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RADIO

REG. U.S. PAT. OFF.

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

MODERN RADIO

EDITED BY ROBERT S. KRUSE

Now Merged With "RADIO"

CONTENTS

In This, The First Issue of the Merged Magazines

And Other Features

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U. S. PATENT No. 1,900,629

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•

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R. P. WUERFEL, Patentee

Chief Engineer

INTERNATIONAL RADIO CORP.
Ann Arbor U. S. A. Michigan

Originators and Manufacturers of the International Kadette

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Vol. 15 JULY, 1933 No. 7

Radiotorial Comment

Amateur Radio Is Not Child's-Play!

DISREGARDING the fact that amateur radio is really business, and one of the very few branches of the radio business that is profitable to the manufacturer and retailer today, let us consider it as a game. As such, it should be a game of skill rather than a game of chance. While young folks can and do play it, more skillful players can and do enjoy it. But since young folks play at it, it has long been treated as child's-play and all players have been treated as children.

Amateurs have played the game as "good children" for many years. When told to behave, they have behaved. When told not to interfere with BCL reception, under penalty of losing their cherished wavelengths, they learned to play without interfering—but lost their wavelengths anyway. When given a substitute lot of wavelengths that nobody else wanted, they may have cried a little about it, but went ahead and discovered that these then-new wavelengths were better than the ones which had been taken away. Then almost everybody else wanted these new wavelengths, and got all but a very few which the amateurs still use.

In this game the cards have always been stacked against the amateur. His complaints were ignored when he was dealt a hand from the bottom of the deck or when the other players cheated. Even when, by mistake, he gets a trump, he forfeits it under new rules made for the occasion. Yet he continues to play the game night after night because it has such a great lure and fascination for him.

But now he wants a new and a square deal with new rules which everybody will live up to. He wants it to be really a game of skill rather than a game of chance where the most skillful players can win only occasionally by luck and the less skillful players never, all because there are so many players that they get in the other's way.

The beginner, with his ten words a minute, is handicapped from the start by having to play at the same table as are those who have been playing for years. He is up against a mental hazard as well as a physical one. For what newcomer does not shake in his boots and applaud himself with his knees when he sends his first CQ? The discouragements that are placed in his way make it almost impossible for him to win.

Yet he is needed in the game. He provides new blood, new interest, new thoughts, new enthusiasm. But all this is dampened, as would be that of the child in the kindergarten who has to play in the same lot with the older boys in Junior High. He can't compete with them on an equal basis, and, unless he has almost superhuman grit, he fades out of the picture.

But while he is in there, and thousands of new recruits each year mean that he is always there, he breaks up the play of the older folks. They are annoyed by his interference. They are hindered in making their useful contribution to the art and to the glory of amateur radio. The babble of the kindergarten frowns his call and that of his fellow-worker whom he wants to hear.

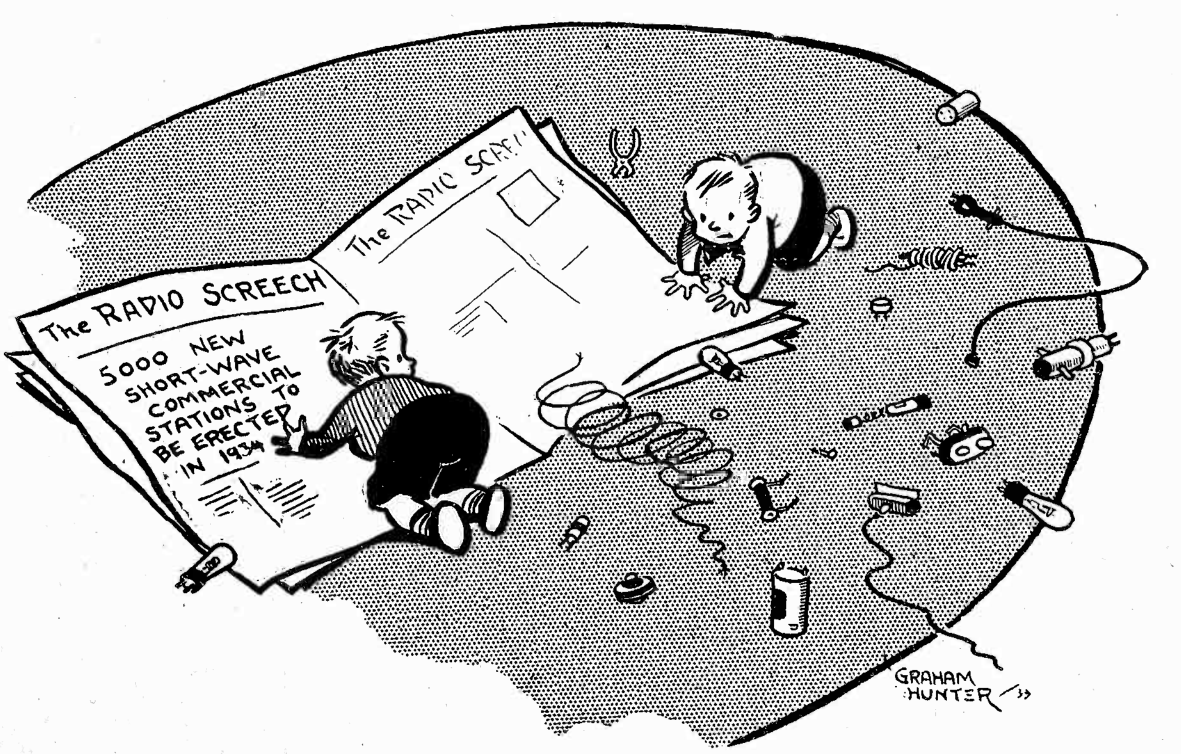
The newcomer does not expect the same player's-privilege as the old-timer. He is content to be under-privileged until he also knows the rules backwards as well as forwards. Yet he is "handed a silver platter" privilege that he knows not how to use. For, under the present rules of the game, "an amateur is an amateur" no matter what his age, power, speed or ability.

The conditions under which amateurs operate today are comparable to those in a narrow highway where the "safe" twenty-mile-an-hour driver blocks the traffic in a forty-five-mile-an-hour zone. But there is no traffic cop to speed up the slow driver and to slow down the driver who exceeds the speed limit. And on either side of the narrow highway are broad avenues without a car. How long would such a condition be allowed in the automobile world? How long before drivers would be classified as to experience and desire? The answer is obvious. With such facilities, there would be a cleared thoroughfare for the speed burner where he could risk no life but his own; there would be a separate wide road for the normal driver; and there would be a third path for those who, from choice or security, are slow drivers. Each class would be encouraged to consume the maximum amount of gas.

Why not apply a similar remedy to the ills under which amateur radio is suffering? Suppose that some or all of the following proposals were put into effect:

(1) Conduct a continuous, powerful publicity campaign to publicize the achievements of the amateur in times of distress and emergency.
(2) Expose the tricks of those who forced the amateur into the few, narrow channels which he now occupies.
(3) Solicit the aid of public-spirited citizens so that the cause of amateur radio can be brought to the attention of friendly interests in Washington.
(4) Make every effort to regain part of the short-wave territory which has been taken from the amateur.
(5) Take immediate action to secure the unused "continental frequency" channels which are now available.
(6) Give the experienced amateurs a group of cleared-channels, free from interference from beginners.
(7) Give the beginners a group of channels free from interference from experienced amateurs.
(8) Give the phone men more and wider frequencies.

Next month's "Radio" will show reproductions of graphs which are being made ready for presentation to those whose services are being solicited in the interest of the amateur. Public opinion, the help of the press, assistance from those with influence in Washington, and cooperation of readers of this magazine will help form the basis for the first plan which will be submitted for action.



"Well, Cornelius, I see our Frequencies are in jeopardy again."

RIP VAN WINKLE AWAKENS

The Amateur Demands a Better Deal; The Forgotten Man of Radio Must Be Served!

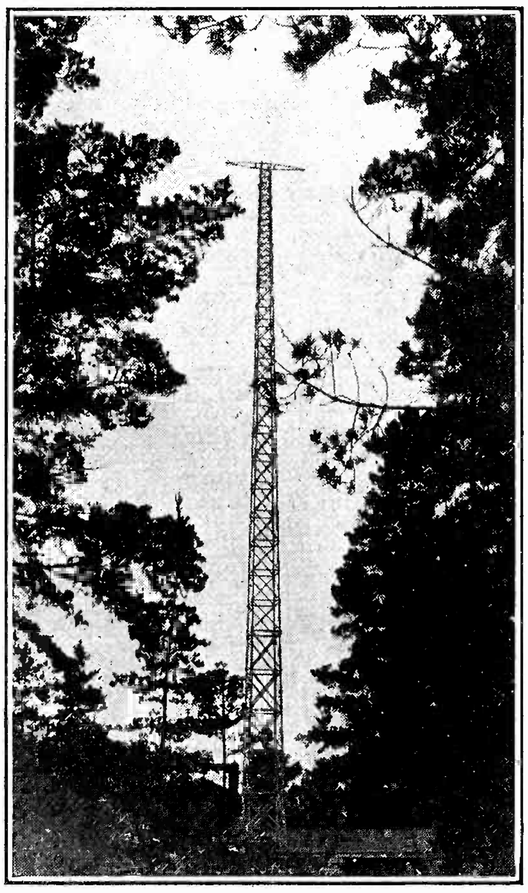
A Few Columns Of Common Sense, By COL. CLAIR FOSTER, W6HM

THE radio waves just above 50 meters come in the category of "continental frequencies." Channels in this classification may be allocated without regard to the consent or approval of other countries, except for the parts to be used by Canadian and Mexican commercials.

In 1928 a new corporation in Buffalo was given by the Federal Radio Commission channels in this "continental" area on the plea that the corporation was entering the domestic communications field in competition with Western Union and Postal. The corporation had political affiliations and experience in the stock-selling field, but none in radio or communications. To everybody who wasn't born yesterday it was plain that it would get just nowhere. It was technically and financially bankrupt before it started and it went broke in no time.

No sooner had the FRC, (two of the five commissioners dissenting), given a fine bunch of channels to this Buffalo company than other commercial interests concluded that they had been overlooking a bet. They, too, wanted a grand array of these continental channels: ostensibly—"to compete in the domestic field with line telegraphy," but more likely to capitalize them—just as they had in the case of the long list of international channels the Commission had previously given them.

When the Commission refused their demands, the RCA promptly went to law, with Case 4990 in the Circuit Court of Appeals of the District of Columbia, which issued a stay order estopping the Commission from allocating any of the continental frequencies in question.



This tower supports the antenna of W6HM. "Home-made", built of wood, it rises almost 100 ft. from the ground.

This was in 1928, and ever since then this fine group of useful channels has been tied up and useless.

In January, 1933, the RCA wrote to the Commission that they have changed their minds, that they don't want these channels after all. After causing the channels to lie idle for over four years, they say: "During the past six months experimental work in the generation, propagation and use of the very high frequencies, (those above 30,000 KC), has been brought to a preliminary conclusion by the engineers of the RCA." And state their conviction that the ultra-high frequency developments have made obsolete apparatus designed for domestic communications with the continental frequencies. They say further, "The company is prepared also to co-operate fully with the commission in endeavoring to secure a modification or a revocation by the Court of Appeals of the stay orders, so that the frequencies tied up by those orders may be released and may be subject to such action as the Commission may determine to be in the advancement of the public interest, convenience and necessity. In making this suggestion as to its own applications the company wishes to make clear the fact that it offers no opposition to action upon the applications of any other company."

Also W6HM

These continental channels will now be available for use. Use by whom? By those interests who can advance the best arguments or exert the greatest pull. They will NOT be allocated to those who adhere to the traditional attitude of the amateurs—the "Oh, why try! We'd never get any consideration," the "Don't ask for more or you'll lose what you have," the "Don't buck," the "Don't rock the boat" type of applicant will get nothing for the plain reason that he deserves nothing. These channels will go to people who have convictions and the courage to assert them and keep on asserting them. All channels now held by commercial interests were obtained by just that type of men employing just that process. If the practice succeeds in the case of men motivated wholly by the desire to make money why won't it succeed in the case of amateurs who have no motive of money gain?

Col. Clair Foster, a champion of the cause of amateur radio and himself the owner and operator of an amateur station that has helped make radio history.

The answer is that it will, if the amateurs will abandon their time-tried and time-discredited attitude of fatalism and their pride in their ability to absorb punishment.

Lest we forget, I again quote from a formal printed statement of the Federal Radio Commission to the Circuit Court of Appeals of the District of Columbia:

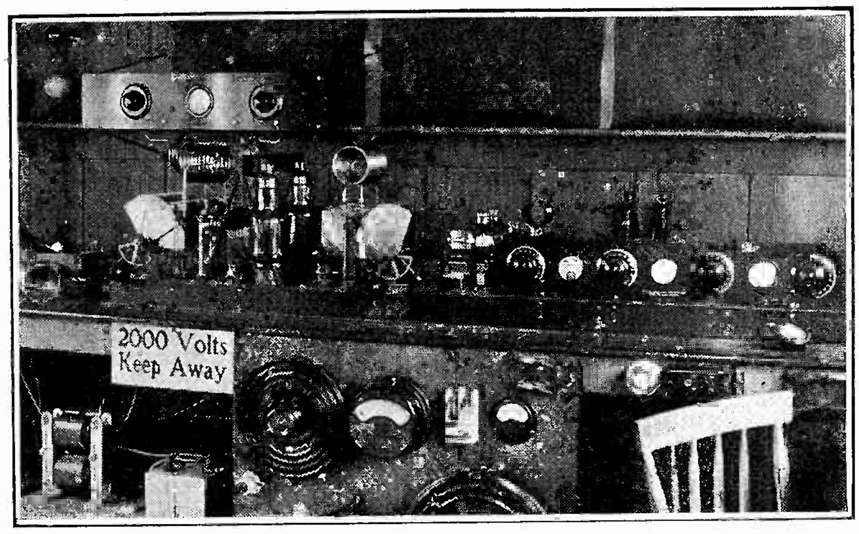
"Prior to February 23, 1927, the amateurs were entitled to use the entire range of frequencies from 1500 kilocycles upwards . . . At the various National Radio Conferences, speaking through their authorized representatives, they offered to relinquish most of their territory for commercial development." I doubt if there was one real amateur in the United States who would say that such an offer of relinquishment represented his conclusions.

And thus, because he forgot himself, the amateur became the Forgotten Man of radio.

But there is no valid reason why the amateurs cannot have their just share of the continental frequencies. But what about the so-called "Treaty" of 1927? This was an agreement of commercial radio men made with their fingers crossed. In many of its features it is vague, incoherent and susceptible of divergent interpretations. It bears the earmarks of a changing of words and sentences in the effort to evolve something that would prove acceptable to warring interests. It has been evaded and slapped in the face times without number by the commercial interests that executed it. No sooner was it made than the Japanese, who were largely instrumental in its making, filed with the Berne Bureau on nine channels in the 40 meter band that they had agreed should be used by amateurs alone. And similiarly in other amateur bands. And, moreover, **put such stations in operation.** Other signatories to the treaty did likewise. And to this day you can find many commercial stations pounding away in the amateur bands. This is common knowledge among all who listen in these bands.

The "Treaty" is really not a treaty at all. It is a mass of technical and commercial bargainings that our Congress signed on the dotted line without knowing what it was all about, or that the document did in fact aim to deprive a large class of our citizens of their rights. It is a collection of pronouncements so loosely phrased that much of it may be, (and has been), interpreted in many ways. It is a document that one hundred commercials drew up and forced one lone amateur delegate to accept on behalf of the 50,000 amateurs of the world. In other words, it is a racket. When an army of men lay a document down on the table and say to one man, "This paper takes certain of your rights away from you but this is what you get and nothing more," that is a racket; nothing less.

Now, most positively, I deplore the breaking of agreements. The amateurs as a class have always been meticulously regardful of agreements—even of "regulations" arbitrarily thrust upon them by people who had no legal authority to apply them. But I do say that our Congress has the power to denounce in this so-called treaty any part of it that may have infringed the rights of the amateurs; and, moreover, that Congress will do just that if its members are shown the treaty's unfairness. Congress has taken this action in the past in cases of unfair treaties and will do so again.



Here is what is needed for reliable and dependable dispatch of amateur radio traffic from California to the Orient. W6HM's 40-meter transmitter is but one outstanding example of many other similar amateur installations the world over.

Whether the amateurs get these continental frequencies just made available by the action of RCA depends upon the amateurs themselves. If the high-minded, experienced and courageous among them carry their needs to Congress they will receive more than a sympathetic hearing. I am told by men of standing in Washington that Congress is disposed to give them everything they ask within reason. There never before has been so good an opportunity for that great body of citizens, the owners of amateur stations, to get an attentive hearing.

The time to act is NOW. Don't be afraid of being called back-seat drivers; it is back-seat drivers with justice on their side who are sitting on the top of the world today. The commercial groups that have been controlling our country for their own private ends are being shown up one after another and their tools in the Government service have had their nerves severely shaken. This exposure of corruption in high places is not the usual periodical flare-up, it is a real conflagration. The malign exploitation of the people and their resources has about come to an end. That ending will last until a new generation of suckers will have grown up. By that time the amateurs may have gained some sense and courage.

The radio amateurs have never exploited anybody, they have always been in the exploited class. Their work has been a great public service paid for out of their own pockets. The practical public service that the amateurs are performing at their own expense is greater now than ever before, and it will be increasingly available and valuable to the public; so there is no need for the amateurs to remain among the exploited—unless they deliberately choose the role.

There are four groups of amateurs that greatly need these certain vacant continental channels—the Naval Communications Reserve, the Army Net, the Trans-Pacific Traffic Association, (for the relaying of trans-Pacific traffic), and the fone men. The navy and army drills are badly handicapped by congestion; the Trans-Pacific Traffic Association — performing a great public service for our citizens in the Orient—is forced to make deliveries in the United States by mail because of congestion in the amateur bands; and the fone men, who are the advance-guard of domestic radiophoning, are notoriously jammed in restricted parts of amateur bands that are invaded scandalously by commercial stations.

Now, you amateurs who have been crying the loudest for more room on the air, let us see if you want it enough to go after it.

Commercial Stations Operating in Amateur 40-Meter Band

On Sunday, May 25, 1933, before and after working traffic schedules with AC2RT and KA1LG I busied myself logging commercial stations that were easily readable operating in the amateur 40-meter band. Heard between 4:50 a.m., P.S.T., and 6:09 a.m., P.S.T., (1250 G.M.T. and 1409 G.M.T.):

K.C.

7270 **RTZ**—Near D.C., crystal-controlled. On this frequency every day for 6 months or more. Either working or running a V wheel. R3 to R6.

7240 Broadcast station, Bangkok, Siam. Loud and would have been easily readable by anyone who understood the language. Music loud.

7220 **RPK**—D.C. modulated by about 900 cycle. Crystal-controlled and on this frequency almost every day for year or more. Either working or running a V wheel. R3 to R6.

7180 to 7160 **Commercial** with a mushy A.C. or R.A.C. note. R4. Working. Not signing call. Signal 20 K.C. wide.

7150 Fone station working Bangkok broadcaster. Not so loud as the Bangkok station but words readable in part. Using language similar to the Bangkok station.

7088 Commercial with 60 cycle or low-pitched mushy R.A.C. note. R5. Working. Not signing call.

7058 Commercial with mushy note R3 to R4. Working. Not signing call.

7052 PMAW—Low R.A.C. note. R7. With a back-wave at 7040 K.C. Calling MWT. He was calling at 5:00 a.m. when I first logged him, was heard at intervals calling MWT, and was **still** calling that station when I stopped listening to him at 6:00 a.m.

7033 VOG—Note like mushy 500 cycle. Working but seldom signing. Was heard on two separate frequencies about 30 K.C. apart, R4 on one and R7 on the other.

JAN is just outside the amateur band at low-frequency end; with D.C. but signals so rough and loud that his mush and key thumps often QRM amateur communications down one-quarter of the way through the amateur band. Often there are parasitic signals that may be read clearly in different places in the amateur band. Is on the air every day and almost never doing anything but making V's and signing. This commercial station is such an obstruction that amateurs in the Philippines, China, Australia and New Zealand never locate anywhere near the low-frequency end of their band. This Japanese commercial renders useless one-third of the band to all amateurs in the Far East.

This by no means completes the list of commercials that can be heard in the amateur 40-meter band. A patient observer would make up a longer list every day than I have given.

The foreign commercials have found that the low-powered amateurs present less QRM to them than the high-powered commercials that are hogging channels with V-wheels all day long in commercial territory. For this situation the amateurs have largely the United States Commercials to blame, for it is common knowledge among radio people everywhere that immediately after the 1927 International Convention divided the radio spectrum for various services the United States commercials grabbed about 85 per cent of all the short-wave channels available for the whole world, and put stations on them for which there was no business.

NOW, patient amateurs, spend some time systematically logging these commercial pirates and report your observations to RADIO. It is neither possible nor necessary to the purpose in hand that every marauder be identified by his call. That he is

(Continued on page 9)

SHORT-WAVE RADIO STATIONS OF THE WORLD

SHORT WAVE BROADCAST STATIONS

(Note—The following group of stations broadcast musical programs:

Station	Location
13.93—W8XK	Westinghouse Electric, E. Pittsburgh, Pa. 7:30 A.M. to noon.
13.97—GSH	British Bdcst. Corp., Daventry, England. Irregular.
14.47—LSY	Buenos Aires, Argentina. Near 4 P.M. Sundays.
15.93—PLE	Bandoeng, Java. Tuesdays 8:40-10:40 A.M.
16.87—W9XF	Chicago, Ills. Irregular.
16.87—W3XAL	Boundbrook, N. J. Week days. 7 A.M. to 3 P.M.
16.88—GSG	Daventry, England. Irregular.
19.57—W2XAD	Schenectady, N. Y. 3 to 6 P.M. daily. Sat. & Sun. 1 to 6 P.M.
19.68—FYA	Pontoise, France. 8:30 A.M. to 10 A.M. daily.
19.73—DJB	Zeesen, Germany. 8 A.M. to 12 noon daily.
19.81—GSF	Daventry, England. Irregular.
19.84—HVJ	Vatican City. Broadcasts daily 5 A.M. to 5:15 A.M.
19.90—T14-NRH	Heredia, Costa Rica. Saturday 11 A.M. to noon, 4-5 P.M. and 10-11 P.M. Sun. and Mon., 11 A.M. to noon and 4-5 P.M.
20.60—HBJ	Geneva, Switzerland. Testing.
20.95—G2NM	Sonning-on-Thames, England, Sundays.
23.35—W2XO	General Electric Co., Schenectady, N. Y. 9 P.M. Mon. to 3 A.M. Tues. Noon to 5 P.M. on Tues., Thurs., Sat.
23.38—	Rabat, Morocco. Broadcasts Sunday, 7:30 to 9 A.M.
25.20—FYA	Pontoise, France. 10:30 A.M. to 1:30 P.M. daily.
25.24—W9XP	Natl. Broadcasting Co., Chicago, Ills. 9-10 P.M. daily.
25.25—W8XK	Pittsburgh, Pa. 3 P.M. to 9 P.M. daily.
25.34—W9XAO	Chicago, Ill., 1-2 P.M., 4-5:30 P.M., 6-7:30 P.M.
25.36—W2XE	Wayne, N. J. Irregular.
25.40—12RO	Rome, Italy. Broadcasts 11 A.M. to 12:30 and 3 to 5:30 P.M. Sundays 11-12:15 P.M. Woman announcer.
25.42—W1XAL	Boston, Mass. Testing, irregularly.
25.47—VE9DR	Drummondville, Quebec, Can. Irregular.
25.50—XDA	Mexico City. 3-4 P.M.
25.53—G5SW GSD—	Chelmsford, England. Monday to Friday, 6:45 A.M. to 7:30 A.M. and 12:30 to 6:10 P.M. Sat. 7-8 A.M. and 12:30 to 6:10 P.M.
25.53—VE9JR	Winnipeg, Can., 5:30 to 7 P.M.
25.60—FYA	Pontoise, France. 3 P.M. till 6 P.M. daily.
25.60—VE9JR	Winnipeg, Canada. Daily exc. Sat. and Sun., 11:45 A.M. to 1:30 P.M.
26.83—CT3AQ	Funchal, Madeira. Tues-Thurs. 5 to 6:30 P.M.; Sun. 10:30 A.M. to noon.
28.98—LSX	Buenos Aires, Argentina. Daily, 8 to 9 P.M.
29.26—DIQ	Zeesen, Germany. Used irregular.
29.30—T14	Heredia, Costa Rica, Mon., Wed. 7:30-8:30 P.M.; Thurs., Sat., 9 to 10 P.M.
30.40—EAQ	Madrid, Spain. 6:30 to 8 P.M. daily. Sat. 1 to 3 P.M.
31.00—T14NRH	Heredia, Costa Rica. Daily exc. Sunday 9 to 10 P.M.
31.10—HSP2	Bangkok, Siam. 9-11 A.M. daily.
31.25—CT1AA	Lisbon, Portugal. Heard Tues., Thurs., Fri., 4 to 7 P.M.
31.28—VK2ME	Sydney, Australia Saturday midnight to Sunday 2 A.M., 4.30 to 8:30 A.M. & 1:30 to 3:30 P.M.
31.29—GSC	Daventry, England. 2-4:30 P.M., 7:30-9:30 P.M., 11 P.M.-1:00 A.M., 1:30-3:30 A.M.
31.30—W3XAU	Byberry, Pa. Relays WCAU daily.
31.30—HBL	Praquins, Switzerland. Testing near 4 P.M.
31.33—SRI	Poznan, Poland. Tues. 1:40-4:45 P.M.; Thur., 1:30-8 P.M.
31.36—W1XAZ	Springfield, Mass. 3:30 P.M. to 11:30 P.M. daily.
31.38—DJA	Zeesen, Germany. 2 P.M. to 6:30 P.M. daily.
31.40—VK3ME	Melbourne, Australia. Wed. 5 till 6:30 A.M., Sat. 5-7 A.M.

Station	Location
31.43—HBL	Geneva, Switzerland. 8 A.M.-8:45 A.M.; 5-5:45 P.M.
31.48—W2XAF	Schenectady, N. Y. Relays WGY daily 5 P.M. to 11 P.M.
31.51—OXY	Skamleback, Denmark. Broadcasts 2 to 6:30 P.M.
31.54—GSB	Daventry, Eng. 8-10 P.M.
31.55—VK3ME	Melbourne, Australia. Wed. 5-6:30 A.M.; Sat. 5-7 A.M.
31.58—PRBA	Rio de Janeiro, Brazil. Heard between 6 P.M. and 8:30 P.M.
31.70—	Buenos Aires, Argentina. No schedule.
32.00—EH9OC	Berne, Switzerland. 3-5:30 P.M.
32.26—	Rabat, Morocco, broadcasts, Sundays, 3 to 5 P.M.
33.50—TGX	Guatemala City, Guatemala. Saturdays 10 P.M. till midnight.
34.68—VE9BY	London, Canada. Mondays 3 to 4 P.M. and irregular times.
35.00—RV15	Khabarovsk, Siberia. 5-7:30 A.M.
38.60—HBP	Geneva, Switzerland. Testing.
39.40—HJ3ABF	Bogota, Colombia. 7 P.M. to 11 P.M.
39.80—	Prado, Ecuador. Thursday 9-11 P.M.
40.20—YR	Lyons, France. Daily, except Sun. 10:30 P.M.-1:30 A.M.
40.50—HJ3ABD	Bogota, Colombia. Tues., Thurs., Sat., 8 to 11 P.M.
40.70—X26A	Nuevo Laredo, Mexico. 9 A.M.-8 P.M. intermittently. 11 P.M. 1 hour.
40.90 —ZTJ	Johannesburg, So. Africa. 9:30 A.M.-2:30 P.M.
41.00—CM5RY	Matanzas, Cuba. Saturdays 10:45 to 11:30 P.M.
41.46—DOA	Doebritz, Germany. No schedule.
41.50—HB9D	Zurich, Switzerland. Alternate Sundays, 1st and 3rd, 7 A.M.-2 P.M.
41.60—EAR58	Teneriffe, Sat. and Sun., 4:30 P.M. to 6:00 P.M.
41.67—VSIAB	Bogota, Colombia. No schedule.
42.00—HJ4ABB	Manizales, Colombia. Thur. and Sat. 7-9 P.M. and 11-12 P.M.
42.20—HKN	Medellin, Colombia. 8 P.M. till 10 P.M. 8:30-10:30 P.M. Earlier Sunday.
42.70—EAR125	Madrid, Spain. No schedule.
42.90—CTIAA	Lisbon, Portugal. Fri. 5-7 P.M.
43.60—F8MC	Casablanca, Morocco. Sat., Sun., Tues., Wed. No schedule.
45.31—PRADO	Riobamba, Ecuador. Thursdays, 9 P.M. till 11 P.M.
46.60—REN	Moscow, U. S. S. R. Relays Moscow, 1 P.M. to 6 P.M.
46.67—VE9BY	London, Canada. Wednes. 8:30-9:30 P.M., Friday 7:00-7:55 A.M. and Saturdays 8-11 P.M.
46.70—W9XL	Anoka, Minn. No schedule.
46.70—W3XL	N.B.C. Bound-Brook, N. J. Irregular.
46.72—RV62	Minsk, U. S. S. R. No schedule.
46.96—W3XL	Boundbrook, N. J. No regular schedule.
47.00—HC1DR	Quito, Ecuador. Daily, 8-11 P.M.
47.00—HKS	Cali, Colombia. Irregular, near 10 P.M.
47.00—HCIDR	Quito, Ecuador. 8 P.M.-10 P.M.
47.35—VE9AP	Drummondville, Can. No sched.
47.35—CN8MC	Casablanca, Morocco. Mon.3-4 P.M., Tues. 7-8 A.M. and 3-4 P.M.
47.50—TITR	San Jose, Costa Rica. 10 to 12 A.M., 4 to 9:30 P.M.
47.81—HKC	Bogota, Colombia. Daily, 8:30-11:30 P.M.
48.00—HKA	Barranquilla, Colombia. Tues., Thurs., Sat., Sun., 8-10 P.M.
48.00—HKA	Barranquilla, Col. 8 P.M. to 10 P.M. daily.
48.85—VE9CL	Winnipeg, Canada. Daily except Sun., 6 P.M. till 8:30 P.M.
48.86—W8XK	Pittsburgh, Pa. 4 P.M. to 11 P.M., daily. Late Saturdays.
48.95—YV11BMO	Maracaibo, Venezuela. Broadcasts 8 to 11 P.M.
48.99—W2XE	Columbia Broadcasting System. 7 A.M. to 11:55 P.M.
48.99—FL	Eiffel Tower, Paris. 5:30-5:45 A.M., 4:15-4:45 P.M., 5:45-12:30.
48.99—YV1BC	Caracas, Venezuela. Nightly, 8-10 P.M.
49.10—VE9CG	Calgary, Canada. No regular schedule.
49.15—VE9CF	Halifax, N. S. Tues., Thurs., Fri., 6-10 P.M.

Station	Location
49.17—VE9GW	Bowmanville, Ontario. 5-11:55 P.M.
49.18—W9XF	Chicago, Ill. 3:30 P.M. to 1 A.M. daily.
49.20—JB	Johannesburg, South Africa.
49.29—VE9BJ	St. John, N.B. Near 5 P.M. and 11 P.M.
49.31—W9XAA	Chicago, Ill. Intermittently, daily, 1 hour at a time.
49.34—W9XAA	Chicago, Ill. Relays WCFL, Sun. 11 A.M.-9 P.M.; Wed., Sat., 8:30 A.M. to 9 P.M.; Tues. and Thurs., 8:30 A.M. to 8 P.M.
49.40—VE9CS	Vancouver, B. C. Sundays, 2 & 10:30 P.M. Fridays, midnight to 1:15 A.M.
49.40—JB	Johannesburg, South Africa. 10:30 A.M.-3:30 P.M.
49.42—VE9CS	Vancouver, B.C. Sun. 3:30 P.M. to midnite. Fri. at 0 to 1:30 A.M.
49.46—SAJ	Motala, Sweden. 6:30-7 A.M. 11 A.M.-4:15 P.M.
49.50—VQ7LO	Nairobi, Africa. Mon., Wed., Fri., 11 A.M.-2:30 P.M.; other days 11:30 A.M.-2:30 P.M. Also Tues. 3 A.M.-4 A.M.
49.50—W3XAU	Byberry, Pa. Intermittent relays.
49.50—W8XAL	Cincinnati, Ohio. 5 A.M.-9:30 A.M., 12:30-2:30 P.M. and 6 P.M. to 12:30 midnight.
49.50—CMCI	Havana, Cuba. 9 P.M.-11 P.M.
49.51—ZL2ZX	Wellington, N. Z. Mon., Wed., Thur., Sat., 2:15 to 6:15 A.M.
49.58—GSA	Daventry, Eng. 8-10 P.M. daily.
49.59—VE9CF	Halifax, N. S. Mon., Tues., 6-10 P.M. Other days 6-7 P.M.
49.67—PK3AN	Sourabaya, Java. Daily, 6-9 A.M.
49.67—W4XB	Miami Beach, Florida. Intermittent, daily, 8 A.M.-10 P.M.
49.75—VE9CA	Calgary, Canada. Intermittent.
49.96—FL	Eiffel Tower, Paris. 6:30-6:45 A.M., 1:15-1:30 P.M., 5:15-5:45 P.M.
49.96—VE9DR	Drummondville, Can. Relays CFCF, 7 P.M. to 12 midnight.
49.97—RV59	Radio Moscow, U. S. S. R. Sundays, 3-5 P.M.
50.00—RW59	Moscow, U.S.S.R. 9 A.M.-11 A.M., 2 P.M.-5 P.M. daily.
50.00—HKD	Barranquilla, Col. Daily 8-10 P.M.
50.26—HVJ	Vatican City. Broadcasts daily, 2-2:15 P.M., Sun. 5-5:30 A.M.
50.80—HKO	Medellin, Colombia. Mon., Wed., Fri. 8 to 10 P.M., Tues., Thurs., Sat. & Sun., 6 to 8 P.M.
51.00—HKB	Tunja, Colombia. Irregular near 10 P.M.
51.40—HKD	Barranquilla, Colombia. 7:45-10:30 P.M. 8-10:30 P.M., Mon., Wed. 7:45-8:30 P.M. Sundays.
51.72—VK3LR	Victoria, Australia. Heard 2 A.M. to 6:30 A.M.
52.50—VE9CL	Winnipeg, Canada. No schedule.
52.70—FIUI	Tananarive, Madagascar. Sat., Sun. 1-3 P.M. Other days 9:15-11:15 A.M.
54.02—W8XJ	Columbus, Ohio. No schedule.
58.00—OK1MPT	Prague, Czechoslovakia. Tues., Fri., 1-3:30 P.M.
58.00—PMB	Sourabaya, Java. No schedule.
58.00—PMY	Bandoeng, Java. 12:40 to 2:40 A.M. and 6:40 to 9:40 A.M.
60.30—W2XV	Radio Engineering Labs, N. Y. No schedule. Tests only.
62.50—W2XV	Long Island City, N. Y. Wed. and Fri. Tests. Intermittent.
62.56—VE9BY	London, Canada. Saturday midnight on.
62.56—W9XAM	Elgin, Ill. Time signals only.
62.56—W3XZ	Washington, D. C. No schedule.
62.56—W9XL	Chicago, Ill. No schedule.
67.65—DOA	Doebritz, Ger. Mon., Wed., Fri., 6-7 P.M., 2-3 P.M.
70.00—OHK2	Vienna, Austria. Sundays, 1-7 P.M., first quarter of each hour only.
70.1—RV15	Khabarovsk, U.S.S.R., 3 A.M.-9 A.M.
80.00—F8KR	Constantine, Africa. Intermittent, Mondays and Fridays.
80.00—13RO	Prato, Italy. 3-5 P.M. daily.
82.90—DOA	Doebritz, Germany. No schedule.
84.24—OZ7RL	Copenhagen, Denmark. Tues., Fridays, 6 P.M.-9 P.M.
90.00—	Aircraft Stations
109.60—VE9CI	London, Ontario. Daily 9 to 11 P.M. Sun, 11 A.M.-7 P.M.
128.09—W7XAW	Seattle, Wash. No schedule.

MORE LOG SHEETS WILL BE IN NEXT ISSUE

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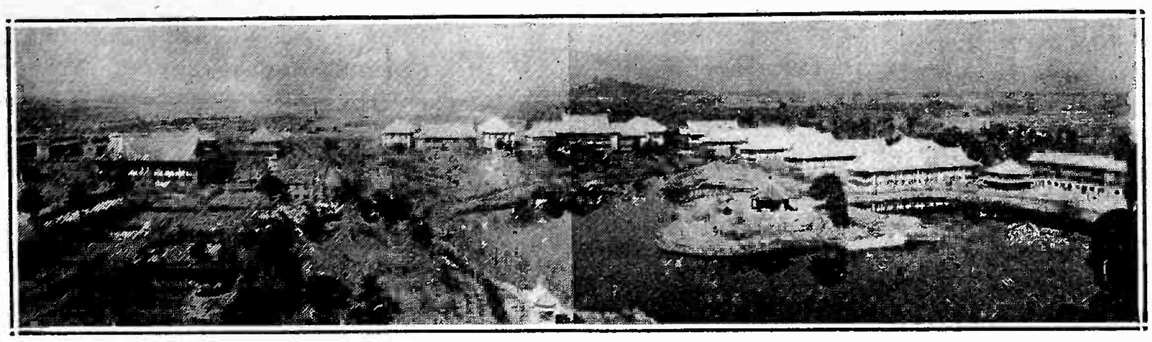


Yenching University Near Peking

AC2RT

Oriental Terminus of the Trans-Pacific Amateur Chain

CAN a fellow check his wife's hasty words from a distance of 6,000 miles? If a wife in Los Angeles says something in a radiogram for the benefit of her husband in Peking, would that husband be justified, offhand, in telling the California operator that he had garbled the message?—that the text didn't at all mean what it said?

