

The parts on top are mounted first. The dual variable condenser is mounted at the front, as shown in Figure 77. The five wafer type sockets are mounted. If a tube shield is used, the shield base for socket V1 should be fastened at the same time this socket is mounted. The audio choke L4 is mounted next. Then the three bending posts, BP1, BP2 and BP3, are fastened in place. All three posts must be carefully insulated from the chassis. Resistor R10 is mounted in an upright position as illustrated. This should also be carefully insulated from the chassis deck. The coil L3 is fastened to the side of condenser section C7. Fixed condenser C4 and resistor R1 may also be soldered in place.

The chassis is now turned upside down and components are mounted on the under side as shown in Figure 78. Where parts are likely to interfere with the wiring, as in the case of condenser C14, as much of the wiring as possible should be completed before mounting that particular part. The locations of the various parts are clearly indicated on the under-side view. The antenna coupler L1 is mounted on top of the

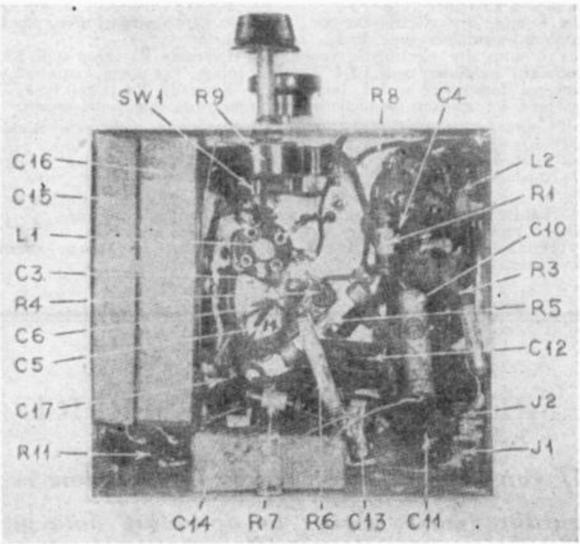


FIGURE 78

triple fixed condenser (C3, C5, C6). Other parts may be located as near as possible to the components with which they function, but they should all be kept safely away from the metal chassis, to prevent any possibility of short-circuiting.

The wiring should be carried through in a methodical manner, using a flexible hook-up wire. The entire filament circuit wiring should be completed first. Next the grids and screen grids, then plates, cathodes, by-pass condensers and all remaining wiring. Wiring should be completed in a short time, as it presents no difficulties whatsoever.

Parts List

BP1, BP2, BP3—Eby insulated binding posts
C1, C7—Cardwell dual midway "featherweight" variable condensers, .00035 mfd. each section, type 407CS
C2, C8—Trutest equalizing condensers, 3 to 35 mmfd.
C3, C5, C6—Aerovox triple section metal case condenser, .1 mfd. each sec. (260-31)

C4—Aerovox .00025 mfd. mica condenser, type 1467
C9—Aerovox .0001 mfd. mica condenser, type 1460
C10—Aerovox .01 mfd. cartridge condenser, type 281
C11—Aerovox .5 mfd. cartridge condenser, type 281
C12, C17—Aerovox .0005 mfd. mica condenser, type 1460
C13—Aerovox .01 mfd. mica condenser, type 1455
C14—Aerovox 2mfd. dry electrolytic condenser, cardboard container type P5-2
C15—Aerovox 8 mfd. dry electrolytic condenser, cardboard container type Pr-8
C16—Aerovox 4 mfd. dry electrolytic condenser, cardboard container type P5-4
J1, J2—Amphenol four-prong socket (only two prongs used for speaker connections)
L1—"Find-all" antenna coupler
L2—"Find-all" r.f. choke
L3—"Find-all" impedance coil
L4—Trutest 20-henry (small size) audio filter choke
R1, R2, R6—I.R.C. (Durham) 1-meg., 1-watt metallized resistors, type F-1
R3—I.R.C. (Durham) 10,000-ohm, 1-watt metallized resistor, type F-1
R4, R5—I.R.C. (Durham) 500,000-ohm, 1-watt metallized resistor, type F-1
R7—I.R.C. (Durham) 1500-ohm, 1 watt metallized resistor, type F-1
R8—Electrad 150-ohm flexible resistor, type 2GB150
R9—Electrad 5000-ohm tapered volume control potentiometer, type R1278-P, with switch SW1
R10—Electrad Truvolt 300-ohm, 50-watt adjustable resistor, type C3
R11—Electrad 50-ohm flexible resistor, type 2GB50
V1, V2, V3—Eveready Raytheon type ER-239 r.f. pentodes, five prong Amphenol sockets
V4—Eveready Raytheon type ER-238 output pentode, five-prong Amphenol socket
V5—Eveready Raytheon type —71-A tube, four-prong Amphenol socket
1 roll Corwico solid-core Braidite hook-up wire
"Find-all" 5-inch cone midget magnetic speaker
Aluminum chassis, 5½ inches by 6 inches by 2 inches high, 16-gauge
4 screen-grid clips
2 knobs, one for volume control, one for tuning condenser

CHAPTER SIX

Ultra-Short-Wave Amateur Equipment

A Five-Meter Receiver

THE 5-meter receiver we present herewith is intended to give the 5-meter enthusiast an inexpensive but highly efficient unit. Its circuit components embody principles long applied to receivers of many types, and while no claim is made of extraordinary novel circuit design, the general get-up of the outfit has proven completely worthy of whatever time and money is spent on its construction, because results have proved to be very gratifying.

The circuit comprises a simple regenerative detector using a type -37 tube, an auxiliary low-frequency oscillator using also a type -37 tube and

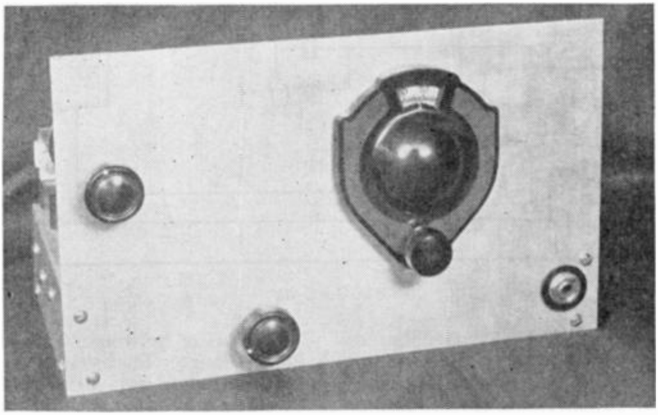


FIGURE 79

finally a simple pentode audio stage using a type -38 tube, which for all purposes provides sufficient amplification for moderately strong signals to be received on a loudspeaker.

The receiver is of the well-known super-regenerative type, embodying an auxiliary oscillator which provides an unusually high degree of sensitivity without the inherent spilling over of the ordinary regenerative detector circuit.

The schematic diagram, Figure 80, illustrates the method of wiring the various components making up the receiver. Most of the parts are standard. The only parts not available on the market and which must be made are the grid and plate coils (L1, L2) for the detector, the radio-frequency transformer (L3-L4) of the auxiliary oscillator, and a high-frequency choke (L5) for the detector plate. This choke may be made by winding 25 to 30 turns of number 36 wire on a piece of ¼-inch-

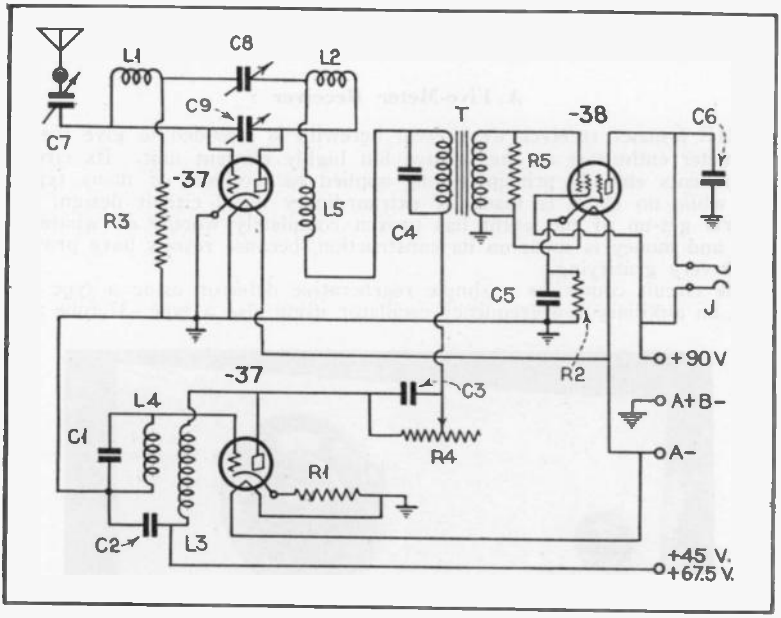


FIGURE 80

diameter bakelite or hard rubber rod. The spacing between turns should be such that the winding is about 3 inches long. The grid and plate coils of the detector may be wound with round bus bar, using a large-diameter pencil for a form. Six or seven turns for each coil is generally satisfactory. The spacing between turns, which must be fairly large, has a great deal to do with the frequency range covered, so that the actual readjustments of these coils to the 5-meter band can best be made after the set is ready for a tryout. The capacity, C8, which tunes the receiver is a 100 mmfd. midget variable condenser. This condenser is connected to the inside terminals of the grid and plate coils, while the outside terminals of these coils are connected respectively to the grid and plate terminals of the detector tube socket. Another small capacity, a neutralizing condenser, C9, is connected across the grid and plate terminals of the detector tube socket. This condenser serves to readjust the set until the 5-meter band has been located, and once this is done, this adjustment need not be touched or altered.

Figure 81 shows the specifications for the radio-frequency transformer for the auxiliary oscillator. The plate coil is wound with approximately 800 turns of number 36 wire, jumble wound, while the grid coil is wound with approximately 1400 turns of the same size wire, also jumble wound. The fixed condenser C1, placed across the grid coil, tunes this oscillator to its proper frequency, which is not critical.

The antenna condenser, C7, plays an important part in tuning the set properly. As shown in the photograph of the receiver (Figure 82), the antenna series and tuning condensers (C7, C8) are placed as far away from the front panel as possible and are equipped with bakelite extension shafts. All variable condensers must be maintained above ground potential, so it is necessary to mount these on insulated pillars as illustrated in the photograph.

All the tubes are biased through resistors—the values of these resistances being given in the list of parts. The regeneration control, R4, is a potentiometer used as a straight variable resistor. The value of this resistor is in the order of 50,000 ohms and any good variable resistor of this value should be entirely satisfactory.

The audio transformer can be any of the commonly used types, preferably of a three-to-one ratio. A high resistance value, in the order of 100,000 to 300,000 ohms, should be connected across the secondary of this transformer to provide a definite load termination and eliminate any tendencies toward audio howling.

Preliminary Adjustment

After the set is made ready for operation, it is only necessary to determine whether the set will tune to the 5-meter band. If it is found that the set tunes too low or too high, it is necessary to adjust the trimmer condenser (C9) across the grid and plate of the detector tube in order to bring the tuning of the set into the 5-meter band. If this condenser will not accomplish this, try increasing or decreasing the spacing between

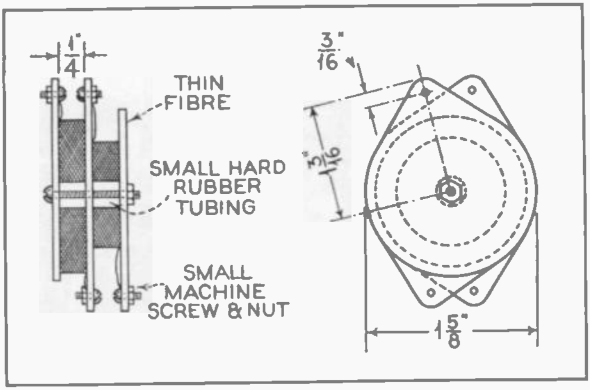
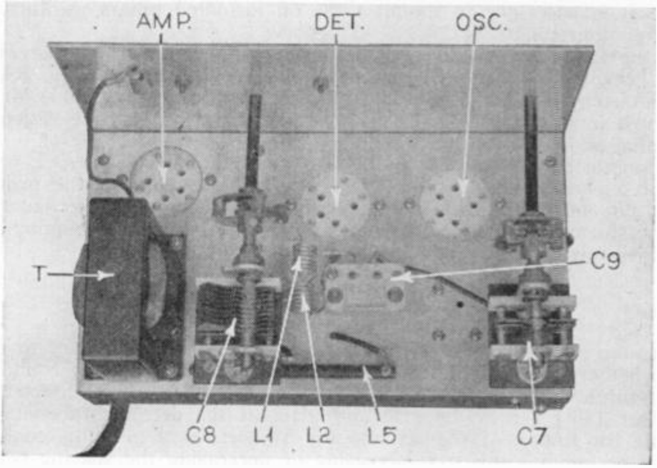


FIGURE 81

turns of L1 and L2. Once this adjustment is reached, it need never be changed.

The antenna requirements may prove rather critical. In some cases a regular antenna may be used effectively, but in some tests made with this receiver a wire about four feet long produced the best results. Experiments with antennas ranging between 2 feet and 20 feet will be worth while.

Characteristic of super regeneration, in operation the set will manifest a hissing sound in the loudspeaker or phones, over the tuning of the



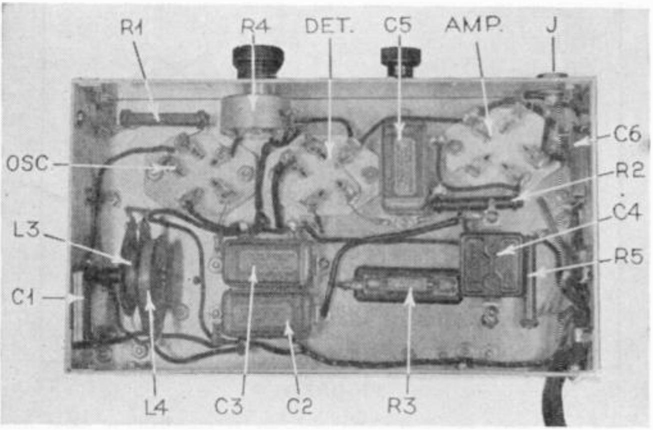


FIGURE 82—Above **FIGURE 83—Below**

greater part of the dial. This hiss will, however, be suppressed as soon as the carrier of a station is tuned in, receiving fairly loud signals the hiss disappears entirely and the signals come in with amazing clarity and fidelity. The outstanding merit of this receiver, besides its being simple and sensitive, is that it is not at all critical in tuning, under the proper conditions of operating. B batteries are recommended for the plate supply because they make for quiet operation of the receiver. However, throughout the tests the writer used a power pack with very fine results and little or no induced noise.

The most fascinating use that a 5-meter set can be put to is in two-way communication, in much the same manner as a telephone. In actual use, over a period of weeks, this receiver has been put through its paces in conjunction with a 5-meter phone transmitter, making it possible for the writer to carry on reliable, hour-after-hour communication with an associate, in very much the same manner as using a house telephone. It is entirely possible to use both receiver and transmitter at the same time—neither one interfering with the other, except when the frequency of the received signal is extremely close to that of the signal being transmitted; even then it is altogether possible to butt into the conversation of the incoming transmission just as though the widely separated operators were talking within arm's reach of one another.

Parts List

C1—Aerovox type 1450 fixed condenser, .002 mfd.
C2, C3, C5—Aerovox type 260 by-pass condensers, .1 mfd.
C4—Aerovox type 1460 fixed condenser, .005 mfd.
C6—Aerovox type 1450 fixed condenser, .001 mfd.
C7—Hammarlund type MC-20-S, 3-plate midget condenser
C8—Hammarlund type MC-140-M, 19-plate midget condenser
C9—Hammarlund type MICS-140, adjustable padding condenser, 70-140 mmfd.
J—Single-circuit (open) phone jack
L1, L2, L3, L4, L5—See text for constructional data
R1, R2—Resistors, 2000 ohms
R3—Resistor, 3 megohms
R4—Electrad type R1-205 potentiometer
R5—Resistor, 200,000 ohms
T—Audio transformer, ratio 1-3 or higher
3 Hammarlund Isolantite sockets, 5 prongs
12-inch length ¼-inch diameter bakelite rod
2 Hammarlund flexible, insulated shaft couplings
1 grid clip
Miscellaneous bakelite pieces for shelves and bushings for mounting C7, C8 and oscillator coils L3-L4
2 type —37 tubes
1 type —38 tube
Aluminum for chassis and panel, 1/16-inch stock, with 12 ½-inch right-angle brackets for assembling
1 5-wire battery cable
1 vernier dial
1 knob for C7

A Five-Meter Transmitter

In the foregoing pages a 56-megacycle band receiver was described which goes to make an excellent radiophone installation for "short haul" work when used in connection with a 56-megacycle transmitter. Such a transmitter is herewith described. This transmitter represents simplicity itself, in spite of the fact that the results and power derived from such an outfit are entirely adequate and satisfactory for any work the average experimenter wishes to do with it. It may be said at the outset that the use of higher power tubes than those originally intended for this set, namely, a couple of -10's seems to offer little advantage. The same circuit, adapted to 75-watt tubes, gave little or no additional signal strength at the short distance over which the test signals were being received. Under the proper conditions, however, higher rated tubes can probably justify their use. No changes in the circuit, Figure 85, other than the grid-bias resistor and plate voltage values are necessary to adapt this oscillator for any size tube desired.

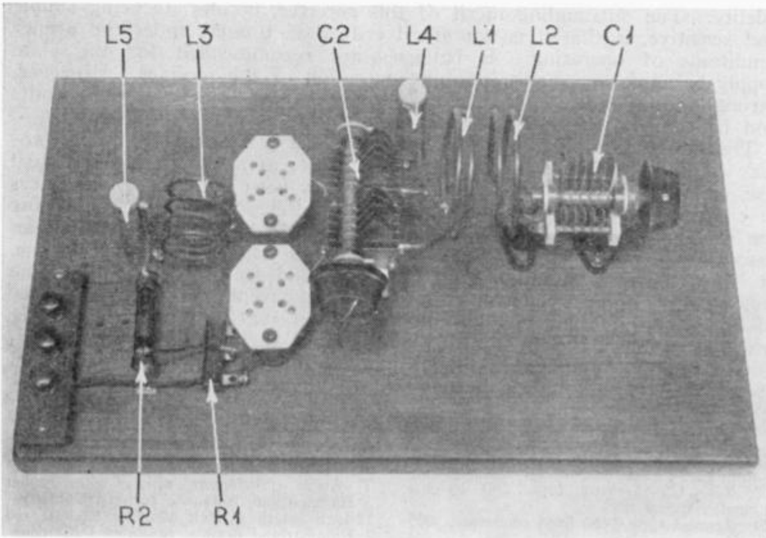


FIGURE 84

The oscillator was assembled in bread-board fashion as shown in Figure 84, and it was found so efficient in that form that no effort was made to alter it.