Well, here's what occurred the other day. "Mac" Fisher, who operates at AC2RT, the physics department at Yenching University (near Peking), was given a message from his wife which contained the word "sin"—as plain as good print. It made sense, but being a rather uncommon word I repeated it so that Mac wouldn't miss it. He did, however, miss the word following it. He called back: **"Six ? ? ? apportioned."** I gave him the fill he wanted and then said, **"Sin, not six."** He answered, **"Oh, she means six. I know her writing; her x's always look like n's. Hi."**

What's a poor girl to do with a husband like that! Who knows what she means when she says something else, and who can correct—from the other side of the Pacific ocean, in pitch-darkness, a handwriting that he can not see?

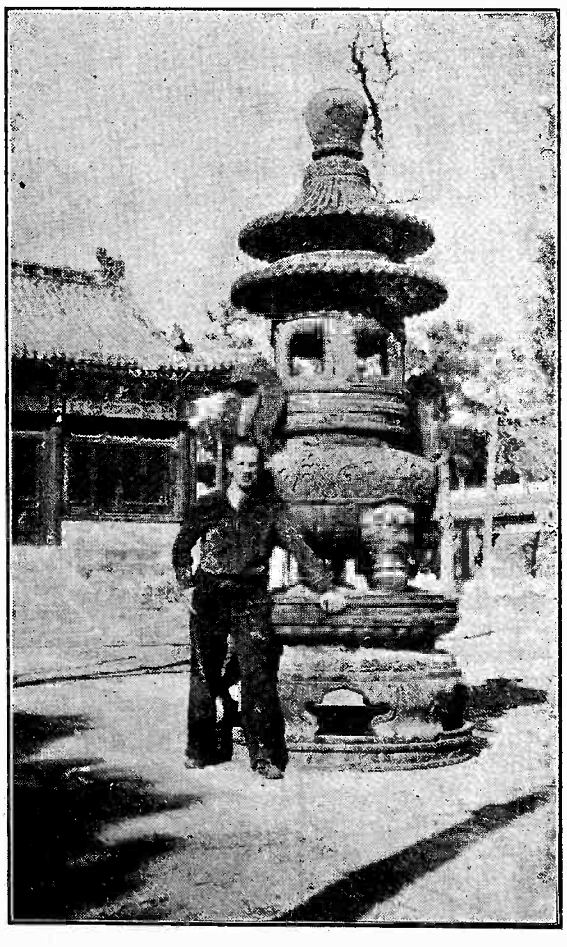
This small station, using only two 7½ watters, is the only amateur station in Peking now on the air. During these troublous times and war with Japan, this station has been a source of great comfort to Yenching students, professors and their families in the United States and other parts of the world. As the Japanese armies approach, and thousands of Chinese soldiers pass by, the knowledge that communication is not entirely cut off relieves much of the tension. Even if telephone communication were broken, there would still be the little amateur station whose operators had arranged emergency watches with the boys at NPP, the Naval radio-station at the American legation.

AC2RT keeps traffic schedules with Tientsin, Shanghai, Chefoo, Burma and the Philippines, and is always ready to relay messages to or from any part of China where there are amateurs. During the past winter the most of AC2RT's traffic with the United States has been handled direct; chiefly with W6BHQ, in the Sierras, and W6HM, in Carmel, California. Occasionally we have had to call in Leon Grove, KA1LG, to relay through the Philippines. Grove is superintendent of schools and directs the work of some 800 teachers. Frankly, W6BHQ and I feel rather out of place among all these "intellectuals."

Our concern in working AC2RT is that we must "reach half-way to China to hear him." It is difficult for him to hear us through the many commercial stations that constantly transmit in the amateur 40-meter band. These stations transmit from China, Russia, Java and other places. Nevertheless, we have made out very well. We often take fifteen messages a morning from AC2RT, and not infrequently over twenty. At this time of the year (June) the best time to avoid QRM and to catch his signals at their best is from 4:00 a.m., PST, to 5:30. At this time, there is QRM for us from W9, Australia, Japanese and other foreign amateurs to our westward. Californians as a rule do not arise so early. After this, a thousand W6s yawn a few times, push the switch to warm up their rectifiers, and commence to call "CQ DX". Then, one may just as well call it a day so far as trans-Pacific traffic is concerned.

Yenching University, about twelve miles northwest of Peking, is in the Summer-Palace grounds of the old emperors. It was the scene of bloody battles when the Tartars came down in the eleventh and twelfth centuries to battle the Chinese. And, by the way, what became of the Tartars after their victory? Well, the Chinese, with their millions of people, simply "absorbed" them, and in a few generations there were no more Tartars.

Yenching is a college of high educational standards. Degrees conferred there are honored in other institutions. There are eight hundred students. Most of them are Chinese. There are, however, students there from other parts of the world, including Mac Fisher who is from the United States. There are 20 Chinese from Hawaii who have gone to Peking to study at this university. Most of the professors at Yenching are Americans who can speak both Chinese and English.



J. M. (Mac) Fisher, AC2RT

The university is supported largely by the Rockefeller Foundation. It is interesting to speculate on what Mr. Rockefeller would think of the new restriction of the Madrid Radio Telegraph Convention that aims to stop all American amateurs from handling messages with foreign countries. This was fathered by commercial organization delegates from the United States. Mr. Rockefeller will get much satisfaction out of this fine university investment. I'll bet that he would rather hear the messages coming from little AC2RT than listen to any other form of entertainment.

The little amateur station at "Yenching" is performing a valuable free service of great value to worthy men and women who cannot afford to pay. Amrican students and professors are kept in contact with their families through the unselfish work of the operators of AC2RT. Chinese students in American colleges and hospitals are kept in communication with their families in China. American Chinese in the United States and Hawaii are kept in communication with their sons and daughters at Yenching. Doctors and nurses of the Rockefeller Medical School and Hospital in Peking are in radio communication with other medical people in the United States. Men of the U. S. Marine Corps stationed at Peking are in contact with their families. Mrs. Mac Fisher, also a student, had to leave Yenching because of illness and return to America. She is striving hard to regain her health and return to Mac. She has been kept in constant communication with her husband. Dr. J. Leighton Stuart, China-born president of Yenching, has just been on a business and professional trip to the Yenching offices in New York. While here, he was kept in communication with Peking and was kept informed of the activities at the university.

And all this is accomplished by a tiny amateur station that will be rendered helpless if the U. S. Senate ratifies the stipulations of the Madrid Convention which were inspired by commercial organizations. No restrictions should be placed on amateur message-handling. By the friendly exchange of large numbers of international messages, international good-will is fostered. Students, missionaries and others, cannot afford to pay the high rates. Our President and our Congress are doing wonders for all. Here's trusting them to do a little good turn for radio amateurs. Among these self-sacrificing "gentlemen of the air" we find the student operators, Bill Band, Mac Fisher and Luke Yuan, at little AC2RT, across the mighty Pacific.

Clair Foster, W6HM.

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THE COMPLETE SHORT-WAVE RADIO COURSE

By the Editorial Staff of "Radio"

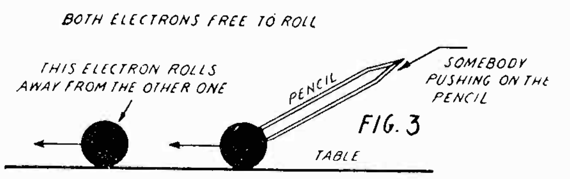
A Complete Course in Short-Wave Radio, Simply Told. Non-Mathematical. Beginners, Experimenters, Amateurs, Advanced Set Builders, and All Those Interested in Short-Wave Radio Will Be Enthused Over This New Course Which Considers Radio From An Entirely Different Point of View. A Modern Radio Course Which Includes Short-Waves and Ultra-Short-Waves. Follow It Every Month In This Magazine.

LESSON TWO

What Have Electrons To Do with Radio?

TO get a better understanding of what electrons are and what they do, let's try some experiments. It is much easier to understand what electrons are and what they do, if we try different things with them. But before we go any farther, why not ask the question, "What have electrons to do with radio?"

To know what electrons are and what they do is very important. To understand how radio receiving and transmitting sets work, it is necessary to know what the electrons in them are doing. Electrons do different things



One electron is placed at the middle of the table. The other electron is slowly rolled toward it, by pushing it with a pencil. When the second electron gets near to the other one, it will make the other electron roll, too. This is caused by the "push" which electrons exert on each other.

in different parts of a radio set and inside radio tubes. They push on each other and move around right inside the different parts of radio sets and tubes. So if we know what the electrons are doing, it is easy to understand why different radio parts have to be made the way they are. If we know what the electrons are doing, it is easy to understand how the different parts of a radio set work.

Later it will be explained how electrons make up an "electric current," how they cluster together to make a "voltage" and how every radio set makes uses of voltages and currents. Almost everything used in radio makes use of electrons in some way. That is why it is so important to know as much as we can about them.

Experimenting with Electrons

WE are going to use some very simple things to see what electrons do. Every one already has all the things needed to learn more about electrons.

We have already learned that electrons are very, very small. How then can we use some of them to see what they do? Are they not too small? Yes, real electrons are very much too small. But we are going to make believe that electrons are as big as marbles. Of course, if electrons really were as big as marbles some of them could easily be put on a table so that we could see what they look like and what they do. But always remember that electrons are really very, very small, so small that they can never be seen.

Let's put one of our make-believe electrons on the table. It looks round just like a marble. Push it with the end of a pencil. Notice how

EDITOR'S NOTE—*The first lesson in this radio course appeared in June "Radio," copies of which are still available from the publishers. In Lesson No. 1 the following subjects were considered:*

What Is an Electron?
What Are "Lines of Force"?
What Is a "Field"?
Force Between Electrons

The first lesson in this course is an important one.

it rolls along the table. Does it roll easy? All we have to do is to give it a push and it just rolls along.

If we try to push other electrons along the table in the same way, we find that every electron rolls along the table in the same way. All electrons are exactly the same, so any electron will roll in the same way.

Experiments with Two Electrons

NOW let's try some experiments using two electrons instead of one. If two electrons are placed close together on a table, a very strange thing happens—the two **electrons roll away from each other!** We say to ourselves, "What is the explanation of this; why do electrons do this? Why do two electrons roll away from each other?" So, to find out more about it, we try to push them close together. Again they roll away from each other. We soon find that this is because two electrons push on each other. So when they are close together they always try to move apart. The push between them is caused by their fields, as we have already learned.

Let's try another experiment with two electrons.

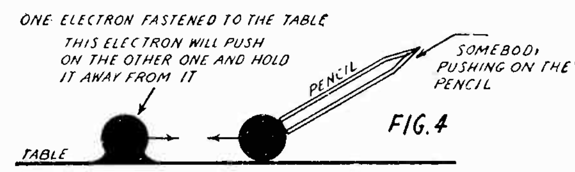
Place one electron at the middle of the table and slowly roll another electron towards it. Roll the second electron towards the first one by pushing it with a pencil. See the electrons in the drawing of Fig. 3. When the second electron gets close to the first one, they both push on each other. So if the second electron is pushed closer and closer, the first one will have to start rolling too. As the second electron gets closer to the other one, the push between them increases until it is so strong that the other electron has to start and roll away.

No matter how many experiments we try, we will always see the same thing happen. For instance, there is always the same force between any two electrons. This force is stronger when they are close together. The strength of the electric field made by electrons increases if more electrons are placed close together. Each electron has a strong electric field around it, and this field always pushes on other electrons within reach.

As another experiment with electrons, let's glue one of them to the table in some such way as shown in Fig. 4. If this is done, and a second electron is rolled toward it, a force will soon be felt. This force will get stronger as the electron is pushed closer and closer. We are really surprised at the strong push between two electrons. For instance, we can push with all our might but we cannot push the electrons at all close together! The force between them is too strong! We could push on the pencil till we broke it but two electrons will not touch each other! Is it not strange that such small things can exert such a strong force?

If we tried the same thing with other electrons we would find that they all push in the same way. The force between them is exactly the same no matter which two electrons we use. All electrons are exactly the same.

We can make an electron "bounce" like a rubber-ball does. For instance, if one electron is fastened to the table and a second one is pushed towards it with a pencil, and then the pencil is suddenly taken away, the second electron will "bounce" back from the other one. This shows that the fields of electrons are very strong near them as we have also seen before. Of course, if we pushed one electron real close to a second one, and then jerked the pencil away quickly, the second electron would bounce back much faster. This



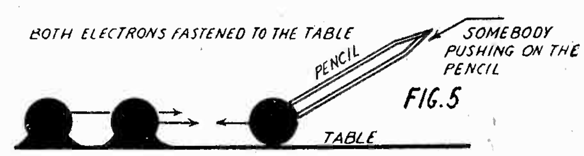
The electron at the left has been fastened to the table. If the other electron is pushed toward it, it will be held away by the "push" between the electrons. A harder push on the pencil will bring them closer together, but two electrons will never touch, no matter how hard the pencil is pushed. The push between electrons is caused by their "fields". These fields are very strong when the electrons are closer togther.

is true because the force between electrons is greater when they are closer together. So the closer we push the two electrons together, the farther the "loose" electron will "bounce" away. This is easy to see. If we just slowly rolled one electron towards the other one, it would just bounce back a little. But if we gave a strong push, the electron would give a good, strong bounce back. This is something like throwing a rubber-ball down on the floor. The harder we throw it down the higher it will bounce back.

Experiments with Three Electrons

ARE NOT the experiments we have tried interesting! Let's try some more experiments with electrons. Let's use three electrons now, and see what they do.

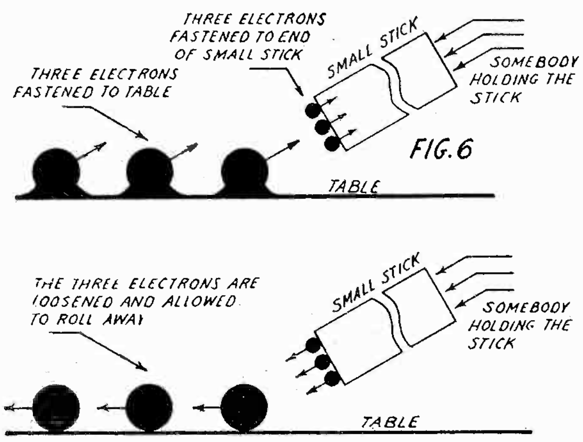
Glue one electron to the middle of the table, push a second one close to the first one and glue it there too; then push a third one close to the other two and glue it there. Take a look at the upper drawing, to the



The two electrons at the left have been fastened to the table, close together. If the electron at the right is rolled toward them, a very strong force will be felt when it gets near to the two electrons. The force that the fields of two electrons can exert is greater, so an electron cannot be pushed as close to two electrons as it can be to only a single electron. The strength of a field is increased by using more electrons.

left, in Fig. 6, to see what we mean. To get the third electron near the other two so that it can be fastened to the table, takes a strong push because the two electrons are both pushing on it. But we can get somebody to help us if necessary. While our helper holds the third electron close to the first two, we can fasten it down. We can, of course, fasten the electrons down in any way so long as they are held in place and cannot move away from each other.

We have found that the field made by two



In the upper drawing, three electrons have been fastened close together on the table. Three electrons have also been fastened to the end of a small stick. The electrons on the table have a very strong field which can be felt at quite a distance. The stick will be held away with a strong force in the upper drawing. If the three electrons on the table are loosened, they will very quickly roll away from the stick, as shown in the lower drawing.

electrons close together is stronger. The strength of the electric field is increased by putting two electrons close together. So to increase the strength of a field, all we have to do is to put more electrons close together. This we just did. We put three electrons close together. The field is now much stronger.

We also already know that a stronger field can be "felt" at a greater distance away. So if we rolled an electron toward a strong field, we could not get it as close to the electrons fastened down. If we rolled an electron towards a weak field, we could get it closer before the same force would be felt. If we wanted to get an electron just as close to the electrons making a strong field, we would have to push harder to get it there.

Everyone has bounced a rubber ball and noticed that the harder it is thrown down the higher it will bounce. The same is true of an electron which is "thrown" at an electric field. The harder the electron is thrown against the field the farther it bounces back.

An electron will bounce back with the same speed no matter how strong the field is at which we "throw" it. This is true because the speed with which it bounces back depends only on how fast we throw it. If the field is strong, the electron will bounce back from a distance farther out. If the field is weak, the electron will bounce back from a point closer to the electrons making the field. This is easy to see. The field gets stronger as the electron gets near the electrons making the field. So if the field is weak, the electron gets closer before the force is the same as it is farther out in a strong field.

It has been seen that the strength of an electric field is increased by using more electrons close together. One electron gave a weak field, two electrons made a stronger field. If a large number of electrons are used, the field will be so strong that an electron cannot even be brought near it.

Let's make a strong field and try some experiments with it.

Three electrons are fastened close together on the table as shown in the upper drawing of Fig. 6. Three more electrons are also fastened close together on the end of a small stick as is also shown in Fig. 6. If the end of the stick to which the electrons are fastened is moved toward the electrons on the table, a very strong force is noticed. This strong force keeps us from bringing the stick very close. We have to hold the stick very tight to keep it from being pushed out of our hand, if we try to bring it very close to the electrons on the table. By pushing hard, we can bring the stick closer, of course. But the force is very strong and we notice it at quite a distance from the electrons on the table. We have increased the strength of the electric field and it is now felt at a greater distance.

The strength of the field is now really surprising. If we hold the stick loosely in our fingers straight above the electrons on the table, it will rest in mid-air! The push exerted by the electrons on the table against those at the end of the stick holds the stick up in the air. If we guide the stick between our fingers, push it down hard, and then let it go, it will shoot toward the ceiling like an arrow! Those electrons certainly are strong! The strength of the fields has been increased by using more electrons.

Push the end of the stick holding the electrons toward the electrons on the table. Push hard. Now have someone hold the stick there while you loosen the electrons fastened to the table. After each electron is loosened from the table, have someone hold it. Now let all of the electrons which have been loosened go free at the same time. What happens? All three of the electrons suddenly start up and roll away. (See the lower drawing in Fig. 6). There is a strong field near the electrons. So if there is nothing to hold them, the fields will push them apart. The three electrons will all roll away from the end of the stick. If there were a great number of electrons fastened to the table, they would also all "flow" away in the same way. This fact is very interesting and also very useful. Electrons are always "flowing" in radio receiving and transmitting sets.

In the last experiment it was seen that electrons can be made to "flow" by building up a field. When electrons "flow" there is said to be a "current" of electrons. A current of electrons makes what is called an **electric current**. Isn't that simple? **A flow of electrons is an electric current.**

Scientists have tried experiments exactly like the ones we have tried. They have found that all electrons are the same, that they push on each other, and that the strength of the electric field increases as more electrons are placed close together. Very delicate measuring instruments have been used to find out these things about electrons. This was necessary because real electrons are so extremely small that they can never be seen. But real electrons do things exactly like the electrons did that we used in our experiments.

Electrons in Motion Is an Electric Current

WHEN a large number of electrons move in the same direction there is said to be a "flow." The word "flow" is an old word which is used to explain the motion of water in a stream or from a faucet. It also can be used to explain the motion of electrons. Other words which are used to explain water-flow can also be used to explain the flow of electrons. If there is a flow of water there is said to be a "current." If there is a large number of electrons moving in the same direction there is said to be an **electric current.**

The flow of water and the flow of electrons is about the same. If a ball is dropped into a moving stream, the "current" will take it along with it. If a number of electrons are moving in one direction and an extra electron is dropped in among them, it will be taken along by the "current" of electrons. So it is easy to see that if a particle of water is dropped into a moving stream, it will become part of the stream. In the same way, if an electron is dropped in among moving electrons it will be carried along with them and become a part of the current which is an **electric current.**

All these examples show that **electrons moving together make up an electric current.** The direction of the current is the direction in which the electrons are moving.

Electric currents are very important. No radio set could work without moving electrons.

A large number of electrons moving together makes a **strong** current. A small number of electrons moving together is a **weak** current. Whether a current is weak or strong depends on the number of electrons moving. **The strength of a current depends upon the number of electrons moving together in the same direction.**

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Commercial Interference On 40-Meter Band

(Continued from page 5)

a commercial is readily recognizable by the nature of his traffic. The purpose of recording these observations is to show that the commercial people who frame these so-called "treaties" have no intention of observing them except where certain provisions chance to suit their individual plans—that any provision may be "interpreted" or "construed" to mean something other than what it says. For example, the present "Treaty" stipulates that a channel once assigned must be put to its best possible use. Scores of stations having no possible use for the channels assigned to them "interpreted" this provision to mean that making a loud noise was "the best possible use." And they have been getting away with it for over four years at this writing—June 1, 1933.

Making public the evidence of commercial invasion of amateur bands will aid greatly the cause of amateur radio.

Clair Foster, W6HM

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★★★ August "RADIO" promises to be one of the banner numbers of '33. With additional contributions from those who formerly used the editorial pages of "MODERN RADIO," with a number of new departments added to the magazine and with the announcement of a definite plan of attack to have relinquished some of the "frequency-holding" channels of commercial interests so that these can be made available for the amateur, it behooves every serious-minded reader to rally to the support of this magazine with his own subscription. Dependent on revenue from paid subscriptions, the publishers have limited the number of pages which are available for advertising. Most gratifying has been the comment on the previous issue. Welcome the more than 700 new subscribers! And with our seventeenth anniversary issue of "RADIO" soon to be released we promise you a bigger and better magazine than we have given you since 1917. Your investment in a subscription will be a lasting one. Can we announce in our next issue that another thousand new subscribers have been added to the rolls? You, and 999 others can make this possible. $1.00 for 4 months; $2.00 for 8 months; $3.00 for 1 year. It's your move!

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Complete Constructional Details for Building a Highly Efficient Crystal Oscillator Which Can Be Used As the First Stage of Higher-Powered Transmitters Which Will Be Described In Later Issues

Easy to Construct. Complies With All Govt. Regulations. Can be used in 160- 80- and 40-Meter Wave Bands. This Transmitter is Composed of Various Units, Complete in Themselves; the Oscillator Unit is Described Here. This Set can be Added to Later for Increased Power. Each Succeeding Issue of "RADIO", for several months, will show how to build additional stages. This Design Never Grows Old. It uses the New 2A5 Tube.

THERE is great interest in amateur radio in these times. The number of licensed radio operators is approaching 50,000! This is the greatest number of amateurs since radio began. They are a very lively group. Present conditions are such that there is a demand for inexpensive equipment of the latest design. This discussion is purposely made simple, so that even beginners will be able to understand every word that is said, and be able to build this set.

It was decided to use crystal control. By purchasing a quartz crystal which has been calibrated, one need not worry about being outside an amateur band.

The circuit diagram of the set is shown in Fig. 1. The tube is a pentode of the latest type. Pentodes are recommended because of their high amplification factors. They require only a small input from the crystal which removes the possibility of damaging it.

Fig. 2 shows the parts layout. The wiring can also be seen in the drawing.

Veneer or ply-wood is used for baseboards and panels. The entire assembly is mounted on a 7 in. by 7 in. baseboard. The front panel is also 7 x 7. The baseboard is given two coats of clear "Duco". The front panel is given two coats of black Duco. After each coat has dried, rub the panel down with fine steel wool. The finished appearance closely resembles bakelite.

The parts are held in place with nickeled round-head wood-screws. The front panel layout is shown in Fig. 3. The large hole necessary for mounting the meter can be drilled with an ordinary carpenter's brace and bit.

The oscillator described here can be added to later. Additions for increasing power and converting it into a telephone transmitter, will be described in the next and following issues. The units to be described will match the oscillator in size and appearance. It is therefore important to construct the set exactly as described here.

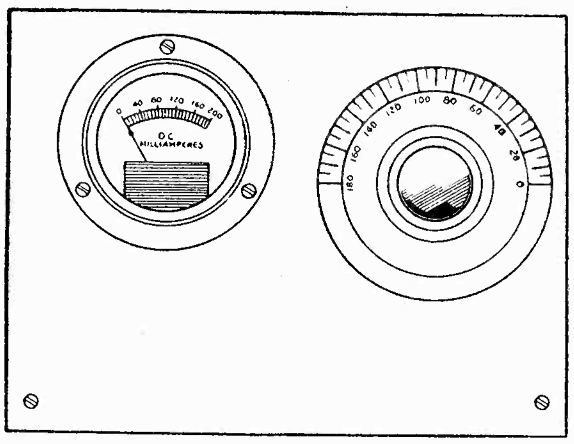

FIG. 3. Front Panel View

Construction of Crystal Holder

A CRYSTAL holder can be purchased if desired. One type is shown here and can be constructed as described below: Cut two pieces of brass to shape shown in Fig. 5. Be careful not to bend the pieces while cutting them. After the brass pieces are cut and drilled, their surfaces are ground perfectly flat. A piece of emery cloth is laid on a flat surface and the brass pieces are ground by using a circular motion and even pressure. Coarse emery or crocus cloth can be used at first. Finer paper is used to finish the surfaces which should be absolutely flat. To test them, place the two surfaces together and look between them toward a source of light. Continue grinding the surfaces until no light can be seen between the plates. Then polish plates.

The larger of the two plates is screwed to the baseboard. The crystal is placed on this plate, and the other plate is placed over the crystal. Fig. 5 shows the details for the phosphor-bronze spring. This spring should be bent over so as to produce a fairly firm pressure on the top-plate of the holder. A variation in the spring pressure has some effect on the oscillator output and frequency.

Adjustment of Transmitter

CHECK the wiring carefully. Apply voltages as shown in Fig. 1. The plate milliammeter should indicate from 40 to 80 milliamperes. The condenser is then slowly turned. At the frequency of the crystal, the plate current will show an abrupt change. If the antenna is not connected, the plate current will drop to about 10 milliamperes. The point of minimum plate current is the best operating point. At this position of the condenser, a spark will be obtained from the plate coil if it is touched with the point of a pencil. If a small loop of wire having a flashlight bulb in series is brought near the plate coil, the lamp will light up.

Putting Power Into the Antenna

CLIP the aerial to the plate side of the plate coil as shown in Fig. 1. Set the antenna tuning-condenser to near a maximum setting. The plate tuning condenser, C_1, is tuned to a point such that the plate current is slightly more than the mini-

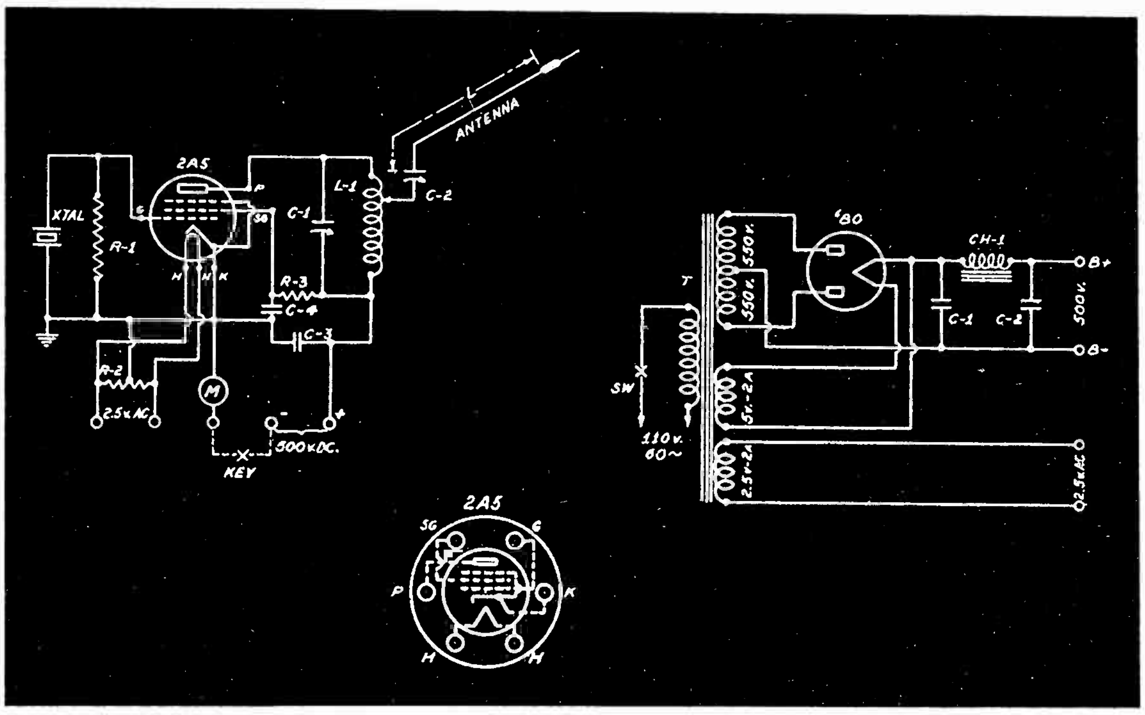

FIG. 1. Circuit Diagram, Tube Socket Symbols and Power Supply Unit

Showing, from left to right, circuit diagram of transmitter with antenna connection; Tube socket for 2A5 tube, (bottom view of socket connections); circuit diagram of power supply unit.

In the left hand portion of the diagram of the transmitter, the following parts are indicated:

XTAL—Crystal, and Holder. See Text for details.

R_1—50,000 ohm, 2 watt, resistor (across crystal).

R_2—20 ohm, center-tapped resistor (across filaments).

R_3—40,000 ohm, 2 watt, resistor (to reduce voltage to screen of tube).
If a 40,000-ohm size is not available, two 20,000 ohm resistors can be connected in series to give 40,000 ohms.

C_1—Variable Condenser, receiving type, about 9 to 13 plates, or a standard Cardwell .00035 mfd. condenser can be used.

C_2—Antenna-series Condenser, variable, Cardwell receiving type, .00035 mfd.

C_3—Plate blocking condenser, Sangamo, .002 mfd.

C_4—By-Pass Condenser, Sangamo, .002 mfd.

L_1—Plate Coil. See Coil-Turns Table for data.

Note:—If only 250-volts is used to operate this transmitter, no resistor at R_3 is required. An ordinary receiving set power supply can then be used.

CENTER ILLUSTRATION (2A5 TUBE SOCKET CONNECTIONS)

P—Plate.
SG—Screen.
S—GRID
K—Cathode.
H.H.—Heaters.

RIGHT ILLUSTRATION (Plate Supply Unit) Showing a 550-volt, center-tapped power transformer, with filament windings for 2½ volts for 2A5 tube, and 5 volts for '80 rectifier tube. An ordinary choke coil (30 henrys, 60 MA.) is shown at CH-1. C_1 and C_2 are 500-volt, 8 mfd. Dubilier electrolytic filter condensers. (4 required. Two in series, in each of two Banks.) Positive side of condenser connects to positive "B" lead, as shown.

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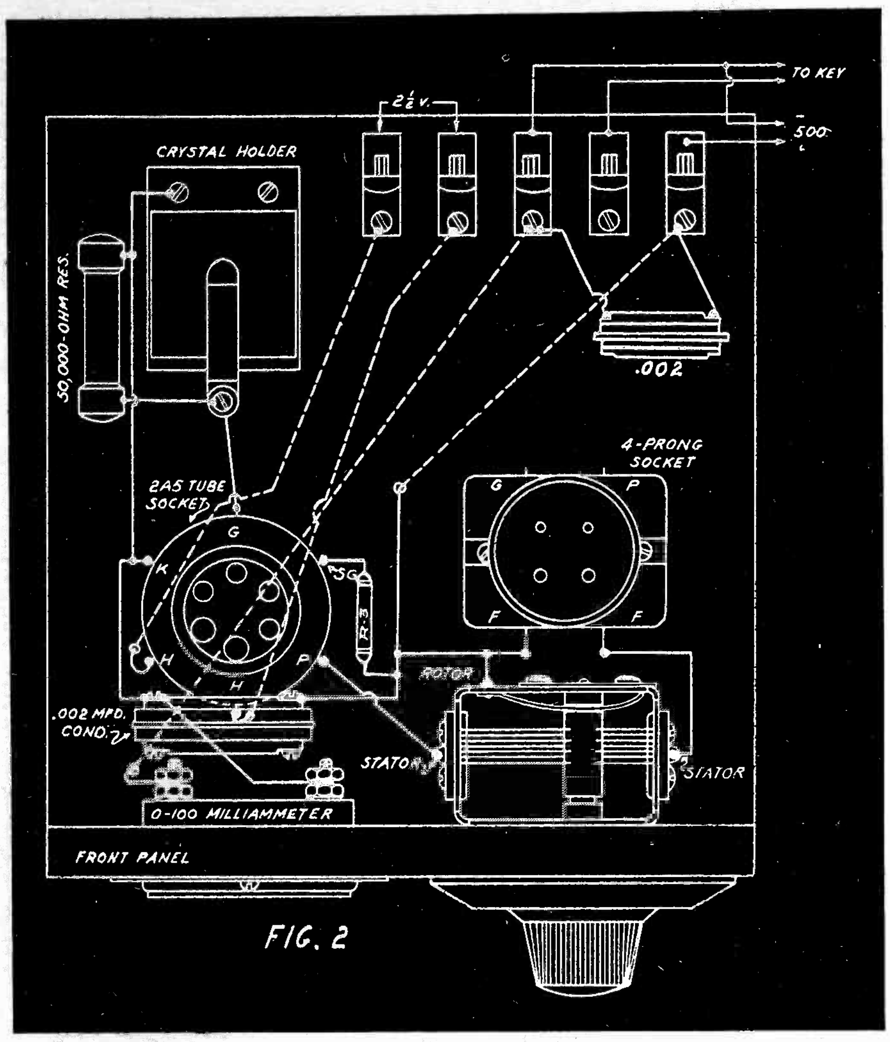


Showing lay-out of parts. Resistor R-3 is NOT used if this transmitter is operated on 250-volts, but is essential if 500 volts is used. Merely "shunt" R-3 if a low-voltage "B" eliminator is used to operate this transmitter. To increase the screen voltage, resistor R-3 can be 25,000 ohms. Various values can be experimented with until maximum results are obtained. However, values from 25,000 to 40,000 ohms will be found most suitable.

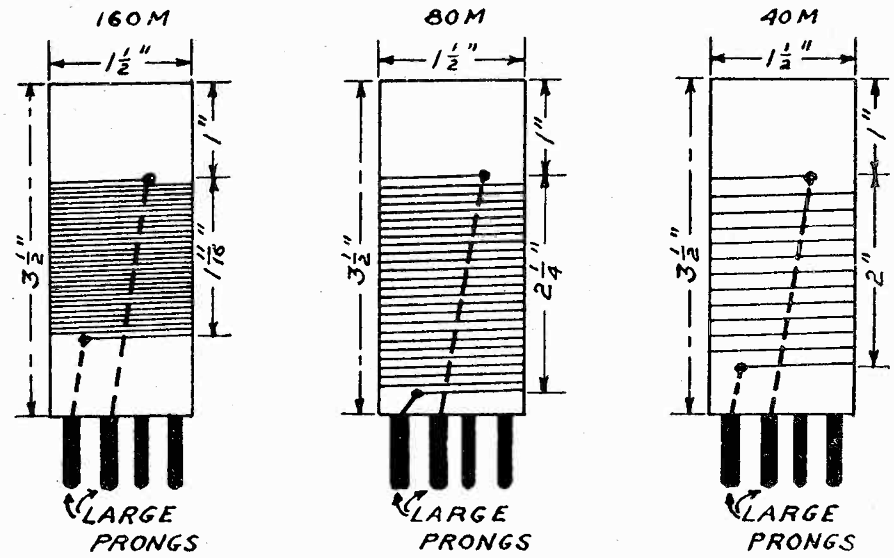


FIG. 6

(Fig. 6) Winding Data for Plate Coils

For 160-Meter Band:
45 Turns, #20 double silk covered wire, close wound, length of winding 1-11/16-in. Use 160-meter crystal.

For 80-Meter Band:
30 Turns, #20 double silk covered wire, spaced diameter of wire. Length of winding 2¼-in. Use 80-meter crystal.

For 40-Meter Band:
20 Turns, #18 double silk covered wire, spaced twice diameter of wire. Length of winding 2-in. Use 40-meter crystal.

Coil Forms Used for the Laboratory Model were 3½-in. long and 1½-in. diameter.

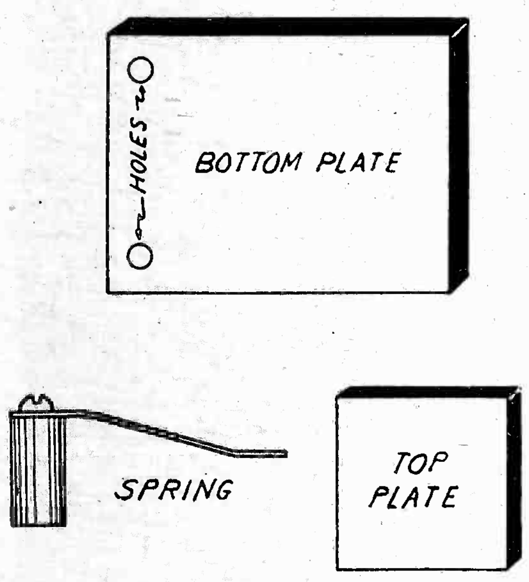
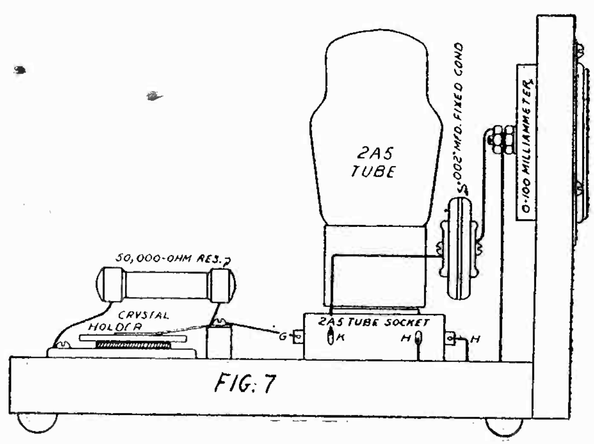


FIG. 5

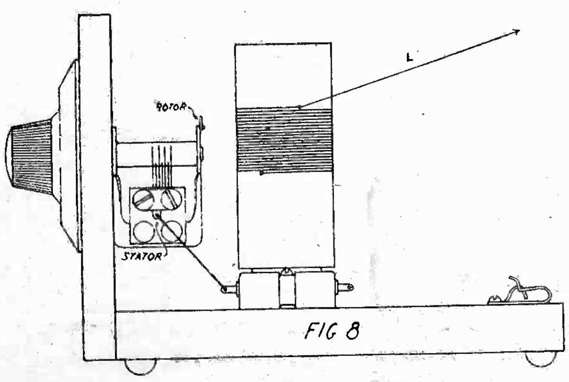
Parts Required for Crystal Holder

List of Parts Used In Simple Crystal-Controlled Transmitter

1—Plate Tuning Condenser, .00035, Receiving Type (C1)
1—50,000-ohm Carbon Pigtail Resistor, 2-watt.
1—40,000-ohm Carbon Pigtail Resistor, 2-watt.
1—Pc. Brass 1¼-in. x 1¼-in. x ⅛-in. thick.
1—Pc. Brass 1¼-in. x 1¼-in. x $\frac{1}{16}$-in. thick,
1—6-Prong Socket for 2A5 Tube.
1—4-prong ("UX") Socket (for Plug-in Plate Coil).
1—0 to 100 Milliammeter. ("Readrite" suggested).
1—Plate Blocking Condenser, .002 (good grade).
1—By-Pass Condenser, .002 MFD. (C4).
5—Fahnestock Clips.
1—Baseboard, 7-in. x 7-in. (5-ply veneer used in this set).
1—Panel, 7-in. x 7-in.; ¼-in. thick (3-ply veneer).
1—Receiving Type Coil Form—1½-in. diameter, 3½-in. long.
1—Dial.
15 ft. Hookup wire, screws, etc.
1—Quartz Crystal for Power Use (Get crystal for band to be used;
Total cost of parts will be under $10.00; it is advisable to get the best parts.



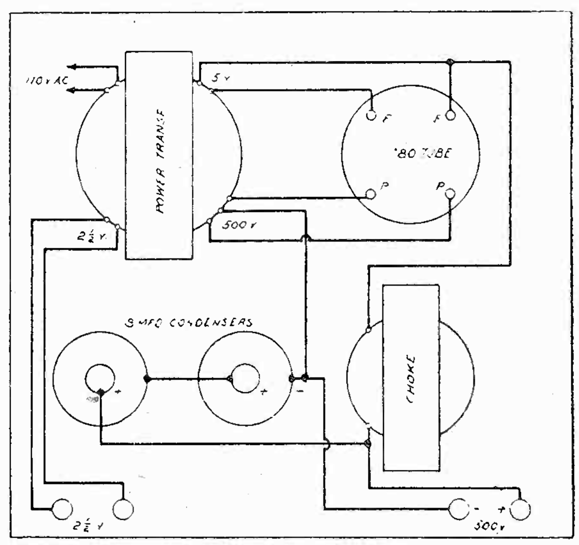
Side-view, showing proper placement of crystal holder, crystal resistor, tube socket, 2A5 tube, .002 fixed condenser and 0-100 MA milliammeter.



Side-view of coil-end of transmitter, showing plate tuning condenser, plug-in coil and socket. The antenna, L, connects to the top turn on the coil. A variable condenser is placed in series with the coil and L, so that the antenna can be tuned to resonance. The circuit diagram (Fig. 1) shows the proper connections for the antenna condenser. This condenser can be placed close to the transmitter, or can be mounted directly on the baseboard, or on the front panel, which must then be enlarged in size to accommodate the extra condenser.

mum which is obtained at exact resonance. The antenna condenser, C_2, is now tuned. If operating properly, the plate current should increase to the value obtained when the antenna is not connected, and the plate circuit is not resonant (between 50 and 80 milliamperes). An increased current is an indication of satisfactory operation. In the antenna shown, an antenna-ammeter or a flashlight bulb in series does not give a very definite indication.

The tube is run at comparatively high power, but this is allowable for a crystal-controlled set for code use. The key should not be held down for long periods.



POWER SUPPLY

If a separate power supply is wanted to operate this transmitter, the one shown in the lay-out above will be ideal. Two 8-mfd. dry electrolytic condensers are connected in series, as shown. This will prevent condenser breakdown. Parts for this power supply can be purchased for about $5.00.

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Writing "Finis" to the Grid-Choke Problem

A Comprehensive Treatise of a Feed-Line Coupling System That Is Becoming Increasingly Popular

By CLAYTON F. BANE *

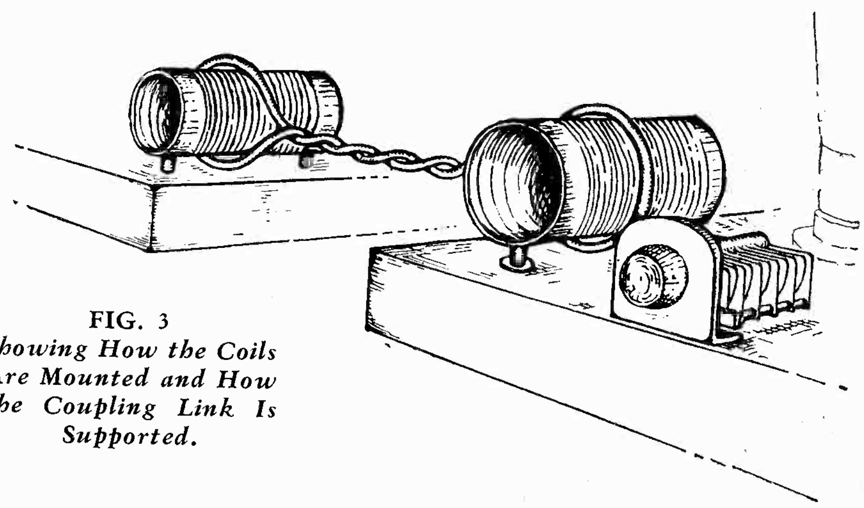

FIG. 3
Showing How the Coils Are Mounted and How the Coupling Link Is Supported.

IF you have joined the ranks of the grid-choke winders, (and who hasn't?) it is safe to predict the result. Wind! Unwind! Rewind! With perspiration on your brow, and murder in your heart, you untangled your feet from the maze of discarded wire on the floor and put the choke, (the fifteenth) in the transmitter. No use!

While not all cases are as sad as this example, I really believe the best choke is hardly good enough when used in a shunt-feed circuit. I've made hundreds of them, but my transmitters really begin to work when, and only when, I adopt a series-grid-feed arrangement and put the choke where it did not have much work to do. For example—the input to a certain transmitter, working on 14-MC, was rarely capable of carrying more than 350 watts without excessive heating of the final tube (a type '52). This, with the ordinary capacitive coupling between stages and the use of grid RF chokes. Upon changing over to inductive coupling, and eliminating the chokes, it was found that the buffer amplifier (a type '10), was furnishing sufficient grid swing to allow the final to be run stone cold, at an input of 600 watts!—nearly double the former input. It is evident, therefore, that this tremendous increase in efficiency is not due solely to the elimination of the grid chokes. Pause a moment to examine a few diagrams and determine exactly what has taken place.

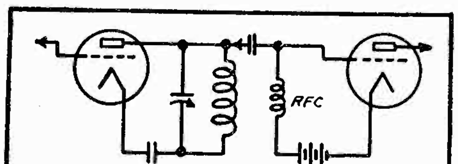

FIG. 1

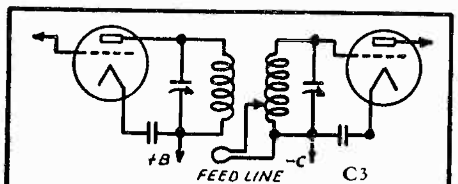

FIG. 1A

Figure 1 shows the usual standard capacitively coupled circuit. Forget for the moment what goes ahead or behind and consider that we are using two coupled stages. (Xtal to doubler; doubler to doubler, etc.)

From Figure 1A we find that the plate circuit of stage 1, remains unchanged. (Series plate feed a good feature, etc.) But the grid circuit of stage 2 is hard to recognize. We have added a tuned circuit, (L2-C2)—connected one side of this to the grid, and the other to the C Bias. Since this C Bias side is also bi-passed to ground by C3, this end of the soil, obviously, is at a ground potential. Very little RF here, so now there is no longer any need to worry about our RF choke. Any old choke will do. Next we are faced with the fact that our diagram (Fig. 1A) shows a peculiar looking pair of leads connecting both stages. This is an RF feed line. Exactly the same thing that we use in our doublet anntennas—a twisted pair. You may say, "But why use a feed line when my stages are only a few inches apart?" A fair question, but stop for a moment and consider why, if this inductive coupling business is so simple, is it not more generally used. Most systems use a grid coil within (or coupled closely to), the plate tank. In order to get a sufficient transfer of energy, the coupling usually is so close that two things happen; first, the grid coil, being so close to the plate coil, couples an appreciable resistance into that tank with the attendant excessive plate dissipation and loss of efficiency; secondly, so much interaction exists that it is practically impossible to tune one stage without seriously detuning the other.

This does not happen when the feed line is used, because the single turn loop will draw all the energy that is needed when it is put far back toward the cold side of the tank. This will result in more energy being dissipated in the plate tank and the load, instead of being dissipated in the form of heat in the plate of the tube.

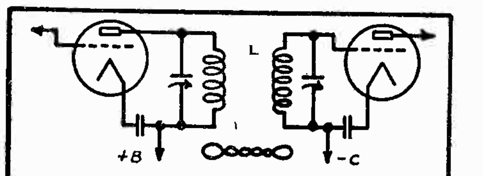

FIG. 2

In my original experiments with line coupling, a single turn loop was placed around L1, (Fig. 2), one of the opposite ends of the line being connected to the cold side of L2. The other lead was tapped about two or three turns up from that end. This system gave satisfaction, but the tap wasn't particularly critical, and added another adjustment, so it was discarded in favor of the simpler feed line shown in Fig. 1A.

This feed line has a single turn loop (slightly larger than the coils to which it is coupled) on both ends. Figure 3 clarifies this explanation. This line may be of any length, up to several feet. Since both loops are exactly the same size, the impedances at both ends of the line are equal, resulting in maximum transfer of energy from the plate tank of one stage to the grid tank of the other. The grid now has a tank circuit of its own, and the voltage impressed on the grid will be considerably greater than that in the plate tank. Result—**more excitation.** Don't forget that the energy we once blissfully poured through a poor choke into our power supply is now arriving at the grid—built-up, of course, by the LC tank. This can be demonstrated by those who must use their sparking pencils," though I personally prefer a more accurate indicator.

Another point of importance is the use of low C circuits throughout. Since the frequency is maintained constant by the crystal-controlled oscillator, there is absolutely no reason to introduce losses by the use of High C. The use of low C has a further advantage in that it allows the use of smaller diameter wire and tubing for inductances, because we are no longer sending high amperage through the coils to dissipate energy in the form of heat losses.

Figure 4 shows a circuit suitable for operation on 7MC, and consists of a '47 crystal oscillator, a '10 doubler and a '10 amplifier. This outfit was in use at the writer's station, with an input of 80 watts to the final '10 (showing no color whatever) and is heartily recommended for those who desire an efficient transmitter but can't afford more than a '10 in the final.

The crystal circuit is a conventional one;

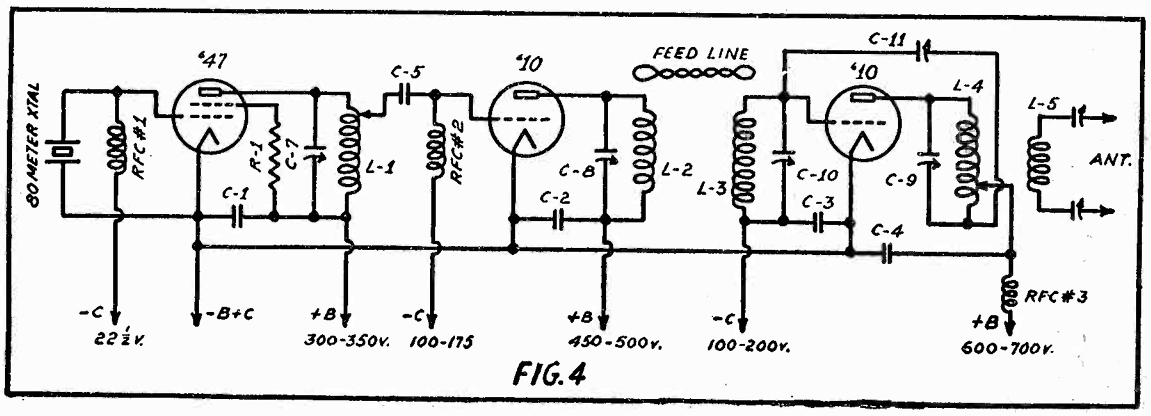

FIG. 4

C1, C2, C3, C4, .006 Sangamo fixed condensers.
C5, .00025 Sangamo condenser.
C7, C8, C9, 100 mmfd. Variable Condensers, Cardwell.
C10, C11, 50 mmfd. variable condensers, Cardwell.
L1, (80-meters) 32 Turns, No. 18 D.C.C. wire, close wound, 1½-in. dia. Bakelite Tubing.
L2, L3, (40 meters) 21 Turns, No. 18 enameled or bare wire, space wound, spaced diameter of wire, on 1½-in. dia. Bakelite Tubing.
L4, (40-meters) 20 Turns, No. 10, spaced diameter of wire, 2¼-in. dia.
R1, 25,000-ohm, 5-watt resistor.
RFC1, RFC2, National Xmtr Chokes.

* W6WB

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capacitively coupled to the doubler. This is deemed advisable in order to avoid another tuned circuit. The National Type-100-RF Chokes are used in both the crystal and doubler C-Bias leads and have proved more efficient than home-made chokes. Now for some pertinent remarks on tuning-up.

Since the grid and plate tanks of the final stage are both working on the same frequency, extreme care must be taken to see than neutralization is perfect. In my own transmitter this was accomplished without trouble by using the grid milliammeter as an indicator. More about that later.

This circuit requires a somewhat different tuning-up procedure than is customary with other types. Assuming the crystal stage to be oscillating, the first consideration is the placing of the excitation tap that goes from the crystal plate tank, through the coupling condenser, C5, to the grid of the doubler. If we connect a milliammeter, (0-50 M.A.) in the C-bias lead of the doubler, we can readily determine the correct position for the tap by moving it from around the middle of the tank toward the hot (plate) end until we get the maximum reading on the meter. The doubler tube filament must be lighted and the C-bias connected in place, in order to get a reading, though the plate voltage need not be on. Having determined the correct point for the grid tap, we now proceed to tune the doubler plate tank to resonance in the usual manner. Our milliammeter is now switched to the C-bias lead of the final, and the coupling line is adjusted. (Fig. 3.) Again the tube must be lighted and the C-bias circuit completed. Tune C10 until a reading is obtained on the meter, bringing this reading to a higher value by a readjustment of C8. A further adjustment can be made by moving the feed line slightly toward the hot ends of the tanks, although this should not be necessary if the loops are placed approximately in the center of the coils. If a heavy rubber covered wire is used for the feed line, the loops can be held in place by simply twisting them tightly around the coil. We can now adjust and neutralize the final. The plate voltage should be off, but the center-tap connection—assuming center-tap keying is used—MUST be connected to the negative side, completing the grid-to-filament circuit. Without touching the neutralizing condenser, C11, tune the final condenser, C9, until the "mills," as shown on the grid meter, take a sudden drop, and rise again as resonance is passed. Tune for the minimum reading (indicating resonance) and then carefully adjust C11 until the meter reaches the same reading obtained before C9 was adjusted. A point that must be remembered: moving the neutralizing condenser will change the tuning of the grid tank (L3-C 10) so that it is best to change the two condensers simultaneously in order to maintain a reading on the meter at all times. Maybe this sounds a little involved, so I had better give an illustration. Let us say that the grid meter shows a reading of 40 mills when we first tune the grid circuit to resonance. When the final plate tank is "on the nose," the mills drop to 20. Move the neutralizing condenser and the mills drop to 10, but by again changing the grid tank we get a reading of 15, showing that the grid tank has been detuned. Merely a matter of compensating for the detuning by a slight, but "instep," adjustment of the grid tank. By following this procedure you will obtain a reading that reaches a maximum, and falls off on either side. Pick the maximum and your transmitter is neutralized. The high voltage tap on the final coil should be about five or six turns from the end which is opposite the plate, for a 50 mmfd. neutralizing condenser, though this tap may have to be adjusted until the maximum meter reading (indicating neutralization) occurs with the condenser in the center of its scale. A final check on neutralization is to shift the final tank condenser back and forth around the resonant position, meanwhile watching the grid meter. If the stage is neutralized, the meter won't budge; but if it isn't you will get a dip every time you pass through resonance.

The plate voltage is now applied to the final, and the final tank is given its "polishing up" adjustment, by tuning for minimum mills on the plate meter or maximum on the grid meter. Going back to the crystal stage, tune all tank circuits for maximum reading on the meter in the C-Bias lead of the final. In this circuit everything must be tuned "on the nose!"

Please don't get the impression that this circuit and its attendant apparatus is "tricky" or inflexible. Everyone who has tried it has obtained results far exceeding those of their old "chokey," capactively-coupled rigs, and superior performance is the rule, rather than the exception. As for its inflexibility—I changed my transmitter (inductive coupling throughout, and 5 stages) from 14MC to 7MC and was ready to shoot, antenna tuning and all, in three and one-half minutes!! Since I have never been noted for speed or tricks of magic, the obvious conclusion is that anyone familiar with the circuit can do the same.

Next month will be shown the constructional data on a new high-power stage (using a type '52) that can be efficiently excited by the three-stage transmitter herein described. It's a honey—wait and see!

Design of Practical Crystal-Controlled Transmitters

Crystal-Controlled Transmitters Have Advantages Not Found In Other Arrangements. Certain Factors Must Be Carefully Considered To Obtain Maximum Efficiency From Oscillators Employing Quartz Plates. A Practical Quartz-Crystal Transmitter, and All Circuit Constants Are Herein Presented. Written By a Well-Known Expert Who Understands Thoroughly the Crystal As Well As the Oscillator In Which It Must Operate. Another Article By the Same Author Will Appear In the Next Issue.

By A. F. HOEFLICH

A PROPERLY operated Transmitter, in which crystal-control is employed, emits an extremely steady wave. Moreover, the unusual properties of a quartz plate are such as to furnish a "D.C. note" at the output with a comparatively inexpensive filter in the plate supply. Such a transmitter not only furnishes a high-quality signal but it is also of low cost. A crystal-controlled transmitter has advantages not found in any other arrangement.

In general, good results will be obtained from standard circuits. Tuning a crystal transmitter is comparatively simple. Fig. 1 shows a simple crystal-oscillator circuit together with the necessary constants for obtaining best results from it.

The tuned circuit LC should be of "low-loss" construction. If good frequency-stability is to be realized, the "tank" circuit should not be tuned exactly to the crystal frequency but somewhat to one side. Minimum plate current is obtained at exact resonance, but the plate circuit should be detuned as far off resonance as the required output will allow, for best results. When so operated, the frequency-stability is practically independent of variations in circuit constants. If the room temperature is nearly constant, the crystal will maintain the frequency of the transmitter at a very constant value.

Constant temperature, relative to room temperature, is most easily maintained if the bottom plate of the crystal holder is of relatively large dimensions. This will allow heat to radiate from the crystal, if its temperature rises above that of the room.

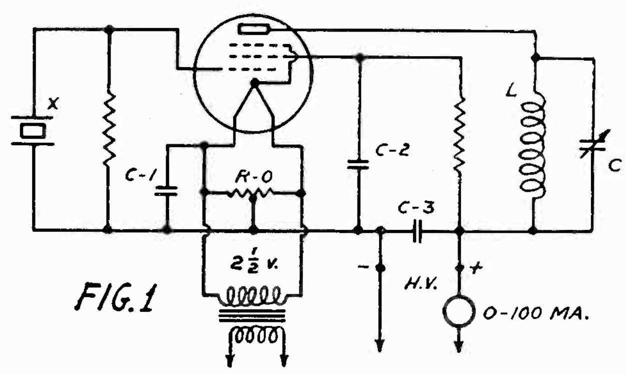


FIG. 1

Table of Constants

TUBES—247 or 2A5

Grid Leak	50,000 ohms, 1 watt
Screen Grid Resistor	5 watts
C-1	.01 mfd.
C-2	.01 mfd.
R_0	50 ohms, centertapped

Coil Table

160 Meters	35 turns, 3" dia.
80 Meters	17 turns, 3" dia.
40 Meters	8 turns, 3" dia.
20 Meters	3½ turns, 3" dia.

Safe Plate Voltages

TA5 Tube	450 volts
247 Tube	450 volts
210 Tube	250 volts
241 Tube	300 volts

Safe Crystal R.F. Currents for Various Wave-Lengths

160 Meters	80 MA.
80 Meters	55 MA.
40 Meters	45 MA.
20 Meters	35 MA.

This current can be measured by means of a thermo-couple milliammeter in series with the crystal

Tubes for Crystal Oscillators

THE best tubes to use in a crystal-oscillator are the Types 47, 2A5, 41 and '10 in the order given. The '47 is perhaps the best; but either a 47 or a 2A5 can be used. The latter tubes will allow operation at higher plate voltages. Greater power output for a given crystal-temperature rise are possible with the pentode tubes.

For maximum frequency-stability, the grid-leak resistance should be about 50,000 ohms. The gridleak value also influences power output. A one-watt pigtail resistor will serve for this purpose.

To protect a quartz plate from excessive current a 150 MA. fuse can be placed in series with the crystal holder. A '99 tube filament is often used for this purpose.

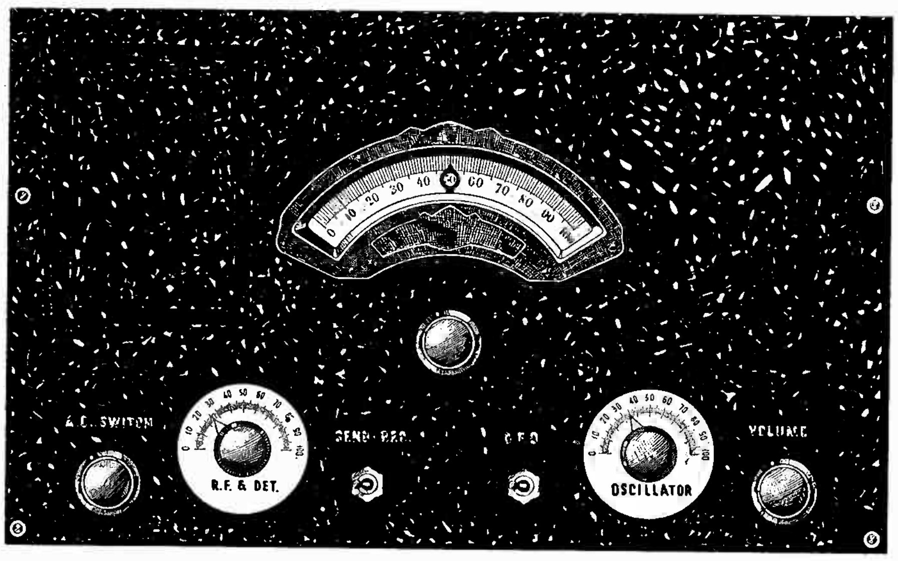
The crystal-holder plates should be ground perfectly flat. If they are polished flat, it will be easier to tell whether the crystal is "brushing." The pressure on the crystal should be capable of adjustment. Unless a dust-proof holder is used, periodic cleaning of the quartz plate will be necessary. It is best to make the holder plates of sufficient area to cover the crystal.

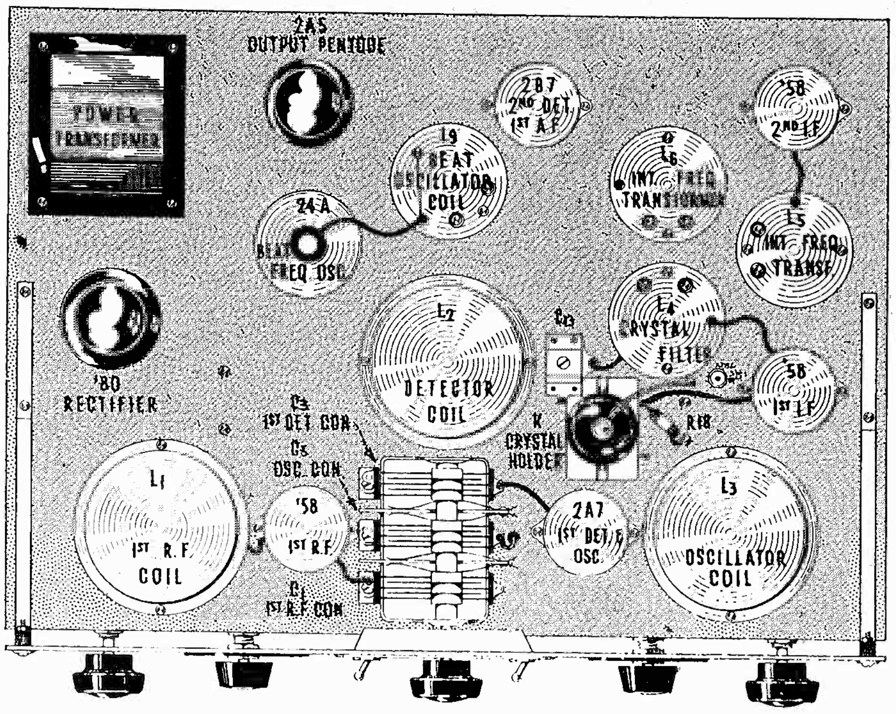
A gridmeter in series with the gridleak will provide a good indicator of circuit efficiency. The various parts of the circuit can be adjusted while noting the gridmeter reading. This meter should be adjusted, originally, to read a maximum value by tuning the plate-circuit condenser. An increase in circuit efficiency will give an increased grid current. Of course, the gridleak should not be changed during such tests. Plate and filament voltages should also remain constant.

(Continued on page 34)

Construction of "Radio's" Laboratory 520-KC. Crystal-Filter Superheterodyne

By RICHARD C. BARRETT



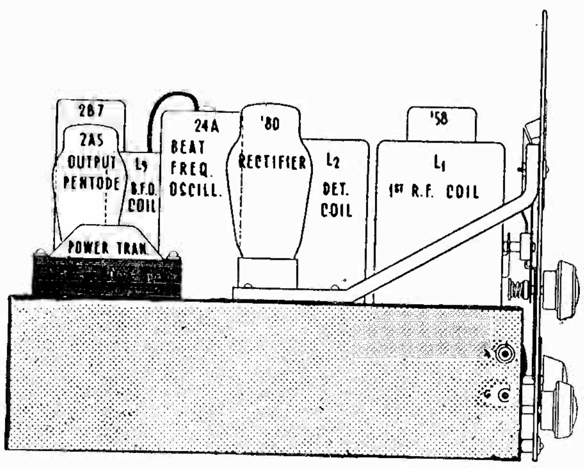


Front-panel view and pictorial parts lay-out for "Radio's" Crystal Filter Superheterodyne. Both illustrations are drawn to scale, making it easy for the constructor to properly locate the correct position for each part. The placing and spacing of the parts on the chassis-deck is all-important.

EDITOR'S NOTE—*This is the second of Mr. Barrett's articles which deal with the design and construction of modern, short-wave superheterodyne receiving sets. The first article in this series appeared in June "Radio," copies of which are still available from the publishers.*

THE latest tubes have been used in this new superheterodyne receiver. It was found possible to reduce the cost of the set by using the latest 2A7 and 2B7 tubes. Exceptional results have been obtained with this set under average conditions met in practice.

The crystal-filter circuit in this set is a bridge arrangement incorporating the split-secondary of the intermediate transformer L4, the capacity of the crystal holder **K**, and the capacity of the crystal-phasing condenser C13. It functions as a balanced unit if C13 is adjusted to neutralize the capacity between the plates in the crystal holder **K**. At balance, it passes a minimum of intermediate-frequency signal voltage to the grid of the first I.F. tube, other than that due to the crystal. The arrangement can be represented by the equivalent circuit of Fig. 1, in which the crystal **K** is represented by its electrical equivalents **L**, **C**, and R. This connection of elements is in series-resonance to the intermediate frequency.



Side elevation, drawn to scale, showing method of front-panel support and placement of various units.

In Fig. 1, the ratio of L to C should be maintained at a high value. The "inductance" L of a quartz plate is a function of its mass and the mechanical load upon it. It is best that the crystal be "X-cut" because when cut in this way a thicker crystal for a given frequency, results. A holder, for the crystal, of the air-gap type is better than one in which the top plate rests directly on the quartz plate. The air-gap holder has the advantage that the top-plate does not rest on the crystal to cause a "load." When such a holder is used, the crystal is allowed to vibrate without restraint. The load referred to introduces the R component (Fig. 1) which broadens the response curve of the crystal and decreases the voltage available for operating the grid of the first I.F. tube.

Accordingly, the holder used in this set is of the air-gap type. The actual gap width is not of prime importance but it should be about .001 in. The top and bottom plates should be parallel. Such an arrangement is readily obtained by using an ordinary crystal-holder and some carefully ground spacers. These are placed at each of the four sides of the crystal, and are about .001 in. thicker than the crystal itself. This allows the top-plate to rest slightly above the top of the crystal.

The crystal-filter coil, L4, consists of an ordinary intermediate-frequency transformer with a center-tapped secondary as commonly employed with the Wunderlich detector tube. By using a center-tapped coil, a split-stator condenser is unnecessary for the selectivity control. The "padding" condenser supplied with the intermediate-frequency transformer serves as a selectivity control. The crystal-holder **K**, switch S1, and phasing-condenser C13, must be arranged near the intermediate-frequency transformer L4 so that the shortest possible leads can be realized. The crystal shorting-switch, S1, should not be placed on the front panel because it will be necessary to run long leads to it. Any single-pole single-throw switch of the knife-blade or toggle types, can be used in this position. Mounting such a switch is quite simple.

The phasing-condenser C13 consists of a 30-mmfd. condenser such as is commonly used with ganged receiving condensers for aligning purposes. A 2-plate midget variable-condenser of the air-dielectric type can also be used.

The padding-condenser across the primary of the intermediate-frequency transformer L4, was omitted from the laboratory model of this receiver. It was not required for selectivity gain. In some intermediate transformers, this condenser will be difficult to remove. In this case, it will be best to leave it in the circuit.

The adjustments to the crystal-filter will be described in greater detail under Tuning and Operation.

Equivalent Electric AC Circuit for Crystal Filter

THE electrical components comprising the crystal-filter are as shown in Fig. 3. C1 represents the capacity of the crystal-holder plates. The phasing-condenser C13 is for the purpose of balancing the other arm of the bridge. The inductance **L** is the electrical

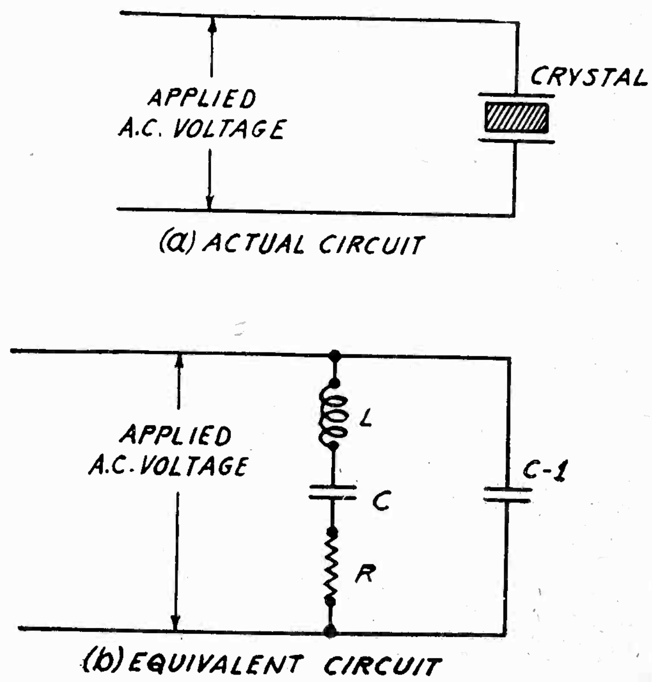


FIG. 1
Equivalent electrical network representing a vibrating quartz-plate's effect on associated electrical circuits.

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equivalent of the crystal's mass. The capacity C corresponds to the mechanical resilience. The mechanical load, electrical impedance, R is the friction to the vibration of the crystal.

The "Q" of this circuit depends upon the ratio of L to C, ordinarily referred to as the "L/C Ratio." The magnitude of R is of importance. For an X-cut 520-KC. crystal, this value should be near 1000. The effective Q of a crystal-vibrator varies inversely with the frequency and is high at low resonant frequencies.

Parts Placement

CAREFUL CONSIDERATION should be given to placement of parts in the tuned-R.F. and detector circuits. The arrangement of the coils, condensers and the sockets for the first R.F., first detector and oscillator tube was considered with respect to eye value and short leads. No other arrangement was found practicable other than the one illustrated. Both requirements have been satisfactorily met..

Coil Details

THE R.F., Detector and Oscillator coils are of the plug-in type. They are wound on 4-prong "low-loss" coil forms. The forms are 1-½ in. diameter and 3½ in. long. Complete coil-winding data will be found in the table herewith. The intermediate-frequency transformers, L_5, L_6, and also L_4, are of special design. They are, however, available on the market. The beat-oscillator tuning-coil, L_9, can be made from a standard intermediate-frequency transformer by removing two-thirds of the primary winding and connecting it in series with the secondary section, at the point at which it connects to cathode. The primary padding-condenser is disconnected, and the secondary padding-condenser is reconnected as indicated at C_9.

The specifications as given for R.F., detector and oscillator coils will allow accurate tracking of the three gangs of the band-spread condenser over the band width. Any slight discrepancies in this respect can be compensated for by using the two-gang R.F.-and-detector-condenser as a trimmer. The input circuit of the R.F. tuning-coil includes a primary winding which is designed for either "Doublet" or single-wire antenna-ground systems.

Note on Resistors

All resistor values for the receiver are critical and no changes should be made in these.

Note on Condensers

ALL condenser values should be as specified. It has been found that a good grade of paper condenser is satisfac-

(Continued on next page)

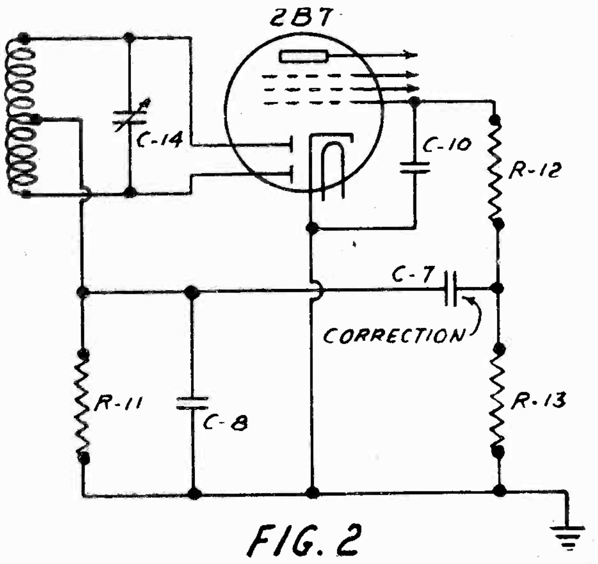

FIG. 2

At the junction between R_{12} and R_{13}, and the center-tap of the secondary of L_6 there should be inserted, in series, a condenser, C_7 (.05 mfd.). This illustration (Fig. 2) shows how this change is made.

BAND	R.F. COIL (L_1)	DETECTOR COIL (L_2)	OSCILLATOR COIL (L_3)
20 Meters	SECONDARY:— 7 turns, #20 D.S.C. Spaced twice thickness of wire. PRIMARY:— 10 turns, #30 D.S.C. close wound.	Same as L_1	GRID WINDING:— 6 turns, #20 D.S.C. spaced twice thickness of wire. PLATE WINDING:— 6 turns, #20 D.S.C. spaced twice thickness of wire.
40 Meters	SECONDARY:— 15 turns, #20 D.S.C. Spaced thickness of wire. PRIMARY:— 10 turns, #20 D.S.C. close wound.	Same as L_1	GRID WINDING:— 14 turns, #20 D.S.C. spaced thickness of wire. PLATE WINDING:— 6 turns, #20 D.S.C. spaced thickness of wire.
80 Meters	SECONDARY:— 30 turns, #20 D.S.C. close wound. PRIMARY:— 10 turns, #30 D.S.C. close wound.	Same as L_1	GRID WINDING:— 25 turns, #20 D.S.C. close wound. PLATE WINDING:— 10 turns, #20 D.S.C. close wound.
Separation Between Any Winding Should Be From ¼ inch to ½ inch.			

NOTE: Winding Data for 160-Meter Coil and for B.C.L. Coil Will Be Given in Next Issue.