It will be noted that all "hot" circuits are insulated with isolantite, including the variable condensers, chokes and tubes. For the latter purpose Hammarlund type S-4 isolantite sockets are used to provide the best possible ultra-high-frequency insulation—not only for the tubes, but for the grid coil which is mounted directly on the grid terminals of these sockets.

The grid and plate coils are wound with No. 8 soft-drawn copper wire. The size of wire has little effect in the working of the set, so that any wire capable of handling the relatively high radio-frequency currents may be used. The main requisite for both the grid and the plate inductances is that they must remain rigid under operating conditions.

The grid coil is aperiodic and is wound with 4 turns of wire, on a diameter of about 1 inch, spaced approximately ¼ inch between turns. The two ends are connected as directly as possible to the grid terminals of the 2 tube sockets. The plate inductance, in conjunction with a plate tuning condenser, tunes the oscillator to the particular frequency desired in the 5-meter band. This inductance is wound with 2 turns of wire, on a diameter of approximately 2½ inches, with a spacing of ⅛ of an inch between each of the adjacent turns.

The type MCD-35-X Hammarlund condenser (C2) used for tuning this inductance is especially designed for ultra-short wave use and is an ideal piece of apparatus for the purpose of this circuit. It is a dual condenser (33 mfd. each section) with the 2 rotor sections mounted on the same shaft, but with the stators insulated from each other. The plates are double spaced, contributing to stability and high voltage insulations. The isolantite mounting keeps losses to a minimum, an extremely important factor when operating at such high frequencies. The location of stator lugs is such as to provide direct support for the plate inductance, thus eliminating long leads in the tuned circuit and helping to concentrate the inductance in the coil, where it belongs. This condenser is mounted on a small stand-off insulator in order to keep the tuned circuits well up in the clear.

Two radio-frequency chokes are necessary—one for the grid circuit and the other for the plate circuit. These are wound on isolantite insulating pillars, ½ inch in diameter and 2½ inches long. To make an excellent job, a collar of bare copper wire was wound around each of these

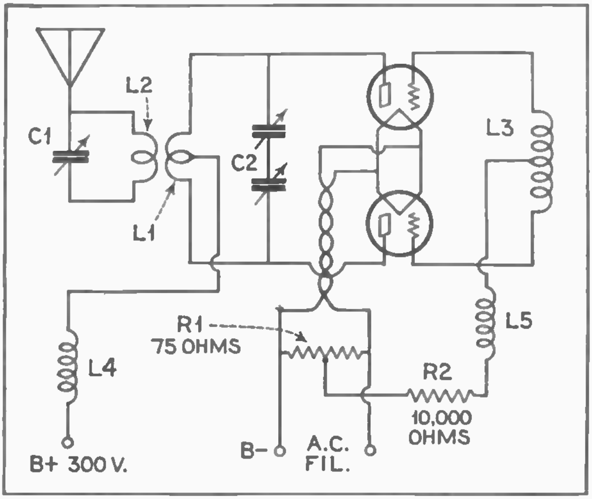


FIGURE 85

pillars, so that after soldering the loose ends together, a neat ring was formed. Between these two rings of copper wire, one on each end of the form, 25 turns of No. 24 wire were wound, spaced to fill the form. The number of turns, which is not critical, may be anywhere between 20 and 30 and the efficiency of these radio-frequency chokes may be best determined after the set is put into actual operation. The object, of course, is to see that no radio frequency is present along the windings farthest from the inductance which they feed. The plate and grid radio-frequency chokes are connected directly to the electrical center of the respective plate and grid inductances.

The Antenna

For all ordinary purposes, it is possible to clip a short antenna wire, about 8 feet in length, on to the plate inductance, but much more stable operation was obtained by using a coil and condenser combination as an antenna tank circuit. The coil is identical to the plate inductance, and is tuned by a Hammarlund type MC-35-X, 11-plate midget variable condenser. This is identical with the one described above, except that it has only a single section. A wire approximately 8 feet long is connected to each terminal of the condenser, making it possible for the radio frequency to hop off into space in great style. In addition to the 8-foot wire advocated, we tried an antenna some 150 feet in length, with excellent results. However, due to the presence of numerous standing waves on an antenna arrangement of this type, the circuit becomes somewhat difficult to manage, and for all ordinary purposes provides no advantage over a short piece of wire strung from one side of the room to the other.

The filaments of the tubes are lighted from a transformer delivering the proper voltage. A center-tapped resistor of 75 ohms is placed directly across the filament terminals of the tube sockets. The filaments of the two tubes are wired in multiple. The grid biasing resistor has a resistance of 10,000 ohms, and is connected between the radio-frequency choke of the grid inductance and the center-tap of the filament resistor.

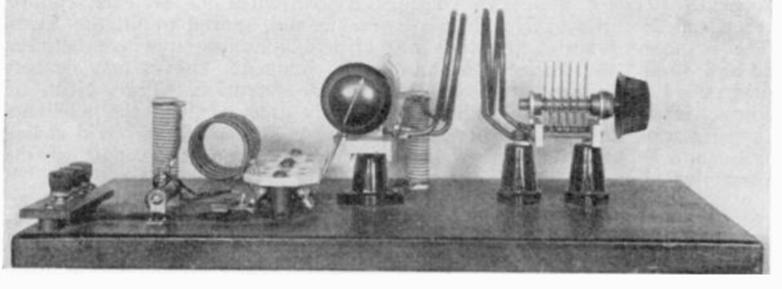
The Power Supply

The plate voltage is fed directly to the midtap of the plate coil, through the radio-frequency choke already described. This voltage may be in the order of 300 volts, derived from a suitable B supply unit. Approximately 180 volts may be derived from ordinary B batteries, if one wishes to operate with a pair of type -71A tubes, which gave excellent results in the tests.

The modulating system for this transmitter may consist of the well-known Heising system, using proportionate tubes—i.e., if a pair -10's are used in the oscillator, a pair of -50 tubes either in push-pull or parallel. should be used as modulators. Using a pair of -71A tubes as oscillators, one would prefer a pair of -45 type tubes as modulators.

In tuning up this oscillator, all one need do is tune in a reliable signal operating in the 5-meter band and then tune the transmitter to emit a signal somewhere in the proximity of this signal. Actual frequency

FIGURE 86



measurements at such high frequencies are somewhat difficult and are beyond our point of discussion, for which reasons they are not dealt with.

With a combination of this transmitter and the receiver previously described for the 5-meter band, all one needs is a good deal of time to work the outfit, so fascinating is the operation of phone on this band that one can depend on spending a lot of time at it.

It must be borne in mind that a Federal Radio Commission license is necessary for the operation of this transmitter. Its use prior to obtaining a valid license is not permitted by the authorities.

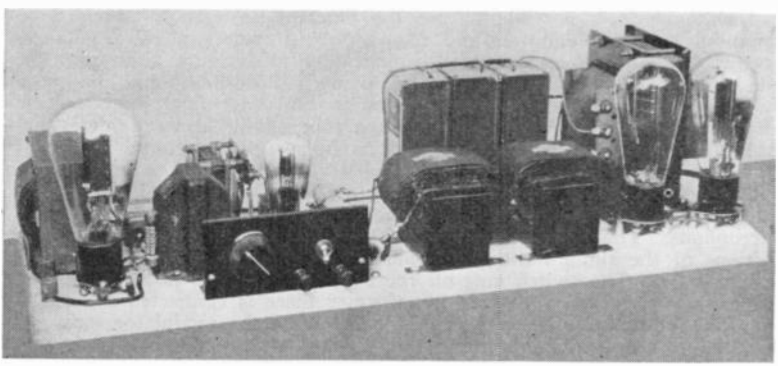
Five-Meter Transmitter Power Supply

Here is a compact modulator and power supply for any transmitter with tubes rated at not more than ten watts (radio frequency) to be modulated, and which is particularly suitable for the 5-meter transmitter described previously in this chapter. It will furnish the 5-meter oscillator with both filament and plate supply in addition to providing a very satisfactory method of modulation for communication by 'phone.

As a matter of fact, the unit as described can be used in conjunction with all sorts of experimental layouts of 'phone transmitters. It is only necessary to build the radio-frequency end of these experimental transmitters. The power supply and modulator circuits are almost always standard, therefore all one needs to do is to hook up this power supply and modulator unit to the radio-frequency unit to be modulated.

As shown in Figure 88, the power supply comprises the following components: One power transformer with two 7.5-volt windings of fairly large current-carrying capacity, one 2.5-volt winding, and a high-voltage, center-tapped winding for plate power. The voltage of this latter winding need only be as high as the requirements for the modulator tube. In the case of the unit illustrated, this voltage is 1100 volts, such that after it is rectified by a full-wave rectifier, consisting of two half-wave rectifier tubes of the -81 or similar type, d.c. plate voltage of 450-500 volts is available.

FIGURE 87



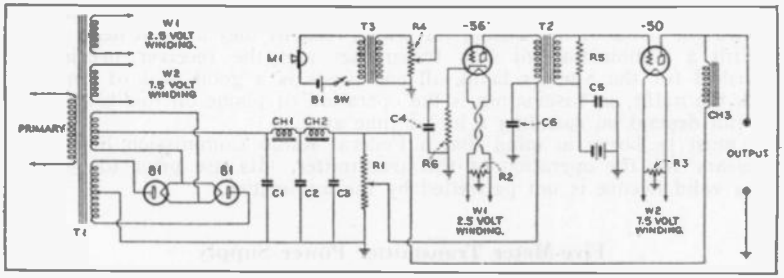


FIGURE 88

A brute-force filter consisting of two 30-henry chokes in series, capable of carrying about 200 milliamperes, and three condensers of 1000-volt d.c. working voltage rating with a capacity of two microfarads each, smoothes out the output of the rectifier to a very satisfactory degree.

A voltage divider is necessary to provide a termination for the filter and to provide the intermediate voltage used in the first audio stage. In the unit illustrated, this divider is rated at 75 watts and has a resistance of 25,000 ohms.

The amplifier section consists of a microphone input stage, and a modulator or output stage. The first tube is a type -56 with an amplification factor of 13, and the output tube is a type -50. The two tubes are transformer-coupled. This transformer can be of any standard make and is a "single-plate-to-single-grid" type of not too high a ratio. The one illustrated has a ratio of three to one.

Automatic bias is provided for the first tube, but, because of a preference for a definitely fixed bias on the output tube, a biasing battery was used on that stage. With a fixed battery bias, it is possible to increase the undistorted audio output of this tube, which factor makes the use of a separate biasing battery highly desirable. Center-tapped resistors are provided for the a.c. filament leads of both tubes. The values are not particularly critical—those used in the unit illustrated are 75 ohms each, and although it is possible to use the filament center-taps provided on commonly obtainable power and filament transformers, these resistances are highly desirable, as they readily provide a grid return right near the tube. The bias resistor for the type -56 tube is 2700 ohms and can be of the 1-watt size. This value of resistor is for a terminal plate voltage of about 200 volts. At these values the tube should draw a plate current of about 2ma. This bias resistor is by-passed to ground by means of a 2-microfarad condenser of about 400 volts d.c. breakdown rating.

The microphone transformer may be of any conventional type. The one used in the illustration was for the accommodation of a single-button microphone. The binding posts and the switch are provided for the connections of the single-button microphone with a single dry cell in series with one leg. The switch cuts off the battery when it is not wanted.

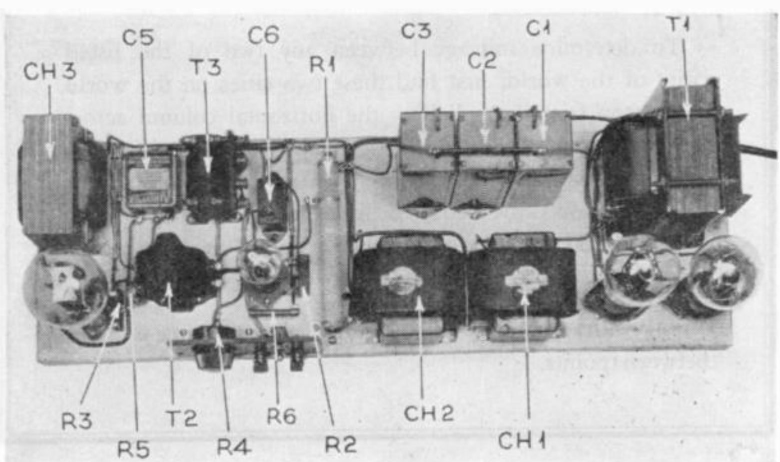
Across the secondary of this transformer there is connected a 500,000-ohm potentiometer to be used as gain control for the modulator unit. In the final tryout it will be found that this amplifier-modulator unit will provide more than sufficient audio push to the 5-meter transmitter, hence the volume control. Across the secondary of the interstage transformer there is connected a resistor of fairly high value—this may be anywhere from 100,000 to 500,000 ohms. It was found best to use a 100,000-ohm unit in the model.

The bias battery which provides grid bias for the final stage tube is by-passed by a 1-microfarad condenser of 500-volt breakdown—this condenser is not essential, but highly desirable.

Finally, the output choke is what is most familiarly known as a "Heising" choke. It is through this choke that the total current to be drawn by the modulator as well as the current to be drawn by the tubes of the external unit to be modulated must pass. The choke must therefore be capable of carrying at least 200 ma. It may be of any convenient manufacture, but must be of fairly good construction, with an inductance of about 30 henries and a fairly low d.c. resistance winding. It is a desirable procedure to ascertain the current draw of the -50 tube before the unit is put into definite operation. Taking it for granted that the B voltage through this choke may be too high for the modulator tube, it is desirable to start with a fairly high C bias for his tube—90 volts would be a safe value. For all ordinary purposes, however, with a plate voltage of about 450 volts and a C bias of about 85 volts, the plate current for this tube should be limited to about 55 mils.

The unit as a whole makes a splendid amplifier for all purposes within its power limitations. Its quality may somewhat be improved by the use of a double-button microphone with a suitable microphone transformer. It is hard to say whether it is worth the bother and expense of these additions. The average ham who has been pounding brass on the regularly allocated amateur bands, and is desirous of going on 'phone, will find this

FIGURE 89
Top view of the power supply



unit all that can be wished for for 'phone communications. Obviously, on the regular amateur 'phone bands, a crystal-controlled transmitter with not more than a 10-watt output tube is a most desirable type of accessory radio-frequency apparatus for a regular set-up with this unit. However, that is not necessarily the limit of its usefulness, there being no limit to linear r.f. amplification which can be tacked onto the end of a 10-watt stage that is modulated by this unit.

The List of Parts

B1—One No. 6 dry cell or small flashlight cell
C1, C2, C3—Polymet filter condensers, 2 mfd., 1000 volts
C4—Aerovox filter condenser, 1 mfd., 400 volts (omitted in model illustrated)
C5—Aerovox filter condenser, 1 mfd., 500 volts
C6—Aerovox filter condenser, 1 mfd., 300 volts
Ch1, Ch2, Ch3—RCA double filter chokes with winding connected in parallel or Todd chokes, 18-30 henry, 160-200 mils.
M1—Single button microphone
R1—Electrad voltage divider, 25,000 ohms. 75 watts
R2, R3—Pilot 75-ohm, tapped fi'ament resistors
R4—Frost or Yaxley 500,000-ohm potentiometer
R5—100,000- to 500,000-ohm, 1-watt resistor
R6—Bias resistor, 2700 ohms, 1 watt
SW—Toggle switch, s.p.s.t.
T1—Thordarson power transformer, type 3202C
T2—Audio transformer, 3-1 ratio
T3—Microphone transformer, preferably a type such as Kenyon BLG, or similar
3 four-prong sockets
1 five-prong socket
1 baseboard measuring 9 by 24 inches
Tubes required—two type —81, one type —50 and one type —56

United States and World-Wide Mileage Chart

(See Page 6)

To determine mileage between any two of the listed cities of the world, first find these two cities on the world chart (top triangle). Follow the horizontal column across the chart from the upper city, and the vertical column up from the lower city. The box at which these two columns intersect shows the required mileage in hundreds. The same method applies to the U. S. chart (lower triangle) except that mileages are shown in tens.

All mileages show the shortest (great circle) paths between points.

CHAPTER SEVEN

Microphones

A Condenser Microphone

AN answer to the prayer of "hams" and other experimenters for a high quality, yet inexpensive condenser microphone is found here.

The condenser head described is available in the form of a complete kit with all parts precision made and ready for assembly. In fact the most critical part, the back plate, comes all mounted in the case and dressed down to provide the exact required spacing from the diaphragm. The builder has only to assemble the diaphragm and spacer rings and attach them to the case. Even the ordinarily critical adjustment of the diaphragm tension has been eliminated by the precision manufacture of the case and spacer rings.

Thus the construction has been made fool-proof insofar as it is physically possible to accomplish this. The result is that the veriest novice should have no difficulty in making a condenser head which will show an excellent frequency characteristic and as good sensitivity as many of the much higher priced units.

The complete microphone kit is shown in Figure 90 and the assembled unit in Figure 91. The finished job is 3⅛ inches in diameter by 1¼

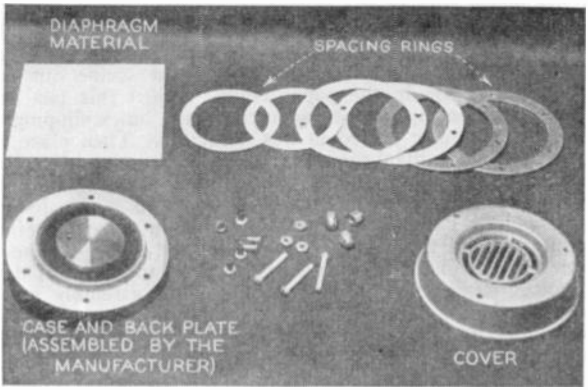


FIGURE 90

inches thick, overall, and the assembly job requires only a pair of pliers, a center punch and a hammer, and can be easily accomplished in 20 minutes because it does not require any grinding, drilling, layout work, or sandpapering, or other dressing.