Circuit Diagram of "RADIO'S" New Crystal-Filter Amateur Superheterodyne

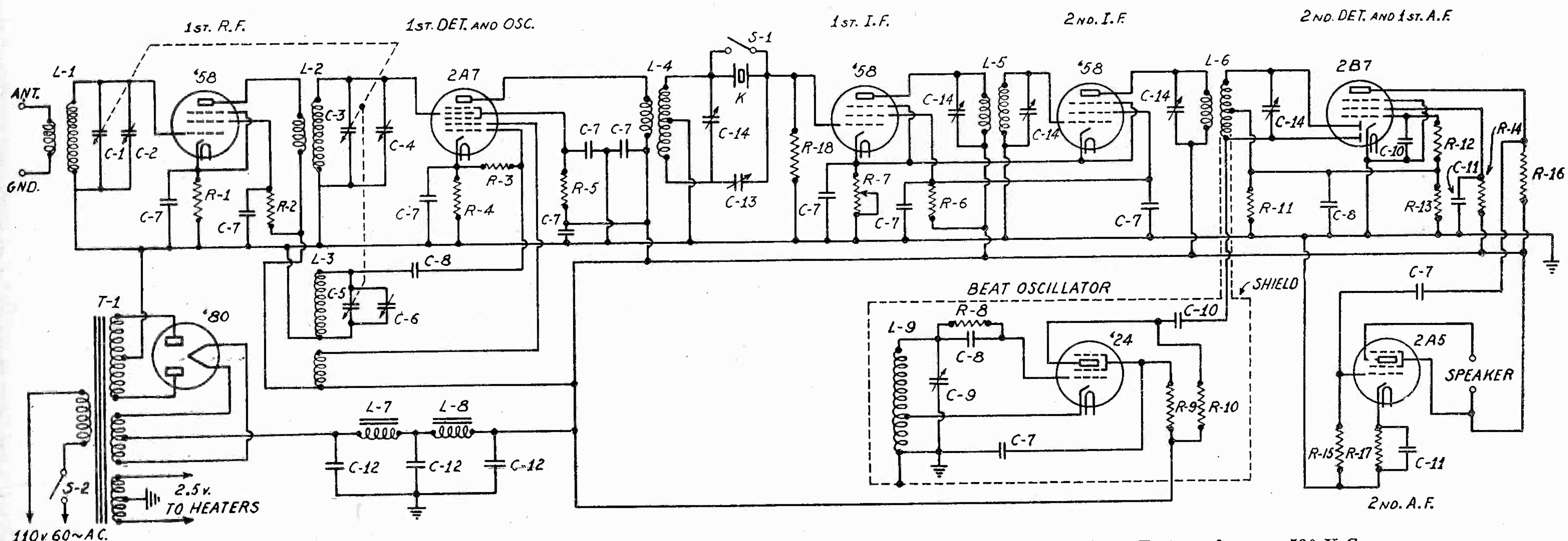

FIG. 3

LEGEND

C_1, C_3, C_5—Three-gang, band-spread condenser. Maximum capacity, 50-mmfd. each section.
C_2, C_4—Two-gang, RF and Detector Tuning Condenser. Maximum capacity, .00025 mfd. per section.
C_6—Single variable condenser, .00025 (for oscillator).
C_7—.05 Mfd. by-pass condensers, paper, cartridge type.
C_8—.00025-Mfd..
C_9—Padding condenser (inside special BFO tuning coil).
C_{10}—BFO Coupling-condenser, .0001 mfd.
C_{11}—4-Mfd. dry, electrolytic condenser, 450-v. (two required).
C_{12}—8-Mfd. dry, electrolytic condenser, 500-v. (3 required).
C_{13}—Crystal-Phasing Condenser.
C_{14}—Padding condensers across special I.F. transformers.
L_1—First R. F. coil.
L_2—Detector coil.
L_3—Oscillator coil. (See text for winding data on these coils).
L_4—I.F. transformer, with center-tapped secondary, 520-K.C.
L_5—I.F. transformer, 520-K.C.
L_6—I.F. transformer with center-tapped secondary, 520-K.C.
L_7, L_8—30-H., 100-ma., filter chokes.

R_1 —250 ohms	R_{10}—100,000 ohms.
R_2 —50,000 ohms.	R_{11}—750,000 ohms.
R_3 —100,000 ohms.	R_{12}—100,000 ohms.
R_4 —1,000 ohms.	R_{13}—750,000 ohms.
R_5 75,000 ohms.	R_{14}—1 Megohm.
R_6 —60,000 ohms.	R_{15}—250,000 ohms.
R_7 —0-100,000 ohm volume-control.	R_{16}—200,000 ohms.
R_8 —100,000 ohms.	R_{17}—410 ohms. (or 450 ohms).
R_9 —250,000 ohms.	R_{18}—1 Megohm.

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tory for ordinary by-pass circuits. There is no need for extremely good condensers, other than those specified in the List of Parts.

Shielding

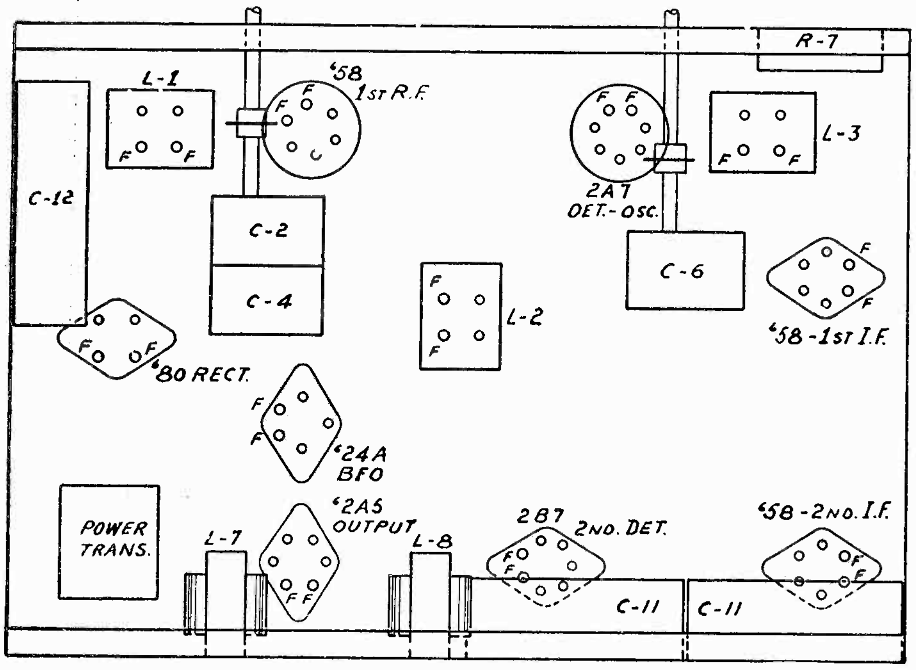
COIL SHIELDING has already been discussed. It is important to shield the beat oscillator and the lead to the second detector. Troublesome harmonics should be kept at a minimum. Because of proper parts placement, no additional shielding is necessary.

Switches

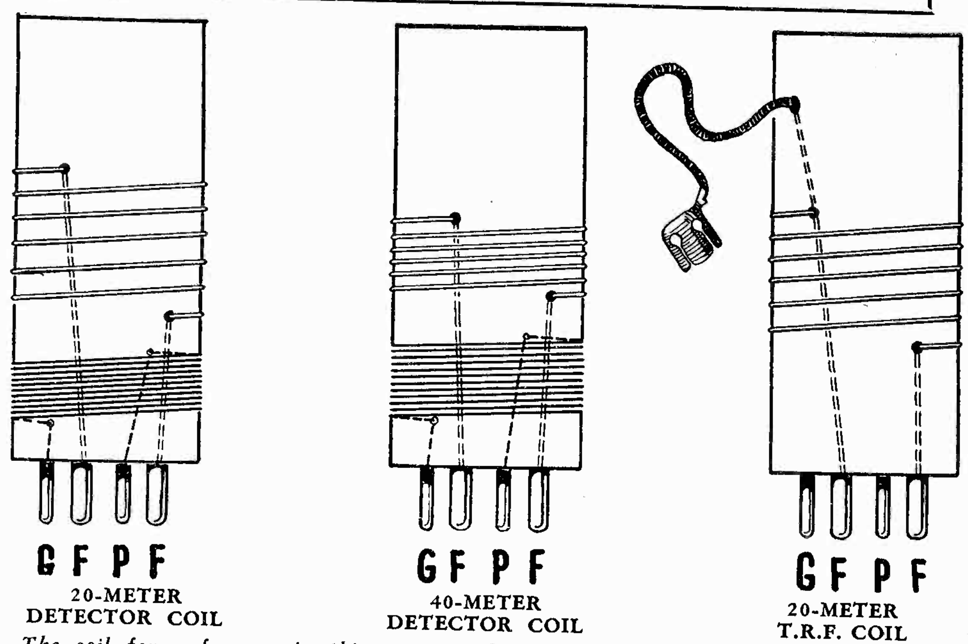
TWO SWITCHES not indicated in the diagrams have been used. One is used in the B-plus lead to the beat-oscillator, so either phone or c.w. reception is possible. The other switch is in series with the center-tap of the power transformer high-voltage winding. It turns off the B-supply in the receiver when the transmitter is operated. These switches are on the front panel. S_2, also on the panel, is the A.C. line switch. They are shown in the drawings of the front-panel. S_1, as indicated in the diagram, is an SPST toggle switch. It is near the crystal holder, K. How to mount it remains for the builder to decide.

List of Required Parts for "Radio's" Superheterodyne

1—Chassis, steel, 3½"x12"x17".
1—Front panel, No. 12 gauge steel, crackle-finished, 10½"x17".
2—Brackets, "Z" shape, ¼" square aluminum rod, 1"x2½"x5".
1—Main Tuning Dial, full vision, "vernier."
2—2½" Black bakelite dials, engraved, for Oscillator and R. F. Tuning.
3—Toggle switches, SPST.
1—SPST rotary switch.
1—0 to 100,000-ohm volume-control ("Super Tonatrol") (Electrad suggested).
3—Shield cans, for coils, 3" dia., 3-3¾" high, with bases.
5—Tube shield cans, latest type (for Type 58 tubes).
1—Tube-shield, old type, for '24-A tube.
3—520-KC intermediate transformers.
1—Special Oscillator Tuning Coil, (L_9).
1—Crystal holder, air-gap type.
1—Crystal, 520-KC, "X-cut."
1—30-Mmfd. phasing Condenser (C_{13}). (Hammarlund suggested).
1—2-Gang variable condenser, .00025 mfd.
1—Single variable condenser, .00025 mfd.
1—Three-gang variable condenser, band-spread type. Max. cap., 50 mmfd.
1—4-Prong, "wafer" sub-panel socket.
1—5-Prong "wafer" socket.
3—6-Prong "wafer" sockets.
1—7-Prong ("midget" type) "wafer" socket.
4—4-Prong sockets of a good short-wave type.
1—7-Prong, as directly above (midget type).
1—6-Prong, as directly above (midget type).
3—8-Mfd. dry electrolytic, filter condensers.
2—4-Mfd. dry electrolytic condensers.
2—30-Henry chokes, 100 ma.
1—Plate-supply transformer, 300 volts each side C. T., also 2½-v., 10-amp., fil. winding, and 5-v., 3-amp., fil. winding.
11—.05-Mfd. 400-v. cartridge condensers.
2—.00025-Mfd. mica fixed condensers.
1—.0001-Mfd. mica fixed condenser.
1—Pigtail resistor, ½-watt, 250 ohms ("Metallized" suggested).
1—410-ohm, as above (450 ohms can be used).
1—1000-ohm, 1 watt pigtail resistor.
1—60,000-ohm, 2-watt pigtail resistor.
1—50,000-ohm, ½-watt pigtail resistor.
1—75,000-ohm, ½-watt pigtail resistor.
1—100,000-ohm, ½-watt pigtail resistor.
1—250,000-ohm, ½-watt pigtail resistor.
1—1,000-ohm, ½-watt pigtail resistor.
1—200,000-ohm, 2-watt pigtail resistor.
1—250-000-ohm, 2-watt pigtail resistor.
2—750,000-ohm, 1-watt pigtail resistor.
2—100,000-ohm, 1-watt pigtail resistor.
1—1-Megohm, 2-watt pigtail resistor.
1—1-Megohm, ½-watt pigtail resistor.
5—Pkgs. hook-up wire, "push-back 10 ft. of each color: black, blue, red, yellow, green.
6—Screen-grid clips.
2—Ft. Shielded hookup wire.
2—Speaker terminals.
3—Antenna Terminals, color coded, plug type.



Proper placement of parts beneath chassis.



The coil forms for use in this receiver should be of lowest-loss material, such as Micalite, Isolantite or R-39 material. Likewise, the coil sockets should be of similar material. A pronounced improvement in reception at the higher frequencies results from the use of proper coil-forms and sockets.

Trimming the Whiskers from Class B

THIS brief article isn't supposed to discuss design—it is merely supposed to list a few practical remedies for the ills of voice transmitters using class B audio that isn't satisfactory but must be made so at low cost.

The most common diseases of both amateur and broadcast class B systems appear to be those which put "whiskers" on the speech sounds, especially if these are loud. Usually a transmitter with this defect will show a tolerably good fidelity curve—that is, it will be "flat" over a wide audio range, yet the transmission sounds like a low-grade phonograph with a loose needle.

In many cases this is due either to r.f. oscillation of the class B audio tubes at some parts of the speech cycle, or else to insufficient separation of the plate supply system of those tubes from the plate circuits of other tubes in the set—especially the tube or tubes which furnish the r.f. input to the grid of the class C amplifier, that is the r.f. stage before the stage which is being modulated.

In the first instance one must stabilize the class B audio tubes against r.f. oscillation. The use of resistive suppressors in the grids or plates easily leads to worse troubles, so it is usually better to secure stability by means of r.f. chokes in the grid leads—preferably unlike chokes—of a size which will be effective in the region of 8 to 30 meters. It also helps materially to make sure that there is little magnetic coupling between the input and output transformers of the class B stage. A simple test will tell: Connect 60 cycle a.c. to one transformer and put a pair of phones across a winding of the other. Move one transformer until minimum hum is heard in the other. Needless to say, everything must be disconnected from the transformers during the test.

One had better go into this thoroughly to make sure that the class B stage is really stable—the oscillations are never steady, hence elusive.

The considerable and abrupt changes in the plate currents of class B audio stages cause almost certain difficulty if the same plate supply is used to feed the r.f. "driver" tube which feeds the grids of the stage-to-be-modulated. This is often true in stations where this tube has supposedly been decoupled by the use of an extra filter section, usually because the filter section isn't made with enough inductance, or else because it is so located that there is coupling between the choke and one of the audio transformers. A fairly generally o.k. filter section seems to be a 20 Hy. choke and a 2 microfarad condenser. If the plate meter of the driver tube varies AT ALL when the class B system is working things are still wrong. Better make up a separate power supply for the stage.

Broadcast transmitters are usually adequately shielded; amateur ones seldom are. In the latter it is often possible to add shielding later, remembering that it is the COIL in the tuned circuit that needs shielding, exactly as in a receiver. The rest of the machinery may be left out in the open as usual with little harm. If the preceding tuned coils are shielded the final output tank may be left unshielded. A rather surprising amount of improvement may be made by merely rolling a sheet of metal into an open-ended cylinder and putting it over the coil—shield diameter twice that of the coil. This gives no magnetic shielding at all, but is a very fair static shield.

Finally, if one cannot tame the class B audio stage with any of the preceding schemes, try a pure power-wasting scheme—a high resistor connected from plate to plate in series with a .0001 condenser to prevent waste of audio power.

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QUESTIONS FREQUENTLY ASKED ABOUT SUPERHETERODYNES ANSWERED IN UNDERSTANDABLE TERMS

QUESTIONS ON VARIOUS SUBJECTS WILL BE ANSWERED EACH MONTH

By The Technical Editors

Question:—Why is it satisfactory to use only one or two stages of R.F. amplification ahead of a superheterodyne receiver?

Answer:—The selectivity of a superheterodyne receiver does not depend alone upon the radio-frequency amplifier ahead of it. The intermediate-frequency amplifier is sharply tuned and also contributes toward the receiver's selectivity. The R.F. amplifier, if modern tubes are used, gives sufficient gain if only one or two stages are used. The other requirement, selectivity, is also met because of the selectivity contributed by the intermediate-frequency amplifier.

Question:—What is meant by "cross-modulation" as applied to superheterodyne receivers?

Answer:—If "cross-modulation" is present in a receiver, two stations can be heard at the same time. One of the stations is usually much weaker than the other. This effect is usually caused bv insufficient selectivity in the R.F. amplifier.

Question:—If the intermediate-frequency amplifier transformers are not tuned properly, how will this affect the operation of a superheterodyne receiver?

Answer:—This condition will cause an apparent loss of sensitivity, and usually less selectivity. In an extreme case, two stations may be received at the same time.

Question:—Why is it that radio telegraph (code) signals can sometimes be heard on a broadcast superheterodyne?

Answer:—Radio telegraph stations can sometimes be heard on a superheterodyne receiver with poor selectivity ahead of the first detector. In this case, stations operating on other frequencies than the broadcast receiver, will heterodyne with the oscillator harmonics in the receiver, and pass into the set, the same as if they were operating on a broadcast frequency.

Question:—What is the probable cause if a receiver gives weak stations or distorted tone over part of its tuning range?

Answer:—This usually results from incorrect alignment of the tuning condensers. Usually, it will be necessary to readjust the trimming condensers. In sets using condensers with slotted end-plates, it may be necessary to readjust these plate sections. This trouble is usually found in the high-frequency stages, and not in the I.F.-amplifier.

Question:—What will cause a superheterodyne receiver to "drift" off frequency at relatively frequent intervals?

Answer:—This is usually caused by a change in the frequency of the oscillator. Sometimes the trimming or "padding" condensers are unstable, and may shift capacity value slightly. In small midget sets this trouble is sometimes due to displacement caused by the expansion and contraction of the apparatus because of heat from tubes and resistors in the set. A variation in voltage, due to lack of constancy in the voltage dividers, condensers, etc., may also cause this trouble.

Question:—What are the steps in checking for noise in a superheterodyne receiver?

Answer:—Some of the steps to follow in checking for noise in a superheterodyne receiver are as follows: Remove aerial and ground connections, and either remove the first R.F. tube or short the grid input-circuit, by connecting a short wire between grid and "ground." Proceed through the receiver, either removing tubes, or shorting out the grid-control circuits until the noise is eliminated or reduced. The location of the noise depends also upon the proper checking of the particular units in the noisy portion of the circuit. Sometimes, a noisy tube will cause the trouble. Spare tubes should be available for replacement. Resistors or condensers are the commonest sources of noise. In the audio-frequency circuits, defective transformers are noise producers.

Question:—How may the combination "long and short-wave" superheterodyne receivers be best arranged for amateur code reception?

Answer:—A separate oscillator is used. Determine the intermediate frequency the set uses. This can best be done (if not available from manufacturers' service notes) by checking with a test oscillator. When the frequency is determined, couple a simple one-tube oscillator to the intermediate frequency circuit. Usually a midget condenser will suffice for tuning it, if shunted by an adjustable padding condenser. A three-electrode tube, either filament or heater type, can be used. The power can usually be taken from the powerpack of the set, for operation of both heater and plate. The oscillator can be mounted in a small can or box inside the set cabinet. An additional control is required for beat-note adjustment. A single knob and a switch for turning on and off the plate current, should be used. The oscillator should be shielded by placing it in a metal can or box, for best results.

Correction

On page 13 of June "RADIO" was given an answer to the Question: WHAT IS IMAGE FREQUENCY? The correct answer should read as follows: Image Frequency is that frequency which differs from the desired incoming frequency by twice the intermediate frequency. Image Frequency is also defined as that frequency which beats with harmonics of the oscillator to produce the intermediate frequency.

Trans-Pacific Traffic Association

A body of men organized to conduct, wholly at their own expense, a public utilities service is NEWS in these days of exploitation of the public.

The Trans-Pacific Traffic Association comprises a group of radio amateurs on both sides of the Pacific Ocean who are engaged in transmitting messages for the public free of charge.

There are many thousands of Americans in the Orient—Army, Navy, Marine Corps and civilian—who must be kept in contact with their families and friends in America and elsewhere. Few of these people have the means for paying the message tolls required by the commercial radio and cable companies. Members of the Trans-Pacific Traffic Association have for several years been conducting this traffic as a free service, handling as many as 3,000 messages a month. That this service is valued is attested by thousands of letters on file expressing the gratitude of the people served.

Besides in the nature of the free service performed the Trans-Pacific Traffic Association is unique in other ways. While it is organized and is fuctioning with a high degree of satisfaction it is in no way hampered by the usual burdens of organization. There are no officers, other than a secretary; there is no constitution; there are no by-laws; there are no yearly dues; there are no regulations, except such as have been adopted by the common consent of intelligent men engaged in a common calling and actuated only by a common purpose.

Membership in the Association is limited. There is neither effort nor wish to have and to advertise a large membership roll. The aim is solely to maintain an efficient service on the part of considerate and competent operators who own stations that can be relied upon to be heard consistently across the Pacific.

The keystone of the Radio Act is the demand that a station in order to justify its right to use the air must be operated "for public interest, convenience or necessity." Stations owned and operated solely at the expense of amateurs that transmit radiograms free of charge are—of all the stations on the air—conforming the most truly with the law.

★ A Merger

"MODERN RADIO" has been merged with "RADIO". All subscribers to "MODERN RADIO" will receive "RADIO" for the unexpired portions of their subscriptions. Feature writers who contributed to "MODERN RADIO" will hereafter use the pages of "RADIO". The merger brings together a group of nationally known authorities whose writings should prove valuable to all.

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The Sargent 9-33 Receiver

By E. M. SARGENT

A New Superheterodyne Receiver Incorporating a Special Band-Spread Arrangement, Two Intermediate Frequencies and Many Other New Features of Special Interest to Advanced Amateurs and Experimenters. Gives Unusual Results Under Average Conditions.

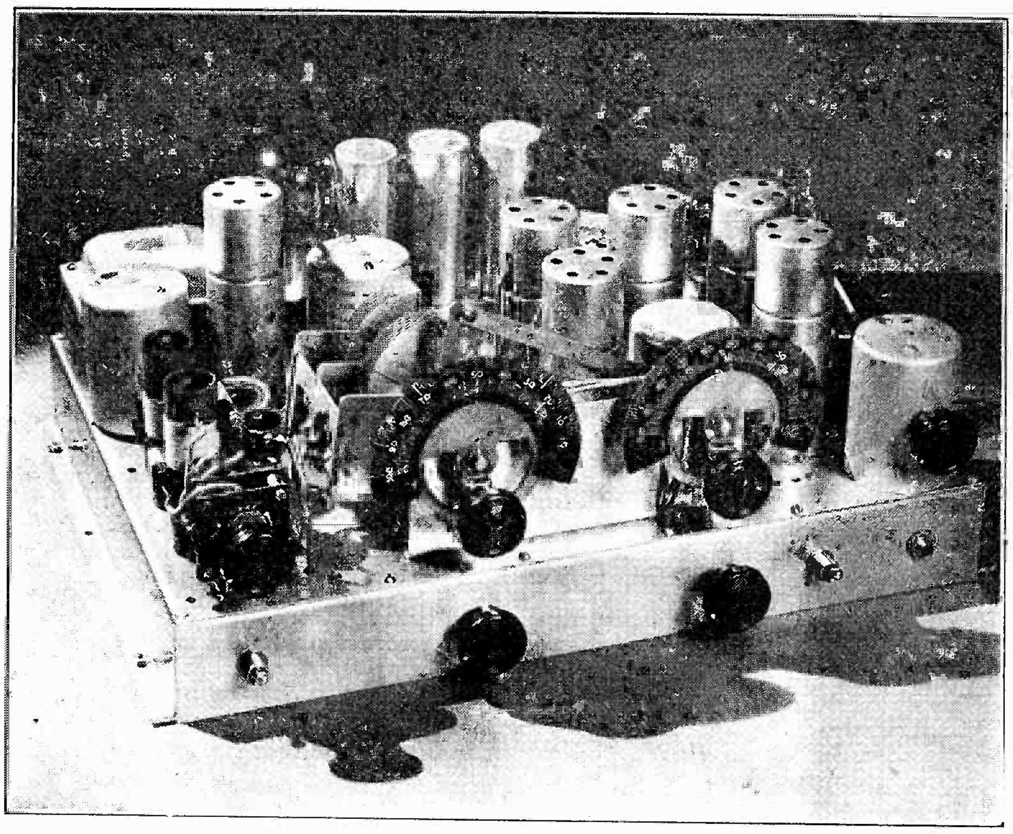


FIG. 1

TWO outstanding features of the new Sargent 9-33 Receiver are the band-spreading system and the double shift of intermediate frequency. The former makes for improvement in tuning, the latter provides for image-frequency elimination without the usual loss of selectivity or complicated wiring.

Band-spreading has become necessary because of the method by which frequencies are assigned to amateurs. For example, the frequency-band 7,000 to 7,300 KC is assigned to amateurs, also 3,500 to 4,000 KC—two narrow, widely-separated bands. A receiver to cover both, with a single coil, would tune over only about four dial degrees on each band. If the entire dial were devoted to the 7,000 to 7,300 KC. band, a feature desired by amateurs using this band, it will become necessary to use about ten coils to cover the remaining frequencies down to, and including, 3500 KC. This is, of course, entirely impracticable.

Many band-spreading methods have been developed to allow a good dial-spread on the amateur bands without sacrificing reception on the other frequencies. One of these methods, which is limited only to the amateur bands, consists in the use of special band-spread coils, one set for each band. Another method employs a variable "tank" condenser with a small "vernier" connected in parallel with it. The vernier is the band-spreader. The larger condenser is also variable and serves for covering the other frequencies. At the lower frequencies on the dial, this method is satisfactory, but at the higher frequencies the losses are comparatively large.

Band-spreading in the Sargent 9-33 receiver is accomplished by mounting the tuning-condenser in a "cradle," instead of connecting it rigidly to the panel. The rotor of the condenser is rotated in the usual manner by the left-hand dial as shown in Fig. 1. The right-hand dial moves the stator through a small angle, and thus furnishes a vernier, or band-spread effect. The width of the band depends upon the angle through which it is moved. The capacity is concentrated in a single unit and no special coils are necessary. This method can be applied to either a single or gang condenser. In operation, band-spreading is possible at any wavelength, amateur or otherwise, at which the left-hand dial is set. The angle of swing is adjustable, hence the band-spreader may be set to give exactly a 100-degree dial-spread on any desired wavelength. This new band-spreading device can be built by the experimenter or purchased as a complete unit.

The New Double-Shift Intermediate-Frequency System

MANY factors, some of them conflicting, enter into the choice of an intermediate frequency for a superheterodyne. It was while studying usual systems that the advantages of the new double-shift method were realized. The two most important factors to be considered are selectivity and freedom from "image interference."

The kilocycle selectivity that it is possible to obtain depends upon the frequency. The best receivers for use on 1000 KC. (300 meters) give a cut-off of approximately 10 KC on each side of a powerful carrier. Stating this in other words, a change of 1% in frequency is necessary for eliminating a powerful carrier. It so happens because of practical limitations as to wire resistance, inductance and capacity values available, that this 1% value holds for any frequency. While a well-designed tuned-RF. receiver tuned to 1000 KC could be expected to give 10 KC selectivity, the same care in designing a tuned RF. receiver for 10,000 KC (30 meters) would result in a cut-off of 100 KC on a station of the same power. A powerful amateur station at this frequency would cover approximately 100 KC, or one-third the width of a 300 KC band, on a tuned RF. receiver. Because of certain limitations, there is no way in which this selectivity can be greatly increased. But 5 KC selectivity (1%) could be expected on 500 KC, and 1.75 KC selectivity on 175 KC, with equal care in circuit design.

In a super-heterodyne, the incoming-frequency is changed, by means of a local oscillator, to the intermediate frequency, which usually lies between 175 and 525 KC. The signals are amplified at the intermediate frequency. The important point is that the selection of an intermediate frequency determines the selectivity obtainable. The obtainable selectivity is 1% of the I.F., not 1% of the signal frequency. "Supers" are, therefore, inherently more selective than any other type of receiver. A 465-KC super, for example, has approximately eight times the selectivity of a tuned RF. receiver operating in the 3500-4000 KC band or about 15 times the selectivity of the same receiver when used in the 7000-7300 band!

Why, then, do we not go to extremes in this respect and select a frequency of 50 KC, or one of 10 KC for our I.F.? We could, except for the limiting effect of image interference.

What is "image intereference"? It is necessary to consider the fundamental principles of superheterodyne operation. The signal frequency is "mixed" in the first-detector with the frequency of the local oscillator, and the difference frequency or "beat" between these two is the intermediate frequency. Suppose, for example that the incoming frequency is 4000 KC, and that the oscillator is set at 4175 KC. The difference between the two frequencies is 175 KC, and it is to this frequency that the intermediate amplifier amplifies. If there is a powerful nearby transmitter operating on 4350 KC, the difference between this and the oscillator frequency (4175) is also 175 KC. That is, an oscillator frequency of 4175 allows reception on frequencies of 4000 and 4350 KC. If the antenna circuit is not sufficiently selective to eliminate 4350 KC., while tuned to 4000 KC, both stations will be heard. The frequency to which the antenna is tuned is, of course, the desired frequency; the other is known as the "image." In this case, the fre-

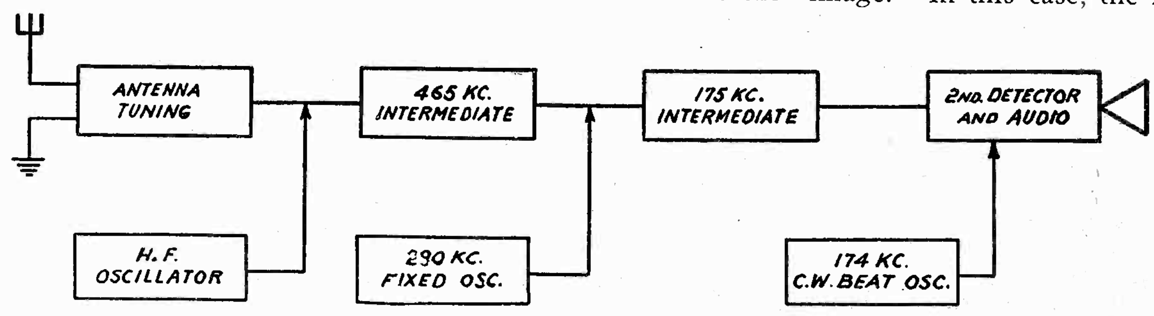


FIG. 2

quency cut-off for complete image elimination would be 350 KC. This is less than 9% of 4000 KC. It cannot be attained without using the very best sharply-peaked RF. stage ahead of the first detector.

An I.F. of 465 KC. simplifies image elimination. The image is separated from the desired frequency by twice the I.F. which is in this case 930 KC. A good antenna input circuit to the first detector is capable of such frequency discrimination in most cases.

An I.F. of 50 KC requires an antenna-circuit discrimination to a frequency difference of only 100 KC. which is impossible at signal frequencies of the order of 4000 KC without complicated circuits. The choice of an intermediate-frequency must be compromised between image elimination and selectivity. In many receivers, 465 KC. has proved to be satisfactory so far as image suppression is concerned. However, for selectivity requirements improvement is possible. The selectivity that can reasonably be expected from a super utilizing a 465-KC I.F. can easily be judged. For example, that which can be obtained at the 550 KC. end of the broadcast band using a tuned RF. receiver, 550 KC. is near enough to 465 to give a fairly accurate comparison. Experience shows that selectivity better than 10 KC is excellent. A selectivity of approximately 3.3 KC could be expected from an intermediate of 175 KC.

In the Sargent 9-33 receiver, the first stage of I.F. is on 465 KC, for the purpose of image suppression. There is a fixed oscillator, adjusted to 290 KC., which beats with 465 KC. to produce a second I.F. of 175 KC. This combination gives excellent practical results. Selectivity is, of course, increased due to the lower frequency. The gain from the 175 KC. stage is greater than that obtainable on 465, due to the inherent property of tubes to give more amplification at lower frequencies. There is also greater degree of stability because the two I.F. stages are on different frequencies. There is no tendency for interlocking, due to regeneration. This effect, even in the best of isolated two-stage I.F. supers makes adjustment of the I.F. transformers critical also tending to create high background noise with the volume fully advanced. In the Sargent 9-33, the background is as low as that of crystal filter receivers.

Fig. 2 shows a block diagram. It is self-explanatory, and shows the relation of the various circuits. The receiver uses the new tubes; 57 tubes for oscillator, first detector and CW beat-note oscillator; 58's for the 175-KC. I.F. stage; 2A7's for the 465 KC. stage and 290 KC fixed oscillator; a 56 for second-detector, and 2A5's in push pull for the output. A jack in the plate circuit of the 56 allows headphone reception. A complete circuit diagram with all resistance and capacity values is shown in Fig. 3. Features that will appeal to the amateur are the B circuit-breaking switch (also relay connections brought out in the rear) for turning the set off during transmission, beat-frequency oscillator for CW reception, and the convenience of tap-switch changing of bands. The receiver is thoroughly shielded, having a metal plate below the chassis and a box-shield (removed for photo) over coils and tap-switch. Leads to all r.f. and detector sockets are by-passed with individual non-inductive condensers, and isolated with resistors. The receiver is so "tight" that it can be used as a monitor. "Single point" grounding is used for each set of circuits. The oscillator is electron coupled, and is unusually stable. The only adjustment is the single tuning-condenser. To insure alignment with the antenna tuning, a trimmer is provided. It is placed in the antenna circuit which is less critical. Hence it has no effect on calibration of the set.

The 290-KC. fixed-oscillator uses a "high-C" (high ratio of capacity to inductance) circuit which insures better stability. The same is true of the CW beat-note oscillator. This receiver has a wavelength-range of 15 to 550 meters, which is a frequency-range of 550 to 20,000 KC. Five taps are used.

The Tapped Coils

A FEW words regarding the relative merits of tapped coils and plug-in coils. Both systems have their advantages. Plug-in coils have certain losses. Tapped coils also have losses such as the "dead-end" effect of unused turns, but they make band-changing convenient. In the Sargent 9-33 receiver, the coil sections are connected in series and are spaced so that there is practically no coupling between sections. Unused turns are "shorted" out of the circuit. The set has been inspected for possible dead-end losses by plotting tuning-curves for all bands. They have been found to be so small as to be considered negligible. Of especial interest are the connections used in the oscillator circuit. It is a capacity-coupled, electron-coupled circuit having the advantage that it allows band-switching with a single tap-switch, one side of which can be grounded. Feed-back coupling obtained from the two .00005 condensers. The coupling remains constant regardless of the position of the variable condenser. This is an excellent oscillator circuit which appears to be especially good below 20 meters.

The method for coupling the CW beat-note oscillator to the second-detector is the most satisfactory one the writer has found. The cathodes of the beat-oscillator and the 56 have individual self-biasing resistors, so that there is no D.C. interaction. The cathode of the beat-oscillator has no grounding condenser, but is coupled through a .001 mfd. condenser to the cathode of the 56 tube. This cathode is grounded for audio purposes, through an RF. choke and a 1-mfd. condenser. With respect to R.F., the necessary coupling is produced by the choke. The size of this choke is not critical; it is about 1-Mh. here. This coupling-method is especially recommended.

The antenna input is arranged so that either a single wire or a "doublet" can be used.

The tuning is simple, with a single tuning dial. With this band-spread system, both dials tune the same condenser and, therefore, are never used simultaneously. In Fig. 1, the upper left-hand knob operates the two-section tap-switch, which changes the oscillator and antenna frequency-bands at the same time. The right-hand knob is the tone control. Lower row, left to right, are the B circuit-breaking switch, trimmer, volume-control, CW beat-oscillator switch, and headphone jack.

(Continued on page 25)

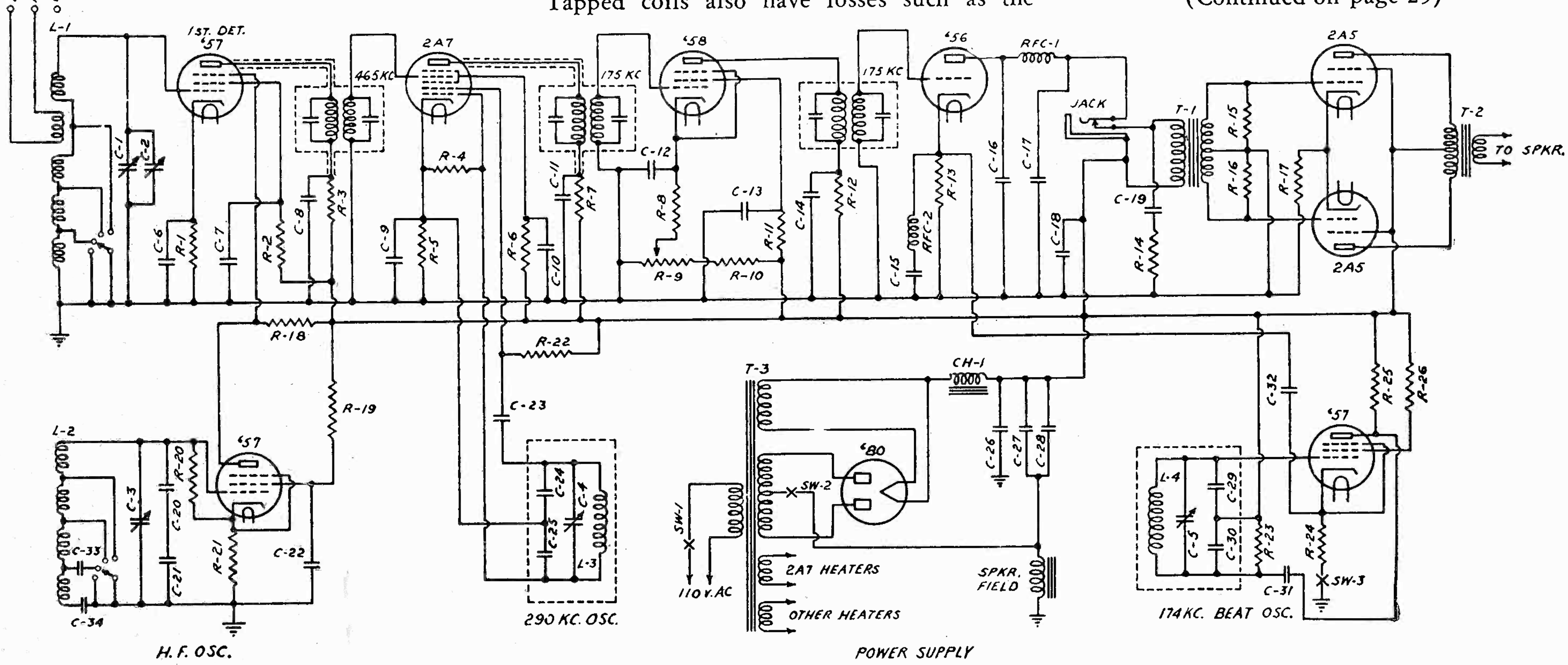
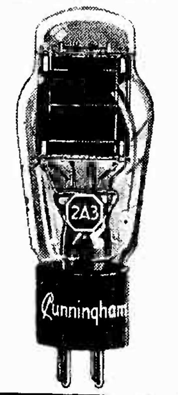


FIG. 3

LEGEND

C1-C2-C3-C4-C5, Variable condensers; C6-C7-C8, .01 mfd.; C9, .001 mfd.; C10-C11-C-12-C-13-C-14, .01 mfd.; C15, mfd.; C16, C17, .002 mfd.; C18, 1 mfd.; C19, 0.1 mfd.; C20, C21, .00005 mfd.; C22-C-23, .01 mfd.; C24, C25, .0005 mfd.; C26, C27, C28, 8 mfd. electrolytic; C29, C30, .0005 mfd.; C31, .01 mfd.; C32-C33, .001 mfd.; C34, .005 mfd.; CH1, 30 henries; L1, L2, L3, L4, Inductances. See text. R1, 5,000 ohms; R2 500,000 ohms; R3, 10,000 ohms; R4 50,000 ohms; R5, 400 ohms; R6, 100,000 ohms; R7, 10,000 ohms; R8, 400 ohms; R9, 30,000 ohms; R10, 50,000 ohms; R11, 100,000 ohms; R12, 10,000 ohms; R13, 20,000 ohms; R14, 25,000 ohms; R15, 100,000 ohms; R16, 100,000 ohms; R17, 300 ohms; R18, 10,000 ohms; R19, 10,000 ohms; R20, 2 megohms; R21, 5,000 ohms; R22, 10,000 ohms; R23 100,000 ohms; R24 400 ohms; R25, 10,000 ohms; R26, 10,000 ohms; SW1, Main line switch; SW2, Send-rcv. switch; SW3, Beat osc. switch; T1, Push-pull input trans.; T2, Push-pull output trans.; T3, Power transformer; RFC1, RF Choke; RFC2, RF Choke.