Figure 92 shows a cross-section drawing of the finished microphone head and a detail of the diaphragm assembly. In assembling, the case (with back plate), the cover, and the two small paper rings are set aside for the time being. Examination of the two large paper rings will dis-

FIGURE 91

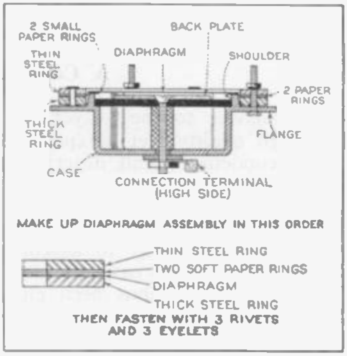


FIGURE 92

close two holes punched in each. Lay these rings on top of the thin steel ring in such a position that these holes coincide with any two of the six holes in the steel ring. Then run an eyelet through the larger of these two holes in the steel ring and a rivet through the other, inserting both from the under side of the steel ring.

Now place the sheet of diaphragm material on an absolutely flat, hard surface such as glass or metal and lay the thick steel ring on top of it. With a scriber or other sharp pointed instrument scribe out two holes corresponding with those in the paper rings. When this has been done place the diaphragm on top of the paper rings, the holes slipping over the eyelet and rivet previously placed in this assembly. Then place the thick steel ring on top of the diaphragm. If these instructions have been followed the assembly will be as shown in the detail cross section of Figure 92. After checking this point the assembly is made secure by means of the rivet and eyelet. Placing the stack of plates on a hard surface (with the thin steel ring and the heads of the rivet and eyelet at the bottom) insert a center punch in the open end of the rivet and drive it down tight with a hammer. Repeat this with the eyelet. The assembly will thus be securely held together.

Next, with a scriber (or a nail will do in a pinch), punch the other four holes through the paper rings and diaphragm. Insert a rivet in each of the two smaller holes, an eyelet in each of the larger ones, all with their heads on the same side as before, and drive them home with a center punch. This completes the diaphragm assembly.

Before progressing further the back plate unit is thoroughly cleaned with a cloth or soft brush to remove all dust, particles of metal, etc., not only from the face of the back plate but also from the bakelite plate. *Do not try to clean by blowing on this assembly because the moisture from the breath is likely to condense on the back plate and may later cause trouble. Do not under any circumstances attempt to remove the back plate from the case or disturb the nut at the back of the case.* Such action might change the predetermined and correct adjustment. To satisfy the curiosity of the constructor it might be well to explain that there is nothing in the space under the bakelite plate except the mounting columns

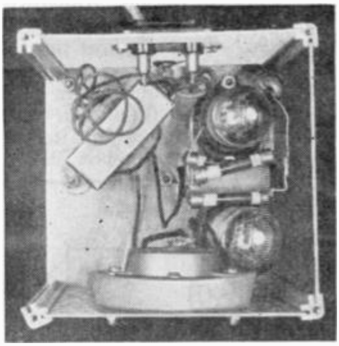


FIGURE 93

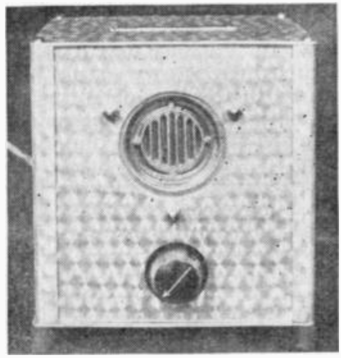


FIGURE 94

shown in Figure 92. The space provides a chamber where air can circulate to relieve pressure which would otherwise be exerted on the under side of the diaphragm and would prevent its free movement.

Having cleaned the back plate assembly thoroughly, the two small paper washers are dropped inside the thick metal ring of the diaphragm assembly and the latter is then slipped over the shoulder of the case, with the thick ring next to the case. This will bring the small paper rings between the top of the shoulder and the diaphragm, their purpose being to properly space the diaphragm and to prevent damage to the diaphragm when it is tightened down. The three machine screws are next inserted from the rear through three of the holes in the flange of the case and through the corresponding eyeletted holes of the diaphragm assembly. The nuts are screwed down on the three screws until they barely touch the top rings of the diaphragm assembly, then tighten them down a quarter turn at a time so as to keep the pressure equal all around. This tightening down process is continued until the bottom ring rests tight against the flange of the case. Due to the precision of the parts this will provide just the right tension on the diaphragm. All that is left now is to slip the front cover over the three projecting screws and fasten it in place by means of the acorn nuts provided.

A Suitable Condenser "Mike" Amplifier

Having completed the microphone head attention naturally turns to the question of a suitable amplifier. The condenser microphone is not comparable with the carbon microphone in output. For that reason it requires a pre-amplifier consisting of two or three resistance-coupled stages to bring the output level up to that of a carbon microphone. The best practice is to build this pre-amplifier in a metal case or box and mount the condenser head within the same case. This complete shielding reduces the possibility of undesirable coupling and the resulting short lead between the condenser head and the pre-amplifier input insures maximum transfer of energy from the condenser head.

Figures 93 and 94 show one such unit, consisting of the head. a two-stage resistance-coupled amplifier and a suitable output transformer mounted in a standard aluminum box shield. The circuit is shown in Figure 95. Another unit is shown in Figure 96. This employs the same circuit as the other (except that R3 and SW are separate units) but this new Bruno case offers a more attractive appearance and better shielding, and is much more substantial inasmuch as it is of aluminum, cast in one piece, with a tight fitting base plate. Another important item—its cost is but little higher than that of the standard aluminum box shield.

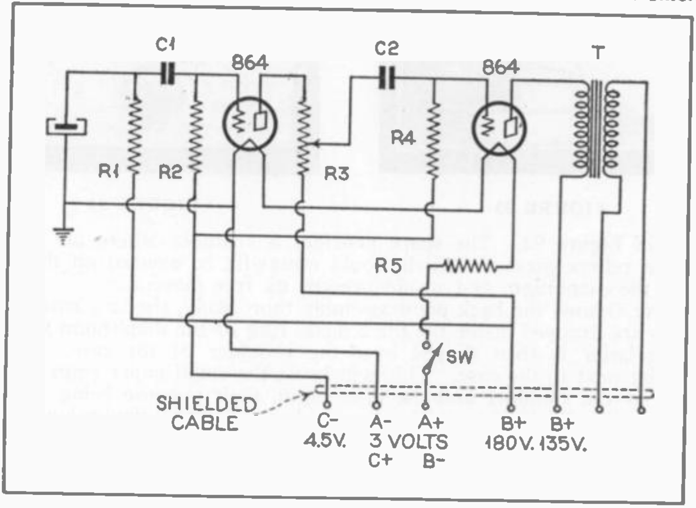


FIGURE 95

The circuit diagram of Figure 95 is for the most part self-explanatory, as the values of all parts are shown in the list at the end of this article. It is by all means advisable to use high grade parts in this circuit. Due to the high degree of amplification resulting from the combination of this amplifier feeding into a regular power amplifier, any noise caused by poor resistors or condensers is much more serious than it would be in any ordinary two or three stage amplified. The tubes employed are of the standard 864 type. These are dry cell tubes intended for use where complete freedom from microphonic trouble is essential, as it is in the case of a pre-amplifier.

The output transformer (T) matches the output of the 864 tube to a 200 ohm line, or to the 200 ohm winding of a standard microphone transformer. This value is considered most practical because in most cases the output of the pre-amplifier will be fed into a main amplifier formerly used with a carbon microphone and which will therefore have a microphone transformer in its output.

The attenuator R3, is not essential if there is one in the main amplifier. However, there is often occasion to locate the microphone at some distance from the main amplifier and it is therefore a decided convenience to be able to regulate volume at the microphone, without having to run

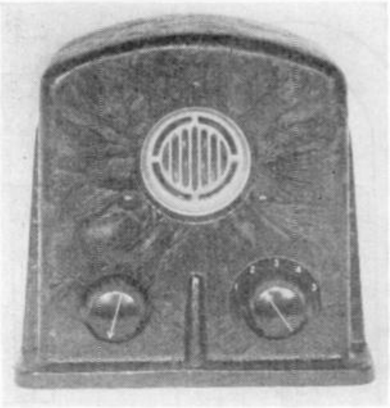


FIGURE 96

back and forth between the "mike" and the main amplifier in making this adjustment.

With the equipment described here an extremely good frequency characteristic is obtained—far surpassing that of the average carbon microphone employed with "ham" transmitters and in public address systems. Not only are the low frequencies faithfully reproduced but a decided improvement is obtained in the case of the high frequencies, which lend richness and natural tone in the reproduction of speech and music.

List of Parts

C1, C2—Fixed condensers, .02 mfd., (mica dielectric recommended)
M—Bruno condenser microphone, Type AM
R1—Resistor, 10 megohms
R2, R4—Resistor, 2 megohms
R3—100,000 ohm wire wound potentiometer with battery switch
R5—Amperite 0.9 ohm ballast resistor
SW—Switch (See R3)
T—Kenyon output transformer, Type KPO
2 Tube sockets, 4 prongs
2 RCA Type 864 tubes
1 Bruno head-amplifier case (see Figure 96) or Alcoa standard 5 inch aluminum box shield (Figure 93)
1 Shielded cable, 6 wire, of desired length

A Ribbon Microphone

The ribbon-microphone—or velocity microphone as it is now called—is enjoying increasing popularity because it demonstrates a number of decidedly advantageous features, aside from its excellent frequency characteristics. It has none of the hiss of the carbon microphone, for instance; is not at all critical in adjustment or as much subject to variations with humidity and temperature as are most condenser microphones; is substantially free from resonance peaks; is a low impedance device which permits its use at a considerable distance from its pre-amplifier; and it has marked directional characteristics enjoyed by no other type of microphone now in common use.

In addition to all these features, this type of microphone has one other

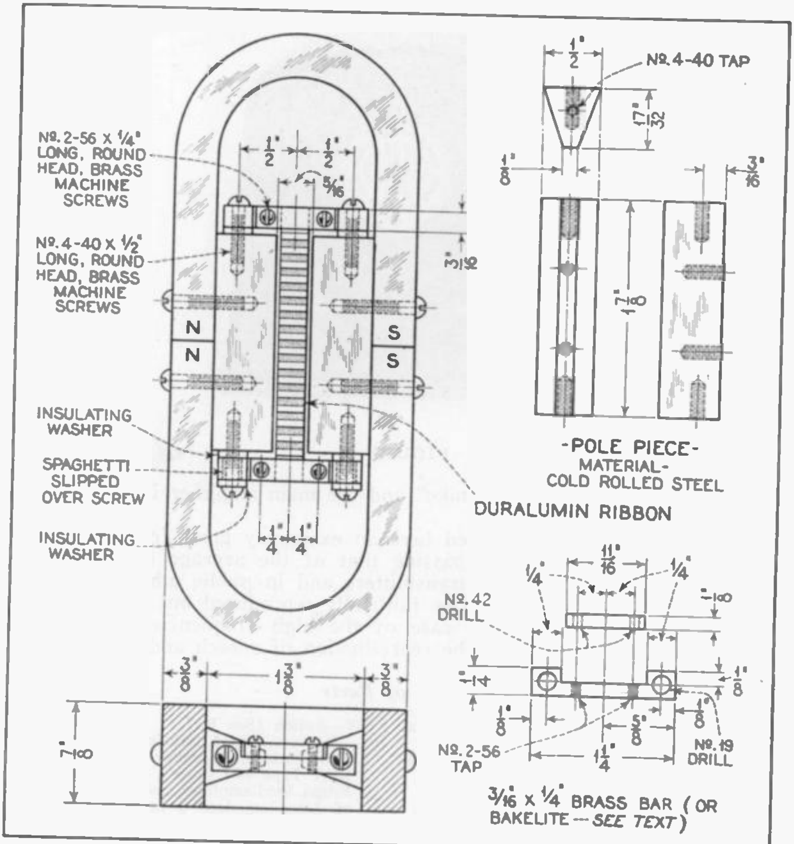


FIGURE 97

which is of particular interest to amateur builders. *It is the most simple type of microphone to construct at home.* There is nothing critical about it. The one requirement is that the parts employed and their assembly be such as to provide a high magnetic flux across the gap in which the ribbon is suspended, and that the ribbon be of sufficiently light material to respond freely to sound vibrations impinging upon it.

The directions given in this article will enable anyone to construct a duplicate of the model shown here and obtain the same excellent results demonstrated by it in several months of use. *(When tested in the laboratory this unit showed up to excellent advantage. It demonstrated its freedom from resonance peaks and both the low and high frequencies held well up, giving it a frequency range so far greater than that offered by* *the average microphone employed by the amateur that there is no comparison.—The Editors.)*

First for a word of detailed explanation. When a conductor is moved across a magnetic field a voltage is induced in it. This is an old, old principle but a mighty interesting one to the radio experimenter, especially when the conductor is a light foil which can be actuated directly by sound waves. Such an arrangement constitutes a microphone which possesses many exceptional and long sought for characteristics.

It is found to possess marked directional properties. Sound waves traveling in the plane of the ribbon have no effect on it while waves

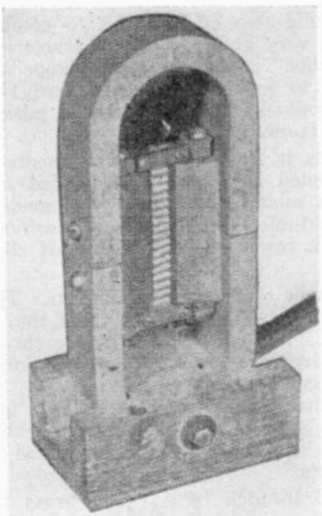


FIGURE 98

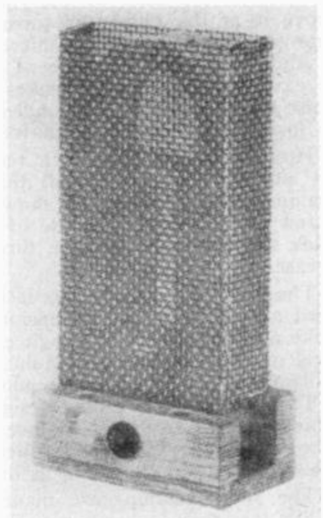


FIGURE 99

traveling in the direction perpendicular to the ribbon produce a maximum effect. This is very desirable, as reflected sounds are picked up from certain directions only. Thus the apparent period of reverberation of a room is reduced, allowing the microphone to be used successfully in places where the ordinary "mike" would sound "boomy".

Next the velocity microphone is found to have a very wide frequency range. It will cover from 30 to 14,000 cycles. It has been shown that the induced voltage is proportional to the velocity of the sound wave which is a constant. Thus it is independent of frequency. Why this is so can roughly be seen as follows. Consider a sound wave which has just reached the front of the ribbon. It will be a fraction of a second later that this same wave is diffracted around the pole pieces (which constitute a small baffle board) and impinges on the back of the ribbon. Thus there exists a difference in phase between the force acting on the front of the ribbon and the force acting on the back of the ribbon. If these two forces are exactly in phase there is no resulting force on the ribbon while if they are 180 degrees out of phase a maximum force is exerted.

This difference in phase varies for each frequency because they all have different wave lengths. Thus for low notes which have wave lengths of several feet the difference in phase is very small while for high frequencies where a wave length may be an inch or so, the difference in phase becomes large. In other words the higher the frequency the greater the difference in phase and hence the greater force tending to move the ribbon. It might now seem that the high frequencies would be overemphasized but because of the mass of the ribbon more and more force is required to move it at the higher frequencies. These two effects tend to compensate each other giving the microphone a very good over-all characteristic.

Another desirable feature of the "Ribbon" is that its output impedance is extremely low. This makes it easy to insulate and keep free from noise as compared to the condenser microphone. It also makes it possible to locate the "mike" several feet away from the amplifier.

However, the thing which recommends it most to the experimenter is its simplicity to build. All that is needed is a ribbon suspended in a magnetic field. Figure 97 shows such a microphone which was made in a few hours without the use of machine tools; just a good old fashioned hack saw, a couple of files, three taps, a few drills and plenty of elbow grease.

The first thing to do is to secure a couple of permanent magnets. They need not be the exact dimensions shown but it is necessary that they be alike and have a hole through each pole. The ones we used were chrome steel magnets found on a Main Street bargain counter. They were originally made for a one time popular magnetic speaker.

The pole pieces are next designed so that the air gap will be 5/16 inch. This leaves 1/32 inch clearance on each side of the quarter-inch ribbon. They are made from cold rolled steel. Tap the ends as shown and tap the backs to suit the holes in the magnets.

The ribbon clamps are made from 3/16 inch by ¼ inch brass bar. While they may look intricate they are in reality easily filed out. In order to line up the holes accurately clamp the top and the bottom pieces together with a small "C" clamp. Then with a No. 50 drill bore the holes for the 2-56 screws. Remove the top part of the clamp and run a body drill (No. 42) through the hole just bored while a 2-56 tap is run through the bottom part of the clamp. In drilling the No. 19 holes for the mounting screws with the spaghetti bushings it is wise to use a small drill first and then run the proper size through afterwards.

It is only necessary to insulate one ribbon clamp from the pole pieces. This is done by means of two fiber washers and a short piece of spaghetti slipped over the mounting screw where it passes through the clamp. A soldering lug placed under the fiber washer so as to make contact with the clamp serves as one terminal while a lug placed under the screw head at the other end of the same clamp serves as the other terminal. This lug is of course in electrical contact with the pole piece which is in turn in contact with the ribbon clamp at the other end. Twisted pair (preferably shielded though not absolutely necessary) connect these output terminals to the amplifier. Construction can be somewhat simplified by using bakelite for the large recessed portions of the clamps. This eliminates the need for insulating washers and bushings. The smaller pieces of the clamp assembly should be brass, with soldering lugs slipped under the head of a clamping screw at each end of the ribbon.

A word of explanation should be given here concerning the magnetic principles involved. By making the air gap small the flux density is greatly increased and it is upon this flux density that the effectiveness of the microphone is completely dependent. The idea is to concentrate the flux as highly as possible in the space in which the ribbon is located and moves. To do this the pole pieces are employed, which decreases the width of the gap 5/16 inch. In addition to this the pole pieces are tapered so that their faces are only ⅛ inch wide. Thus practically the entire magnetic field is limited to the small air gap between the ⅛ inch faces of the pole pieces and the maximum practical flux obtainable from the two magnets is therefore taken fullest advantage of.

In assembling the magnets be sure that they are placed with like poles together. After the magnets and pole pieces have been assembled the entire assembly should be remagnetized because if the magnetism of either magnet has been partly lost the effectiveness of the microphone will be

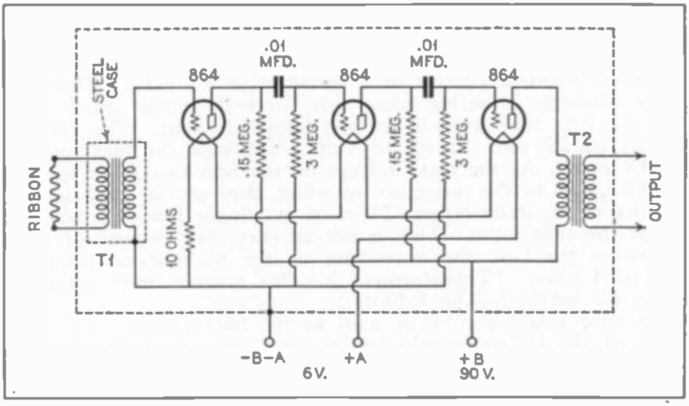


FIGURE 100

very much lower than it would be with fully saturated magnets. Unless one has the necessary electro-magnets for this work, it will be advisable to take the assembly out to a magneto service station where it can be magnetized at a very nominal cost.

The ribbon is the very heart of the instrument. It is advisable to purchase a specially made duralumin ribbon properly corrugated for this purpose. The most common practice is to use ribbon material approximately .00035 inch thick. Thinner ribbons increase the sensitivity somewhat while thicker ribbons reduce sensitivity and seem to reduce the high-frequency response.

In stringing the microphone one end of the ribbon is clamped in place. The other end is then picked up with a pair of tweezers and the ribbon loosely stretched, just enough so that it will hold itself in position. While holding it in this position the top part of the second clamp is put in place. Slight readjustments may be necessary to properly center the ribbon. The tension on the ribbon is such that the natural period is below the audible range. The ribbon should appear to float freely in the gap when gently blown.

The microphone is now ready for use. It may be mounted on a small stand as shown or suspended by a cord.

A metal screen in the form of a rectangular tube is made to slip over the "Mike". To the under side of this is sewed a piece of voile cloth. This will protect the ribbon from heavy drafts. Be sure the sound waves are just as free to enter the back of the "mike" as they are the front.

A Ribbon Microphone Pre-Amplifier

An amplifier suitable for use with a ribbon microphone is essentially no different from one that would be used with a condenser microphone. To change one to the other all that is necessary is to replace the condenser coupling resistors with a ribbon coupling transformer.

Figure 100 shows the circuit of such an amplifier. This uses the standard, non-microphonic, UX-864 tubes. These tubes draw one-quarter of an ampere filament current at a potential of 1.1 volts. Thus running the three filaments in series takes only 3.3 volts which leaves 2.7 volts bias for the first tube when a six volt source is used. The second tube has a bias of 2.7 plus 1.1 of 3.8 volts. Likewise the bias on the last tube is 4.9 volts. As the plate voltage on the first two tubes is less than on the third, due to the resistance coupling, they should have less bias.

The microphone transformer, T1, must match the low impedance ribbon to that of the tube input. This is not an easy task because of the large ratio between the two, the impedance of the microphone being only a fraction of 1 ohm. (Transformers for this purpose have recently been placed on the market.—The Editors.)

If two wire shielded cable is used as the microphone cord then both terminals of the ribbon should be insulated and the microphone frame grounded to the cable shield which in turn is grounded to minus A at the amplifier. If twisted lamp cord is used one side of the ribbon should be grounded to the frame and the wire connecting this to the amplifier is grounded to minus A at the amplifier. The two wire shielded cable is preferable.

In the interest of readers who may find difficulty in obtaining suitable magnets and other parts for this microphone arrangements have been made to make all parts available, cut, drilled and tapped in readiness for assembly.

CHAPTER EIGHT

Efficient Hearing Aids

A Home-made Hearing Aid

THE instrument shown in the accompanying photographs is efficient, professional-looking and can be built for from seven to fifteen dollars, depending upon whether one makes or buys the microphone and upon the quality of earphone used. *And*—both A and B batteries are standard flashlight cells that can be easily and cheaply obtained in any city, town or hamlet in the world.

The microphone, shown in Figure 103, is of the home-made variety, using a "button" taken from a small hand-type, home-recording microphone. If such is not available, one can experiment with buttons from an old telephone. Telephone replacement microphones, sometimes known as "corn plasters," may be purchased from telephone supply houses for less than one dollar. The construction of a microphone utilizing one of these buttons is simple and requires only a small lathe; or, lacking this, an equally good job can be done with a saw and file, as explained further on.

The microphone frame is of quarter-inch basswood. This is sold in small pieces by most lumber dealers, and costs very little. First turn out, on the lathe, a back plate 3 inches in diameter and 2 rings of the same size, as shown in Figure 104. If you do not have access to a lathe,

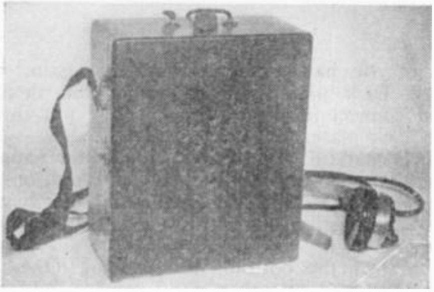


FIGURE 101

follow the dotted outlines for the frame, sawing out the two-inch circles with a coping saw, keeping a bit inside the lines, and then finish the circular openings with a half-round file. This will give you a square frame, which will work just as well as a round one. Pile up the back plate and rings, and after clamping them, drill the twelve small holes. Last of all, drill the center hole in the back plate of a suitable size to accommodate the mounting screw or post on the back of your microphone button. The frame should now be given a coat or so of black lacquer.

Now turn your attention to the diaphragm and the microphone button. First unscrew the commercial button and remove about half of the carbon grains. Also make sure, before reassembling it, that there is but one thickness of mica over the front of the button. This operation will greatly increase the instrument's sensitivity, and is a safe procedure with the low voltage we shall use with it. The exact amount of carbon grains to be removed is a matter of experiment. If the instrument does not hiss to any noticeable extent, you have guessed right. If it does, return

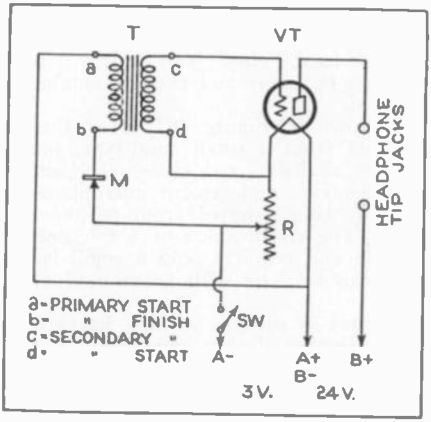


FIGURE 102

part of the grains you have removed and try again. Now mount the altered button the back plate, and solder a thin flexible wire to the front contact and connect it to a terminal screw put through one of the vent holes in the back plate.

The diaphragm is made of lightweight bond letter paper, cut to the size shown in Figure 104 and cemented with Ambroid or celluloid cement along the narrow flap. After the cement is dry, punch a tiny hole in the apex of the cone with a small nail. It is now ready for mounting, which is done as follows:

Coat the top face of the bottom wooden ring (the ring next to the back plate) with Ambroid or other good cement, and stretch over it a single thickness of China silk or georgette crêpe. Hold this taut until the cement dries, and your ring now has a drumhead of silk. Centering your diaphragm on this silk drumhead and holding it down lightly, apply a coat of cement around its periphery. When this has dried thoroughly, cut out the circle of silk over the hollow of the conical diaphragm, leaving a very narrow rim of silk projecting inside the cone for the sake of strength. You now have a relatively free-floating, light, non-resonant diaphragm.

In the final assembly, adjust the button so that the screw on the front contact projects about one-thirty-second of an inch through the hole in the apex of the diaphragm, first removing any clamping nuts that are on the screw. Now place the top and final ring on the microphone, and clamp evenly and tightly with six machine screws around its circumference. Last of all, fasten the front contact to the diaphragm with a drop or two of cement. When this is dry, the microphone is finished. It will later be attached to the inside of the box cover, by means of wood screws.

Now for the battery cases. The A battery holder is made from a cheap tubular type flashlight case. Remove the switch and its connections, and also the lens. Solder an 8-inch wire lead to the reflector, after first solder-

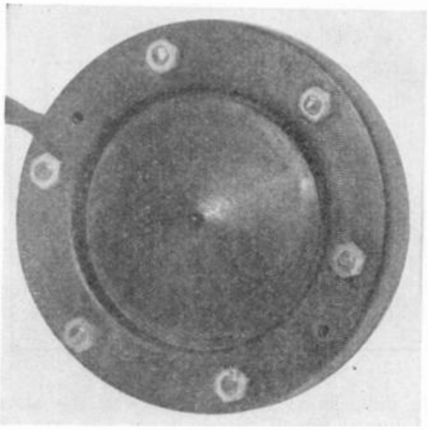


FIGURE 103

ing a piece of metal, such as a brass thumb nut, into the lamp threads to serve as the positive contact stud. Cut a circle of heavy cardboard or fibre the size of the lens, punch a hole in it to pass this 8-inch wire (the positive lead) and screw the reflector and fibre disc in place. Now solder another 8-inch lead to any exposed metal part of the case to serve as the negative lead.

The B battery case is more trouble, which is justified because it permits the use of ordinary "pen-light" batteries which are cheap and obtainable anywhere. If you wish you may dodge the construction of this case by employing an ordinary 22½ volt B battery, midget size.

Assuming that you have decided upon the use of the "pen-light" batteries, construct your case as shown in Figure 105, following all dimensions exactly. Batteries can easily be replaced by removing the bottom cover of the case and pulling out the nail which serves to hold the bottom insulator in place. This can now be removed and the old batteries dumped out. Always put the batteries in with the brass caps against the spring contacts.

The wood carrying case is a cigar box and can be obtained for the asking at any cigar counter. Get one of the kind that is made of redwood or Spanish cedar, and used to hold fifty "corona" size cigars. These boxes are nicely made with dove-tailed or glued and nailed corners and are of unfinished natural wood instead of being paper covered. The one used by the writer measured 7½ inches long, 6¼ inches wide and 3½ inches high on the outside, and came equipped with nickeled hinges and

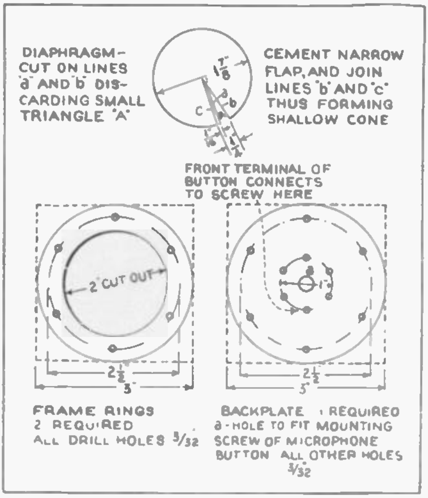
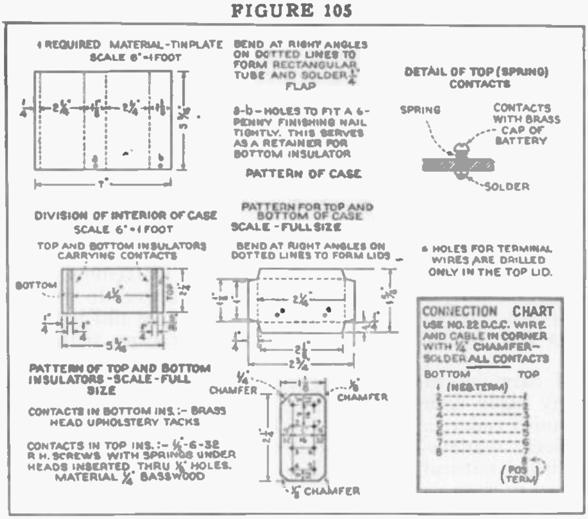


FIGURE 104

catch. The inside dimensions corresponding to the above, after pulling out the thin wood liners, which we shall not use, are 6⅝ inches by 5½ inches by 3 inches. If the constructor employs a box of different dimensions, the layout of parts may have to be varied from that shown.

FIGURE 105



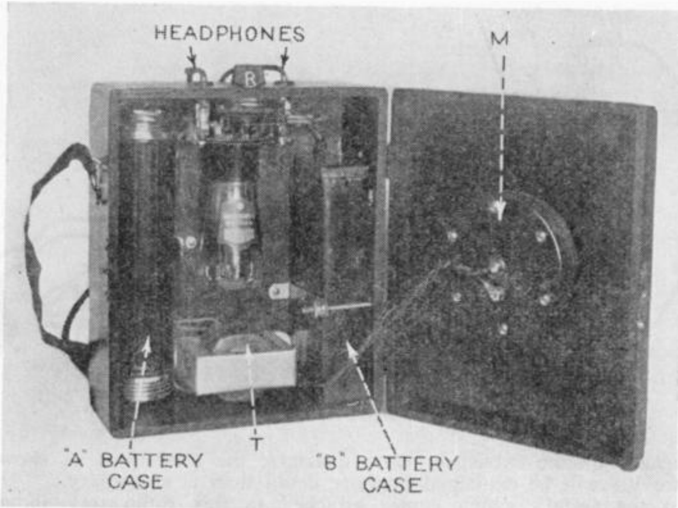


FIGURE 106

The first thing is to lay out the parts in the case to determine where the mounting holes and the holes in the cover must be drilled. The drilling having been accomplished, the burned-in printing on the box must be removed. This is most easily accomplished with a plane; or else a sanding drum or wheel covered with a coarse grit sand or garnet paper. Be sure to remove all printed indentations, or these will show through on your finished case, which is now ready for ebonizing.

This is easy and gives an inconspicuous, durable, professional looking dull black luster to your case. Here's how to do it. Get a twenty-five cent bottle of Griffin's Black Rapid Dye, a shoe coloring preparation sold everywhere. Using the swab in the package, give your case two copious coats about an hour apart, which will dry quickly into the wood. After the dye is *thoroughly dry,* a matter of several hours, go over the whole case with a soft cloth, rubbing hard to remove all excess dye.

A Combination Hearing-Aid Radio

If the instructions are carefully followed, the results obtained through the use of this combination hearing-aid radio will be satisfactory even for those with severe hearing losses. The designer of this set has about twenty per cent of normal hearing remaining in one ear, the other entirely gone, but this device enables him to carry on a conversation from any position in a room with ease and provides clear and natural results—both as a hearing aid and as a radio. Also, means for amplifying a telephone conversation are incorporated.

Since something that will stand carrying around was desired a General Electric Model M-40 was selected. This is a four tube a.c.-d.c. set, which has a steel case.

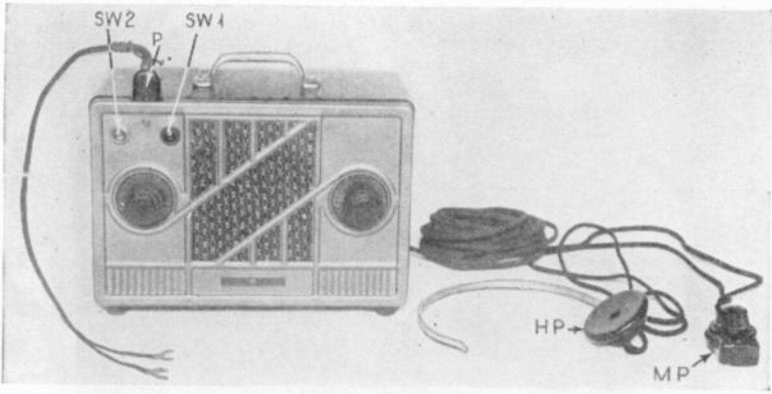
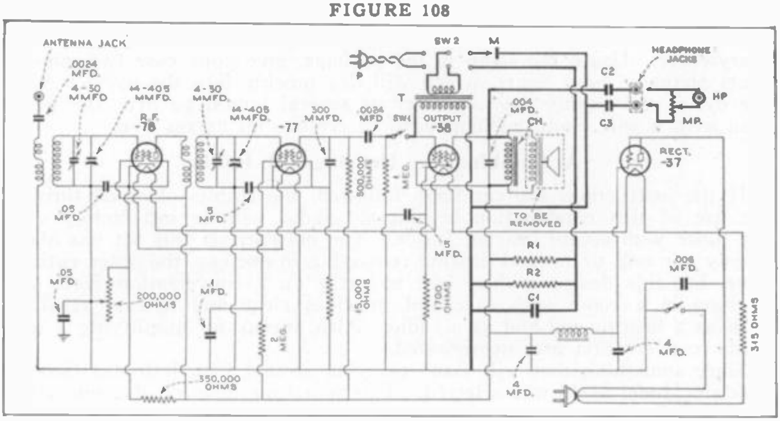


FIGURE 107

Because of the extremely close quarters, the alterations as shown in Figure 108 will be explained in more detail than is customary.

Cut the aerial (which comes attached to this radio set) about six inches from the case. Take the radio from the case and remove the loudspeaker. The loudspeaker cutout in the chassis has a projecting cutout at the rear into which the microphone transformer (T) will just fit. First, however, remove the transformer from the case and take off the transformer terminal screws. Solder insulated radio hookup wires, each 1 foot long, directly to the leads in the place of the terminal screws. Replace the case, making sure the soldered ends are well taped and secure. Bring the leads out of the holes where the terminal screws were. To

FIGURE 108



maintain the insulation here is essential as the transformer primary is to be part of the telephone circuit when the device is used as a telephone amplifier and the telephone circuit must not even be grounded, much less be allowed to come in contact with any of the high-voltage leads.

Mount the transformer at the rear of the square portion of the speaker cutout. Bend such wires out of the way as may be necessary to get the transformer in place and fasten the transformer by drilling, and tapping two 10/32 holes, 1½ inches from the front of the chassis and 3/16 inch from each side of the cutout. Mount the transformer with its base below the sub-panel, two ⅜ inch by 1½ inch tubular brass spacers being used between the sub-panel and transformer screw lugs. Two 10/32 round-head screws, 2 inches long, hold the assembly.