NEW AND BETTER TUBES

Useful Information Dealing With the Latest Types
How To Read Tube Numbers

By W6AAR

A LARGE number of new tubes have recently been placed on the market. To be more explicit, many of these are later than the Types 56, 57 and 58 which are considered as new by the average person. Many of the new tubes are improvements over earlier tubes of the same general kind but many of the new ones perform special functions. There is a trend toward manufacturing tubes which perform more than one function. Among these tubes are the pentagrid convertor (Type 'A7), and the diode pentode ('B7). Many of the new tubes have more base prongs than usual. We understand that tubes having eight and nine prongs on the base are now being tested in the laboratory, and will soon be available.

Clues to Tube Identity

The first number in the new system for designating tube types refers to the filament or cathode voltage. The last number refers to the number of elements connecting with the base pins. The heater is counted as a single element, although it has two terminals on the base. If there is an element, such as a suppressor grid, connected to the cathode **internally** (as in the Type 47 tube), it is not counted, because it has no base prong. The letter separating the first and last numbers has no important meaning. A "B" is evidently a later tube than an "A." A "Z" indicates a rectifier tube.

If, for example, a tube is marked 2A3 the filament or heater voltage is standard and near 2 volts. The tube is evidently a triode. Table One gives most of the older tubes and the ones replacing them.

One manufacturer has recently placed on the market a special short-wave receiving tube, the Type T-30-S. This is a definite forward step. There is a good market for such tubes.

Several tube manufacturers have recently produced transmitting tubes. The production of transmitting tubes is of course on a smaller manufacturing scale. It usually costs considerable for the machinery necessary to manufacture tubes of a new design. However, in the case of the larger tubes, of which only a small quantity are made, this is not the case. Manufacturers are sometimes opposed to new tube designs. The tendency is to follow leaders in this field.

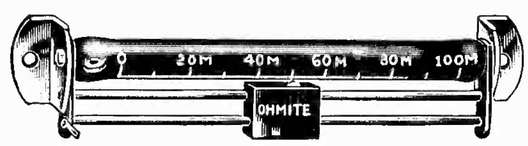
TABLE ONE
Useful Comparison Table

Older Tube Type Numbers	Later Tubes	Advantages of the Latest Tubes
99	30	Less Fil. current; quieter
20	31	Same as above.
22	32-34	Same as above.
24	57-6C6-29	Quieter; more gain.
26-27	56	Same as above.
35-51	58-6D6	Same as above.
36	77	Same as above.
39-44	78	Same as above.
47	2A5	Same as above.
46	59-53	Quieter and better "class-B" results.
38	89-41-6A4	More output; less distortion.
45-50	2A3	Same as above.
55-2A6	2B7	Greater gain.
85-75	6B7	Same as above.
80-81	5Z3	Longer life; heavier current.
82	83	Heavier current.
84	6Z4	Improved characteristics.

New Products From the Manufacturers

Ohmite "Handy-Ohm"

The "HANDY-OHM" is a variable resistance, used to determine the resistance values of defective and burned out resistors in radio sets. To use it, first remove the old resistor from the circuit; then connect the clips of the "HANDY-OHM" in this circuit in the exact place of the old resistor; see that the slider is set at the maximum resistance, 100,000



ohms. Then turn on the set and after the tubes have had time to heat up, reduce the resistance of the instrument by sliding the contact along the unit until the volume and tone of the radio are most satisfactory. Read the value of the correct replacement resistor from the scale on the side of the unit. Select the proper value of replacement resistor.

The "HANDY-OHM" may also be used as a slide-wire rheostat for experiments and laboratory work; for multiplying the range of voltmeters and milli-ammeters, etc. The slider does not have to be held in place, thus the hands are free to operate meters or to make other adjustments.

THE transformer division of the Universal Microphone Co., Inglewood, Calif., has gone into production with transmitting transformers for short wave work.

These have been created for the amateur and experimenter from specifications of Don C. Wallace, writer of the "1933 Short-Wave Manual."

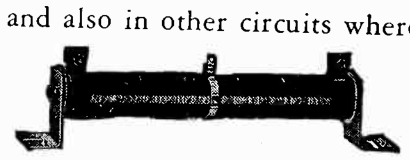
The new line includes two power transformers: one 1,000 volts and one 1,500 volts, both 200 M.A. There are two power units: one 500 volts at 70 M.A. and one 900 volts at 100 M.A. Three filament transformers: 11 volts, 5000 volts insulation; 10 volts, 2500 volts insulation, and number "T7", two 7½ volts, 2500 volts insulation.

The new line also includes a power filament unit and three chokes—heavy duty, medium duty and small filter. All of the products have been built to specifications by Don C. Wallace and eight small blueprints are available in loose leaf folder style.

If you desire copies of Manufacturer's Catalogs, write and tell us your wants. We will forward your communications to the manufacturer.

Aerovox Adjustable Pyrohm Transmitting Grid Leak Resistors

AEROVOX CORPORATION announces a new Adjustable Pyrohm Resistor especially designed for use as a transmitting grid leak in connection with all standard tubes, and also in other circuits wherever ad-

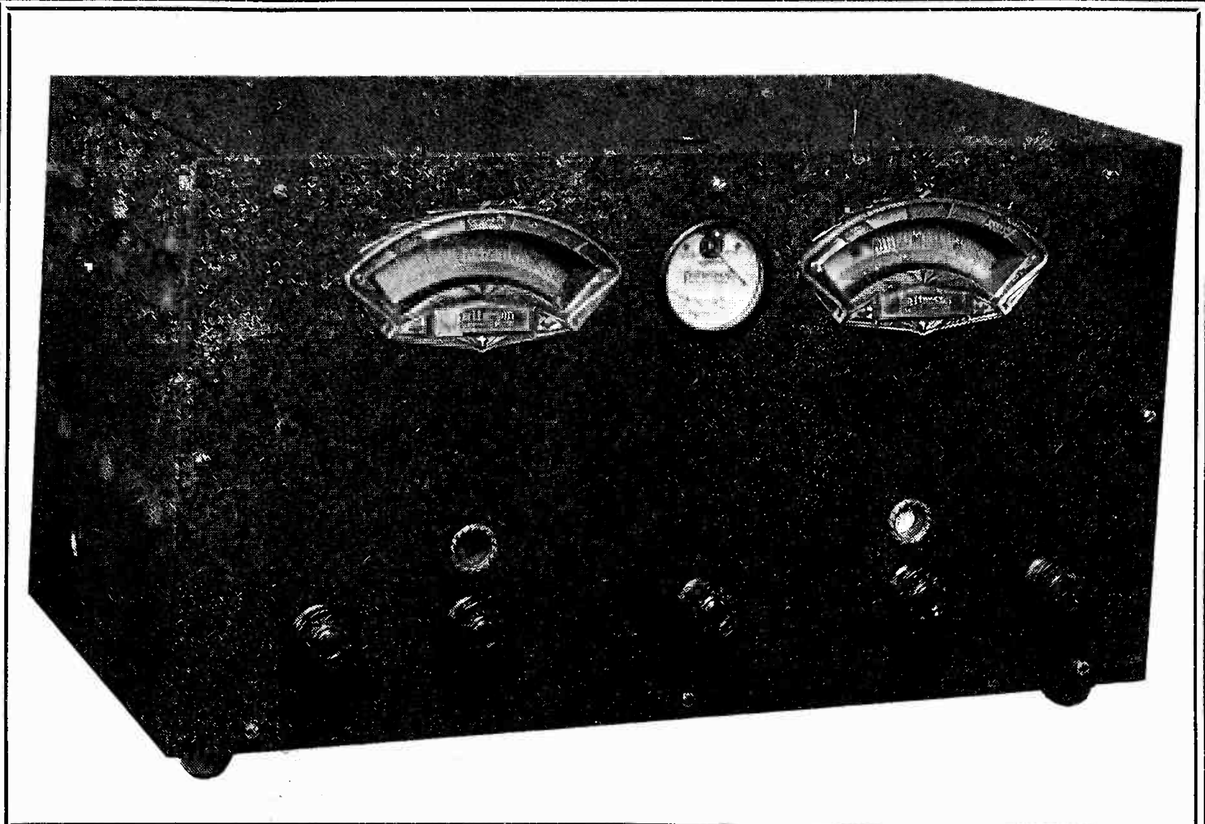


justable heavy duty resistors or voltage dividers are required.

A strip of the wire windings is left exposed along the length of the unit so that contact may be made by means of an adjustable slider to obtain any resistance value from minimum to the maximum value. A scale marked on the side of the unit permits setting the adjustable slider to any desired resistance tap without having to take meter readings for resistance values. Standard resistors for transmitting grid leaks are made in values ranging from 5,000 to 100,000 ohms and rated at 200 watts. All units, size 1 3/16-in. diameter by 8½-in. long.

Patterson Enters the Amateur Field

With a New Superheterodyne—10 Tubes—Three Stages of Intermediate Frequency — R1 to R9 Meter—and Switching Arrangement for Broadcast Reception



THE Patterson Radio Company announces a new All-Wave Superheterodyne, covering from 15 to 575 meters. Since this receiver incorporates several new and novel features, our readers will be interested in a brief outline of some of the important ones as given by the manufacturer.

Equally efficient on all frequencies (15 to 575 meters). Bands are changed by means of a specially designed, low loss, four-point six section switch, which changes the complete set of three coils with each point movement. This switch automatically disconnects the trimmers when the set is tuned to the broadcast band.

The tube line-up is as follows: one '57 as first detector, three '58's as I.F. amplifiers, one 55 as second detector, automatic volume control and first audio; one 59 as output tube; 1 5Z3 as rectifier; one 57 as B.F.O.; one 57 as vacuum tube voltmeter control tube and one 56 as signal frequency oscillator.

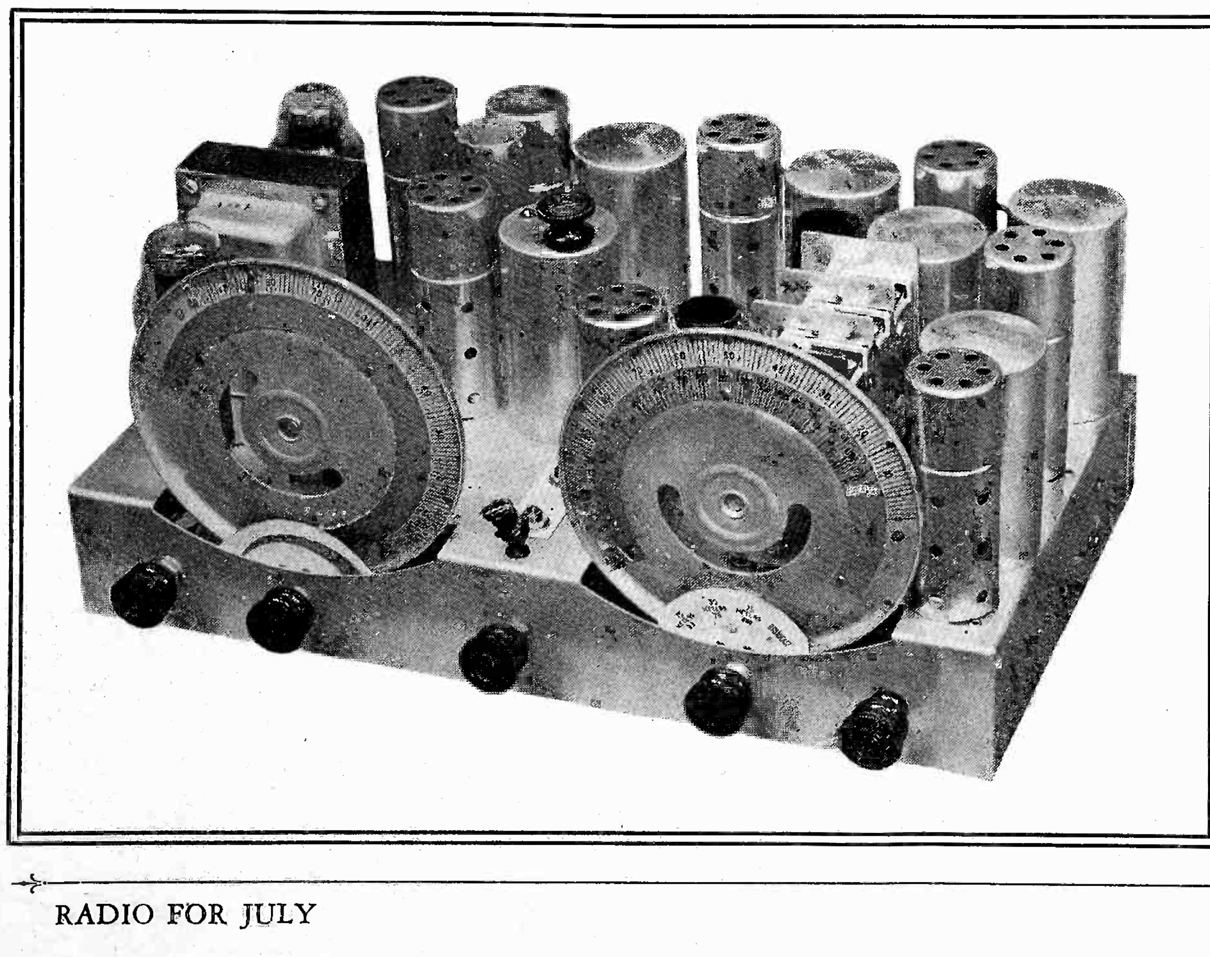
Exhaustive tests were made under actual working conditions in order to eliminate image interference on the higher frequencies (a common trouble on all superheterodynes). An intermediate frequency of 432.5 K.C. was selected as being most satisfactory on all bands. The 525 and 465 K.C., used in most S.S. receivers, was discarded because of the extreme high noise levels around these frequencies. A tuned antenna circuit, inductively coupled to another tuned circuit that feeds into the first detector (a '57), gives better image frequency rejection and signal-to-noise level, than an R.F. stage. The R.F. stage was not used because an extremely weak signal will not swing the grid of a '58 tube properly, when it is biased sufficiently high to keep the tube from blocking on a strong local signal. A '57 in the detector circuit is extremely hard to block, and yet very sensitive to weak signals. This was proven by using the receiver in the same room with a 1,000-watt transmitter working duplex, eleven kilocycles away from the carrier of an R9 signal, and eighteen kilocycles on an R5 signal.

Ten tubes; beat oscillator; three highly selective I.F. stages, band-pass tuning in all stages; vacuum-tube voltmeter, with meter directly calibrated in "R" units; band-spread on all frequencies. Power pack is self-contained and uses the field of the speaker as filter choke.

Black metal, 18 ga., stretched metal case with phone jack on the left side. All connections are to the rear of the chassis and can be reached without opening the lid of the case.

Very low hum level—hum cannot be heard with earphones.

The vacuum-tube voltmeter is calibrated in "R" units from approximately 2,000 points, plotted on a curve taken at numerous amateur stations. The averages were taken from these test points to establish a calibration curve that closely follows the general run of reports as given by the amateurs.



The automatic volume control works at all times. This is a Diode type, push-pull connection in the '55 tube. It will hold the signal level of a station from R4 to one volt input, at a constant ear-volume level, deducting of course, the percentage of modulation at static input.

The intermediate transformers are not air-tuned. Extensive experiment has shown that a correctly designed, compression type tuning condenser is in no way inferior to air-tuned types. A special imported wax is used to impregnate the I.F. coils and bases. A set using these intermediates was carried over 1,500 miles in the rear of a car without shifting the original balance.

The signal oscillator has a rising characteristic. In other words, the higher the frequency, the greater the output of the oscillator circuit. This makes the set more sensitive on the shorter wave-lengths.

A special band-spread arrangement is incorporated for high-frequency work. A trimmer tunes the antenna and input circuits at the same time. This is highly desirable as it is possible to work two stations on the same frequency, by shifting of the oscillator condenser to the side-band of one of the stations. This naturally distorts the quality, but allows the hearing of a station that otherwise could not be copied.

Circuit diagrams and further engineering data will be given in the next issue.

Tube Characteristics and Technical Data

Arcturus Radio Tube Company has issued a comprehensive chart of tube characteristics and technical data covering the entire Arcturus line. Copies of this chart can be secured by writing to Mr. J. Geartner, Arcturus Radio Tube Co., Newark, New Jersey.

www.americanradiohistory.com

ON 5 METERS—AND BELOW

By FRANK C. JONES

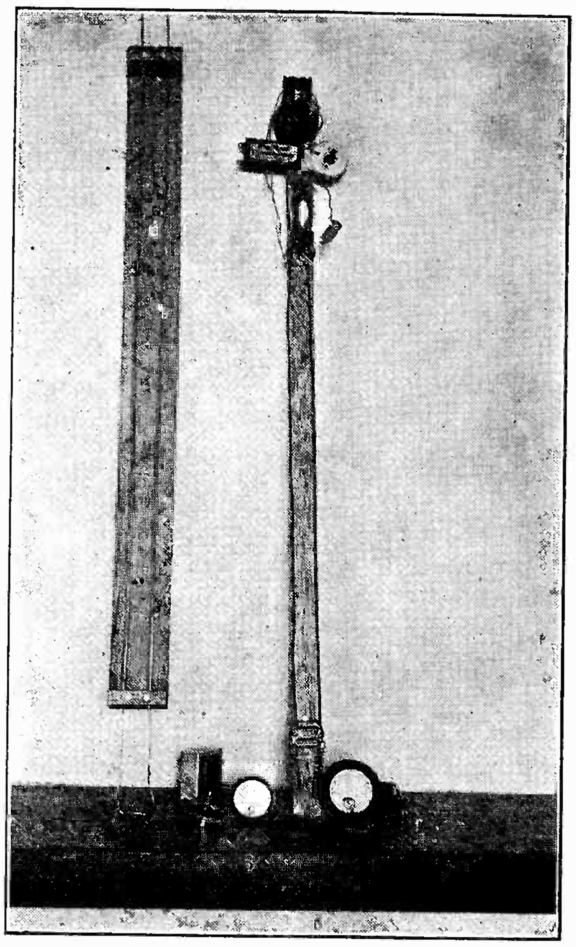
Ultra-Short-Wave Editor

FEW amateurs know that their license permits the use of a band of frequencies at a wavelength of ¾ meters, or 75 centimeters. The license doesn't say that modulated emission is allowable, which means no telephony, but apparently this must be an oversight and will be modified if any interest is shown in this ultra-high frequency band. For laboratory experiments, modulated emission may be used, and since the set-up of equipment is simple, a few pleasant evenings can be spent on this band.

The oscillator circuits suitable for this wavelength are somewhat different from the ones used in the other amateur bands. A form of Barkhausen system, in which the plate is either zero or negative with respect to the filament and the grid is positive, is generally used. The grid accelerates the filament emitted electrons, most of which hit the grid and go to waste as heating energy. Some electrons pass through the grid; are repelled by the negative plate back towards the filament, then repeat the cycle in an oscillatory fashion. An external Lecher wire system can be connected to the elements of the tube so as to form an external resonant system coupled to the electron oscillatory orbit system. The electronic frequency is proportional to the square-root of the accelerating grid voltage, and inversely proportional to the distance between the grid and plate in a symmetrical tube, such as a type '99 '27 or an 852, which have circular plates and grids.

Most micro-wave oscillators use a Lecher wire system connected between grid and plate. Tests here using tvpe '27 tubes indicated much stronger and more easily obtained oscillations when the parallel wires were connected to the plate and cathode. Oscillation on or near 75-cm. was very erratic when using a '27 or '99 tube with the wires connected to grid and plate.

The parallel wires, one wavelength long, or 75-cm. from the tube elements to the terminating condenser, were connected to the plate and cathode as shown in Fig. 1. Satisfactory results were secured. Oscillations were easily obtained at 75-cm. as checked by a separate Lecher wire system using a shorting



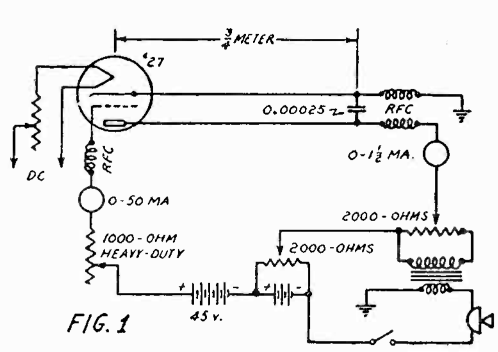


FIG. 1

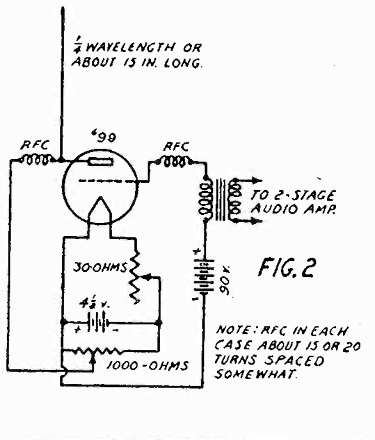


FIG. 2

ling moved along to half-wave points. A sudden change of plate current of the oscillator takes place when these points are found on the external Lecher wire system when the closed loop end is coupled to the oscillator parallel wires. With some '27 tubes the plate voltage had to be less than zero; that is, slightly negative to prevent oscillation at about 1.3 meters instead of 75-cm.

Modulation for phone tests across a room was obtained by coupling a microphone through a transformer into the plate circuit. Adjustment of the plate voltage seemed to have a decided effect on the percentage modulation. The grid voltage was usually set to around 35 volts at about 40 milliamperes and the plate current would usually be about 1 milliampere for most '27 tubes.

The input to the grid was therefore usually in the neighborhood of one watt. A thermocouple and resistor in series with the terminating condenser indicated about .01 watt when the tube was oscillating. This really isn't a true measure of the output power, except as a comparison between similar circuits and tubes.

The same circuit may be used for receiving by coupling either the grid or plate circuit to an audio amplifier. The circuit of Fig. 2 seems to function well over short distances, and by the use of directive transmitting and receiving antennas it may cover a range of several miles. The circuit is a form of electron oscilltaor, but is maintained just below oscillation by a simultaneous adjustment of the filament and plate voltage potentiometer. The adjustment of these two voltages acts like tuning controls having an optimum signal response. Apparently the tube acts as a diode detector having a virtual cathode close enough to the plate so that the electronic orbit is less than the desired signal frequency. Its detection efficiency is then many times higher than an ordinary diode or crystal detector. The method may be likened to a regenerative oscillator in which the efficiency drops to nearly zero at ultra-high frequencies because the tube elements spacing becomes a factor in the electronic orbit oscillation. Regenerative oscillators will seldom function below one meter. Electron oscillators should then be used.

Let's hope that more suitable tubes for use as electron oscillators will be made available for amateurs. In the meantime, some interesting experiments are possible with present types of tubes.

FRANK JONES' XTAL CONTROL EXPERIMENTS ON 5 METERS

MEASUREMENTS of frequency change of several single and push-pull tube 5 meter oscillators showed an alarming frequency shift for variation of DC plate voltage. An increase or decrease of 50% varied the frequency of the various oscillators from 60 KC to 200 KC, as checked by beat note method on a 20-meter receiver. Super-regenerative receivers cover a wide enough band to make reception possible under such conditions, but superheterodynes are usually too selective. The plate voltage of a modulated tube usually varies at least 50% when modulated, which means considerable frequency modulation, or what is more generally known as "wobbulation." It also means that each five-meter phone is using at least ten times as much of the 56 to 60 megacycle band as is necessary, and so limits the number of stations operating simultaneously.

MOPA transmitters eliminate this undesirable effect and allow the use of more selective receiving sets. The crystal-controlled oscillator is less subject to frequency creeping than tube oscillators, and quite a few amateurs are experimenting along these lines. The results of some experimental work done at station w6ajf is presented as a possible aid to other amateurs interested in five-meter transmission.

A 1765KC quartz crystal in regular use on the 40 and 20 meter bands was used in these experiments. The frequency doubler circuits seemed to be so efficient that they showed possibilities for use below 20 meters where most circuits prove ineffective. In Fig. 1 on the facing page is shown the circuit used in which the crystal oscillator tube, a 2A5, acts as a doubler of enough output to light up a flashlight bulb coupled to the plate circuit by means of a single turn. The plate circuit is tuned to the second harmonic of the crystal, or approximately 80-meters, by means of tube and other miscellaneous capacities across the oscillator plate coil. In fact, all of the plate coils are tuned to their desired frequency by the same means, except for the 5- and 10-meter plate circuits. It means juggling plate and "neutralizing" coil turns until resonance is obtained, as indicated by plugging a milliammeter into the grid return circuits of each successive stage. Because all of the stages had closed circuit jacks, it was a simple matter to read plate and grid currents, neutralize, or tune to resonance, since the plate voltage could be cut off by means of an open-circuit plug.

This unit was built with plug-in coils and the turns adjusted so that any stage could be used as either a frequency doubler or a

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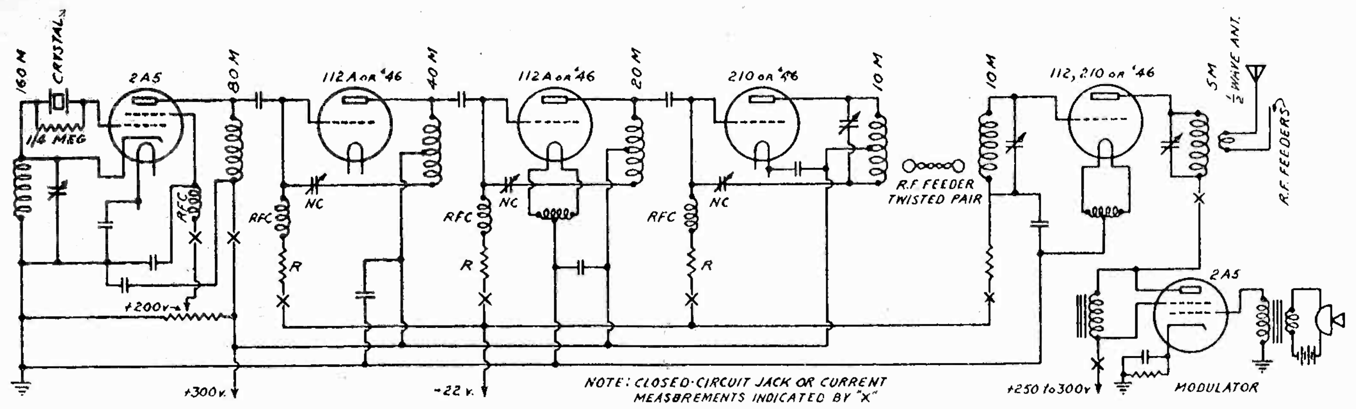


FIG. 1

Circuit Used By Frank C. Jones for 5-Meter XTAL Experiments

straight neutralized amplifier in order to operate on any amateur band from 10-meters, up. For five-meters a separate doubler and modulator with separate power pack is used. Coupling from any output stage is obtained by means of a two-turn coupling coil, slipped over any plug-in coil, connected to a twisted r.f. feeder, several feet long, terminating in another one or two turn coil. This coil was closely coupled to the tuned grid circuit of buffer or final output stage, and the actual grid swing obtained was quite a bit greater than can be obtained by capacity coupling to the next grid circuit, especially where the stages are separated very far apart. The efficiency of this form of coupling can be seen from the fact that on 40-meters a single 210 tube drives more grid current into a 204A quarter-KW tube than is necessary for class C operation.

The frequency doubler circuits are interesting in that regeneration is used so that the output of each successive stage is greater than the preceding stage. The efficiency is high; the tubes seem to be nearly as efficient as straight neutralized amplifiers. For straight-through amplification, the plate section of any coil has about twice as many turns as the neutralizing section. Then for frequency doubling, the plate and "neutralizing," or rather regeneration winding, have the same number of turns. The neutralizing condensers are set to their proper value for neutralizing, which is about twice the grid-to-plate capacity of the tubes used. Then for frequency doubling, this same capacity setting is sufficient to give considerable regeneration, and much higher efficiency.

Since this regeneration is obtained by feeding-back some of the plate circuit energy into the grid, it is necessary that at this doubled frequency the grid circuit impedance to ground or filament should be as high as possible. The preceding plate coil then should not have much tuning capacity across it, since it is tuned to the "fundamental" frequency. A large tuning capacity would by-pass the second harmonic or doubled frequency and would reduce regeneration. For this reason, the plate coils are tuned by the tube and neutralizing capacities only. Since the neutralizing condensers actually have a very decided tuning effect on the preceding plate or grid coil, the coil inductance must be varied in the preliminary adjustments if the stage is ever to be used as a straight amplifier. Its tuning effect on a frequency doubler is just the same, but a slight variation one way or the other isn't as important, since it only varies the regeneration and not the neutralization. There is no such thing as neutralization of a frequency doubler, in the ordinary sense, as any one will find if they figure the circuit networks with respect to the frequencies.

These same frequency doubler circuits work very efficiently as triplers, and quite well as quadruplers, with some tubes. The output as an efficient quadrupler is at least one-half that obtainable as a doubler. The output as a tripler is nearly as much as a doubler, which, in turn, is nearly as much as a straight amplifier. Triode tubes, such as 205D, 112A or 210, work well, but the '46 tube with the two grids tied together seems to give more output. The values of grid leaks and fixed C-bias vary, depending upon the type of tubes used; 5000 to 10,000 ohms for a '46 tube, and 20,000 to 50,000 for the ordinary triodes. A little fixed C-bias is a safety factor when making adjustments, or when the crystal stops oscillating.

When doubling from 10-meters down to five-meters, the fun usually begins. Sufficient excitation must be available to drive the grid circuit hard, even though considerable regeneration is present. It was found here that with triode tubes, such as a 112A or 210, sufficient regeneration existed when tuning both grid and plate circuits to some times cause self-oscillation. This occurred in spite of the grid circuit being tuned to 10-meters and the plate to five-meters. The feed-back through the grid-plate capacity of the tube is excessive and a small reactance in the grid circuit may be enough to cause oscillation. By using a high C-bias, large grid leak, and plenty of excitation from the ten-meter output tube, it was found that the doubler would put out a good signal on five-meters; in fact, enough to nearly burn out a small flashlight bulb with a single turn of wire coupled to the plate circuit.

This amount of output is sufficient for most five-meter work and it can be modulated in the plate circuit of this doubler by means of a '47 or 2A5 tube, as shown in Fig. 1. For better quality and greater output, a neutralized push-pull five-meter amplifier operating in Class C should be coupled to the output of this final doubler. Of course, a modulator such as class B with 46 tubes would be necessary to handle the modulator job on the final stage.

The circuit as shown has the advantage of being flexible for operation in any amateur band, even on 160-meters, if the plate-to-cathode and inside suppressor grid capacity is neutralized; or if the cathode coil is shorted out, and the plate coil tuned to 160-meters by means of a fairly good-sized tuning condenser. The system has the disadvantage of having several harmonics in the five-meter band from a 160-meter crystal, strong enough to cause interference in a nearby receiver. It prohibits break-in or two-way phone communication.

A 60-meter crystal could be used to eliminate the last named disadvantage. By tripling and doubling stages it could be used on 20, 10 or five meters. Personally, I believe the 10-meter band will be popular within a few months and crystal control is even more important for that band than for 5-meters. It is usually advisable to build up five-meter equipment in bread-board fashion, to allow new ideas to be tried. Many interesting hours can be spent at home, experimenting with crystal control and various types of modulation, without the use of expensive apparatus.

BOOK REVIEW

RADIO OPERATING QUESTIONS AND ANSWERS, by Arthur R. Nilson and J. L. Hornung, Published by McGraw Hill Book Co., New York City, 389 pages. Price $2.50.*

A complete list of questions and answers, covering the scope of all radio operator examinations held by the Federal Radio Commission. A very satisfactory book for anyone preparing to take a radio operator examination of any grade, either for the first time, or for one who simply wants to brush up prior to the examination. Appendices are included, giving in concise and handy form data on the International Abbreviations, symbols used for diagrams, and wave-length allocations, as well as full data on the Federal Commission's Regulations covering the qualifications for the various grades of operator examinations. A book well filled with facts, without unnecessary padding or theory.

* * *

PRINCIPLES OF RADIO COMMUNICATION, 3d Edition. By Prof. J. H. Morecroft, D.Sc., Professor of Electrical Engineering, Columbia University.

This, the third edition of "Morecroft", has been thoroughly revised. In it is shown the action of piezo active quartz oscillator systems, action and calibration of microphones, questions of harmonics and modulation and a wealth of new data on radio circuits and shielding. The more important findings regarding the action of short waves and their reflection from the ionized layers of the atmosphere comprehensively treated. There is much material dealing with the attenuation of radiated energy and the fields covered by a given amount of power under different conditions. Radio beacons, airplane radio and other new systems of communication are introduced at suitable places in the text. 1084 pages. Cloth Bound. $7.50 per copy. Published by John Wiley & Sons, Inc., New York.

* Obtainable from the Book Department of "RADIO."

HI!

Query from a subscriber, sent to this magazine 10 years ago: "When I hold my hand near the receiving set it howls. Please tell me what is wrong."

Answer: "I have never heard a hand howl. You must be a freak. Advise you to see a doctor immediately."

The answer was supplied by none other than the inimitable Earle Ennis, whose daily rib-tickling strip, **"Fairy Tales"**, is a feature of one of our large metropolitan newspapers. Ennis is getting ready to rejoin the ham ranks, and he's going to tell you, in "RADIO" the mess he's making of it. Drive dull care away . . . read his column every month, beginning in the next issue.

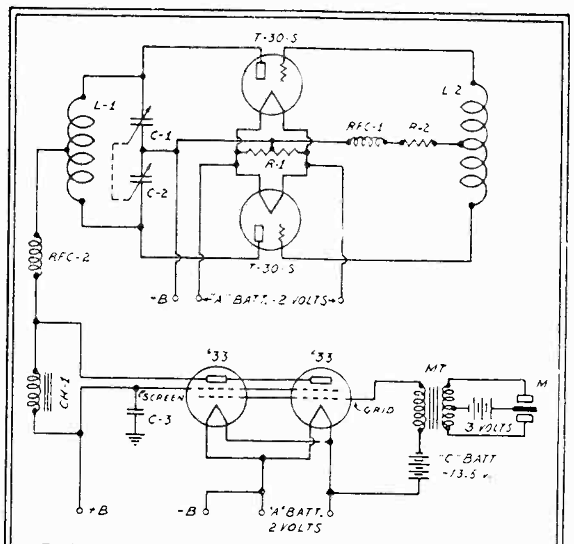
A Push-Pull 5-Meter Radio Telephone

By A. BINNEWEG, Jr.

Suitable Also For Use at Higher Wavelengths. An Inexpensive 5-Meter Telephone Transmitter of High Efficiency. Uses the Latest, Special Short-Wave Tubes. Easily Constructed at Small Cost. Output Is Greater Than Transmitters Employing Usual Power Tubes. Actual Use On the Air Proves Its Superiority.

THE push-pull transmitting circuit is known for its high efficiency. It is particularly adapted to ultra-high frequency work. Under some conditions, other circuits do not oscillate well at ultra-short waves unless unusually high plate voltages are employed. The push-pull circuit will often allow the use of ordinary apparatus. The efficiency of this circuit is due in large measure to reduction in circuit capacity, since the tube capacities are in effect in series. The capacities introduced into the circuit by the tubes should be small, the smaller the better.

With less capacity in the circuit due to the tubes themselves, more inductance can be used in the oscillating circuit and the all-around efficiency of the oscillator is increased. The new short-wave T-30-S tubes, have given unusual results in this transmitter. The RF. output from this set is greater than that obtained when larger power tubes, such as '71-A's, are used.



PUSH-PULL 5-METER RADIOTELEPHONE
USING NEW T-30-S TUBES

Results At 5 Meters

IN TESTS with this transmitter, a very strong signal could be heard over a radius of many miles, and many amateurs were worked on phone. With 180 volts on the plates of the oscillator tubes, the operator's voice was very strong at a distance of 20 miles. One station was worked for 30 minutes with entirely satisfactory results.

Constructional Details

IT WILL be noticed that the inductance used in the oscillating circuit is larger than usual. This is due to the low circuit capacities. The efficiency of this transmitter is relatively high. The complete List of Parts is given herewith. The complete wiring details of the radio-telephone are shown; if desired, the modulator may be omitted and the set operated as a code transmitter.

If used for code transmission only, the B-plus high voltage is connected outside choke RFC2.

The T-30-S tubes used are of the 2-volt filament type. Care should be taken not to overload the filaments. A 2-volt storage cell can be used for filament supply. If two dry cells are used, a 10-ohm rheostat in series will reduce the filament voltage to 2 volts. The entire set can be operated from batteries, if desired, although the plate current taken by the pentode modulator tubes is fairly high. A small power pack would be better.

If the set is to be used only for code work, it can be simplified materially; batteries can be used throughout since the current taken by the oscillator tubes is comparatively small.