On top of this transformer the output choke (Ch) is mounted. Use one of impedance suitable for a pentode tube, and with dimensions not

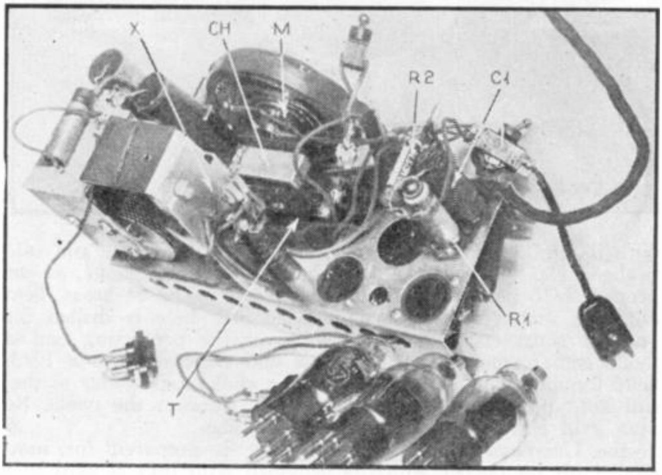


FIGURE 109

exceeding 1¼ inches thick, 1½ inches high and 1¾ inches long. This will fit the space provided. Before mounting this choke, wrap it with two or three turns of friction tape and make a 1/32 inch thick fiber insulator 1½ inches long by 1½ inches high with a cutout of 1 inch by 1⅛ inches to form a "U" shaped insulator with legs 3/16 inch wide. Slip the insulator legs between the tape and core of the choke on the side that will be towards the front of the chassis, so it will insulate the microphone center contact from the choke core.

Fasten the choke in place with a brass angle, made from 1/16 inch by ⅜ inch by 1 inch stock, bent at ⅜ inch from one end to a right angle. Drill and tap a 6/32 inch hole in the center of the short side and fasten in place on the front of the radio-frequency tube shield (X-Figure 109) in the hole which helped support the loud-speaker. Put the choke in

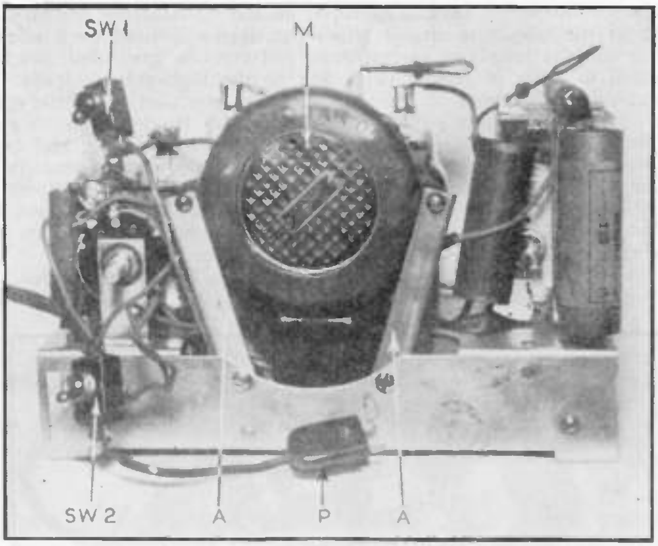


FIGURE 110

place with its end against the projecting side of this angle and solder its shell to the angle. To steady the opposite end of the choke, an angle is made from a 1/16 inch by ⅜ inch by 1¼ inch piece of brass, bent to a right angle ½ inch from the end; a 3/16 inch hole is drilled into the center of the short end and is slipped over the projecting end of the microphone transformer mounting screw and fastened with a 10/32 nut. Then bend the angle against the side of the choke and solder to the shell. This will hold the choke securely in place. Connect the choke between the screen grid and plate of the 38 output tube.

Next, the Universal Model A microphone is prepared for mounting. A "Daisy" fruit jar opener which is provided with lugs is used to mount it. Cut four slots 90 degrees apart for the microphone lugs. Cut these through at the rear of the fillet on the inside of the opener. Slip it on the microphone, working the microphone lugs through the slots. Then, trim the excess rubber off the back, flush with the back of the microphone. Now, punch holes through the lugs of the rubber jar opener ring with an ice pick. Make two brass strips (A, Figure 110) 1/16 inch by ½ inch by 3¼ inch, with 5/32 inch holes drilled 3/16 inch from each end. Fasten these strips (which are to support the microphone) at one end with No. 8/32 flat head screws, ½ inch long in the holes that were used for the loudspeaker at the front of the chassis. Use lock washers under the nuts. Now file points on two No. 8/32 round head screws, ¾ inch long, to go through the upper holes in these metal strips into the holes punched into the jar opener lugs. Use nuts on these screws after mounting the microphone in place on the top end of the brass strips.

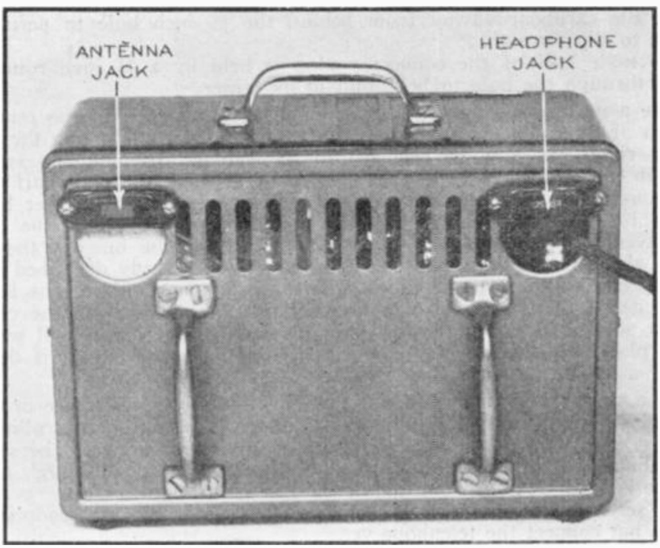
Next, mount the resistor (R1) for microphone current supply by drilling a 7/8 inch hole in the chassis behind the volume control, 1⅝ inches from the front and ⅝ inch from the end. Use a No. 10/32 r.h. screw, 2½ inches long, and nut. Use fibre washers at each end of this resistor, one between the chassis and resistor and another under the head of the screw. Connect R2 between the top connection of R1 and the bare wire connection on the volume control. This bare wire is a set ground. Do not allow this or any other connection to contact the chassis. Connect the lower end of R1 to the screen grid of the 38 output tube.

Now connect a 10 mfd., 25 volt, tubular dry electrolytic condenser across R2. This condenser is to filter the microphone current. R2 protects it from high voltage when the switch is thrown for telephone amplification. Mount the condenser in a vertical position beside the 9000 ohm resistor, toward the front of the chassis as shown in Figure 109.

Connect the two toggle switches so that they can later be fastened on the front panel over the volume control. Dimensions for the mounting holes in the front panel will be given later. Sw2, a d.p.d.t. switch is the microphone current supply-telephone connector switch. Bring the microphone transformer primary leads up over the volume control. Twist them together and cut off with two inches extra length of wire, measuring to the upper corner of the radio cabinet. Solder these wires to the center terminals of this switch. The terminals on one end of this switch are connected; one to the junction of R1 and R2, the other to the center terminal of the microphone. The ground terminal of the microphone is connected to set ground (not the chassis) at the junction of the R2 and the receiver volume control terminal.

Mount a .25 mfd., 400 volt condenser under the chassis at the end

FIGURE 111



under the volume control. One side goes to the 38 plate, the other side to one side of a twin 'phone jack. A second, similar condenser is put in the opening underneath the microphone between the microphone transformer and the chassis. One end of this condenser is connected to the other terminal of the twin 'phone jack, the other end goes to the set ground.

Unsolder the grid lead of the 38 tube at the cap clip and solder a three inch wire in its place. Connect the switch Sw1 in this lead so the radio circuit can be broken. Bring the grid lead of the microphone transformer directly to the grid clip of the 38. Solder the filament lead of the transformer to get ground. Thus, the radio circuit can be opened by the switch but the microphone transformer is always connected.

Next, a Wirtco miniature flat connector is arranged with the male half (P) supplied with 2 inch insulated leads which are soldered to the connection in the remaining end of the d.p.d.t. switch. The female half is connected with a No. 103 Birnbach, five foot cord with pin and spade tips. The spade tips are left on to go to the telephone connection, the pins are removed and the ends go to the connections in the female half of the connector. This is shown, plugged into the top of the set in the front view photograph.

Next, lay out and drill three holes in the top front of the radio cabinet over the volume control. Two ½ inch holes, 1 inch from the top and ⅞ inch and 2⅜ inches respectively from the ends of the cabinet. A 5/32 inch hole is drilled central between the ½ inch holes and ⅝ inch from the top of the cabinet.

Cut a rectangular opening in the top of the cabinet ½ inch wide by ⅞ inch long, ⅛ inch from the front and 1¼ inch from the end of the cabinet.

Cut the cardboard away from behind the ½ inch hole to permit the switch to slip through.

The male half of the connector plug is held by a ¾ inch roundhead screw through the hole to be found in its center.

Take a neat appearing brass drawer pull and fasten it in the center of the top of the cabinet to provide a ready means for transporting the outfit.

The radio can now be replaced in the cabinet, slipping the switches through the ½ inch holes in the front, and fastening the male half of the telephone connector plug with its screw through the small center hole.

The 1½ inch holes in the back cover are each filled out at the top of the cover to accommodate double 'phone jacks. The one on the right facing the back of the set is for the 'phone jack already described in the plate circuit of the type 38 tube. The other is to provide means to plug in the aerial. The aerial which was cut off six inches from the chassis, is now soldered to both terminals on the jack so the aerial will work in either place. A single insulated tip jack may be used instead, if desired. Solder a pin tip on the end of the long aerial to plug it in.

Use a single or double headphone of 1000 ohms d.c. resistance or more. A 2000 ohm potentiometer type "Modu-plug" is used for controlling the hearing aid volume. An extension cord may be used between the set and the volume control (the writer uses a twenty foot cord) although a little volume is lost. A four foot 'phone cord is about right.

The set is now ready for test. Plug in the aerial, also the headphones—but do not connect the telephone yet.

Plug the set into any 110 volt line, d.c. or a.c. See that the Modu-plug volume control is full on and operate the switches. In one position of the d.p.d.t switch the sounds of the room should be heard regardless of the position of the other switch. If this operation is obtained, advance the radio volume control and try to tune in a radio station. Should none be heard, throw the s.p.s.t. switch. It should now be possible to tune in a radio program and at the same time the room sounds will continue to be heard. If this is O. K., again throw the s.p.s.t switch to cut off the radio program—the room sounds will continue to be heard. Next, operate the d.p.d.t. switch and the room sounds will cease and nothing will be heard, excepting possibly a slight hum. Take the telephone connector cord, which is not yet to be connected to the telephone and plug it into place in the other half through the rectangular opening in the top of the cabinet. If the spade tips on the end of the cord are put together, a click will be heard, if all connections are O. K.

To test the telephone circuit connections, get a 45 volt B battery and connect one end of the Trimm headphone cord to plus 45 and the other headphone tip to one of the spade tips. Connect an insulated wire to the minus side of the battery, the other end of the wire is left bare for per-

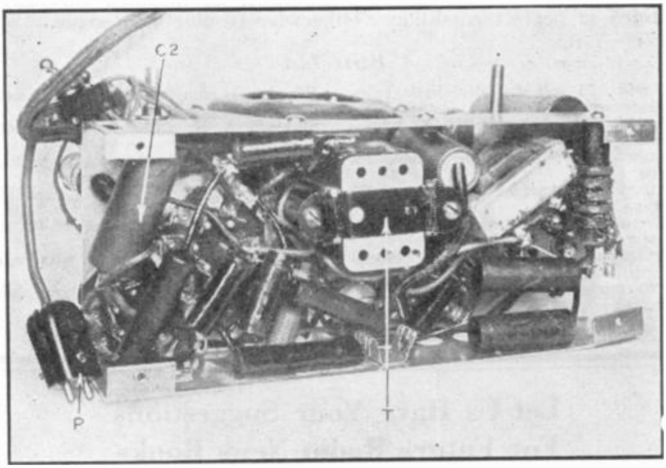


FIGURE 112

haps ¼ inch to be used for an exploring point. Disconnect the set from the power line, and while listening to the headphone, use the exploring point to touch the set ground, and the chassis, and the other spade terminal. A loud click should be heard only when the other spade terminal is touched. If a loud click is heard when the set ground or chassis is touched then note the telephone circuit is not insulated and it must not be connected to a telephone instrument till the trouble is found and corrected. Check from both terminals. If this checks, the telephone receiver can be lifted off the telephone, the hook weighted down to prevent the telephone from operating, the receiver ear cap unscrewed, the spade tips slipped through the hole in the end alongside the telephone wires and one spade tip fastened under each telephone receiver screw; on top of the regular telephone spade tips. It should be pointed out here that many local telephone companies do not permit any equipment to be connected to their instruments. The telephone-amplifier feature is included in this hearing aid-radio for the benefit of those not served by such companies and can be omitted if desired.

The telephone connector cord is thus connected in parallel with the telephone receiver. It must not be connected in series as the telephone will be out of service unless the circuit is completed in the radio, and we want to be able to disconnect the plug at the radio; leaving the female half attached to the telephone, and still be able to use the telephone in the usual manner.

Lifting the weight off the telephone receiver hook, the amplified telephone signal can now be heard in the Trimm headphone.

The switch positions are now marked, if desired, to enable easy operation. As many aerials are put up as desired in different locations.

Telephone connecting cords and plugs; that is, female halves, may be placed on as many telephones as may be desired. These connectors and also the telephone circuit in the radio must be installed carefully and maintained in perfect condition. Otherwise trouble will ensue.

Parts List

C1—10 mfd., 25 volt dry electrolytic tubular condenser
C2, C3,—1/4 mfd., 400 volt tubular bypass condensers, .25 mfd., 400 volts
Ch—Output choke; impedance suitable for 38 tube
HP—Trimm Featherweight headphone, 1000 ohm type
M—Universal Model A microphone, sensitive type
MP—Centralab 20,000 potentiometer "Modu-plug" with as long a cord as desired
P—Wirtco miniature flat connector
R1—Electrad 9,000 ohm wire-wound resistor
R2—1,000 ohm wire-wound or metallized resistor
SW1—H & H, s.p.s.t. toggle switch with 3/8 inch neck
SW2—H & H, d.p.d.t. toggle switch with 3/8 inch neck
T—Thordarson No. 2357, single-button microphone transformer
1—General Electric Model M-40 a.c.-d.c. compact type radio set
1—"Daisy" fruit jar opener with lugs
3—Brass drawer pulls
1—No. 103 Birbach, 5 foot cord, pin and spade tips
Assorted hardware as described

CHAPTER NINE

Radio Servicing Equipment

A Simple Capacity Bridge

IT is a generally accepted fact that every serviceman's laboratory should contain an ohmmeter, an oscillator, and a set and tube checker. In addition to these instruments, it is sometimes very desirable to have some quick, as well as accurate, method of determining unknown capacities.

Very little apparatus will be required to construct an instrument of this latter kind. As can be seen from the illustrations, the apparatus consists essentially of a source of a.c. potential, an indicating instrument, a known standard of comparison, and a variable resistance. It will be well to say a word about this latter item. Any variable resistance having a value of from 1,000 to 100,000 ohms may be used. It is necessary, however, to know the total resistance of the unit and to be able to determine what portions of this total resistance are being used for any given setting of its dial. Refer to Figure 113. Suppose the total resistance of the unit is 1,000 ohms and we are using a dial which is calibrated from 0 to 100. Then, every division on the dial represents 10 ohms resistance. If our dial reads, say, 63, we are reasonably sure that we have a resistance of 630 ohms on one side of the slider arm and 1000-630=370 ohms on the other side.

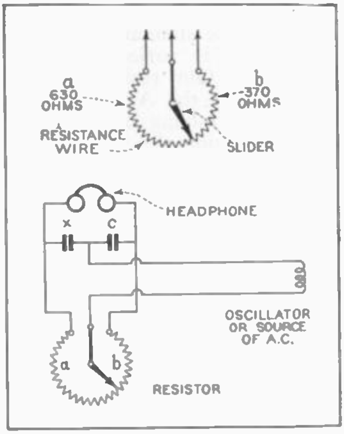


FIGURE 113—Above FIGURE 114—Below

To operate the instrument, connect the apparatus as shown in Figure 114. At the point marked C, we use a known capacity, which should not vary too greatly from the value we believe the unknown to be. In other words, if we believe the unknown condenser to have a capacity of something near 1. mfd. we would use a known capacity at C of perhaps 0.5 mfd., or one perhaps as high as 2.0 mfd. Convenient binding posts may be arranged so that these connections may be easily and simply made.

The oscillator is started and its note will be heard in the headphones. The slider arm of the resistance is then varied until the oscillator note can no longer be discerned. If the slider is moved further in the same direction the note will again become audible. The point we desire to find is the spot of least volume, at which the bridge is said to be balanced. If a galvanometer is used in place of the headphone, this balance is indicated when the meter deflects in neither direction. We can now calculate the value of the unknown capacity from the following equation:

$X = \frac{BC}{A}$ where X is the unknown capacity, A is the resistance as read from the dial of the variable resistor, B is the total resistance minus the reading of A, and C is the capacity of the standard.

A specific example will perhaps make the procedure more clear. The unknown capacity is connected at the point X, the standard being connected at C. The capacity of the standard is 1/3 mfd. The oscillator is now started and the resistance is varied until the signal is no longer discernable in the headphones. Our resistance dial now reads 31.3—the equivalent of 313 ohms. This is the A of our equation; and for B we have 1000-313=687 ohms. Multiplying 687 by 1/3 (the C of the equation) we get 229. We now divide this 229 by A, and get 0.72 as our answer. This value is the capacity of the unknown condenser.

Some readers may lack both the audio oscillator and the galvanometer suggested to build the instrument as described here. In that case it is only necessary to substitute the 110 volt 60 cycle alternating current supply as the source of potential and a headphone as the indicating instrument. When a headphone is used, regardless of the source of potential, care must be taken to find the exact spot at which the volume is weakest, in order that a minimum of error is caused in locating the bridge balance. It is usually more satisfactory to use a small step-down transformer with this later voltage so that only 10 or 12 volts potential is actually connected across the apparatus. This low voltage also eliminates the danger of getting a shock while using the equipment.

The device as described is particularly effective in determining the capacity of variable condensers at different settings. As an example, suppose we have constructed a circuit in which we are using a variable condenser of 0.0005 microfarad capacity with its plates only partly meshed. We desire to substitute a fixed capacity for this variable one in order to make the equipment more compact. We therefore remove the variable condenser from the circuit, taking care not to disturb its adjustment, and measure its capacity in our bridge circuit. We can now substitute a fixed capacity of this amount and get exactly the same results from our circuit as when we were using the variable condenser.