This transmitter as a whole, or in part, can be used for many interesting tests at the station. It can also be used as a portable.

By using coils having a suitable number of turns, it can be used at 10 meters, or in the other amateur bands. For use at 20 and 40 meters, use larger RF chokes. For such relatively high wavelengths, condensers C1 and C2 should each have values of about .00035. Only the coils, condensers and RF chokes in the oscillator need be changed. Of course, phone cannot be used in all amateur bands.

List of Parts for 5-Meter Radio-Telephone

L1—2 turns of No. 10 enameled copper wire, 2½-in. in diameter; ½-in. spacing between turns. (3/16-in. copper tubing could also be used). Tapped at dead center.

L2—5 turns of enameled No. 10 copper wire, 1-in. in diameter, ¼-in. spacing between turns, tapped at dead center.

R2—Gridleak. 50,000 ohms, 2 watt (pigtail type).

RFC-1; RFC-2—Each 30 turns No. 30 wire. Wind on ½-in. form. Space the turns of the winding about twice the diameter of a wire.

C1, C2—Two-gang variable condenser. Each section should have a capacity of .00035. It is advisable to use a small-frame variable condenser having a low minimum capacity. A condenser having isolantite or similar insulation is recommended.

C3—2 mfd, 250 volt condenser.

R1—20-ohm center-tapped resistor.

ULTRA-SHORT-WAVE EXPERIMENTATION AND POSSIBILITIES

What Are Ultra-Short-Waves?

THIS cannot be answered definitely. One cannot say that ultra-short-waves start with waves having a definite length and end with waves having a definite length. From one point of view, any wavelengths below 20 meters are ultra-short-waves. "Ultra" means extreme. Certainly waves longer than 20 meters cannot be said to be extreme, for all short-wave sets go down as low as 20 meters and most of them reach to 15 meters. Let us say that ultra-short-waves are any waves below 10 meters.

Ultra-short-waves exhibit characteristics not found at ordinary short wavelengths. As the wavelength is reduced below 20 meters, daylight communication over great distances is possible. Amateurs have communicated over great distances at a wavelength of 10 meters. Below 10 meters, the exact nature of the radiations has not been investigated to any extent. Amateurs have done work at 5 meters but these waves apparently do not reach great distances. The radiation from small oscillators is quite strong nearby, or at a distance if there are no obstructions between the transmitter and the receiver. Objects such as houses, trees, and so on, cast radio shadows and reception is often quite erratic. Ultra-short-waves are apparently only of value for short distance work. A wavelength of 5 meters corresponds to a frequency of sixty million cycles, or sixty megacycles!

What Equipment Is Necessary?

FOR ultra-short-wave work, a minimum of equipment is necessary. The cost of the parts for a low-power oscillator is surprisingly small. The parts for a receiver cost very little. Most of the equipment can be constructed. The experimentally inclined can even set up Letcher-wire systems to calibrate their own wavemeters. The coils for both receiver and transmitter become so simple here, that only a turn or two of wire or copper tubing is required.

Although the cost of the equipment necessary is low, considerable more care is necessary in construction and adjustment than is necessary at higher wavelengths. The frequencies employed are relatively great, and many of the parts available have not been designed for ultra-short-wave use. Higher voltages will in general be necessary for the satisfactory operation of regenerative receivers employing common tubes at these frequencies. The operation of such receivers is sometimes not very good. Unusual care in adjustment, construction and placing of parts is required. Many have resorted to the use of super-regenerative receiving sets to obtain the required sensitivity.

Common inexpensive transmitting tubes are not very efficient at ultra-short-waves. The smaller types must be used with lower plate voltages to prevent stem punctures. For best reception a special ultra-short-wave tube (such as the new T-30-S tube), should be used. Ordinary tubes have been used with some success. Of the many possible transmitting-circuit arrangements, the push-pull arrangement is comparatively efficient. In this circuit, the tube capacities of the two tubes used are in effect in series, greatly reducing losses from high capacity.

Some Advantages of Ultra-Short-Waves

ALTHOUGH the range of ultra-short-wave sets is comparatively limited, these frequencies have much in their favor. One of the outstanding advantages is the simple, and yet highly effective antenna necessary for transmitting purposes. The reader has perhaps seen pictures showing the huge and expensive aerial systems required to transmit long waves. The size of antenna necessary is largely determined by the wavelength to be transmitted. At ultra-short-waves, the antenna required consists of relatively short lengths of wire.

Another advantage of the ultra-short waves is that the antenna systems can be made highly directional at comparatively small cost. The addition of a few simple wires will provide a directive antenna giving a much stronger signal at the receiver. A directional antenna concentrates the transmitted energy in a beam much like an ordinary automobile headlight directs the light in a beam.

(Continued on facing page, lower center col.)

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Detectors and Detection

By NORRIS HAWKINS*

What Is A Good Detector--and Why?

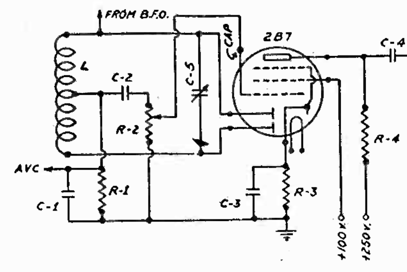
ALL receiving sets employ a detector in some form. Detectors and principles of detection are not, in general, well understood. This article considers detectors and the principles of operation.

The purpose of a detector is to remove the audio component from the RF. carrier and to suppress half of the AC. wave. Some detectors suppress the negative half of each cycle. Detectors do not suppress all of the undesired portion of the AC wave, and some types are more efficient in this respect. By "efficiency" we do not mean "sensitivity".

There are two classes of detectors: Rectifiers and distortion amplifiers. "Plate detection" is the common name for "distortion amplification". This is also called "power detection" and "plate-bend detection".

A detector with grid bias is a plate detector. The bias is so chosen that the grid-voltage plate-current curve of the tube bends sharply at the point about which the incoming signal fluctuates. Because of the sharp bend at the point on the curve chosen for operation, the positive half of each cycle is amplified, but the negative half of each cycle is not effective because the grid is operated at a point on the curve at which increased negative values have no effect on the plate current. A plate detector, of course, amplifies, as well as detects. Comparatively little amplification is realized.

The other class of detectors are rectifiers. Included in this class are gridleak detectors, Wunderlich detectors, diode detectors and such detectors as have low initial bias. Rectification is usually more efficient with respect to the proportion of the desired component. The suppression of the negative half of the cycle is more complete than in plate detection. This results from the fact that electrons pass only in one direction, between filament (or cathode) and plate inside the tube.



CIRCUIT RECOMMENDED FOR USE WITH THE 2B7 TUBE

R1—.5 Megohm.
R2—.5 Megohm.
R3—500 ohms.
R4—100,000 ohms.
C1—.0002 mfd.
C2—.05 mfd.
C3—2 mfd.
C4—.05 mfd.
C5—I.F. trimmer.
L—Secondary of I.F. transformer.
R2 is the Manual Volume Control.

Gridleak detection is a common type. A gridleak detector, from one point of view is not more sensitive than a plate detector, and slightly less sensitive than a true diode. Most forms of detection, if the circuits are properly adjusted, are nearly alike in their efficiencies. Anything that can be heard with one type can be heard on the others, providing that the same amount of RF and AF gain is used in the cases considered.

A gridleak detector, for a given number of tubes, gives the greatest output. This has created the belief that such a detector is more "sensitive". A gridleak detector gives the loudest signal **per tube,** because it functions as an amplifier as well as a detector. Because of this double function, more gain is realized. Any tube gives good gain at audio frequencies.

The latest tubes obtain the necessary gain from another source.

The grid bias to be used with ordinary detectors depends upon the signal strength. A strong signal may give simultaneous grid and plate detection, which results in distortion. Distortion affects the quality of phone signals. The Wunderlich push-pull detector is one form of detector which avoids simultaneous grid and plate detection. Recent articles by Mr. Terman should be consulted for detailed information on this type.

Push-pull diode rectification is found in many of the newer broadcast receivers. This type of detection should be used to a greater extent in short-wave receivers. Points in its favor are better quality, freedom from overload, and higher "rectification efficiency". Higher rectification efficiency means greater "sensitivity". It is true that the diode rectifier gives no gain in itself but in its modern tube form it includes also a pentode, high gain stage. The 2B7 and the 6B7 (identical except for heater voltage), have in the same envelope a pentode tube which can be used ahead of the diode as an IF amplifier, or after the diode as a high gain audio stage.

Considerable improvement is possible in the present systems of producing beat-notes in high-frequency receivers. The use of a separate oscillator is an improvement over the autodyne system, but the signal-to-noise ratio is lower.

In the future, regeneration may in some cases be limited to amplifier stages, as it is difficult to keep a regenerative detector at best detection efficiency over a very wide range of frequencies.

Detector sensitivity to weak signals is a matter of rectification efficiency, and is independent of RF or AF gain.

* W6AAR

Ultra-Short-Wave Experimentation

(Continued from facing page)

A directive antenna will direct the energy toward the receiving station instead of broadcasting it in all directions and wasting most of it. Not only can less power be used in the transmitter, but less interference will be caused, possibly allowing many stations to operate successfully on the same wavelength. For broadcasting purposes, an ordinary antenna would be used. Investigations up to this point indicate that the use of these frequencies is limited to local broadcasting only. The future may change this view.

If a station desires highly efficient, directive transmission, very little power need be used. It should be understood that a directive antenna can also be used on a receiver. A directive antenna for reception is in effect a **radio-frequency amplifier.** With no apparatus of any kind, other than the antenna and reflector wires, the received energy can be "amplified" many fold before reaching the receiving set. With a directional antenna at both transmitting and receiving stations, a very high efficiency is possible with a minimum of interference.

Television promises considerable at these frequencies.

The Sargent 9-33 Receiver

(Continued from page 19)

The receiver, as shown in the photo, contains its own power-pack. Those desiring a separate power pack should notice that a three-inch strip along the rear of the chassis is provided for the power supply. It is a simple matter to construct a receiver, either incorporating its own power supply or using a separate one.

Results With New Sargent Receiver

AN excellent test for any short-wave receiver is to operate it in the congested 160- and 80-meter 'phone bands. In these bands, the advantages of 175-KC selectivity are apparent. The "interheterodyning," "whistling" and howling of the many 'phone stations is reduced to a minimum. It is possible to separate the majority of phones that are heard. The same C.W. reception is excellent. The five selectivity and general absence of background noise give this receiver an exceptionally high degree of performance. Sensitivity is at a maximum on all bands. European C.W. signals have been logged on both 20 and 40 meters. Phones have been heard from every U. S. district. Results were excellent.

Sizzling Letter to The Editor!

Editor, "RADIO":

There are RAZZ-berries going the rounds in this town about the new "RADIO". The trouble seems to center on that article on the 160-meter radiotelephone on Page 14. The phone hams are all up in the air about it. One of them, who has a small fortune sunk in a high-grade, pure d.c. crystal phone set, said: *"Suppose a few dozen hams build that set. Four of them would fill up the band, and what good would all the good sets be?"* I'm not stating my opinion, I'm just telling you what I have heard from more than a dozen different sources in Oakland. If you sign my name to this criticism (if you publish it) I'll never write you again.

Yours,

Editor's Note:

Thanks, O. M., we won't divulge your name. The 160-meter radiotelephone described in June "RADIO" is a slightly-revised circuit used in a large number of somewhat similar outfits used for commercial purposes. This transmitter, as constructed in our laboratory and described in the magazine, used crystal control. The opinion of a representative group of amateurs was solicited before the article was published. Because of the wide difference of opinion, and to relieve congestion, the publishers have decided to print only crystal-controlled phone circuits in the pages of the magazine in future issues. Amateurs in various localities are cooperating among themselves to clear up the much-congested 160-meter band. "RADIO" encourages the use of crystal-control, for beginner and advanced experimenter alike, as is evidenced elsewhere in these pages.

www.americanradiohistory.com

An Efficient Short-Wave Receiver

By MAURICE JAMES FLYNN*

Uses latest type tubes: –57, –58, –59 and –80.

Operates a dynamic loud speaker, or head phones.

Designed for either Standard, Doublet or Zepp receiving antennas.

Novel system of Audio Coupling for Maximum Efficiency.

Here is a "de-luxe" short-wave receiver that brings 'em in—a set that can be constructed without much previous experience in set-building—and the cost is exceptionally low.

General Considerations

DESIGNING a simple and yet highly satisfactory short-wave receiver is a problem of no little importance. Here is one that uses a special antenna coupling system to provide for transfer of maximum power from antenna to receiver. The first stage uses the '58 tube, which provides substantial gain, and prevents the oscillating detector from feeding back into the antenna and causing local interference with a neighbor's receiver. The output of the first stage is inductively coupled to the detector, which is a '57 tube.

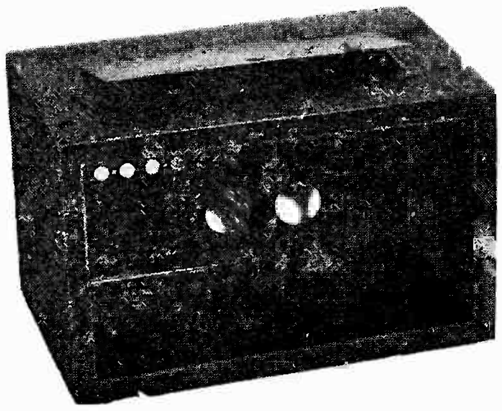
The detector circuit uses grid-leak detection with regeneration controlled by varying the voltage applied to the accelerator grid. This provides a very smooth form of regeneration.

Another feature is the method of coupling the audio stage to the detector. A special system for feeding the audio component of the detector plate current to the grid of the audio pentode has been devised, and it equals, if not surpasses, the efficiency of a direct-coupled system.

This audio channel is also responsible for the extremely low hum level of the receiver. Another feature is the high gain, resulting from the use of specially designed coils. These coils, for best results, should be machine-wound, in order to obtain accuracy and uniformity as well as proper coupling between coils.

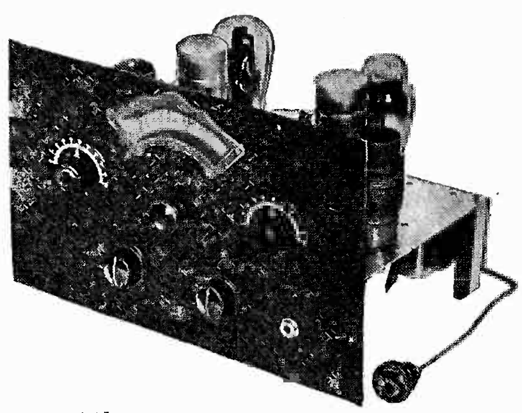
Constructional Details

THE receiver is mounted on an aluminum subpanel with the power transformer in the center rear. To the left of the transformer is mounted the '80 tube, in front of it is the '58 radio-frequency tube,



with its coil and tank tuning condenser. To the right of the transformer is the '59 audio pentode tube and directly in front of it are the '57 detector tube, its coil and corresponding tank-tuning condenser. In front of the power transformer is the two-gang band-spread condenser which allows band-spread tuning over any part of the range of the coils used. The choke coil, filter condensers and various resistors and condensers are mounted beneath the subpanel, out of sight, which gives the receiver a professional appearance. The wiring is done with push-back wire, and spaghetti is used on all exposed resistor leads, etc.

To use an ordinary antenna and ground system, terminals 5 and 6 are connected to the antenna lead-in, terminals 3 and 4 are joined together, and terminals 1 and 2 are joined and connected to the ground lead. This system, as shown in Fig. A, allows the



The completed Receiver and its metal case

potentiometer, R1, to control more directly the strength of the incoming signal so that local stations will not block the sensitive grid leak detector system that is used in this receiver. Fig. B shows the method of connecting the receiver to an untuned feeder system which connects to either a receiving

(Continued on facing page)

Any Type Antenna Can Be Used

The six connector terminals permit use of ordinary antenna, zepp or doublet—with or without feeder balancing condenser.

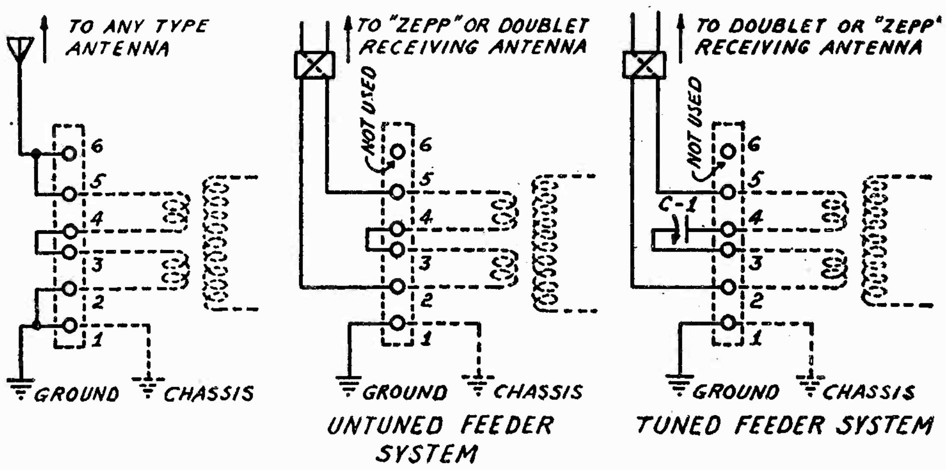
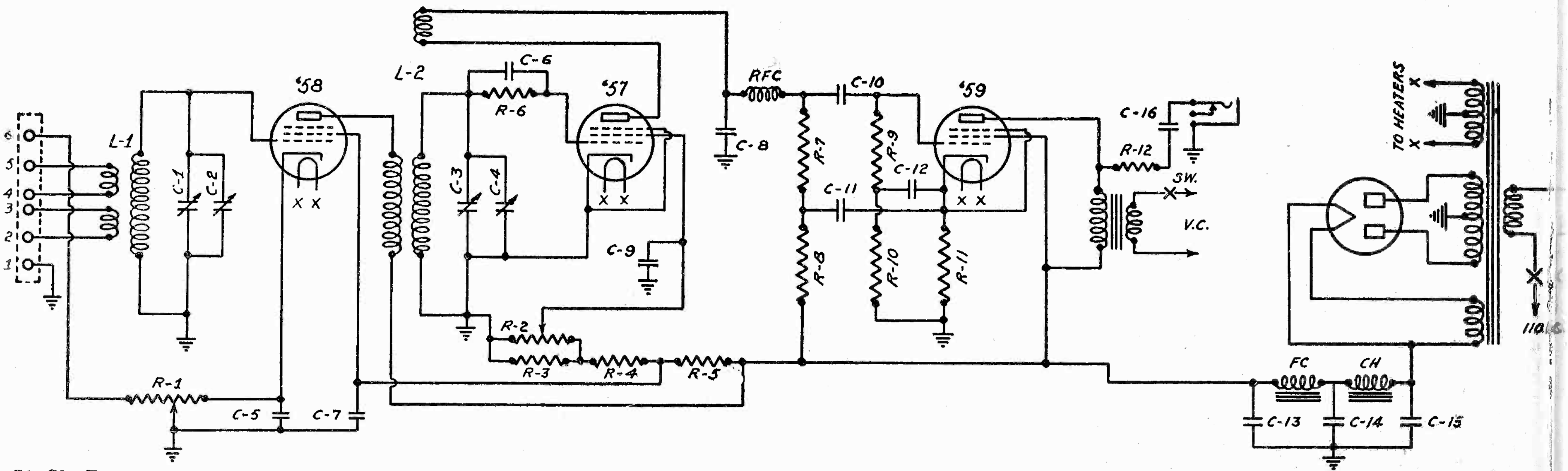


FIG. A — FIG. B — FIG. C



C1, C3—Two-gang condenser, each section 35 mmfd. maximum.
C 2—.0001 midget variable cond.
C 4—Same as C2.
C 5, C7, C12, C16—4 .1 mfd. 400 volt cond.
C 6—.0001 mfd. fixed mica condenser.
C 8—.00025 mfd. fixed mica condenser.
C 9—.5 mfd. bypass condenser.
C10—.05 mfd. non-inductive coupling cond.
C11—.25 mfd. bypass condenser.
C13, C14, C15—3 8-mfd.. electrolytic filter cond.
L1. L2—One set of Electronic coils.
R 1—10,000 ohm gain control (variable potentiometer).
R 2—50,000 ohm potentiometer regeneration control.
R 3—3,000 ohm 2 watt resistor.
R 4—2,000 ohm 2 watt resistor.
R 5—8,000 ohm 2 watt resistor.
R 6—5 meg. ½ watt resistor.
R 7—200,000 ohm 1 watt resistor.
R 8—50,000 ohm 1 watt resistor.
R 9—250,000 ohm 1 watt resistor.
R10—75,000 ohm 1 watt resistor.
R11—500 ohm 10 watt Ohmite resistor.
Ch—30 henry 55 ma. choke, coil.
Power transformer—4 or 5 tube standa[rd] replacement type.
Dynamic Speaker Resistance 900 ohms. D.[C.]

* Chief Engineer, Electronic Laboratories.

doublet or "zepp" antenna. Terminals 5 and 2 are connected to the feeder system, terminals 3 and 4 are connected together, and terminal 1 is connected to a ground lead; terminal 6 not being used. If it is desired to use the tuned feeder system (which should be used to get the best possible results and highest selectivity and sensitivity from this set) it is only necessary to connect a .00035 variable tuning condenser across terminals 3 and 4, as shown in Fig. C.

The complete receiver is mounted on a steel front panel and housed in a crackle enameled steel box. A full vision dial is used for the band-spread tuning and two calibrated dials are used for the tank tuning condensers. The AC switch and regeneration control knobs are mounted on the right of the front panel, and the radio-frequency gain control is mounted on the left side. A jack is provided for the use of ear phones. The receiver has an extremely low hum level which can hardly be detected even when using head phones.

Anyone desiring further informtaion regarding this receiver and its construction is invited to write to the author, care of RADIO.

The 80-Meter Listening-Post

DX on 80 still pounds in, despite the heavy QRN. On the morning of May 24th, "RADIO'S" Listening-In station reports the following 80-meter reception:—ZL3AR, calling CQ. Signals were QSA-4, R-8, on loud speaker. ZL2AQ, calling CQ. signals were QSA-3, R-7 to 8, on loud speaker. On June 10th, ZL1GV was QSA4, R7.

CALLS HEARD

W9FO—Radio Amateur Call Book, 608 S.

7000kc band

Dearborn, Chicago, before June 1, 1933

W1AMR. DSE. FDC, W2AN. BHA. BOX. BST. BTF. BVP. BWD. CJY. DYJ. DZO. WR, W3AHJ. BCE. BLS. CHE. CLQ. CRQ. CV. FB. OM. TC. ZD, W4ABS. ACV. AFD. ARU. AFD. ARU. BMG. BRO. BSI. BSK. CP. FO. FX. JG. NI. RI. SQ. US. PCY, W5ABW. AJG ALN. ALZ. ANQ. ATF. AUW. AXI. BCA. BFI. BIO. BJD. BKE. BUZ. CEN. CFE. CHE. CJU. CNA. CNO. CQ. CQI. CQJ. CTW. FR. IF. JS. WG, W6AL. AMZ. AWA. BC. BRB. BVK. BWF. BYB. BYQ. CDU. CLU. CKF. CNX. COE. CQS. DDD. DFO. DYB. DZR. EAR. EHI. ELA. FA. FUF. FZY. GAT. GFS. GRX. HFG. RV. UK. VT, W7AOT, APJ. CEC. CPA. EK. TX, W8API. AUN. AWX. AYQ. BBB. BBL. BDA. BK. BPF. BXH. CDH. CEH. CL. CNA. CNO. CYZ. CZE. EAQ. ENN. FGR. FUD. FYM. HYO. IHU. LM. NL. QV. VY. ZZAT, W9AMN. ANV. BAR. BLF. BZD. CXQ. DDK. DJF. EJC. EYF. EYI. FNM. FOV. FST. FTA. GDU. HED. IHN. IRE. JI. JXR. KIF. LBJ. LEP. LHO. LLR. MO. NP. YB, CM2GR, 2MG, 2MJ, 2MM, 2OP, 2SG, 2SV, 2VC, 2WD, 2WW, 2ZB, 5OF, 5ZS, 8YB, EAR37, 46, 225, 227, HC2EA. HI8X, K4BRN. BU, K5AB, K6BOE. CQF. CQZ. LU3BD. 5AR. 9AX NY1AA. 2AB, SM7RV, TI2RC, 2TAO, 2WD, VE1AL, DT. ET, VE2DR. FF. FG. GL. GU. VE3EL. HO, MI, MT, OV, OY, OZ, PQ, PZ, UB, VE4CI. FT. VE5HI. HQ. HS. HU. VK2YL, 3WL, 3XF, 5MF, VO8WG, VP5IS, X1ER, 1H, 1U, 1Z, 9A, XPK6ER (QRA?), Y2NP, YV2AM, ZL1CN, 2CI, 2FP, 2GN, 2JE, 2KQ, 3AW, 3DJ, 4BY.

1400kc. Band

W1APQ. BDW. BPY. DHD. DJQ. DMO (fone). DNM. EAP. W2AIS. BHJ. CBI. W3CLG. ZX (fone). W4BBO. BGG. DE. W5AEA. AFV. AXI. BFI. BQF. BQU. W6BAG. BAM. CXW. ELU. W7BAC. BB. CGN, VY, CM2DO, 2RZ, 6DW, EAR185, F8PZ, G2NH, HC1FG, K4AAN, K5AA, 5AE. PY1IF, VE1DT, 1EE, 2CO, 2EW, 4IJ, 4ML, 5CP. VO8AW, VP4TB, X1AA, 9A, ZD2A. Cards to any of the above on request.

Federal Radio Commission Decision on Amateur Portable Stations

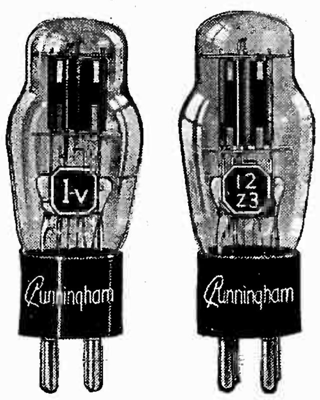
MANY applications for portable amateur station license have been denied by the Federal Radio Commission because they showed intention to use the transmitters aboard anchored yachts. It appears that the Commission did not feel it advisable to issue licenses for portable amateur stations implying express use aboard a vessel. The danger of international complications probably presented itself in contemplating cases where amateurs might be using portable transmitters on board yachts which had every right to anchor or dock in foreign waters.

However, the Commission is now looking at the matter from the opposite direction and a decision has been made that any or all licensees of portable amateur transmitters may use their stations aboard anchored, docked or moored vessels or even in automobiles as long as they are stationary. The decision is based on the definition of a portable station given under the Rules and Regulations of the Federal Radio Commission. This says, "The term 'portable station' means a station so constructed that it may conveniently be moved about from place to place for communication and that it is in fact so moved about from time to time, but not ordinarily used while in motion." Under the amateur rules and regulations it is stated that licenses for amateur mobile stations will not be granted, but a mobile station under Commission regulations is defined as a station that is capable of being moved and ordinarily does move.

It is believed that the test in the case is hinged on whether the automobile or vessel, on which the portable amateur station is used, is in motion or not. The authorization is only extended to the operation of amateur portables aboard vessels docked or anchored in United States harbors or navigable waterways and in parked automobiles.

Radiotelephone Operator Third Class Privileges Increased

BY a recent modification of Section 9 of the Rules and Regulations Governing the issuance of Radio Operators Licenses, holders of Radiotelephone Third Class Licenses may operate any class of station licensed for and operating on frequencies above 40,000 kilocycles, using any type of emission. This class of license is also valid for the operation of any licensed station using A-3 (radiotelephone) emission except amateur or broadcast. In the case of those stations, other than broadcast or amateur, using A-3 emission, where power in excess of 50 watts is licensed, the chief operator must have a radiotelephone second class license or higher and at least one operator holding the same class license must be immediately available on call in case of emergency, otherwise an operator with a third class radiotelephone license may not operate.



NEW RCA-CUNNINGHAM TUBES

[Additional New Class-B Tube Data on page 34]

RCA RADIOTRON RCA-1-v. — CUNNINGHAM C-1-v.

Half-Wave Rectifier

TENTATIVE DATA SHEET

The 1-v. is of the high-vacuum type employing a 6.3-volt heater-cathode. Owing to the electrode structure and spacing, this tube has excellent regulation characteristics which facilitate its use in universal and automobile radio receivers.

Heater Voltage (A.C. or D.C.) (See Note 2)	6.3 Volts
Heater Current	0.3 Ampere
A-C Plate Voltage (RMS)	350 max. volts
D-C Output Current	50 max. milliamperes
Maximum Overall Length	4¼"
Maximum Diameter	1-9/16"
Bulb	ST-12
Base (for connections, refer to Note 1)	Small 4-Pin

Note 1—Pin 1—Cathode Pin 3—Heater
Pin 2—Plate Pin 4—Heater
Pin numbers are according to RMA Standards.
Note 2—The potential difference between heater and cathode should be limited to 500 volts d.c.

RCA RADIOTRON RCA-12Z3 — CUNNINGHAM C-12Z3

Half-Wave Rectifier

TENTATIVE DATA SHEET

The 12Z3 is of the high-vacuum type employing a 12-6-volt heater-cathode. Owing to the electrode structure and spacing, this tube has excellent regulation characteristics which facilitate its use in universal radio receivers.

Heater Voltage (A.C. or D.C.) (See Note 2)	12 6 Volts
Heater Current	0.3 Ampere
A-C Plate Voltage (RMS)	250 max Volts
D-C Output Current	60 max. Milliamperes
Maximum Overall Length	1¼"
Maximum Diameter	1-9/16"
Bulb	ST-12
Base (for connections, refer to Note 1)	Small 4-Pin

Note 1—Pin1—Cathode Pin 3—Heater
Pin 2—Plate Pin 4—Heater
Pin numbers are according to RMA Standards.
Note 2—The potential difference between heater and cathode should be limited to 350 volts d.c.

CALIFORNIA TO NEW ZEALAND ON 80 METERS WITH A 2-TUBER AND A GOOD LOCATION

Showing the Circuit Diagram of a Low-Power Transmitter That Has Been Doing Exceptionally Fine Work

HERE is a two-tube 80-meter transmitter that has been heard frequently in Australia and which has successfully worked ZL2AQ with a report of R-6. It is a simple outfit. Nothing new about it, from a constructional standpoint. However, a number of requests have been received for a complete list of parts and the data here given will enable any one to build a similar transmitter. Not many two-tube sets have reached from California to the Antipodes, with the low-power that this transmitter uses. In fact, a number of California amateurs believe this small transmitter has established a record for watts-per-mile.

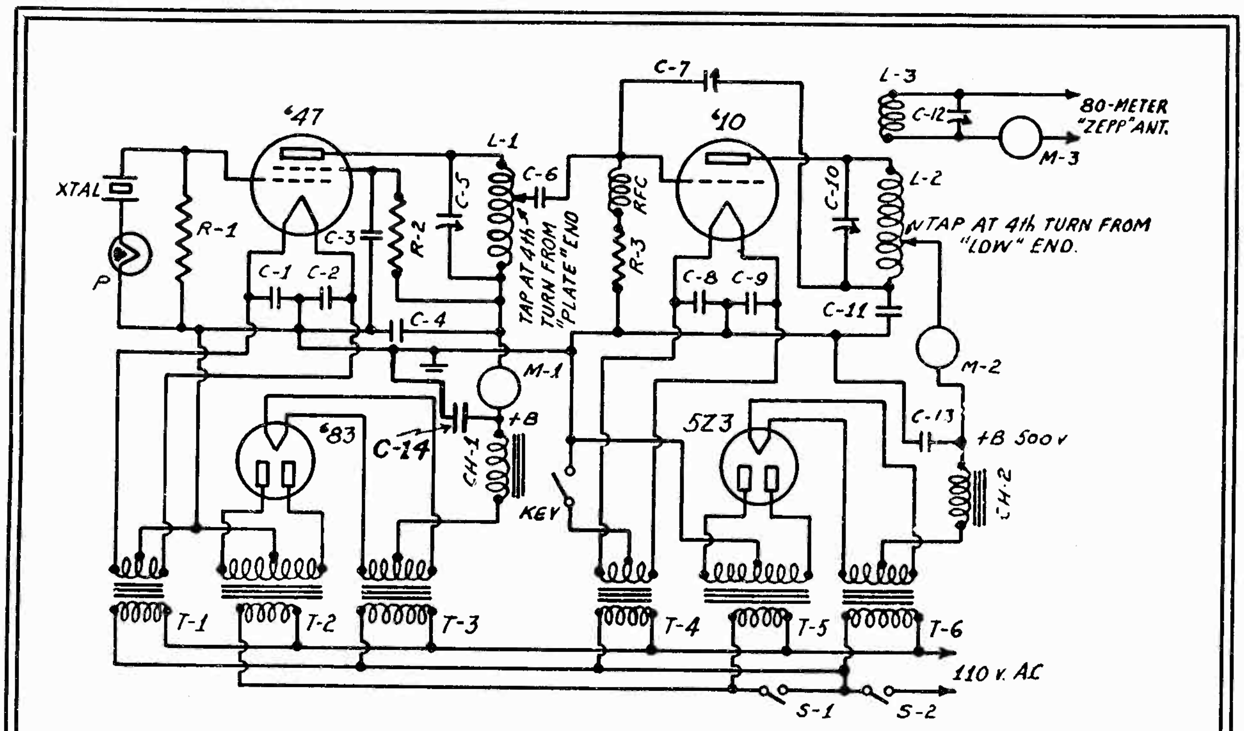
The transmitter uses a '47 oscillator and a 210 final amplifier. No buffer is used. Two separate power supplies make for better regulation. A 5Z3 tube is used in the power unit that feeds the final stage, an '83 in the unit that feeds the oscillator.

The plate supply for the oscillator gives 420 volts, the other, for the amplifier, gives 620 volts. Ordinary 8 mfd. dry electrolytic condensers are used for filters. A bank of eight of these is connected in series-parallel for the high-voltage stage. Switches are provided so that the plate supply for both stages is cut off when receiving, but the filaments remain lighted at all times while the outfit is in operation.

A protective tube is in the crystal circuit to indicate the degree of oscillation and to prevent the crystal from cracking or otherwise becoming damaged by overload. This tube is an ordinary X-99, the filament only being used. The resistor across the crystal is 5000 ohms. Some crystals may require a resistor of as much as 50,000 ohms.

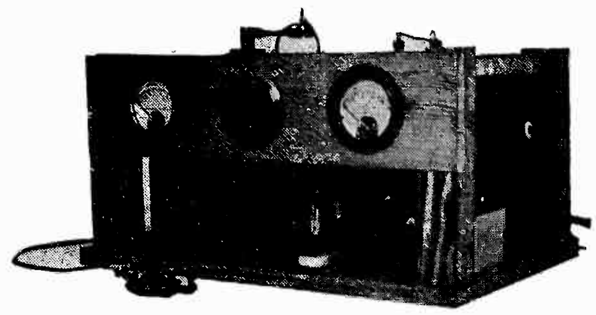
The variable condensers are the Cardwell 407-B receiving type, and the neutralizing condenser is a small Cardwell 7-plate receiving condenser. The inductance coils are wound on standard R.E.L. coil forms, 2⅛ in. diameter. The fixed condensers are Sangamo.

The final stage is capable of handling the full 620 volts on the plate of the 210 without damage. An 80-meter Zepp antenna is used.



Circuit Diagram of 47-210 Transmitter

Although the circuit diagram shows 500 volts for the final stage, this has been boosted to 620 volts. In tuning the transmitter it is desirable that the voltage remain at the lower figure, higher voltage being supplied when the tuning operation is completed.



The upper illustration shows a photograph of a neat, inexpensive framework and baseboard for mounting the transmitter. The power supply is mounted on a wood baseboard, and is located about four feet from the transmitter. Heavy wire is used for all connections. The list of parts also serves as a Legend for the symbols shown in the diagram:

LEGEND 2-TUBE TRANSMITTER

XTAL 80-meter crystal.
R1 5,000 to 50,000 ohm Ohmite resistor, 5 watt.
R2 Screen dropping resistor, 35,000 ohms, I.R. C., 5 watt.
R3 7,500 ohm, 5 watt Ohmite resistor.
C1, C2, C3, C4—C8-C-9 .002 mfd. Sangamo.
C5 .00035 mfd. Cardwell Receiving Cond.
C6 .00025 Sangamo Fixed Cond.
C-7 7-Plate Cardwell V. C.
C-10 .00035 mfd. Cardwell V. C. Receiving Type.
C-11 .002 mfd. Sangamo Fixed Cond.
C-12 .00035 mfd. Cardwell V. C. Receiving Type.
C-13 4 mfd. 1000v. Fiter Condenser.
C-14 4 mfd. 1000v. Fiter Condenser.
L1 20 Turns No. 14 enameled wire on REL form, 2⅛ in. dia.
L2 20 Turns, space wound, thickness of wire.
L3 10 Turns No. 14 double silk covered, on 2-in. form.
M1 0-100 MA Triplett Milliammeter.
M2 0-200 MA Triplett Milliammeter.
M3 0-3 RFA Weston Thermo-Couple Meter.
P X-99 Tube.
S1 SPST switch, controlling plate.
S2 SPST 110 volt line switch.
T1 2½v. CT fil. transformers, for '47 tube.
T2 500-CT-500 trans, for '47 tube.
T3 5v. CT fil. transformer, for '83.
T4 7½v. CT fil. transformers, for '10.
T5 500-750-CT-500-750 trans. Universal.
T6 5v. fil. transformers for 5Z3 tube.

OLD TIMER'S CORNER

Old-timers are returning to radio in great numbers. It is believed there will be considerable interest in an OLD-TIMER'S CORNER. How old an Old-Timer are you? How good is your memory? We are listing below several questions taken from the old files of "RADIO". You will receive Honorable Mention in this Corner if you can supply the correct answers to the questions.