A Simplified "Short" Tester

The arrangement shown in Figure 115 consists of a 2.5-volt lamp lighted through a 15-ohm resistor tapped every 3 ohms. The taps are

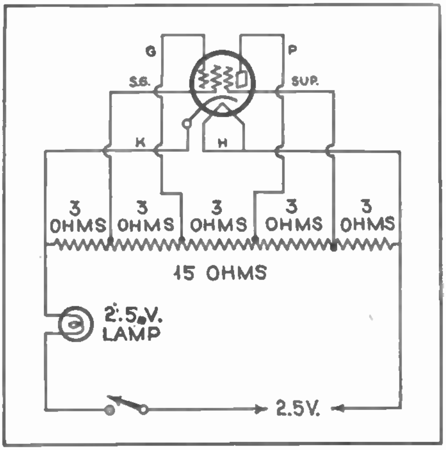


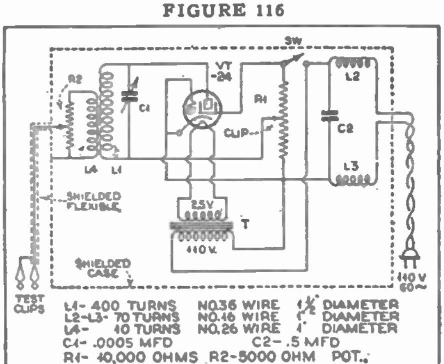
FIGURE 115

connected to the prongs of the test socket. When a tube is plugged in, a short-circuit between any of the elements will short-circuit a corresponding section of the resistor and the bulb will burn more brightly. The location of the short-circuit will not, of course, be indicated. But who cares?

An A.C.-Operated Dynatron Oscillator

The circuit shown in Figure 116 is recommended for simplicity and economy. All values are given on the diagram. The fundamental of the oscillator functions over a wide range of intermediate frequencies from

FIGURE 116



120 to 385 kc., and is extremely rich in harmonics, which are used for checking over the broadcast band. It can be readily calibrated against a standard broadcast receiver and the fundamental located by the fifth harmonic.

No switch is provided in the primary circuit, the heater being left on over an entire test period providing instant and accurate operation the

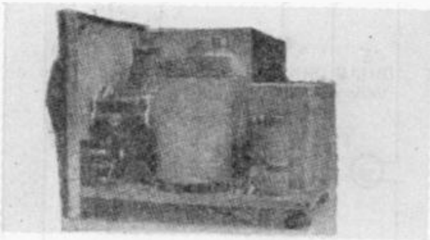


FIGURE 117

moment the plate voltage switch is closed.

Figure 117 shows the completed oscillator with the outside shield removed, indicating the constructional details.

A Thermionic Condenser Tester

The circuit of Figure 118 is primarily a vacuum tube voltmeter used for testing condensers, and indicates opens, shorts and leaky capacitors. The necessary parts and values are indicated on the diagram. The rheostat

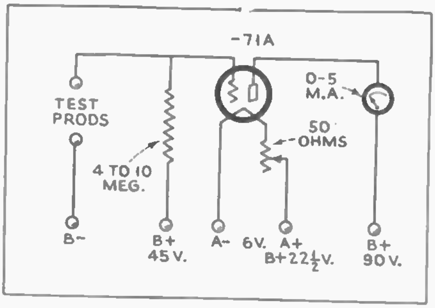


FIGURE 118

is adjusted for full scale deflection of the 71A. A good condenser will cause a momentary movement of the needle to the left, the original setting being resumed as the condenser takes its charge. The larger the capacity the greater the temporary deflection. An open condenser will show no kick at all, while a shorted capacitor will deflect permanently to zero. A leaky condenser will show a consistent deflection to the left—with possible erratic flickers—the degree of leakage, or short, corresponding to the extent of the left-handed deflection.

A Simple Tube "Short" Tester

After all, what the serviceman really wants to find out from a tube short tester is whether or not the tube under test has a short-circuit between any of the adjacent elements. Just where the "short" is, is not

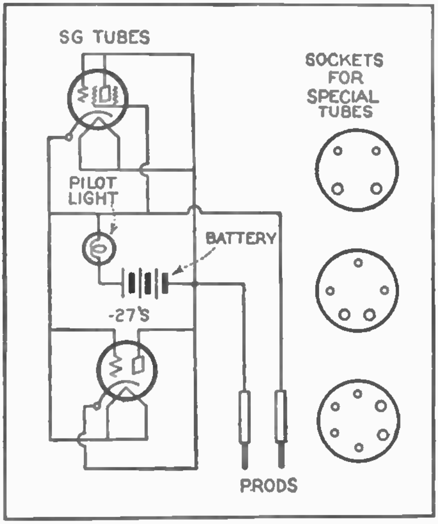


FIGURE 119

important, because the chances are nothing permanent can be done about it. As Hamlet would have said if he read *The Service Bench* of RADIO NEWS "The short's the thing."

The "short" tester can therefore be simplified to the very elemental and universal device diagrammed in Figure 119. The most common tubes of the screen-grid variety and the -27 type are tested directly by plugging into the indicated sockets. The pilot light will flash if there is a short-circuit between any adjacent elements. Additional 4, 5 and 6-prong sockets may be provided for testing special and less common tubes by means of test prods.

Another Condenser Tester

A minor variation in the usual vacuum-tube voltmeter circuit provides a convenient check on condensers from .05 to 2 mfd., immediately indicating open, short-circuited or leaky capacitors. The diagram and values are shown in Figure 120.

Before test, the milliammeter is adjusted to full-scale deflection by means of the 30-ohm filament rheostat. When a perfect condenser is connected across the test leads, the charging current causes an IR drop in the grid leak which places a momentary negative bias on the grid, causing the plate current to drop. The extent and duration of the drop increases with the capacity of the condenser. After the condenser is fully charged,

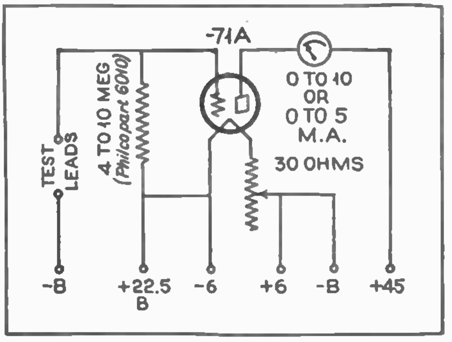


FIGURE 120

the charging current falls to zero, and the meter returns to full-scale reading. If the condenser is leaky, having some resistance (even as high as 100 megohms), the needle will not return to the maximum reading. The lower the reading, the greater the leakage. If the condenser is short-circuited, the needle of the meter will swing left to zero—or to the value indicated when the test leads are directly crossed. An "open" gives no deflection. (Due to the constant leakage current, electrolytic condensers cannot be tested by this device.)

A Universal Volt-Ampere-Ohmmeter

The versatility of the 0-1 milliampere meter is well demonstrated in the diagram of Figure 121, which shows the circuit arrangement of a universal meter. The following parts, keyed with the diagram, are employed:

M—Pattern 88 Jewell, 0-.001 ampere, d.c., with special dial
S1—Yaxley No. 1625 switch, 2-gang, 6-point, non-short circuiting type
S2—Yaxley No. 1615 switch, 1-gang, 5-point, non-short-circuiting type
S3—Yaxley No. 1613 switch, 1-gang, 3-point, non-short-circuiting type
S4— H. & H. off-on toggle switch
R1—Lynch type LW-1 precision resistor, 10,000 ohms
R2—Lynch, type LW-1 precision resistor, 100,000 ohms
R3—Lynch type LW-1 precision resistor, 150 000 ohms
R4—Lynch type LW-1 precision resistor, 250,000 ohms
R5—Lynch type LW-1 precision resistor, 500,000 ohms
R6—10ma. meter shunt made from old resistor strip
R7—25ma. meter shunt made from old resistor strip
R8—100 ma. meter shunt made from old resistor strip
R9—250 ma. meter shunt, Jewell Pattern 88
R10—500 ma. shunt, Jewell Pattern 88
R11—Ohiohm carbon resistor, 20,000 ohms
R12—Ohiohm carbon resistor, 40,000 ohms
R13—Yaxley Junior variable resistor, 5000 ohms
R14—Yaxley Junior rheostat, 50 ohms
Eight No. 751 Yaxley tip-jacks
One 7" by 9" Goodrich hard-rubber panel

The general construction of the Universal meter will vary from serviceman to serviceman. The parts may be mounted in a small box, 7 inches by 9 inches by 4½ inches. The operation is indicated in the diagram, and the following measurements are possible:

Voltmeter

(All made with S4 open)
0- 10 volts d.c., 1000 ohms per volt
0- 100 volts d.c., 1000 ohms per volt
0- 250 volts d.c., 1000 ohms per volt
0- 500 volts d.c., 1000 ohms per volt
0-1000 volts d.c., 1000 ohms per volt

Milliammeter

(All Made with S4 closed)
0-.001 ampere, d.c.
0-.01 ampere, d.c.
0-.1 ampere, d.c.
0-.25 ampere, d.c.
0-.5 ampere, d.c.

Ohmmeter

0-1000 ohms—S3 on "low," S1 to 100 ma., S4 closed—4.5 volts
0-10,000 ohms—S3 on "low," S1 to 10 ma., S4 closed—4.5 volts
0-100,000 ohms—S3 on low, S4 open—4.5 volts
0-500,000 ohms—S3 on "med," S4 open—22.5 volts
0-1,000,000 ohms—S3 on "high," S4 open—45 volts

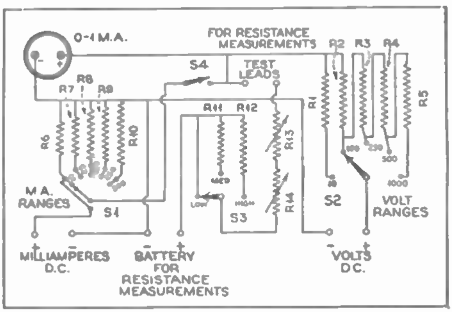


FIGURE 121

On the two lowest ranges, balancing is effected by R13 and R14. On all other ranges, R13 alone is sufficient for the full-scale adjustment.

A special scale is provided for this meter by the manufacturer and costs ninety cents. This makes all measurements direct reading as far as the cardinal figures are concerned, it being only necessary to locate the decimal point.

How To Make An Output Meter

Since the amount of current available for the operation of an output meter is often very small, it is advantageous to use a rectifier type of instrument. If a low-range d.c. milliammeter of the D'Arsonval type is available, it can readily be converted into a rectifier type output meter by connecting it (as shown in Figure 123) to an old rectifier unit taken from a trickle charger such as the National or Elkon. These chargers have three units, although one is sufficient for our purposes. The connections and schematic circuit of the rectifier are shown in Figure 122.

The meter could, of course, be calibrated by comparison with an a.c. meter, but for use as an output meter this is not necessary. If an 0-1

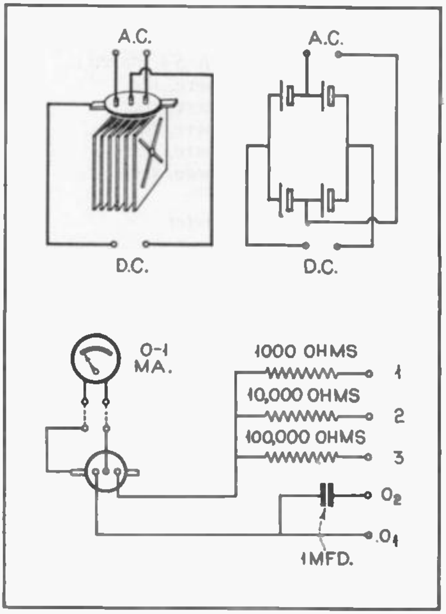


FIGURE 122—Above **FIGURE 123—Below**

or 0-1.5 milliampere meter is used, it will be necessary to use resistors as shown to cut down the sensitivity. When used across the coil of a dynamic speaker, post 1 may be used. When used across the input transformer to the speaker it will be found necessary to use one of the other scales.

The meter shown was constructed in a small box having connections for the 0-1 milliammeter so that it could be easily removed, hence the low-range meter was available for other purposes when not used in the output meter.

Two common posts, O1 and O2, are used, so that the meter may be available with a 1 mfd. condenser series for use directly from plate to ground.

Condenser Test Box

Construct a small box three inches square and fit it with a bakelite panel, on which is mounted a tap switch lever, six contact points and two binding posts. In the box mount six fixed condensers of the following values: .002, .006, .01, .5, 1.0, 2.0 mfd. A pair of test prods with short leads are connected to the binding posts and the condensers are hooked up so that any one value can be selected and made available at the prod

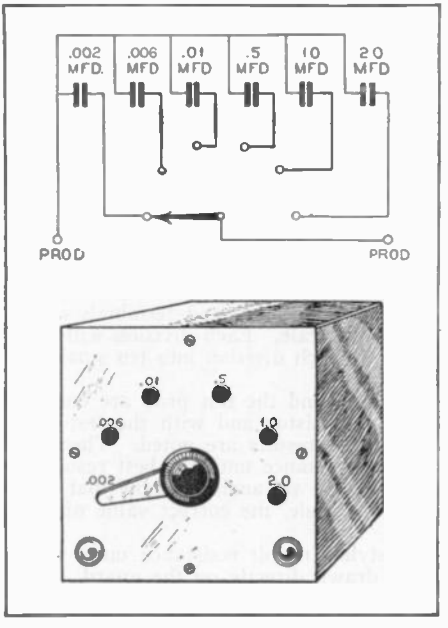


FIGURE 124

tips by means of the tap switch. The values at tap points are marked on the panel. (See Figure 124.)

This little capacity box will prove very convenient in locating open by-pass condensers by substitution, probing for hum reduction and especially so when the cut and try method of determining the effects of various capacity values is used.

Resistor Indicator

Resistor indicators which enable a serviceman to find the value of an uncoded resistor that has given up the ghost are extremely useful.

Take a 100,000-ohm voltage divider resistance of the Electrad Truvolt type, which has the wire exposed. Mount it on a small bakelite or other insulating panel, together with three binding posts, as shown in Figure 125. The two end binding posts go to the end terminals of the resistance unit and the center binding post goes to a short length of flexible wire which is connected to an ordinary test prod with the end filed or ground so that it forms a rounded point that will not cut the wire in the unit. In front of the resistance provide a third piece of bakelite to hold the

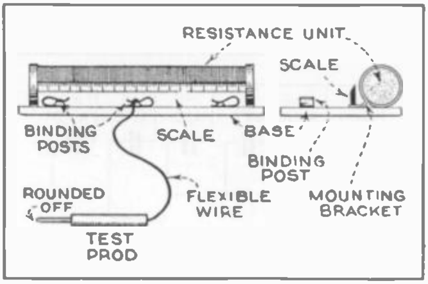


FIGURE 125

scale, which is drawn on bristol board and fastened to the support. Divide the distance between the two end terminals of the resistance unit into ten equal parts on the scale. Each division will then represent 10,000 ohms. Further subdivide each division into ten smaller divisions, each of which indicates 1,000 ohms.

In use, one end terminal and the test prod are connected in the circuit in place of the defective resistor and with the test prod at the 100,000-ohm mark on the scale the results are noted. Then gradually move the prod so that it cuts out resistance until the best results are obtained from the set or the readings on the set analyzer show that the resistance is correct. Then by noting the scale, the correct value of replacement resistor can be found.

If one of the new style Truvolt resistance units with a fiber guard is used, the scale can be drawn directly on the guard.

Home-made Meter Rectifier

A low-range milliammeter of the D'Arsonval type can readily be converted to use as an output meter by the addition of the reconstructed rectifier described here. This unit is one made from an Elkon type rectifier.

The original rectifier unit is dissembled and the various parts inspected. The thick blue-black discs are composed of copper sulphide. The pliable washers are lead, while the stiff ones are magnesium. If any of these pieces have a whitish appearance, they should be polished with fine emery cloth. A copper sulphide, a lead and a magnesium disc are taken and cut as shown in Figure 126. The sulphide disc is easily cut with a hacksaw.

Four terminals 1 inch by ¼ inch are cut from sheet copper. A small angle of heavy copper or brass is bent as in Figure 127 and a hole is bored in the side for the set-screw. The unit is reassembled as shown in Figure 128 with a heavy piece of paper on the bottom for insulation.

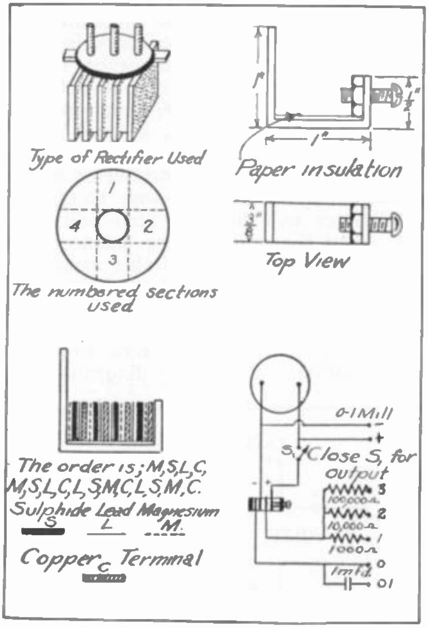


FIGURE 126—Upper Left **FIGURE 127—Upper Right**
FIGURE 128—Lower Left **FIGURE 129—Lower Right**

The outer terminal is positive, the center one negative, while the other two are the a.c. terminals. The set-screw must be very tight.

The circuit used is shown in Figure 129. The meter has 3 ranges, as shown, with the terminal .01 being used for measurements from plate to ground. The meter can be calibrated by comparison with an a.c. meter, but this is not necessary for use as an output meter. The unit is boxed, with connection posts so that the meter can be used for other than output measurements.

Accurate Voltage Measurements In High Resistance Circuits

Only a few servicemen possess devices with which to measure voltages in high resistance radio circuits, such as are found in direct-coupled and resistance-coupled amplifiers. A device much used in laboratories, is the potentiometer method of measuring voltages without drawing any current from the circuit under test. By using accurate meters and resistors this method will give results as precise as one part in 10,000. For use in radio work, precision on the order of 95% or better is entirely satisfactory. With only this aim in mind the apparatus is simple to construct, simple to operate, and above all it is quite cheap, since the expensive constituents are always available from the serviceman's analyzer. The schematic circuit is shown herewith in Figure 130. The mechanical arrangement needs no care and is consequently left to the builder's ingenuity. The original outfit was constructed for measuring voltages up to 500 volts d.c. The power supply which should supply 500 volts to 550 volts is used to put a potential of 500 volts across the 50,000 ohm potentiometer at a current of 10 ma. This supply, incidentally, is used in service work when the power pack in a receiver is haywire, and, therefore, it does not constitute an investment solely for the potentiometer voltmeter. When the tap on the potentiometer is set at the same voltage as the voltage to be measured, the voltmeter will indicate zero voltage, since no current flows in that branch when the voltages are balanced.

To use this device, a milliameter of suitable range is connected at the ma binding posts, and R1 is adjusted until the current is 10 ma. A voltmeter of any range in excess of that to be measured is connected to the voltmeter posts. Before connecting the device to the circuit to be measured, turn the dial on the potentiometer to zero which turns the potentiometer tap to the end marked "a" on the diagram. The voltmeter will

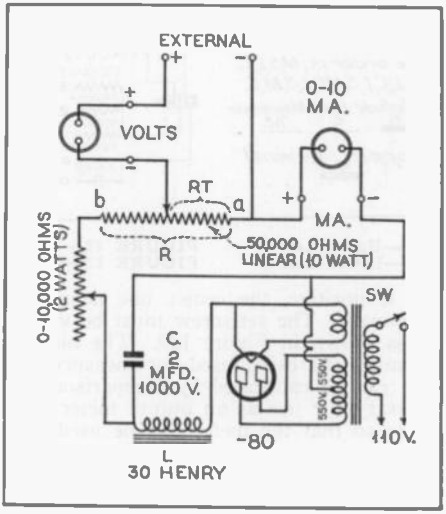


FIGURE 130

then give a reading when the external binding posts are connected to the points across which the voltage is measured. The next step is to turn the potentiometer knob, so that the tap slides towards "b", until the voltmeter reading is zero. If the meter is of the multi-range type, the range can then be changed to 5 or 10 volts, and the potentiometer still further varied for greater accuracy. During this time the current through the potentiometer should remain at 10 milliamperes.

Since the potentiometer is linear in its characteristics, the voltage will be equal to the number of dial divisions from zero divided by the total number of dial divisions, times the voltage drop which is 500. If the potentiometer is turned ¼ of the way the voltage is ¼ of 500 volts or 125 volts, if ½, it is ½ of 500 or 250 volts. The dial used should preferably be one of about 4-inch diameter divided over its entire circumference. The average potentiometer will cover about 180 divisions on a 200 division dial. It is not necessary that the 0-10 milliameter be other than the 1 ma. movement of the voltmeter with a shunt, for it is not necessary to have instantaneous readings of both meters at once. By the appropriate use of Ohms Law, other values than those given can be used. For instance a 250 volt supply with a 25,000 ohm potentiometer, etc. To make readings easier, the values of the dial may be plotted on a chart or graph.

Inexpensive Output Meter

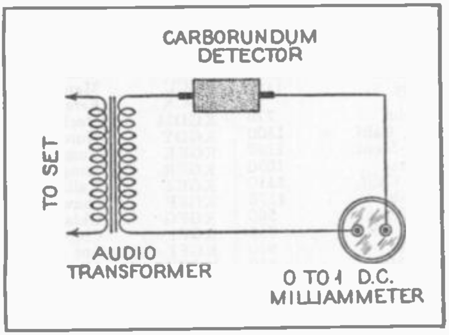


FIGURE 131

This circuit (Figure 131) shows how to make an output meter out of an ordinary 0 to 1 d.c. milliammeter, a carborundum detector and an audio transformer.

This simple arrangement works very well and can be made at a fraction of the cost of an expensive output meter.

CHAPTER TEN

Station Lists

U. S. Broadcasting Stations

Call	Location	Kilocycles
KABC	San Antonio, Texas	1420
KALE	Portland, Ore.	1300
KARK	Little Rock, Ark.	890
KASA	Elk City, Okla.	1210
KBPS	Portland, Ore.	1420
KBTM	Jonesboro, Ark.	1200
KCMC	Texarkana, Ark.	1420
KCRC	Enid, Okla.	1370
KCRJ	Jerome, Ariz.	1310
KDB	Santa Barbara, Calif.	1500
KDFN	Casper, Wyo.	1440
KDKA	Pittsburgh, Pa.	980
KDLR	Devils Lake, N. D.	1210
KDYL	Salt Lake City, Utah	1290
KECA	Los Angeles, Calif.	1430
KELW	Burbank, Calif.	780
KERN	Bakersfield, Calif.	1200
KEX	Portland, Ore.	1150
KFAB	Lincoln, Nebr.	770
KFAC	Los Angeles, Calif.	1300
KFBB	Great Falls, Mont.	1280
KFBI	Abilene, Kans.	1050
KFB	Sacramento, Calif.	1310
KFBL	Everett, Wash.	1370
KFDM	Beaumont, Texas	560
KFDY	Brookings, S. D.	550
KFEL	Denver, Colo.	920
KFEQ	St. Joseph, Mo.	630
KFGQ	Boone, Iowa	1310
KFH	Wichita, Kans.	1300
KFI	Los Angeles, Calif.	640
KFIO	Spokane, Wash.	1120
KFIZ	Fond du Lac, Wis.	1420
KFJB	Marshalltown, Iowa	1200
KFJI	Klamatb Falls, Ore.	1210
KFJM	Grand Forks, N. D.	1370
KFJR	Portland, Ore.	1300
KFJZ	Fort Worth, Texas	1370
KFKA	Greeley, Colo.	880
KFKU	Lawrence, Kans.	1220
KFLV	Rockford, Ill.	1410
KFNF	Sbenandoah, Iowa	890
KFOR	Lincoln, Nebr.	1210
KFOX	Long Beach, Calif.	1250
KFPL	Dublin, Texas	1310
KFPM	Greenville, Texas	1310
KFPW	Fort Smith, Ark.	1210
KFPY	Spokane, Wash.	890
KFQD	Anchorage, Alaska	600
KFRC	San Francisco, Calif.	610
KFRU	Columbia, Mo.	630
KFSD	San Diego, Calif.	1000
KFSG	Los Angeles, Calif.	1120
KFUO	St. Louis, Mo.	550
KFVD	Los Angeles, Calif.	1000
KFVS	Cape Girardeau, Mo.	1210
KFWB	Hollywood, Calif.	950
KFWI	San Francisco, Calif.	930
KFXD	Nampa, Idaho	1200
KFXF	Denver, Colo.	920
KFXJ	Grand Junction, Colo.	1200
KFXM	San Bernardino, Calif.	1210
KFXR	Oklahoma City, Okla.	1310
KFYO	Lubbock, Texas	1310
KFYR	Bismarck, N. D.	550
KGA	Spokane, Wash.	1470
KGAR	Tucson, Ariz.	1370
KGB	San Diego, Calif.	1330
KGBU	Ketchikan, Alaska	900
KGBX	Springfield, Mo.	1310
KGBZ	York, Nebr.	930
KGCA	Decorah, Iowa	1270
KGCR	Watertown, S. D.	1210
KGCU	Mandan, N. D.	1240
KGCX	Fergus Falls, Minn.	1200
KGDM	Stockton, Calif.	1100
KGDY	Huron, S. D.	1340
KGEK	Yuma, Colo.	1200
KGER	Long Beach, Calif.	1360
KGEZ	Kalispell, Mont.	1310
KGFF	Shawnee, Okla.	1420
KGFG	Oklahoma City, Okla.	1370
KGFI	Corpus Christi, Texas	1500
KGFJ	Los Angeles, Calif.	1200
KGFK	Moorhead, Minn.	1500
KGFL	Roswell, N. M.	1370
KGFW	Kearney, Nebr.	1310
KGFX	Pierre, S. D.	630
KGGC	San Francisco, Calif.	1420
KGGF	Coffeyville, Kans.	1010
KGGM	Albuquerque, N. M.	1230
KGHF	Pueblo, Colo.	1230
KGHI	Little Rock, Ark.	1200
KGHL	Billings, Mont.	950
KGIR	Butte, Mont.	1340
KGIW	Alamosa, Colo.	1420
KGIX	Las Vegas, Nev.	1420
KGKB	Tyler, Texas	1500
KGKL	San Angelo, Texas	1370
KGKO	Wichita Falls, Texas	570
KGKY	Scottsbluff, Nebr.	1500
KGMB	Honolulu, T. H.	1320
KGNF	North Platte, Nebr.	1430
KGNO	Dodge City, Kans.	1340
KGO	San Francisco, Calif.	790
KGRS	Amarillo, Texas	1410
KGU	Honolulu, T. H.	750
KGVO	Missoula, Mont.	1200
KGW	Portand, Ore.	620
KGY	Olympia, Wash.	1210

Call	Location	Kilocycles
KHJ	Los Angeles, Calif.	900
KHQ	Spokane, Wash.	590
KICA	Clovis, N. M.	1370
KICK	Carter Lake, Iowa	1420
KID	Idaho Falls, Idaho	1320
KIDO	Boise, Idaho	1350
KIDW	Lamar, Colo.	1420
KIEM	Eureka, Calif.	1210
KIEV	Glendale, Calif.	850
KIFH	Juneau, Alaska	1310
KIT	Yakima, Wash.	1310
KJB	Seattle, Wash.	970
KJBS	San Francisco, Calif.	1070
KLCN	Blytheville, Ark.	1290
KLO	Ogden, Utah	1400
KLPM	Minot, N. D.	1240
KLRA	Little Rock, Ark.	1390
KLS	Oakland, Calif.	1440
KLUF	Galveston, Texas	1370
KLX	Oakland, Calif.	880
KLZ	Denver, Colo.	560
KMA	Shenandoah, Iowa	930
KMAC	San Antonio, Texas	1290
KMBC	Kansas City, Mo.	950
KMED	Medford, Ore.	1310
KMJ	Fresno, Calif.	580
KMLB	Monroe, La.	1200
KMMJ	Clay Center, Nebr.	740
KMO	Tacoma, Wash.	1330
KMOX	St. Louis, Mo.	1090
KMPC	Beverly Hills, Calif.	710
KMTR	Hollywood, Calif.	570
KNOW	Austin, Texas	1500
KNX	Hollywood, Calif.	1050
KOA	Denver, Colo.	830
KOAC	Corvallis, Ore.	550
KOB	Albuquerque, N. M.	1180
KOCW	Tulsa, Okla.	1400
KOH	Reno, Nevada	1380
KOIL	Council Bluffs, Iowa	1260
KOIN	Portland, Ore.	940
KOL	Seattle, Wash.	1270
KOMA	Oklahoma City, Okla.	1480
KOMO	Seattle, Wash.	920
KONO	San Antonio, Texas	1370
KOOS	Marshfield, Ore.	1370
KORE	Eugene, Ore.	1420
KOY	Phoenix, Ariz.	1390
KPCB	Seattle, Wash.	710
KPJM	Prescott, Ariz.	1500
KPO	San Francisco, Calif.	680
KPOF	Denver, Colo.	880
KPPC	Pasadena, Calif.	1210
KPQ	Wenatchee, Wash.	1500
KPRC	Houston, Texas	920
KQV	Pittsburgh, Pa.	1380
KQW	San Jose, Calif.	1010
KRE	Berkeley, Calif.	1370
KREG	Santa Ana, Calif.	1500

Call	Location	Kilocycles
KRGV	Harlingen, Texas	1260
KRKD	Los Angeles, Calif.	1120
KRLD	Dallas, Texas	1040
KRMD	Shreveport, La.	1310
KROW	Oakland, Calif.	930
KRSC	Seattle, Wash.	1120
KSAC	Manhattan, Kans.	580
KSCJ	Sioux City, Iowa	1330
KSD	St. Louis, Mo.	550
KSEI	Pocatello, Idaho	890
KSL	Salt Lake City, Utah	1130
KSO	Des Moines, Iowa	1370
KSOO	Sioux Falls, S. D.	1110
KSTP	St. Paul, Minn.	1460
KSUN	Lowell, Ariz.	1200
KTAB	San Francisco, Calif.	560
KTAR	Phoenix, Ariz.	620
KTAT	Fort Worth, Texas	1240
KTBS	Shreveport, La.	1450
KTFI	Twin Falls, Idaho	1240
KTHS	Hot Springs, Ark.	1040
KTM	Los Angeles, Calif.	780
KTRH	Houston, Texas	1120
KTSA	San Antonio, Texas	1370
KTSM	El Paso, Texas	1310
KTW	Seattle, Wash.	1220
KUJ	Walla Walla, Wash.	1370
KUMA	Yuma, Ariz.	1420
KUOA	Fayetteville, Ark.	1260
KUSD	Vermillion, S. D.	890
KVI	Tacoma, Wash.	570
KVL	Seattle, Wash.	1370
KVOA	Tucson, Ariz.	1260
KVOO	Tulsa, Okla.	1140
KVOR	Colorado Springs, Colo.	1270
KVOS	Bellingham, Wash.	1200
KWCR	Cedar Rapids, Iowa	1420
KWEA	Shreveport, La.	1210
KWFV	Hilo, Hawaii	1210
KWG	Stockton, Calif.	1200
KWJJ	Portland, Ore.	1060
KWK	St. Louis, Mo.	1350
KWKC	Kansas City, Mo.	1370
KWKH	Shreveport, La.	850
KWLC	Decorah, Iowa	1270
KWSC	Pullman, Wash.	1220
KWTO	Springfield, Mo.	560
KWWG	Brownsville, Texas	1260
KXA	Seattle, Wash.	760
KXL	Portland, Ore.	1420
KXO	El Centro, Calif.	1500
KXRO	Aberdeen, Wash.	1310
KXYZ	Houston, Texas	1440
KYA	San Francisco, Calif.	1230
KYW	Chicago, Ill.	1020
KZRM	Manila, P. I.	618.5
NAA	Arlington, Va.	690

Call	Location	Kilocycles
WAAB	Boston, Mass.	1410
WAAF	Chicago, Ill.	920
WAAT	Jersey City, N. J.	940
WAAW	Omaha, Nebr.	660
WABC	New York, N. Y.	860
WABI	Bangor, Me.	1200
WACO	Waco, Texas	1420
WADC	Akron, Ohio	1320
WAGM	Presque Isle, Me.	1420
WAIU	Columbus, Ohio	640
WALR	Zanesville. Ohio	1210
WAMC	Anniston, Ala.	1420
WAML	Laurel, Miss.	1310
WAPI	Birmingham, Ala.	1140
WARD	Brooklyn, N. Y.	1400
WASH	Grand Rapids, Mich.	1270
WAVE	Louisville, Ky.	940
WAWZ	Zarepath, N. J.	1350
WAZL	Hazleton, Pa.	1420
WBAA	West Lafayette, Ind.	1400
WBAK	Harrisburg, Pa.	1430
WBAL	Baltimore, Md.	1060
WBAP	Fort Worth, Texas	800
WBAX	Wilkes-Barre, Pa.	1210
WBBC	Brooklyn, N. Y.	1400
WBBL	Richmond, Va.	1210
WBBM	Chicago, Ill.	770
WBBR	Brooklyn, N. Y.	1300
WBBX	New Orleans, La.	1200
WBBZ	Ponca City, Okla.	1200
WBCM	Bay City, Mich.	1410
WBEN	Buffalo, N. Y.	900
WBEO	Marquette, Mich.	1310
WBHS	Huntsville, Ala.	1200
WBIG	Greensboro, N. C.	1440
WBNX	New York, N. Y.	1350
WBOQ	See WABC	
WBOW	Terre Haute, Ind.	1310
WBRC	Birmingham, Ala.	930
WBRE	Wilkes-Barre, Pa.	1310
WBSO	Babson Park, Mass.	920
WBT	Charlotte, N. C.	1080
WBTM	Danville, Va.	1370
WBZ	Boston, Mass.	990
WBZA	Springfield, Mass.	990
WCAC	Storrs, Conn.	600
WCAD	Canton, N. Y.	1220
WCAE	Pittsburgh, Pa.	1220
WCAH	Columbus, Ohio	1430
WCAL	Northfield, Minn.	1250
WCAM	Camden, N. J.	1280
WCAO	Baltimore, Md.	600
WCAP	Asbury Park, N. J.	1280
WCAT	Rapid City, S. D.	1200
WCAU	Philadelphia, Pa.	1170
WCAX	Burlington, Vt.	1200
WCAZ	Carthage, Ill.	1070
WCBA	Allentown, Pa.	1440
WCBD	Zion, Ill.	1080
WCBM	Baltimore, Md.	1370
WCBS	Springfield, Ill.	1210
WCCO	Minneapolis, Minn.	810
WCFL	Chicago, Ill.	970
WCKY	Covington, Ky.	1490
WCLO	Janesville, Wis.	1200
WCLS	Joliet, Ill.	1310
WCNW	Brooklyn, N. Y.	1500
WCOA	Pensacola, Fla.	1340
WCOC	Meridian, Miss.	880
WCRW	Chicago, Ill.	1210
WCSC	Charleston, S. C.	1360
WCSH	Portland, Me.	940
WDAE	Tampa, Fla.	1220
WDAF	Kansas City, Mo.	610
WDAG	Amarillo, Texas	1410
WDAH	El Paso, Texas	1310
WDAS	Philadelphia, Pa.	1370
WDAY	Fargo, N. D.	940
WDBJ	Roanoke, Va.	930
WDBO	Orlando, Fla.	580
WDEL	Wilmington, Del.	1120
WDEV	Waterbury, Vt.	550
WDGY	Minneapolis, Minn.	1180
WDOD	Chattanooga, Tenn.	1280
WDRC	Hartford, Conn.	1330
WDSU	New Orleans, La.	1250
WDZ	Tuscola, Ill.	1070
WEAF	New York, N. Y.	660
WEAN	Providence, R. I.	780
WEBC	Superior, Wis.	1290
WEBQ	Harrisburg, Ill.	1210
WEBR	Buffalo, N. Y.	1310
WEDC	Chicago, Ill.	1210
WEED	Greenville, N. D.	1420
WEEI	Boston, Mass.	590
WEEU	Reading, Pa.	830
WEHC	Charlottesville, Va.	1350
WEHS	Cicero, Ill.	1420
WELL	Battle Creek, Mich.	1420
WENC	Albany, Ga.	1420
WENR	Chicago, Ill.	870
WESG	Elmira, N. Y.	1040
WEVD	New York, N. Y.	1300
WEW	St. Louis, Mo.	760
WEXL	Royal Oak, Mich.	1310
WFAA	Dallas, Texas	800
WFAB	New York, N. Y.	1300
WFAM	South Bend, Ind.	1200
WFAS	White Plains, N. Y.	1210
WFBC	Greenville, S. C.	1200
WFBE	Cincinnati, Ohio	1200
WFBG	Altoona, Pa.	1310
WFBL	Syracuse, N. Y.	1360
WFBM	Indianapolis, Ind.	1230
WFBR	Baltimore, Md.	1270
WFDF	Flint, Mich.	1310
WFDV	Rome, Ga.	1500
WFEA	Manchester, N. H.	1430
WFI	Philadelphia, Pa.	560
WFLA	Clearwater, Fla.	620
WGAL	Lancaster, Pa.	1310
WGAR	Cleveland, Ohio	1450
WGBB	Freeport, N. Y.	1210
WGBF	Evansville, Ind.	630
WGBI	Scranton, Pa.	880
WGCM	Mississippi City, Miss.	1210
WGCP	Newark, N. J.	1250
WGES	Chicago, Ill.	1360
WGH	Newport News, Va.	1310