1—Why did Army station operators turn a hand-crank when tuning-in stations?
2—Why did the first feminine shipboard wireless operator resign her post?
3—How many radio operators lost their lives when the "Titanic" went down?
4—What is the International Distress Signal?
5—What does SOS mean?
6—Why was "CQD" replaced with "SOS" for distress calls?
7—When commercial operators went on strike in 1914, how were they replaced? Were they successful in receiving an increase in salary above the $30.00 and $35.00 monthly wage they were getting?
8—What is the name of the prominent old-time amateur who brought about the conviction of Public Defender Frank Egan of San Francisco in the famous Hughes murder case?
9—When were amateurs forbidden to jam the commercials? Likewise, when were the commercials forbidden to "roast" the amateur?
10—Why did the early commercial radio telephone operators deliver their traffic by messenger instead of by radio?
11—What was the function of the "Northumberton Jigger"?

Look for more questions in next month's "RADIO", and the answers to the above.

RAMBLINGS

W6HM shunts a .00001 mfd. condenser across his crystal to shift the wavelength slightly. This enables him to be heard through QRM on his frequency. The small condenser across the crystal changes the frequency of the transmitter just enough to throw it off of the interfering station.

* * *

Heard at a recent meeting of the ARA: "I am using a Super-Signal-Super-Sensitive-Super Het."

* * *

W6AM tells us that amateur radio was the only dependable means of communication during the recent Long Beach quake. Telegraph service was three days behind. Mail planes were specially chartered to carry telegrams to San Francisco, so as to relieve congestion. Many amateurs each handled more than 700 messages daily.

SOUND

"Radio" Includes This New Monthly Departmental Feature Because of Its Close Alliance With the Radio Art. Conducted by D. B. McGown, Who Was Long Associated With the Sound and Projection Engineering Divisions of Warner Bros. and Erpe, the Reader Will Find In These Columns Complete Information On Many Heretofore Unpublicized Developments

CHAPTER ONE

THE fundamental principles of sound with which we have to deal in radio broadcasting, public address, program distribution and talking pictures and the phenomena encountered are all primarily the same. The technique of one field is closely allied to that of the others. Each field of course has its own particular applications and problems but these are so closely allied that anyone experienced in one field usually can adapt himself quite readily to the operating practices of the others. It is the purpose of this series of articles to discuss in detail "Sound Recording," "Public Address" and "Radio Input" Systems.

We are first concerned with the generation or formation of sound, with its travels through the conducting or transmitting medium and with the phenomena of reflection, absorption, refraction, diffraction and interference. We shall then be concerned with the problem of causing sound to create an electric current varying in value and frequency exactly as the sound varies in intensity and frequency and then reconverting this electrical energy to sound energy so that the reproduced sound will be a faithful copy of the original.

In radio broadcasting or, in fact, radio telephone transmission and reception of any kind sound is first made to set up a small electric current which is then stepped up or amplified and to which is added a radio frequency component permitting transmission of the sound energy over great distances by purely electrical means.

In public address work the sound is re-created, with greater volume than the original, so that a large space that could not be covered by the relatively weak unaided human voice can be so completely covered that everyone present can hear satisfactorily.

In the recording of sound for electrical transcriptions, or phonograph records, we have the problem of making a permanent record of the sound so that it can be reproduced with the greatest possible truthfulness and fidelity. When the sound is to be reproduced in conjunction with a motion picture we have the added problem of making the permanent record of sound coincident with the making of the motion picture. The sound record must be such that it can later be reproduced in exact synchronism with the action of the photographic scene so that a spectator will accept the reproduction of both sound and scene as a faithful duplicate of the original and will be able to concentrate his full attention on the story without being conscious of either the sound or scene individually.

With such complex problems to be solved we may well wonder how the results obtained are as good as they actually are. It will be appreciated that very small factors may adversely affect the final reproduction. Such factors must be taken into account in all commercial systems. In most cases, two inherent faults may be such that they offset each other and permit satisfactory performance overall. The various imperfections introduced as the result of individual faults in the process all go to make up what is generally called "distortion" and it would be impossible to list all of them here. They may occur anywhere in the process all the way from the pick-up through the amplifying and reproducing systems to the loud-speaker unit. As we progress we shall discuss the causes of distortion in detail.

The accompanying "block diagram," Figure 1, shows the basic units through which sound passes when it is picked up and caused to produce certain effects. These units are shown in exactly similar series for each of the three elementary processes "Sound Recording," "Public Address" and "Radio Input." It will be seen that the first six units are identical in each case. In any case, after leaving the last amplifier, which is a "power amplifier," i.e., one which delivers enough energy to do an appreciable amount of work, the electric current, which is an exact but greatly magnified copy in electrical form of the original sound, can be made to modulate a light and thus impress an image of the sound on a moving sensitized film. After this film has been developed and printed in the usual manner the process can be reversed and the resulting positive print arranged to modulate a narrow slit of light which affects a photo-electric cell. The cell output, which is electrical in nature, is then amplified and reconverted into sound.

For public address work the power amplifier output is usually led through an output panel which incorporates an impedance-matching transformer, or network. The output panel feeds a group of loud-speakers which reproduce the original sound with much greater volume than it originally had.

In radio broadcast we have the same preliminary arrangement as in the other systems but the output of the power amplifier is fed to a "modulator system" wherein the high frequency current which sets up the radio wave emitted from the transmitting antenna is modulated or varied exactly in accordance with the original sound.

The arrangements shown in Figure 1 are general and are intended to show the fundamental sound and electrical units employed in the three basic processes. Actually, the equipment used in different installations of the same general type may differ considerably. For instance, if one microphone were used, the mixer would not need to be included; the two amplifiers shown might be built up as a single unit; a volume indicator would probably be connected to the output of the power amplifier so as to give a satisfactory measurement of the output power being delivered at any instant. If recording were to be disc recording, employed for phonograph records, electrical transcriptions and some talking pictures, the film recording machine would be replaced by a disc recorder. In this case the power amplifier would operate a cutting stylus which would cut an exact reproduction of the sound in the recording "wax." Disc records would then be made from this wax recording.

The only complete process shown in the figure is the public address arrangement and this was so shown intentionally. In film (or disc) recording it is not enough that the sound be recorded; it must be so recorded that it can be reproduced easily and with reasonable resemblance to the original at any time and as many times as may be desired. In the radio system, of course, operation would not be complete without a receiver to pick up the radio wave and ultimately convert it into sound energy. We shall discuss the three basic systems in detail in subsequent articles of the series.

What Figure I Represents

THE original sound reaches the microphone (1) causing the diaphragm to move and setting up a small current which is amplified in the preliminary amplifier (2) and passes into the mixer (3), where the speech currents from the several microphones are combined and equalized in volume, and hence into the volume control (4), where the sound level is adjusted to the desired value, from which it passes into the voltage amplifier (5) which increases the electrical energy sufficiently to operate the power amplifier (6) which will in turn operate the various devices indicated.

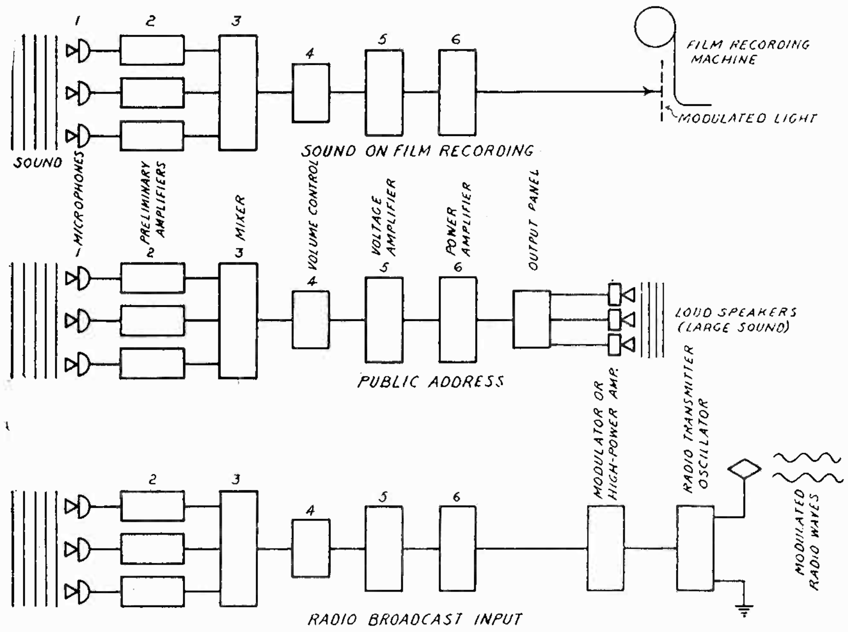
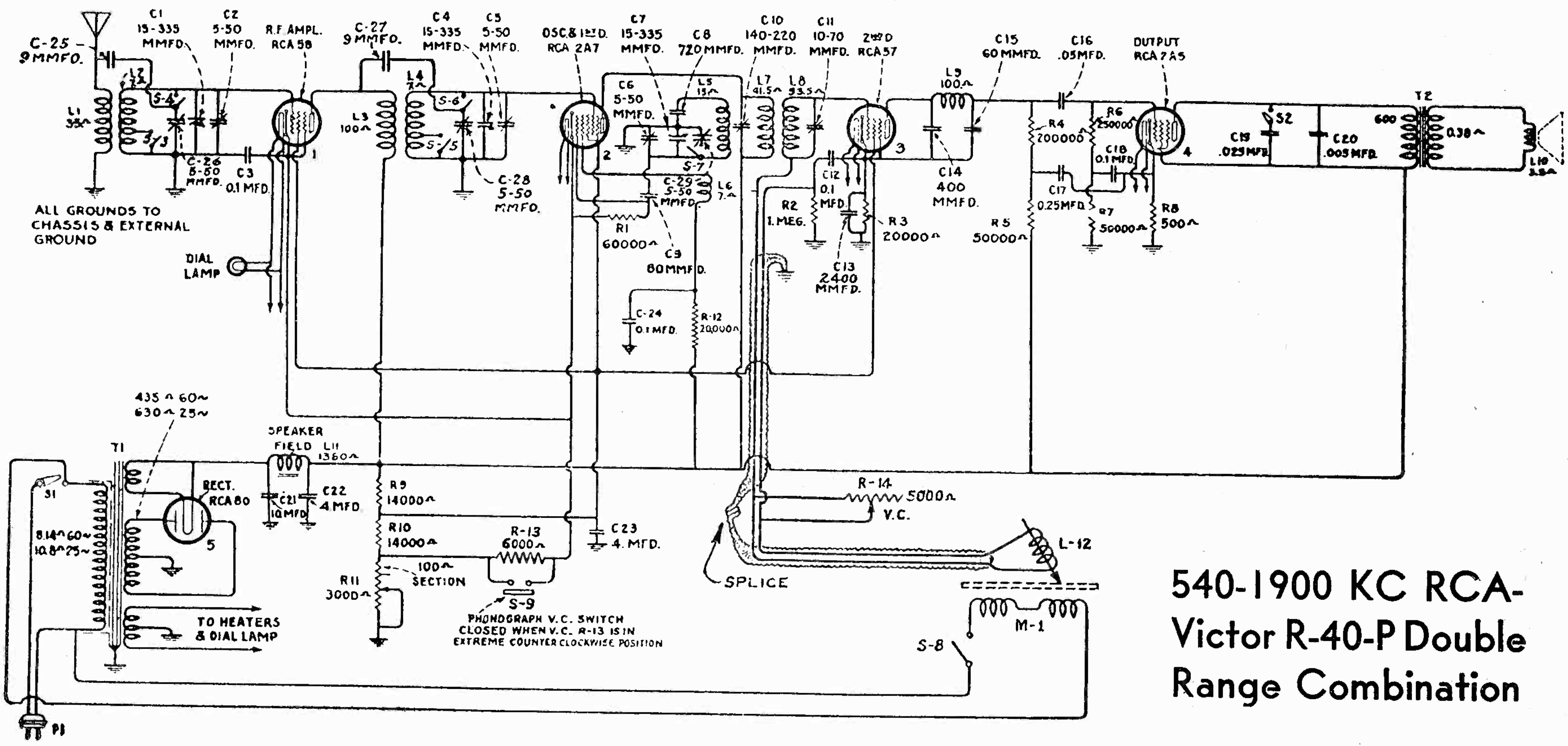


FIG. 1

NO DEBATE

The Debater's Club, announced in June "RADIO", has disbanded. Of the thousands who received the magazine, but one reader submitted an answer to the question to be debated. We can't conduct a one-man debate. To Mr. Louis Kutner of Martinez we publicly acknowledge receipt of the lone answer (but it was wrong, Louis). So we put the fifty thou . . . beg pardon . . . the five dollars and five short-wave tubes back into the kitty where the treasure will repose until next month, to be used as prizes for best answers to "QUIZ-MATICS", similar to those which were published in "MODERN RADIO". The first QUIZ will be in August "RADIO".

Circuit Diagrams of New Factory Receivers and Power Amplifiers



540-1900 KC RCA-Victor R-40-P Double Range Combination

Police-Band Reception and Two-Speed Phonograph Motor.

This combination radio-phonograph instrument uses a five-tube Super-Heterodyne receiver incorporating a dynamic loudspeaker, two-point tone control, single heater type Pentode Output tube and the inherent sensitivity, selectivity and tone quality of the Super-Heterodyne.

The standard RCA Victor two speed motor board equipment is used and the entire assembly enclosed in a table type cabinet.

A special feature is the Range Switch that allows reception of signals either of the broadcast band or higher frequencies. With the switch in the broadcast band position, the frequency range is from 540 to 1500 K.C. At the higher frequency position, the receiver covers the 1400 to 2800 K.C. band.

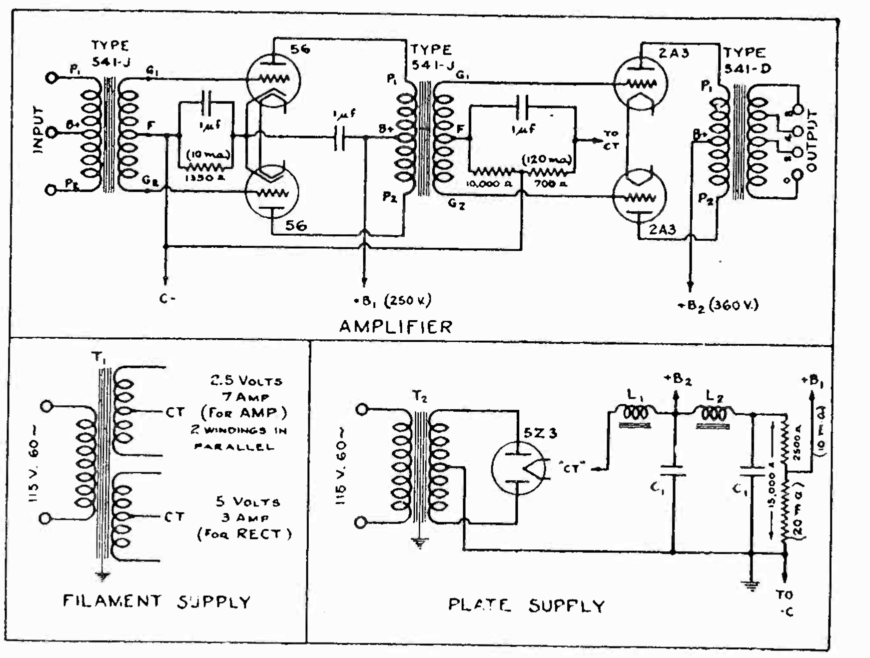
The circuit consists of an R.F. stage, a combined oscillator and first detector in the RCA-2A7 tube, an intermediate stage consisting of a transformer using two tuned circuits, a second detector, an output tube and a rectifier.

Police Calls—At dial settings near "80" for stations transmitting at 1712 kilocycles, and at "118-122" for stations operating in the 2450 kilocycle band.

Amateur Radio "Phone"—At dial settings "90-95" (assigned band 1900-2000 kilocycles.)

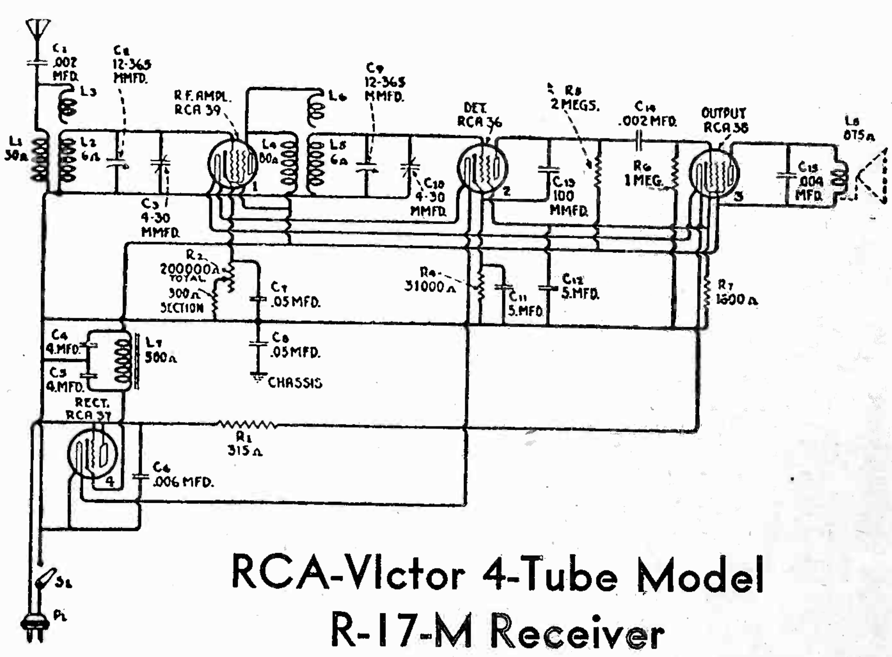
Aviation Reports, Airport Beacons, Etc.—At dial settings "95-118" (assigned band 2000-2400 kilocycles).

Amateur Radio "CW" (Code)—At dial settings "80-90" (assigned band 1715-1900 kilocycles). Signals of this class are normally unintelligible or inaudible with this type of receiver.



New General Radio Push-Pull Amplifier Using 2A3 Tubes

The 2A3 is known for its large power output. For high-power push-pull amplifiers these new tubes have proved exceptionally suitable. Shown here is the circuit diagram of the new General Radio Co. 2A3 push-pull amplifier. The standard G.R. transformers are used and the type numbers are clearly indicated in the diagram.



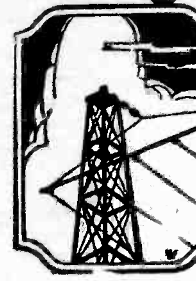
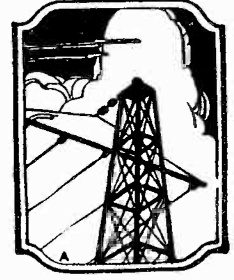
RCA-Victor 4-Tube Model R-17-M Receiver

This receiver is an A.C.-D.C. table model tuned R.F. broadcast receiver. Features such as universal operation on both A.C. and D.C., wide tuning range, excellent performance and compact construction characterize this instrument. The voltage readings are given below.

ELECTRICAL SPECIFICATIONS

Voltage Rating .... 105-120 Volts, 25-133 Cycles A.C. or D.C.
Power Consumption .... 40 Watts
Frequency Range .... 540 K.C.-1700 K.C.
Type and Number of Radiotrons:
1 RCA-36, 1 RCA-37, 1 RCA-38, 1 RCA-39—Total 4

for The RADIO NOTE BOOK

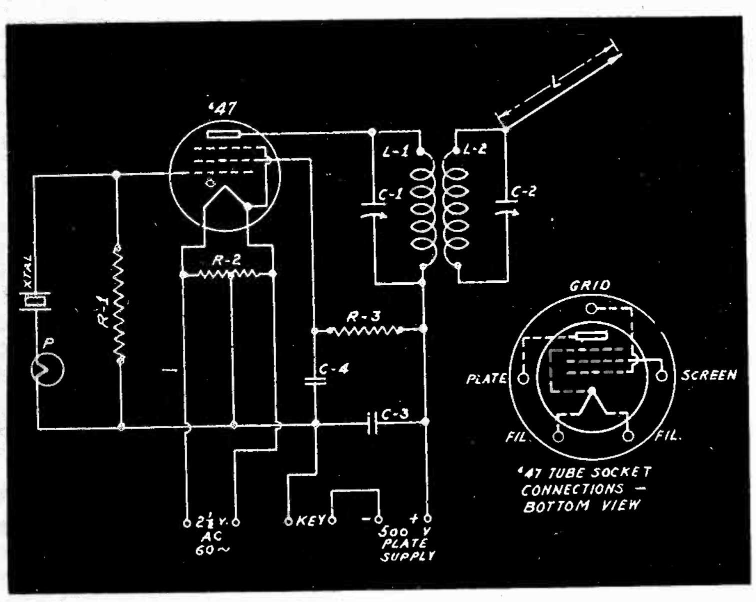
Crystal Oscillator Circuit Diagrams Showing the '47, 210, '59 and 2A5 in Push-Pull. Next Month's Note Book Page Will Bring You Another Group of Interesting Circuits

A DIFFERENCE of opinion exists among short-wave experimenters as to the best all-around circuit for use in a crystal-oscillator. What is the best tube to use in a crystal oscillator? Some prefer the '47, others claim better results from the 2A5, still others maintain the '59 is the best. Then there are others who will use only a 210 tube.

In next month's "RADIO" a chart will be shown illustrating test results with all of the tubes mentioned when used in such circuits. The '47, 2A5 and '59 tubes give about the same results when used in crystal oscillators. The 210, if used with relatively low voltage, will give satisfactory performance but it costs more. For low-power oscillators, the 2A5 has given excellent results. The '47 and '59 have also proved their worth.

The reader has here the modern crystal-oscillator circuits for instant reference. The circuits shown are for the four types of tubes most used for this purpose. Each circuit is a complete crystal-controlled transmitter. All connections are clearly shown. The antenna is of the single-wire voltage-feed type, perhaps the simplest form of antenna that a beginner can use. These same circuits will also give good results, of course, when connected to any of the other types of conventional transmitting antennas.

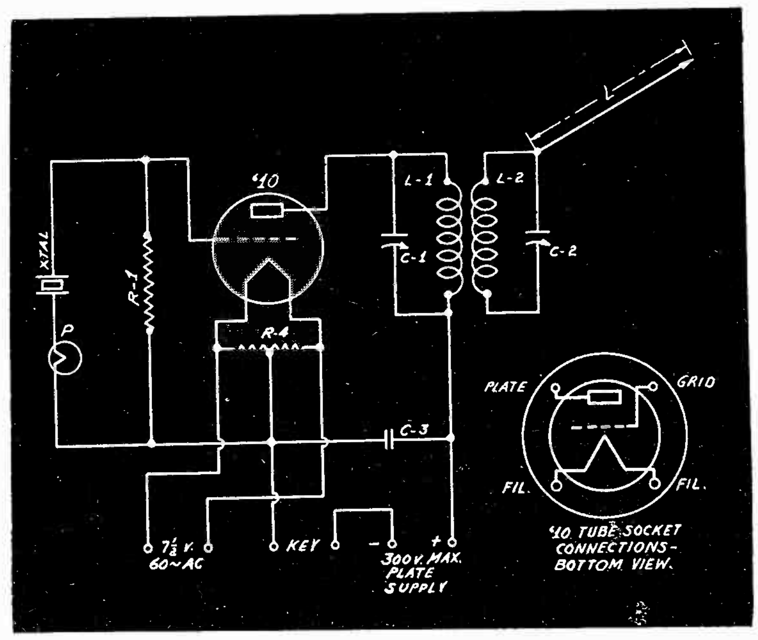
This group of oscillator circuit diagrams presents many practical methods used for crystal control. Next month these pages will show the many radiotelephone one-tube circuits that can be used in conjunction with these simple oscillators. In subsequent issues, there will appear a family of "buffers" and "doublers," amplifier stages, modulators and speech amplifiers for high-power equipment. Thus, this year's "RADIO" will in itself comprise a complete encyclopedia of practical circuits for all common types of transmitters, from the smallest to the largest. Receiving set circuits will also be treated thoroughly in these "Note-Book" pages.



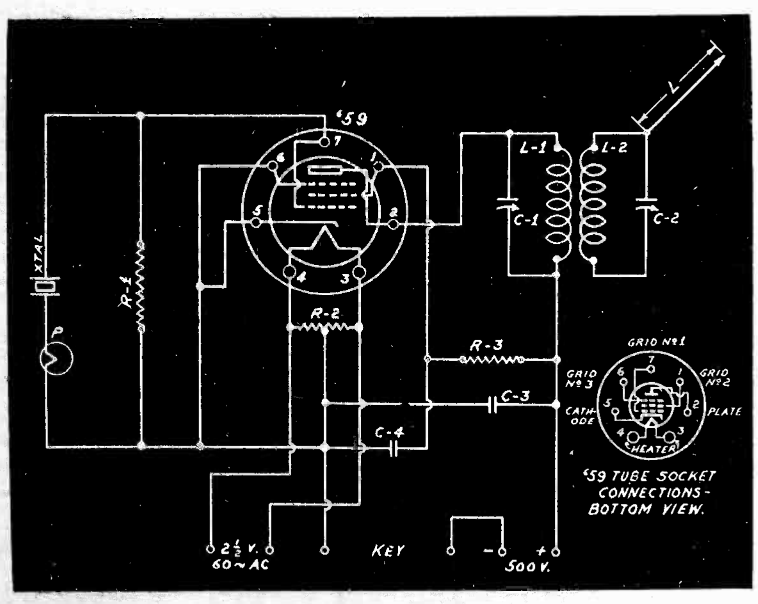
'47

LEFT: Simple '47 tube as an oscillator, shown as a complete 1-tube transmitter. R1—5,000 to 50,000 ohms, depending on the grade of crystal used. R2—20 ohm CT resistor. R-3—Screen-dropping resistor, approximately 40,000 ohms. C1-C2—.00035 variable condensers, receiving type. C3-C4—.002 mfd. fixed condensers. P—Filament of '99 tube to protect crystal.

RIGHT: '10 tube as oscillator in a complete 1-tube transmitter. 300 volts MAXIMUM for plate. Other values same as '47 circuit.



'10

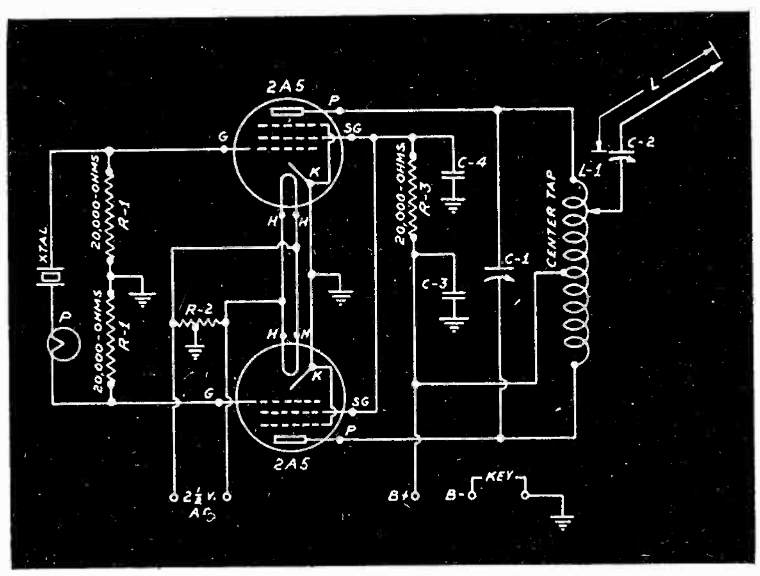


'59

A good oscillator. All constants for the circuit are same as for the '47 tube, above. Screen-voltage dropping resistor R3 is about 40,000 ohms, when 500 volts is used. The '59 and the 2A5 give about the same output.

COIL TURNS TABLE FOR ANY OF THESE CIRCUITS

L1, (Plate Coil) 20-turns (for 80-meters) wound with #14 enameled or #22 covered wire, DSC preferred, on a form approximately 2-in. dia. L2—Antenna Coil. Usually about 15 turns, wound same as L1, and spaced about 1-in. away from L1. Turns can be added or taken from L2 as antenna is brought in tune.



2A5 In Push-Pull

A strong oscillator. The new 2A5's are giving fine service, although they are slow-heaters, requiring about 30 seconds to heat. Note R1 is two resistors, each 20,000 ohms. R-3 is also 20,000 ohms. Other values same as '47 oscillator circuit. Tube socket connections are shown elsewhere in this issue.

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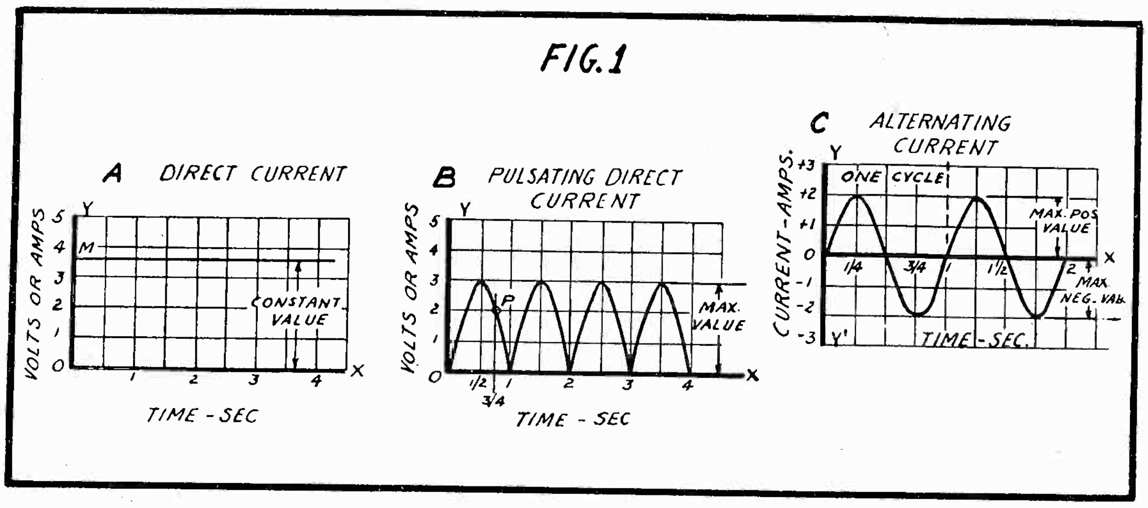
The Superheterodyne—Its Theory and Operation

A One Year Course of Instruction—Lesson Two

By D. B. McGOWN



IN "B" of Fig. 1 we have represented a pulsating direct current. Note that it is represented by a curved line consisting of a succession of "humps." Since all points on this curve are located above the time axis O-X, the current always flows in the same direction. This direction is "positive". If lines parallel to axis O-Y are drawn through various points on the time axis O-X the distances measured to the curve along these lines will not all be equal and since these distances represent current values we know that the value of the current does not remain constant with respect to time. For instance, let us draw through the point "½" on O-X a line parallel to O-Y. (The distance "O-½" on O-X represents the passage of one-half second from "zero time".) This line intersects the curve at "M." Since "M" is the highest point on the curve it is the maximum value of the current. Draw a line through "M" and parallel to O-X. It intersects the axis O-Y at 3 which tells us that the value of the current after the lapse of one-half second from zero time is 3 amperes. Now draw a line through the point "1" on O-X and parallel to O-Y. It is found to intersect the curve at a point "P." A line drawn through "P" and parallel to O-X intersects O-Y at 2 which tells us that the value of the current is two amperes after the lapse of one second from zero time. Examining the curve we also see that the value of the current is zero one second from zero time, two seconds from zero time, etc. We further see that it reaches its maximum value one-half second from zero time, again at one and one-half seconds from zero time, etc.

IN "C" of Fig. 1 we have represented an alternating current. Notice that parts of our curve lie above the axis O-X and parts of it lie below that axis. Those parts which lie above O-X represent current flowing in one direction (positive) while those parts lying below O-X represent current flowing in the opposite (negative) direction. We see that the current is zero at zero time, rises to a maximum positive value during the first quarter second following zero time, decreases to zero during the second quarter second following zero time, and reaches zero after the lapse of one-half second. It reaches a maximum negative value three quarters of a second after zero time and then "decreases" to zero again, reaching zero one second after zero time. During the second, third, fourth seconds, and so on, following zero time, the current again goes through this same cycle of changes in value. One complete series of value changes, represented for instance by that part of the curve lying between zero time and the one-second division on the time axis, is a **cycle**. In this particular case the current goes through one cycle each second. The **frequency** of the current is therefore **one cycle per second.** If the current went through two cycles during each second of time its frequency would be two cycles per second, and so on.

We have learned how to distinguish between direct or continuous voltages and currents, pulsating direct currents and voltages and alternating currents and voltages. We have also learned how to represent them by lines or curves drawn on paper. We might also define "amplitude." We shall not have occasion to use it to any extent in our discussion of the superheterodyne but it will often be encountered in discussions of alternating currents and voltages. The amplitude of an alternating current or voltage is the maximum value which it reaches. It reaches this value once in a positive direction and once in a negative direction during each cycle.

We are now ready to consider some sources of alternating currents—particularly high-frequency alternating currents, that is, alternating currents which go through a very large number of complete cycles per second. Here, we are only concerned with the vacuum tube as such a source. A vacuum tube of the correct type connected to circuit elements of correctly chosen values will act as an **oscillator** or generator of alternating currents of constant amplitude (said to be **undamped**). The frequency of these alternating currents can be changed by changing the constants of the circuit associated with the tube, that is, by changes in the inductance and capacity of the associated circuits. A vacuum tube will oscillate, that is, act as a source of alternating currents, if energy is fed back from its output or plate circuit to its input or grid circuit in phase with the current or voltage in the input circuit and in amount sufficient to at least overcome resistance losses in the circuit.

If we connect a vacuum tube oscillator to a properly designed antenna and ground system we shall have flowing in the antenna and ground system alternating currents of exactly the same frequency as those generated by the tube. These currents flowing in the antenna and ground system will set up disturbances in the surrounding medium (a hypothetical medium called the "ether" which is assumed to occupy all space and to penetrate all matter). The disturbance in the ether immediately adjacent to the antenna and ground system will be proportional to the value of the current flowing and hence goes through the same cycle of value changes as does the current. But the disturbance existing immediately adjacent to the antenna-ground system at any instant does not remain confined to that region alone but travels outward through space in all directions at a fixed speed (roughly 186,000 miles per second or 300,000,000 meters per second). Thus the medium at any point a given distance from the antenna-ground system will be subjected to a series of disturbances varying in intensity in the same manner as the current in the antenna-ground system varies in value. This disturbance will go through a cycle or series of changes in value from zero to a maximum in one direction, through zero to a maximum in the opposite direction and back to zero just as the current does. It may thus be represented by a curve like that of "C", Fig. 1, which we use to depict an alternating current.

We may also use the same form of curve to represent the disturbances set up in the either surrounding the antenna-ground system. Such a curve will help us to understand the term "wave-length."

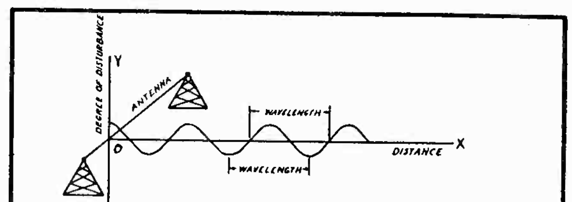


FIG. 2

REFER to Fig. 2. Notice that distances along our vertical axis Y-O-Y1 now represent "degree of disturbance" while distances along our horizontal axis O-X represent distance from the antenna. Suppose that at some instant of time "T" the current in our antenna-ground system is at its maximum value. This means that at the same instant the disturbance set up in the ether immediately adjacent to the antenna is a maximum and this maximum disturbance instantly travels outward from the antenna through space at a speed of 300,000,000 meters per second. Suppose that the current in the antenna goes through one complete cycle and again reaches maximum value in the same direction exactly one second later. In the meantime the maximum disturbance in the ether set up by the previous maximum value of antenna current has reached a point 300,000,000 meters from the antenna. Our new maximum value of antenna current now sets up another maximum value of disturbance in the ether which, since it is immediately adjacent to the antenna for the instant, is 300,000,000 meters from the nearest maximum disturbance. This distance between maximum values of disturbance in the ether is the wave-length of the signal and, in this case, is 300,000,000 meters. Suppose the current in the antenna were to reach a maximum positive value twice each second instead of only once. The maximum disturbance set up in the ether by one positive current peak would have time to travel only half of 300,000,000 meters from the antenna before a second maximum value of disturbance was set up by the succeeding positive current peak; the distance between areas of maximum disturbance would be 150,000,000 meters and this would be the wave-length of the new signal.

QUERIES *and* REPLIES

READERS ARE INVITED TO SEND IN THEIR QUESTIONS. THOSE OF GENERAL INTEREST WILL BE ANSWERED IN THESE COLUMNS.

In the June issue of "RADIO" you show a 160-meter radio telephone with Class B modulation. I can not see how this is a Class B arrangement. Will you explain? H.E.J., Santa Barbara, Calif.

A "Class B" condition exists in any tube which has great enough grid bias, or grid control so that the plate current is reduced to "cut-off." This condition exists with the 46 and 59 tubes when proper interconnections are made on the tube socket, as explained in the tube characteristic data sheets. When a tube is operating in the Class B condition the tube has a very high amplification factor, obtained by a large number of grid wires, and there are so many of these wires that they exert a complete control on the electron stream emitted from the filament or cathode without recourse to use of grid bias, and thus with no bias voltage, only a very small number of electrons are able to travel to the plate. When the grid potential is changed by a signal, the plate current will flow during the positive part of the cycle, and this will cause a resultant modulation in any output device connected in the plate circuit, either another tube, as in the transmitter circuit where the plate supply of the oscillator tube is modulated by the A.C. output from the modulators, or by operating a loudspeaker or other device. In the transmitter circuit shown, the microphone has a relatively high audio frequency output which is coupled through the coupling transformer to the two grids of the modulator tubes, and thus the grids of the tubes are driven directly from the microphone. This requires a microphone of relatively high level speech output, and also a transformer with a rather high step-up ratio, to get sufficient voltage to operate the grids of the two Class B tubes.