Call	Location	Kilocycles
WGL	Fort Wayne, Ind.	1370
WGLC	Hudson Falls, N. Y.	1370
WGN	Chicago, Ill.	720
WGNY	Chester, N. Y.	1210
WGR	Buffalo, N. Y.	550
WGST	Atlanta, Ga.	890
WGY	Schenectady, N. Y.	790
WHA	Madison, Wis.	940
WHAD	Milwaukee, Wis.	1120
WHAM	Rochester, N. Y.	1150
WHAS	Louisville, Ky.	820
WHAT	Philadelphia, Pa.	1310
WHAZ	Troy, N. Y.	1300
WHB	Kansas City, Mo.	860
WHBC	Canton, Ohio,	1200
WHBD	Mount Orab, Ohio	1370
WHBF	Rock Island, Ill.	1210
WHBL	Sheboygan, Wis.	1410
WHBQ	Memphis, Tenn.	1370
WHBU	Anderson, Ind.	1210
WHBY	Green Bay, Wis.	1200
WHDF	Calumet, Mich.	1370
WHDH	Boston, Mass.	830
WHDL	Tupper Lake, N. Y.	1420
WHEB	Portsmouth, N. H.	740
WHEC	Rochester, N. Y.	1430
WHEF	Kosciusko, Miss.	1500
WHET	Troy, Ala.	1210
WHFC	Cicero, Ill.	1420
WHIS	Bluefield, W. Va.	1410
WHK	Cleveland, Ohio	1390
WHN	New York, N. Y.	1010
WHO	See WOC	
WHOM	Jersey City, N. J.	1450
WHP	Harrisburg, Pa.	1430
WIAS	Ottumwa, Iowa	1310
WIBA	Madison, Wis.	1280
WIBG	Glenside, Pa.	970
WIBM	Jackson, Mich.	1370
WIBU	Poynette, Wis.	1210
WIBW	Topeka, Kans.	580
WIBX	Utica, N. Y.	1200
WICC	Bridgeport, Conn.	600
WIL	St. Louis, Mo.	1200
WILL	Urbana, Ill.	890
WILM	Wilmington, Del.	1420
WIND	Gary, Ind.	560
WINS	New York, N. Y.	1180
WIOD	Miami, Fla.	1300
WIP	Philadelphia, Pa.	610
WIS	Columbia, S. C.	1010
WISN	Milwaukee, Wis.	1120
WJAC	Johnstown, Pa.	1310
WJAG	Norfolk, Nebr.	1060
WJAR	Providence, R. I.	890
WJAS	Pittsburgh, Pa.	1290
WJAX	Jacksonville, Fla.	900
WJAY	Cleveland, Ohio	610
WJBC	La Salle, Ind.	1200
WJBI	Red Bank, N. J.	1210
WJBK	Detroit, Mich.	1370
WJBL	Decatur, Ill.	1200
WJBO	Baton Rouge, La.	1420
WJBW	New Orleans, La.	1200
WJBY	Gadsden, Ala.	1210

Call	Location	Kilocycles
WJDX	Jackson, Mich.	1270
WJEJ	Hagerstown, Md.	1210
WJEM	Tupelo, Miss.	990
WJJD	Chicago, Ill.	1130
WJMS	Ironwood, Mich.	1420
WJR	Detroit, Mich.	750
WJSV	Alexandria, Va.	1460
WJTL	Atlanta, Ga.	1370
WJW	Akron, Ohio	1210
WJZ	New York, N. Y.	760
WKAQ	San Juan, P. R.	1240
WKAR	East Lansing, Mich.	1040
WKBB	East Dubuque, Ill.	1500
WKBC	Birmingham, Ala.	1310
WKBF	Indianapolis, Ind.	1400
WKBH	LaCrosse, Wis.	1380
WKBI	Cicero, Ill.	1420
WKBN	Youngstown, Ohio	570
WKBO	Harrisburg, Pa.	1200
WKBV	Richmond, Ind.	1500
WKBW	Buffalo, N. Y.	1480
WKBZ	Ludington, Mich.	1500
WKEU	LaGrange, Ga.	1500
WKFI	Greenville, Miss.	1210
WKJC	Lancaster, Pa.	1200
WKOK	Sunbury, Pa.	1210
WKRC	Cincinnati, Ohio	550
WKY	Oklahoma City, Okla.	900
WKZO	Kalamazoo, Mich.	590
WLAC	Nashville, Tenn.	1470
WLAP	Louisville, Ky.	1200
WLB	Minneapolis, Minn.	1250
WLBC	Muncie, Ind.	1310
WLBF	Kansas City, Kans.	1420
WLBL	Stevens Point, Wis.	900
WLBW	Erie, Pa.	1200
WLBZ	Bangor, Me.	620
WLEC	Portland, Me.	1340
WLEY	Lexington, Mass.	1370
WLIT	Philadelphia, Pa.	560
WLS	Chicago, Ill.	870
WLTH	Brooklyn, N. Y.	1400
WLVA	Lynchburg, Va.	1370
WLW	Cincinnati, Ohio	700
WLWL	New York, N. Y.	1100
WMAC	See WSYR	
WMAL	Washington, D. C.	630
WMAQ	Chicago, Ill.	670
WMAS	Springfield, Mass.	1420
WMAZ	Macon, Ga.	1180
WMBC	Detroit, Mich.	1420
WMBD	Peoria, Ill.	1440
WMBG	Richmond, Va.	1210
WMBH	Joplin, Mo.	1420
WMBI	Chicago, Ill.	1080
WMBO	Auburn, N. Y.	1310
WMBQ	Brooklyn, N. Y.	1500
WMBR	Tampa, Fla.	1370
WMC	Memphis, Tenn.	780
WMCA	New York, N. Y.	570
WMMN	Fairmont, W. Va.	890
WMPC	Lapeer, Mich.	1500
WMT	Waterloo, Iowa	600
WNAC	Boston, Mass.	1230

Call	Location	Kilocycles
WNAD	Norman, Okla.	1010
WNAX	Yankton, S. D.	570
WNBF	Binghamton, N. Y.	1500
WNBH	New Bedford, Mass.	1310
WNBO	Silverhaven, Pa.	1200
WNBR	Memphis, Tenn.	1430
WNBW	Carbondale, Pa.	1200
WNBX	Springfield, Vt.	1260
WNBZ	Saranac Lake, N. Y.	1290
WNEW	Newark, N. J.	1250
WNOX	Knoxville, Tenn.	560
WNRA	Muscle Shoals City, Ala.	1410
WNYC	New York, N. Y.	810
WOAI	San Antonio, Texas	1190
WOBU	Charleston, W. Va.	580
WOC	Des Moines, Iowa	1000
WOCL	Jamestown, N. Y.	1210
WODX	Mobile, Ala.	1410
WOI	Ames, Iowa	640
WOKO	Albany, N. Y.	1430
WOL	Washington, D. C.	1310
WOMT	Manitowoc, Wis.	1210
WOOD	Grand Rapids, Mich.	1270
WOPI	Bristol, Tenn.	1500
WOQ	Kansas City, Mo.	1300
WOR	Newark, N. J.	710
WORC	Worcester, Mass.	1280
WORK	York, Pa.	1000
WOS	Jefferson City, Mo.	630
WOSU	Columbus, Ohio	570
WOV	New York, N. Y.	1130
WOW	Omaha, Nebr.	590
WOWO	Fort Wayne, Ind.	1160
WPAD	Paducah, Ky.	1420
WPEN	Philadelphia, Pa.	1500
WPFB	Hattiesburg, Miss.	1370
WPG	Atlantic City, N. J.	1100
WPHR	Petersburg, Va.	1200
WPRO	Providence, R. I.	1210
WPTF	Raleigh, N. C.	680
WQAM	Miami, Fla.	560
WQAN	Scranton, Pa.	880
WQBC	Vicksburg, Miss.	1360
WQDM	St. Albans, Vt.	1370
WQDX	Thomasville, Ga.	1210
WRAK	Williamsport, Pa.	1370
WRAM	Wilmington, N. C.	1370
WRAW	Reading, Pa.	1310
WRAX	Philadelphia, Pa.	1020
WRBL	Columbus, Ohio	1200
WRBX	Roanoke, Va.	1410
WRC	Washington, D. C.	950
WRDO	Augusta, Me.	1370
WRDW	Augusta, Ga.	1500
WREC	Memphis, Tenn.	600
WREN	Lawrence, Kans.	1220
WRHM	Minneapolis, Minn.	1250
WRJN	Racine, Wis.	1370
WROL	Knoxville, Tenn.	1310
WRR	Dallas, Texas	1280
WRUF	Gainesville, Fla.	830
WRVA	Richmond, Va.	1110
WSAI	Cincinnati, Ohio	1330
WSAJ	Grove City, Pa.	1310
WSAN	Allentown, Pa.	1440
WSAR	Fall River, Mass.	1450
WSAZ	Huntington, W. Va.	1190
WSB	Atlanta, Ga.	740
WSBC	Chicago, Ill.	1210
WSBT	South Bend, Ind.	1230
WSEN	Columbus, Ohio	1210
WSFA	Montgomery, Ala.	1410
WSIX	Springfield, Tenn.	1210
WSJS	Winston-Salem, N. C.	1310
WSM	Nashville, Tenn.	650
WSMB	New Orleans, La.	1320
WSMK	Dayton, Ohio	1380
WSOC	Charlotte, N. C.	1210
WSPA	Spartanburg, S. C.	1420
WSPD	Toledo, Ohio	1340
WSUI	Iowa City, Iowa	880
WSUN	St. Petersburg, Fla.	620
WSVS	Buffalo, N. Y.	1370
WSYB	Rutland, Vt.	1500
WSYR	Syracuse, N. Y.	570
WTAD	Quincy, Ill.	1440
WTAG	Worcester, Mass.	580
WTAM	Cleveland, Ohio	1070
WTAQ	Eau Claire, Wis.	1330
WTAR	Norfolk, Va.	780
WTAW	College Station, Texas	1120
WTAX	Springfield, Ill.	1210
WTBO	Cumberland, Md.	1420
WTEL	Philadelphia, Pa.	1310
WTFI	Athens, Ga.	1450
WTIC	Hartford, Conn.	1060
WTJS	Jackson, Tenn.	1310
WTMJ	Milwaukee, Wis.	620
WTNJ	Trenton, N. J.	1280
WTOC	Savannah, Ga.	1260
WTRC	Elkhart, Ind.	1310
WVFW	Brooklyn, N. Y.	1400
WWAE	Hammond, Ind.	1200
WWJ	Detroit, Mich.	920
WWL	New Orleans, La.	850
WWNC	Asheville, N. C.	570
WWRL	Woodside, N. Y.	1500
WWSW	Pittsburgh, Pa.	1500
WWVA	Wheeling, W. Va.	1160
WXYZ	Detroit, Mich.	1240

PLEASE NOTE

These station lists have been thoroughly checked for accuracy. However, due to the fact that short-wave stations change their call letters or frequencies quite often, the editors suggest that you follow RADIO NEWS for changes.

Popular Short-Wave Stations

Wave-length Meters	*Call Letters*	*Frequency Kc.*	*City Country*
13.9+	W8XK	21540	Pittsburgh, Pa.
13.9+	GSH	21470	Daventry, England
14.2+	LSN	21020	Buenos Aires, Argen.
15.2+	IRW	19700	Rome, Italy
15.9+	PLE	18860	Bandoeng, Java
16.5	LSY	18115	Buenos Aires, Argen.
16.8+	GSG	17790	Daventry, England
16.8+	W3XAL	17780	Bound Brook, N. J.
16.8+	PHI	17775	Huizen, Holland
17.2+	JIAA	17380	Kemikawa-Cho., Jap.
17.3+	W3XL	17300	Bound Brook, N. J.
19.5	W2XAD	15330	Schenectady, N. Y.
19.6+	CP5	15308	La Paz, Bolivia
19.6+	W2XE	15270	New York, N. Y.
19.6	FYA	15243	Pontoise, France
19.7	W8XK	15210	Pittsburgh, Pa.
19.7	DJB	15200	Zeesen, Germany
19.8	GSF	15140	Daventry, England
19.8	HVJ	15123	Vatican City
22.0	JYK	13610	Kemikawa-Cho, Japan
23.3	CNR	12830	Rabat, Morocco
24.8+	CT1CT	12082	Lisbon, Portugal
25.1+	RNE	11924	Moscow, U. S. S. R.
25.2	FYA	11900	Pontoise, France
25.2	W8XK	11870	Pittsburgh, Pa.
25.3	GSE	11860	Daventry, England
25.3+	W2XE	11830	New York, N. Y.
25.4	I2RO	11810	Rome, Italy
25.4+	W1XAL	11790	Boston, Mass.
25.5	DJD	11760	Zeesen, Germany
25.5	GSD	11750	Daventry, England
25.6	FYA	11720	Pontoise, France
25.6	CJRX	11720	Winnipeg, Canada
26.0	XGR	11530	Shanghai, China
26.8	CT3AQ	11180	Funchal, Madeira
27.9+	JVM	10740	Kemikawa-Cho, Japan
28.1	CEC	10670	Santiago, Chile
28.9+	LSX	10350	Buenos Aires, Argen.
29.0+	ZFD	10335	Hamilton, Bermuda
29.0+	ORK	10330	Brussels, Belgium
30.0	KAZ	9990	Manila, P. I.
30.4	EAQ	9860	Madrid, Spain
30.4+	JYS	9840	Kemikaway Cho, Jap.
30.5+	IRM	9820	Rome, Italy
30.6+	GCW	9790	Rugby, England
31.2+	XETE	9600	Mexico City, Mexico
31.2+	CT1AA	9600	Lisbon, Portugal
31.2+	W3XAU	9590	Philadelphia, Pa.
31.2+	VK2ME	9590	Sydney, Australia
31.3	HBL	9580	Geneva, Switzerland
31.3	VK3LR	9579	Lindhurst, Victoria
31.3	GSC	9575	Daventry, England
31.3+	W1XAZ	9570	Springfield, Mass.
31.3+	DJA	9560	Zeesen, Germany
31.4+	LKJ1	9540	Jeloy, Norway
31.4+	W2XAF	9530	Schenectady, N. Y.
31.5	VK3ME	9510	Melbourne, Australia
31.5	GSB	9510	Daventry, England
31.8	PLV	9415	Bandoeng, Java
32.2+	CNR	9294	Rabat, Morocco
36.2+	CM6XJ	8265	Tuinucu, Cuba

Wave-length Meters	*Call Letters*	*Frequency Kc.*	*City Country*
36.6+	PSK	8185	Rio de Janeiro, Braz.
37.5	HC2JSB	8000	Guayaquil, Ecuador
38.0+	JYR	7880	Kemikawa-cho, Japan
38.4+	HBP	7790	Geneva, Switzerland
40.5+	HJ3ABD	7402	Bogota, Colombia
43.8+	HAS	6840	Budapest, Hungary
44.8	YNLF	6692	Managua, Nicaragua
45.0+	HC2RL	6668	Guayaquil, Ecuador
45.3	PRADO	6618	Riobamba, Ecuador
45.3+	RV72	6611	Moscow, U. S. S. R.
46.1	HJ5ABD	6504	Cali, Colombia
46.5	HJ1ABB	6450	Barranquilla, Col.
46.6	W3XL	6425	Bound Brook, N. J.
47.5	HIZ	6315	San Domingo, D. R.
47.8	HI1A	6272	San Domingo, D. R.
48.5	TGW	6180	Guatemala City
48.7+	CJRO	6150	Winnepeg, Manitoba
48.7	VE9CL	6150	Winnipeg, Man.
48.7	YV3RC	6150	Caracas, Venezuela
48.8+	W8XK	6140	Pittsburgh, Pa.
48.9+	ZGE	6130	Kuala Lumpur, F. M. S.
48.9+	ZTJ	6122	Johannesburg, Africa
49.9	W2XE	6120	New York, N. Y.
49.0+	YV2RC	6112	Caracas, Ven.
49.0+	VE9HX	6110	Halifax, N. S.
49.1+	W3XAL	6100	Bound Brook, N. J.
49.1+	W9XF	6100	Chicago, Ill.
49.2	VE9GW	6095	Bowmanville, Can.
49.3+	CP5	6080	La Paz, Bolivia
49.3+	W9XAA	6080	Chicago, Ill.
49.3+	OER2	6072	Vienna, Austria
49.3+	VE9CS	6070	Vancouver, B. C.
49.3+	YV5RMO	6070	Maracaibo, Venez.
49.4+	VQ7LO	6060	Nairobi, Kenya, Africa
49.4+	W8XAL	6060	Cincinnati, Ohio
49.4+	W3XAU	6060	Philadelphia, Pa.
49.4+	OXY	6060	Skamlebaek, Den.
49.5+	GSA	6050	Daventry, England
49.6+	W4XB	6040	Miami, Fla.
49.8	DJC	6020	Zeesen, Germany
49.8	CQN	6020	Macao, China
49.8+	ZHI	6012	Singapore, Malaya.
49.8+	COC	6010	Havana, Cuba
49.9+	XEBT	6006	Mexico City, Mex.
49.9+	VE9DN	6005	Montreal, Quebec
49.9+	HIX	6000	San Domingo, D. R.
49.9+	RV59	6000	Moscow, U. S. S. R.
50.1	YV4BSG	5984	Caracas, Venezuela
50.1	TGX	5984	El Liberal, Guatemala
50.2+	HVJ	5969	Vatican City
50.4	HJ2ABA	5880	Tunja, Colombia
50.6+	HJ4ABE	5860	Medellin, Colombia
51.4+	HJ2ABC	5824	Cu Cuta, Colombia
52.7	XQAJ	5660	Shanghai, China
69.4	C6RX	4320	Rugby, England
70.2	RV15	4273	Khabarovsk, Siberia
73.0	HCJB	4107	Quito, Ecuador
80.0	CT1CT	3750	Lisbon, Portugal
84.6+	CR7AA	3543	Lourenzo Marques, Moz.