□ □ □

Question—What is meant by "Kilocycles"? Will you explain this term? **F.L.I., Lancaster, Calif.**

Answer—"Kilocycles" is short for "kilocycles per second". "Kilo" means 1000; it is used extensively in the metric system of measurement as used in science. Radio frequencies are very high, and it is therefore easier to express them in kilocycles rather than in cycles, just as it is easier to express large distances in miles rather than in the smaller unit, feet. 1000 cycles is one kilocycle. One million cycles is one megacycle. At short waves, the megacycle unit is often more convenient because the frequencies are comparatively very high.

So they will not interfere, stations are given frequencies having a definite separation between them. Scientists prefer to use the more scientific "frequencies' instead of wavelengths." However, there is a definite relation between wavelength and frequency, so that if either is known, the other can be found. At short wavelengths, it is sometimes convenient to state the wavelength rather than the frequency.

Question—I live near an airport station. When this station is transmitting I can hear the operator's voice but the speech is not clear. Moreover, this station covers the whole dial of my set. Please explain. How can this be remedied? F.K.T., Salt Lake City, Utah.

Answer—The effect mentioned probably occurs when this station uses somewhat more speech input power to its modulation system than is necessary, actually operating at 100% modulation. When this happens, the power tube system which supplies the energy radiated, is momentarily shut off. The aerial then oscillates at its own natural frequency until the energy has died out. This kind of interference is very "broad" within a short distance of the transmitting station.

It is difficult to suggest a remedy, since this condition may occur near any radiotelephone station using a high percentage of modulation. Special apparatus is necessary to check the percentage of modulation at frequent intervals. The trouble exists at the transmitting station, so there is little that can be done at the receiver. The use of a very small aerial on the receiver may help. The use of a tuned circuit ("wave trap") may improve results. It is connected in the aerial of the receiving set, and tuned to the frequency of the transmitting station.

□ □ □

Question—Transmitting tubes are said to have a certain "wattage." What is meant by this?

Answer—As employed by most manufacturers, the rating of a transmitting tube is the "safe plate dissipation in watts." It is possible to load a "50-watt" tube so that about 50 watts will be radiated as heat from the plate and bulb. A "50-watt" tube is not a tube that will deliver 50 watts power output, but will in the average circuit deliver about half of the input power as output. If a transmitting circuit is operating properly with circuits of low resistance, the output may be more. Tube overloading, it must be remembered, shortens tube life.

□ □ □

Question—What is a "pad"? I understand they are used in broadcast speech circuits. Why are they used?

Answer—A "pad" is an artificial line or resistance network for reducing the speech level in a sound amplifier in a land line, or between land lines.

If a broadcast station is receiving programs from two studios, located at a distance from the transmitting station, and one of the programs is to follow the other, it would be necessary to make rapid changes in circuit controls, if a "pad" were not used. There is only a few seconds available for making these changes.

If one studio is near the transmitting station, it will give more volume at the station end, than if it were located at a distance of say, 15 or 20 miles. There is loss or "attenuation" of energy in passing over the lines between the studio and the station. If the two studios are at different distances from the station, the volume received from them will differ. It is not entirely practicable to make changes in the volume control adjustment on the speech amplifier circuits to compensate for the differences in volume from the two studios. Here's where the "pad" performs a useful function.

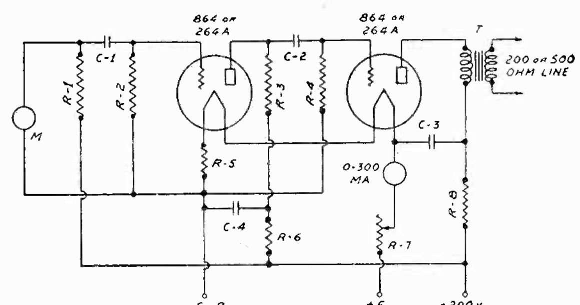
When the two program sources differ in volume, the loudest is "attenuated" or "padded" to approximately the speech level of the weaker of the two. No readjustment is then necessary in the station volume-control when changing from one studio to the other. The "pad" or artificial line absorbs a part of the energy, and allows changes to be made from various program sources without the necessity of making troublesome adjustments during a broadcast.

□ □ □

Question—Please give the circuit diagram of a two-stage condenser microphone amplifier. C.J.T., Columbus, Ohio.

Answer—The circuit diagram you request is given herewith. The tubes to be used should be either RCA Type 864 or Western Electric 264-A. Satisfactory performance can not be obtained by using ordinary tubes because they will be "microphonic". Jarring the amplifier will produce "ringing" sounds if such tubes are used.

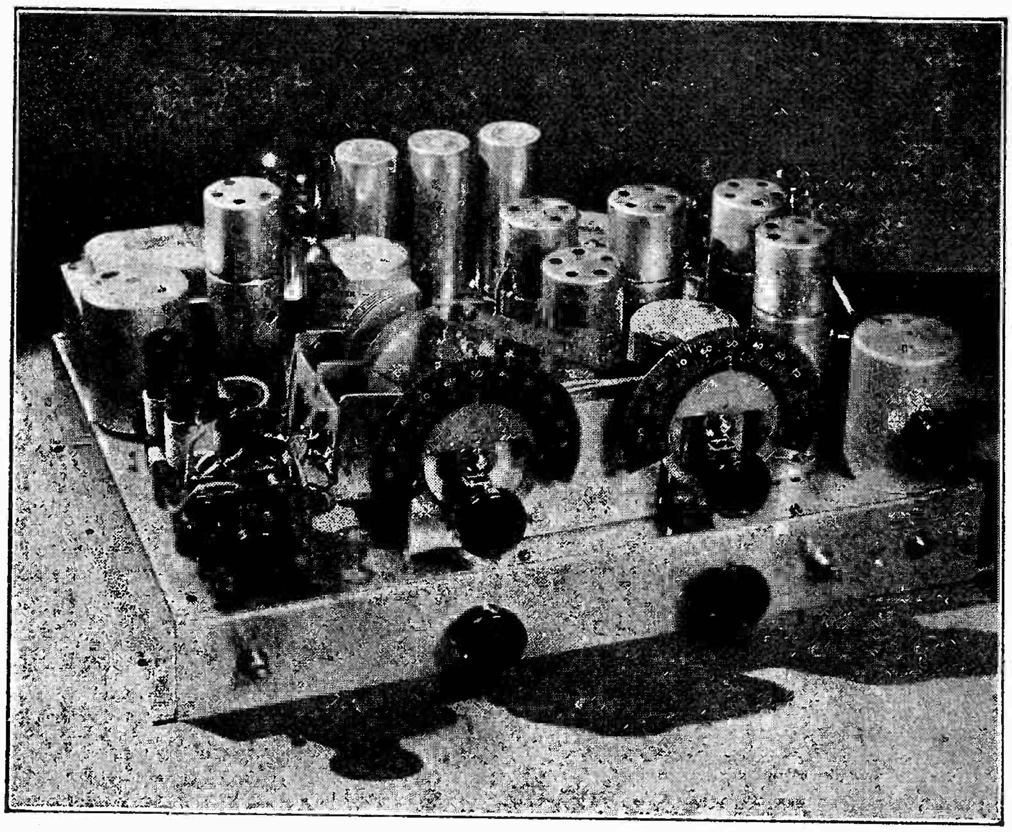
The output transformer shown should be either 200 or 500 ohms. This is essential if the output is to be used through a mixer, or passed through a line before being fed to the final amplifier.



R-1—2 to 10 megohms.
R-2—2 to 10 megohms.
R-3—100,000 ohms.
R-4—500,000 ohms.
R-5—12 ohms.
R-6—100,000 ohms.
R-7—30 ohms.
R-8—100,000 ohms.
C-1—.005 mfd. Mica condenser.
C-2—0.25 mfd.
C-3—0.5 mfd.
C-4—0.5 mfd.
M—Condenser Microphone.
T—Output Transformer.

What a Quick Answer, or a Circuit Diagram by Mail? Let "Radio" solve your problems.

Questions answered, 25c each. Circuit diagrams, 50c each. Send your questions to the Technical Editors. (No charge is made for questions answered on this page).



Announcing The

"SARGENT 9-33"

ALL-WAVE SUPER RECEIVER

15 TO 550 METERS

The Most Unique Receiver Ever Offered For Sale . . . Distinctly New

OUTSTANDING FEATURES

Has Two Intermediate Frequencies

The first stage on 465 KC is for image suppression. The second, on 175 KC provides razor-edged selectivity that cannot be matched by higher I.F.

Single Dial Tuning, Band Spread on All Waves

Both dials tune the **same condenser.** The left hand dial is for general tuning while the right hand one provides band spread on any wave to which the other is set.

Tap Switch for Changing Wave Bands

For efficiency, the equal of any other system. For convenience, this method is in a class by itself.

Separate Beat Oscillator for CW

A new method of coupling to Beat Frequency Oscillator gives super efficiency and high sensitivity on even the weakest C.W. signal.

No "Frequency Creep"

All oscillators use either electron coupled or "High C" circuits, providing exceptional stability and complete freedom from frequency creeping.

Low Background Noise Level

Due to the I.F. system used, and complete absence of inter-coupling the Sargent 9-33 has a background noise level as low as in any receiver of equal power, and much lower than the average.

Push Pull 2-A-5s in Output Stage

Also a headphone jack in the second detector plate circuit.

Sargent Band Spreader Units

At Your Dealer's Store

Amateur Net Price . . . $1.35

Completely Shielded Coils

A separate unit shield encloses coils and tap switch. This, together with the cabinet which shields the entire top and bottom of the chassis makes the receiver extremely free from direct pick-up.

Handsome, Two-Tone, All-Metal Cabinet

The panel is of grained aluminum finish and is set into a steel cabinet finished in dark, crystalline lacquer. The receiver is a commercial style job that adds to the attractiveness of the best radio station.

Detachable Power Pack

The power pack is a separate unit that bolts solidly to the receiver chassis, thus providing the convenience of a single chassis for both. However, for those who wish an entirely separate power pack, this unit may easily be unbolted and removed to any desired distance from the receiver.

Exceptional Phone Band Results

The 175 KC I.F. stage provides a degree of selectivity for phone band work that is without an equal. During the week in which final tests were conducted on this receiver, 2nd and 3rd district phones were heard R-5 on the 160 meter band, while on 80 meters all U. S. Districts and two K-6s were heard. On 20 meters all districts were recorded.

Excellent for CW—High 20-Meter Efficiency

Strong signals on CW from all districts and many foreign stations including G-2-HG on 20 meters picked up during final tests. Local "raw A.C." signals cut off at 2 KC on all bands.

LIST PRICE, Including Power Pack, Less Tubes and Speaker $125.00

Prices of D.C. Models on Request.

Speaker and Tube Requirements

The Sargent 9-33 is furnished for operating permanent magnet speaker or for dynamic having 70 mil, 1000 ohm field. Field supply is furnished for the speaker. Be sure and specify which model is desired. There is no difference in price.

Tube requirements are as follows:
2—2A5s, 1—2A7, 1—56, 3—57s, 1—58, 1—80.

IMMEDIATE DELIVERY

E. M. SARGENT

721 McKINLEY AVE. - - - - - - OAKLAND, CALIF.

Design of Practical Crystal Controlled Transmitters

(Continued from page 13)

A FAHRENHEIT thermometer is a useful adjunct to a crystal oscillator. It should be placed at the crystal holder. If desired, the oscillator can be accurately calibrated. If a frequency vs. temperature curve is plotted for the crystal, the exact frequency for any temperature can be readily found from the curve. Such a curve can be plotted on ordinary cross-section (or "graph") paper. A useful fact for this purpose is that an "X-cut" crystal decreases 15 cycles per million in frequency for every degree rise, on the Fahrenheit scale. The temperature vs. frequency curve for such a quartz plate is practically a straight line. It is therefore easy to plot, because only two points determine it. A few more points will determine it more accurately.

A crystal is essentially a frequency-stabilizing rather than a power device. It is true that considerable power can be obtained from overloaded crystal oscillators but the frequency emitted will suffer accordingly. Often, overloading spoils the "note," and a noticeable frequency-drift results. If a "Y-cut" plate is used in an overloaded oscillator, the crystal may even "jump" to another frequency. The frequency-drift under normal operation should be checked. For this, use a test oscillator having a very small frequency drift. The frequency-drift of the test oscillator should also be known for accurate results.

The test-oscillator should be allowed to operate until the period necessary for "warming up" is over. If possible, check it against signals known to be steady. WWV is an excellent standard. Broadcast-station harmonics can also be used. The frequencies are checked by setting the test oscillator to beat with the crystal oscillator. A beat-note of one cycle per second should be obtained, starting the oscillator under test, "cold." The oscillator is then allowed to operate for a period of time, after which it is again checked. By retuning to a one-cycle beat-note, the drift is ascertained. The difference between the original and final frequencies should be only a fraction of a kilocycle under proper operating conditions.

New Class-B Tube

RCA RADIOTRON RCA-19 — **CUNNINGHAM C-19**

The 19, like the types 53 and 79, combines in one bulb two triodes designed for Class B operation. It is intended for use in the output stage of battery-operated receivers and is capable of supplying approximately two watts of audio power.

Class "B" Twin Amplifier

Filament Voltage (DC)	2.0 Volts
Filament Current	0.26 Ampere
Maximum Overall Length	4¼-in.
Maximum Diameter	1 9/16-in.
Bulb	ST-12
Base (for connections, refer to Note 1)	Small 6-pin

Class "B" Power Amplifier

Plate Voltage	135 max. Volts
Dynamic Peak Plate Current (per plate)	50 max. Milliamperes

Typical Operation:

Filament Voltage	2.0 V.
Plate Voltage	135 V.
Grid Voltage	0 V.
Static Plate Current	10 MA.
Load Resistance (plate to plate)	10000 Ohms
Average Power Input*	170 MWTS.
Nominal Power Output	2.1 Watts

*Applied between grids to give indicated values of power output.

Note 1:

Pin 1—Grid (Triode T_2)	Pin 4—Filament
Pin 2—Plate (Triode T_2)	Pin 5—Plate (Triode T_1)
Pin 3—Filament	Pin 6—Grid (Triode T_1)

Pin numbers are according to RMA Standards.

CLASSIFIED RADIOADS

Advertising rate 10c per word, minimum 10 words. No charge is made for name and address. RADIOADS for the August issue should be mailed on or before July 10th.

SENSATIONAL microphone value — Universal Model "Y"—Experimenters' single-button, watch model type. 200 ohms. Pure gold spot center diaphragm. Only $2.00, including valuable 1933 general catalog with diagrams. Universal Microphone Co., Ltd., Inglewood, California.

250 WATT TUBE, RCA 204A, slightly used, $25.00. Several new and unused Western Electric 205-D tubes (5 watts), $4.50 each. Half kilowatt Lowenstein Navy Type 500 cycle quenched spark transmitters, complete with 500 cycle motor generators, new and unused. Make an offer. Navy Type Receivers, SE 143 (same as IP 500) with audion control cabinets, $25.00 each; wavelength range 250-3100 meters, but loads up to 7500 meters. SE899 receivers (ultraudion ckt), less audion panels, $15.00 each, 250 to 7500 meters. Used but O.K. D. B. McGown, 1247 47th Avenue, San Francisco, Calif.

BARGAINS IN SHORT WAVE APPARATUS— July specials, AC-DC receivers using 77, 43, 25Z5, in beautiful black crackle finished metal cabinet. Complete with four coils, $14.75. Wired crystal stage, complete with crystal, holder, tube, in aluminum can, $19.90. Many more. Write for free sheet. Edbern Radio Co., 2156 Cruger Avenue, New York City.

PLUG-IN COILS, set of four wound on bakelite four prong forms, 15-210 meters, 50 cents postpaid. NOEL, 809 Alder, Scranton, Pa.

POWER SUPPLY EQUIPMENT: General Electric Five Kilowatt 120 volt DC generator, direct connected to 4 cylinder gas engine (built as a single unit) with 90 cells of 150 ampere hour EDISON storage batteries. Used, but overhauled and in good condition. Fine for remote radio station, large ranch, or small town; switchboard, and incidentals included. Original cost about $3500. No reasonable offer refused. D. B. McGown, 1247 47th Ave., San Francisco, Calif.

FOR SALE—BACK ISSUES OF RADIO, 1920-30, inclusive, being Vol. 1, No. 6 to end of Vol. 12, short 3 issues, $20. Also QST, Vols. 1-16 inclusive, 15 volumes bound, first issue of Vol. 1 missing, $58. Transportation extra. Harold M. Reavis, 1180 So. Fair Oaks Ave., Pasadena, Calif.

QSL CARDS, 75c per 100, 2 colors. Post-paid. WD9GH, 1816 5th Ave., North, Minneapolis, Minn.

FIVE HUNDRED WATT TUBE, Mullard (English make) new and unused, $65.00. Two kilowatt 500 cycle motor-generator, with shaft extended for 1750 RPM AC motor drive, $50.00. D. B. McGown, 1247 47th Ave., San Francisco, Calif.

ANSWER FACTORY CAN HELP YOU WITH that receiver, transmitter, antenna. Send problem and ask for quotation. All work supervised by Robert S. Kruse, RFD No. 2, North Guilford, Conn.

1933 WALLACE SHORT WAVE MANUALS. Warehouse stock. Jobbers and dealers supplied promptly. Edw. J. Byrne, 263 West 128th St., New York, N. Y.

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WRITE for your copy of the new Ohmite eight-page resistor and rheostat bulletin Number 9 which contains full information about the newest types of units and their uses. It's yours for the asking.

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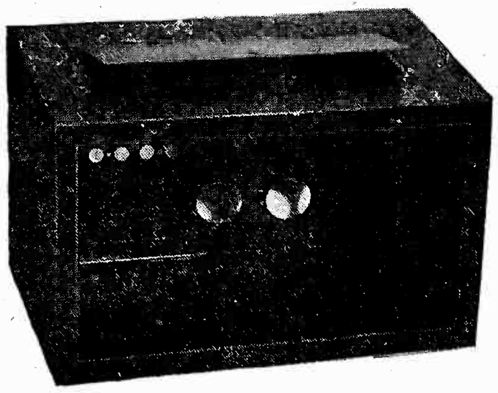
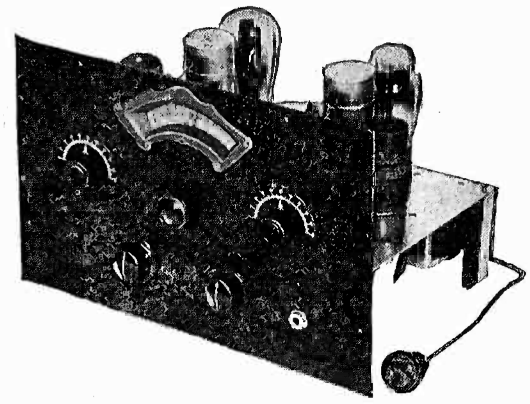

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Unusual Performance

A MODERN receiver . . . one that spreads-out the bands with micrometer vernier tuning. A receiver that is housed in a professional black crackle metal cabinet, totally shielded. A receiver that uses the tubes that give best results for short-wave reception. The circuit is novel, in that it permits the use of ANY type of antenna, by means of many connection terminals at the rear of the cabinet. Tuned radio-frequency amplification; newly designed coils that have given optimum performance with lowest losses. New type audio system. Beautiful in appearance. Cadmium plated chassis. Tube shields. Fine condensers. Heavy power supply. Can be used either with headphones or dynamic speaker. Has special detector bias adjustment. Here is a receiver that PULLS 'EM IN. Its selectivity is **amazing!** Sold completely wired, in beautiful metal cabinet, with tubes and speaker . . . ready to operate. Sold also in kit form, with or without speaker, tubes or cabinet. Sold in assembled and unwired form. Or you can buy any of the individual parts. For SELECTIVITY, SENSITIVITY, VOLUME, SIMPLICITY and BEAUTY, here is YOUR receiver.

TERMS:—50% cash with order, balance C.O.D. Prompt deliveries. We ship to any part of the world. All merchandise fully guaranteed. Only best parts used.

Uses 57-58-59-80 Tubes . . . A.C. Operated . . . New Audio Coupling System . . . New Type Coils

PRICES

The Complete Kit of Parts, everything needed, excepting tubes, speaker and cabinet. (List price $27.50) Your price........ **$16.50**

Complete Receiver Kit, assembled and wired, but without tubes, speaker and cabinet, $24.00, NET. (List price $34.60)

Complete Receiver Kit, with beautiful black crackle metal cabinet, all tubes, dynamic speaker, unwired, $26.70, NET. (List price $44.50). Without speaker, $25.20, NET.

Complete Receiver, cabinet, tubes, speaker, assembled but not wired, $28.70, NET. (List price $47.50). Without speaker, $46.00, NET.

Complete Receiver, cabinet, tubes, matched dynamic speaker; wired and ready to operate, and fully guaranteed, only $31.95, NET. (Without speaker, $30.40, NET.)

COILS SOLD SEPARATELY. $2.70 NET per set of two. (List price $4.50.) Or a complete set of six coils (3 pair) for the entire amateur band, $7.50, NET.

ELECTRONIC LABORATORIES
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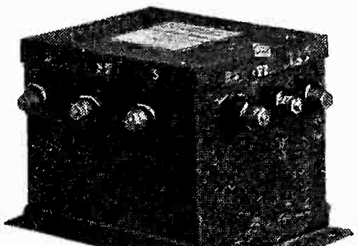
DON C. WALLACE TRANSMITTING TRANSFORMERS



UNIVERSAL announces an entirely new line of transformers, engineered and produced under the personal supervision of Don C. Wallace . . . world's foremost authority on short-waves, winner of the Hoover radio cup and author of the "1933 Short-Wave Manual" . . . all created specifically to meet exacting requirements of the amateur and have withstood rigid laboratory tests and practical use in the field.

THE new Wallace power transformers include corrugated porcelain insulators on all high voltage, terminals impregnated and sealed wingings . . . Power units that humidity and moisture cannot affect, and voltage regulation far superior to anything heretofore available . . . Power filament transformers are provided with an insulation safety factor far in excess of any circuit needs.

A SPECIAL circular showing diagrams and giving full description of Wallace transformers now available at your dealer or jobber.

Universal Microphone Co.
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POWER CRYSTALS

MAXIMUM OUTPUT
SATISFACTION GUARANTEED

40-, 80-, 160-METER CRYSTALS (ground to approximate frequency) $3.75 each, NET.

Crystals ground to exact frequency, at special prices.

S.S. SUPER CRYSTALS............$4.00, NET.

These crystals can be supplied for 450, 465 or 520 KC.

Crystals For Commercial Transmitters and Receivers. Prices on application.

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All crystals guaranteed to give complete satisfaction.

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Dept. RAD, 85 CORTLANDT ST., NEW YORK

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No. 465-151

Jefferson Class "B" Amplifier

Transformers and chokes are typically Jefferson in quality of materials and fine workmanship. The latest and most modern engineering features enter into their construction. The transformer and choke items which make up the class "B" amplifier are as folows:

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465-151	Plate Supply Transformers	$8.75
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Radio Wholesalers and Dealers everywhere stock Jefferson Class 'B' Amplifier Transformers as well as Jefferson Audio, Input, Output and Power Replacement Transformers.

Send for Catalog 35-R describing these quality transformers. Class "B" Amplifier circuit diagram is also available upon request.

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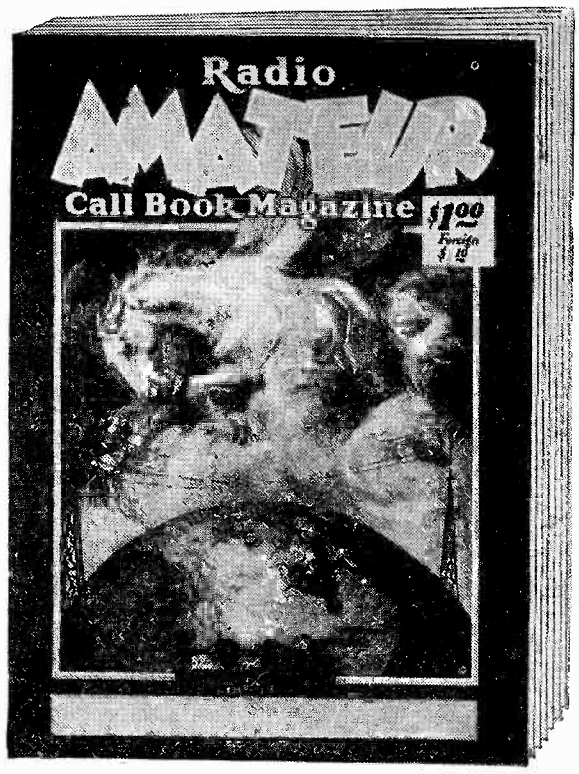

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COMPLETE KIT OF PARTS For Beginner's Transmitter

DESCRIBED IN THIS MAGAZINE

Here Is What You Get:— **$4.69** NET

Everything included except crystal, & tube.

1—Barrett Micalite Coil Form.
1—Barrett Micalite 4 prong Coil Socket.
1—Barrett 6-Prong Micalite 2A5 Tube Socket.
1—O-100MA Readrite Milliammeter, Panel Mount.
1—Baseboard; Correct Size.
1—Front Panel; Correct Size.
1—3" Bakelite Dial.
1—Set Crystal Holder Parts.
5—Connector Clips.
2—.002 Mica Fixed Condensers.
1—.00025 Variable Condenser.
2—Resistors, 40M. and 10M. Ohms.
1—Pkge. Hardware and Wire.

Power Supply For This XMTR

Complete Kit of Parts including 450 volt transformer, choke, 2 condensers, sockets, connector clips, baseboard and wire. Everything required, except rectifier tube. **$4.69** NET

BARRETT ULTRA-EFFICIENT Low Loss MICALITE PARTS New-Type XTAL HOLDER

Plug-in type crystal holder. Dust-proof. made of Barrett Micalite, insuring lowest losses. Low Capacity between top and bottom plate connection. Monel metal plates, accurately lapped. Fits any standard 4-prong socket. Top plate connection standard screen-grid cap. Will take up to full 1 in. sq. crystal.

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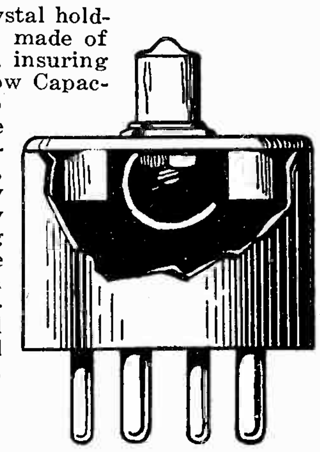
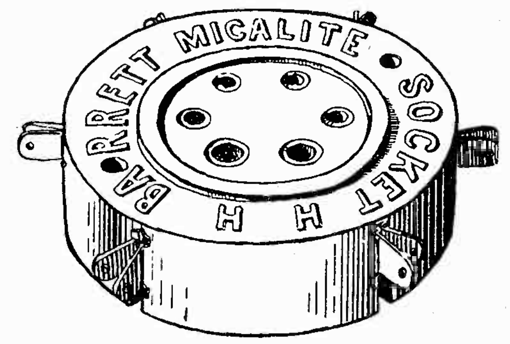
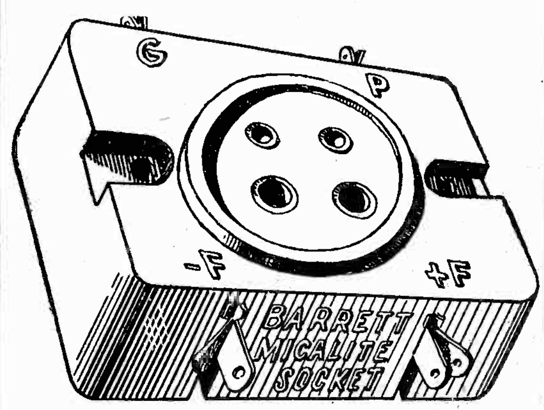




BARRETT RS-50 SOCKETS

5-, 6-, and 7-prong Micalite sockets with new positive-grip, self-cleaning contacts that never work loose or cause noisy reception. Highly insulated for transmitters. The ultimate for any purpose. Price 48c each NET.



Barrett 4-PRONG SOCKET

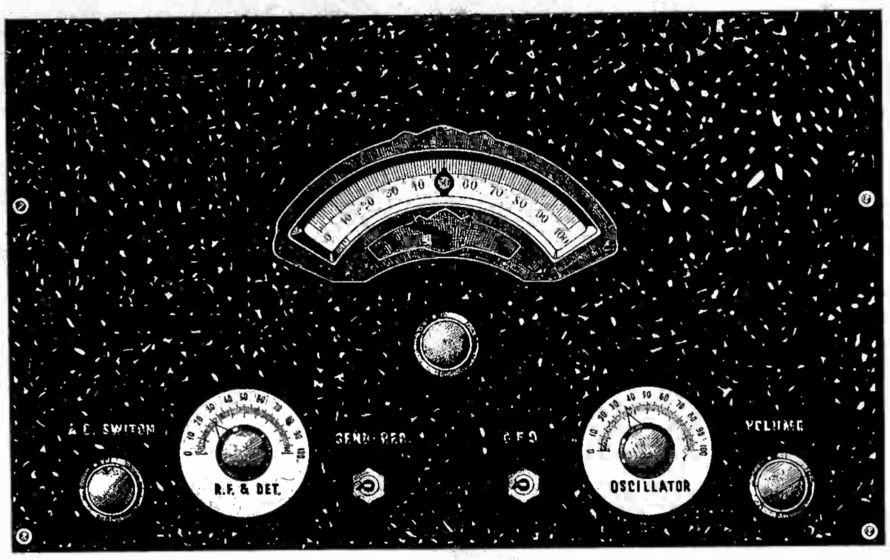
Same as above. Same price.

BARRETT MFG. CO.
1382 - 16th Avenue, San Francisco, Calif.

DX-8 CRYSTAL FILTER SUPER-HETERODYNE

NEW FEATURES
Found Only in This Receiver

1. Uses all new type tubes throughout where they can be utilized to advantage. Eight in all; equivalent to ten of old type tubes.
2. Stage of TUNED Radio Frequency amplification ahead of First Detector.
3. 520 kc. Intermediates and crystal which allows maximum freedom from "image interference."
4. High sensitivity of approximately two micro-volts per meter with low ratio of signal-to-noise due to inclusion of quartz crystal filter.
5. Universal output for speaker or headphone reception.
6. Single-dial tuning of full band-spread type.
7. Convenient switch for cutting B-lead in set when transmitter is in use.



THE FRONT VIEW IS STRIKING IN APPEARANCE

Front panel is of cadmium plated steel finished in black crystal enamel, baked; tough and durable. Full vision precision vernier dial on the band-spread condenser allowing 180° spread of the 80-meter band. Accurately calibrated Tank Condenser tuning dials, thereby permitting receiver to be logged and reset to any predetermined setting. All hardware and dials in satin silver finish with engraving carefully done through the enamel finish. A professional looking job, giving the whole receiver a commercial appearance.

SPANS THE WORLD!

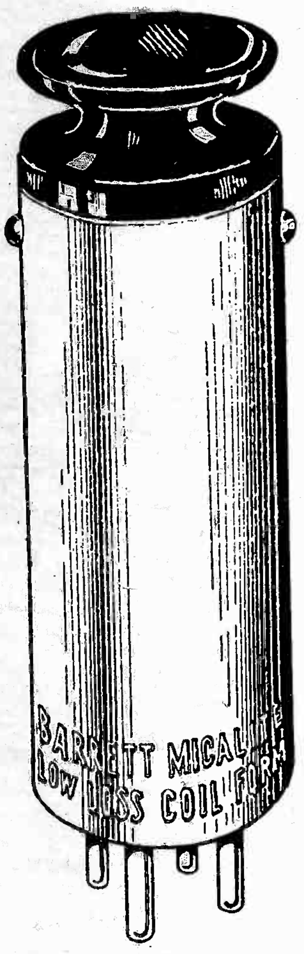
THE 520 kc. Crystal Filter Superheterodyne is offered to a discriminating Amateur and Short-Wave-minded group as the finest receiver for the price ever presented. Actual tests have indicated a sensitivity of better than 2 microvolts per meter on the forty-meter band; a sensitivity that is so desirable to get the weakest "DX" stations. This is truly a "DX" Receiver, one that will "dig in" and bring out those elusive Europeans or Asians; one that will make communication over great distances a pleasure, and will bring to the Amateur eager for a "WAC" a thrill never before experienced. Without a doubt, the receiver that "SPANS THE WORLD."

Complete with full set of MATCHED RCA or Cunningham Tubes—$61.00

Dealer's inquiries solicited; usual trade discounts.

$53.50 NET TO AMATEURS

Above prices include cabinet, electrically welded steel, cadmium plated with black crystal finish to match panel.



Micalite Coil Forms

Coils wound on genuine Barrett "MICALITE" Coil Forms, recognized for their extremely low-loss and low power factor properties. Coils plug into "sure-grip" Barrett "MICALITE" Sockets, making for an extremely high efficiency in the tuned RF and Detector circuits.

2 Sets of Coils with Each Receiver

Two sets of coils (three in a set) are furnished at no extra cost with DX-8 Receiver (any band). The purchaser has the option of selection of these coils in any band: 20, 40, 80 or 160 meters, or the short wave broadcast band of 25 and 48 meters.

LOG
California to Ceylon

These stations were logged by W6BYB, John Mayes, Sacramento, Calif., in the short time of 30 minutes on the 20-meter band at 9:30 P.M., May 26th, 1933.

Ceylon
VS7GM (QSO made)
Australia

VK5FM	VK3KX
VK3HK	VK2JT
VK2HW	VK3WX
VK2OT	VK3BX

Tasmania
VK7JB
VK7GE
Japan
J1EG
Hungary
HAF1G

SELECTIVITY

1. Continuously variable degree of selectivity from around 100 cycles to 5 kc.
2. High degree of selectivity and single-signal effect obtained through use of quartz filter in Intermediate frequency stages.
3. Freedom from "image interference" and gain in pre-detection selectivity due to use of Tuned RF ahead of First Detector.
4. Specially designed intermediate transformers operating at 520 kc for greatest efficiency and sharp peaking.

SENSITIVITY

1. Sensitivity approximating two micro-volts per meter on 40-meter band.
2. Greater sensitivity on "weak signals" due to inclusion of a stage of tuned RF amplification ahead of first detector.
3. High overall sensitivity gained through use of new type tubes, 2A7 and 2B7 as first and second detector respectively.
4. High efficiency obtained by careful design of circuit; proper engineering of parts placement, and correct use of extremely low power-factor coil forms and sockets.

DX-8

KITS! READY TO WIRE

For the man who likes to "build his own"
Complete set of parts, hardware, wire, blueprints, etc., is offered in kit form; everything necessary for the complete receiver with full instructions and layout. Nothing more to buy; nothing to make.
PRICE..........$46.50 Net to the Amateur

TERMS

C.O.D. 50% deposit with order; balance upon delivery. Merchandise fully guaranteed. Your money cheerfully refunded if you are not satisfied with performance after ten days trial.
Prices advertised FOB, San Francisco, Calif.

INDIVIDUAL PARTS

COILS—Completely wound sets of coils for the 520 kc. super; 20, 40, 80, or 160 meter bands; also special short-wave broadcast band and regular broadcast band coils. Wound on regular BARRETT "MICALITE" Coil forms, per set of three, any band. **PRICE**..........**$4.50 per set, Net.**

SS XTALS and XTAL HOLDERS—520 kc., power type xtals and special air-gap type holder; molded of "MICALITE," efficient, dust-proof and low capacity. Xtals especially cut and tested for this circuit, and xtal holder accurately designed for maximum results in the 520 kc. superheterodyne.
PRICE..........520 kc. Xtal, $4.00; Air Gap Holder.....$2.50 Net.

INTERMEDIATE TRANSFORMERS—Specially designed set of required intermediate frequency transformers including split secondary crystal filter unit and oscillator unit for Beat Frequency Oscillator. Accurately peaked at 520 kc. **PRICE**..........**$4.96 per set, Net.**

ORDER BLANK

THE BARRETT MANUFACTURING CO.
1382 - 16th Ave., San Francisco, Calif.

Gentlemen:—Please send me the following checked items via..........
.... C.O.D.; enclosed is 50% cash deposit;
(Express, Parcel Post)
balance to be regular C.O.D., and it is understood that if the merchandise is not satisfactory in any way, my money will be refunded in full within ten days trial period.

☐ **TYPE DX-8 Amateur Superheterodyne,** in metal cabinet, completely wired to order and custom-bilt, with any two sets of coils. Specify which bands desired for coils. $53.50, Net.
☐ Ditto, but with complete set of matched RCA tubes, $61.00, Net.
☐ **TYPE DX-8K Amateur Superheterodyne,** Kit Form, complete with metal cabinet, all hardware, wire, parts, etc., including two sets of coil forms. $46.50, Net.
☐ **COILS,** completely wound set of coils; **Micalite** 20, 40, 80 or 160 meter bands (underline band wanted). Per set, $4.50, Net.
☐ **520 Kc Intermediate Transformers and Crystal Filter Unit,** including beat oscillator coil unit. Per set, $4.96, Net.
520 Kc. "Y" Cut Power Type Xtal; of finest Brazilian quartz, with special BARRETT Micalite air-gap precision type dust-proof plug-in xtal holder.
☐ 520 Kc. Xtal—Net, $4.00. ☐ Holder—Net, $2.50
☐ Both units together..........Net, $6.00

Name (print) ....
Address..........
City or Town.......... State..........

WHERE TO BUY THE DX-8

SAN FRANCISCO, CALIF.
I. S. Cohen's & Sons, 1025 Market St.

SACRAMENTO, CALIF.
Pearson's Radio Laboratory
2321 "F" St.

LOS ANGELES, CALIF.
Radio Television Supply Co.
1000 So. Broadway

LONG BEACH, CALIF.
Inter-City Radio Stores Co.
405 American Ave.

PORTLAND, OREGON
Wedel & Co. 443 Washington St.

SEATTLE, WASH.
Wedel & Co. 520 - 2nd Ave.

TACOMA, WASH.
Griffith Sales Co., 710 St. Helens Ave.

OAKLAND, CALIF.
Amateur Supply Co. 390 - 11th St.
G. M. & C. Radio Supply Co.
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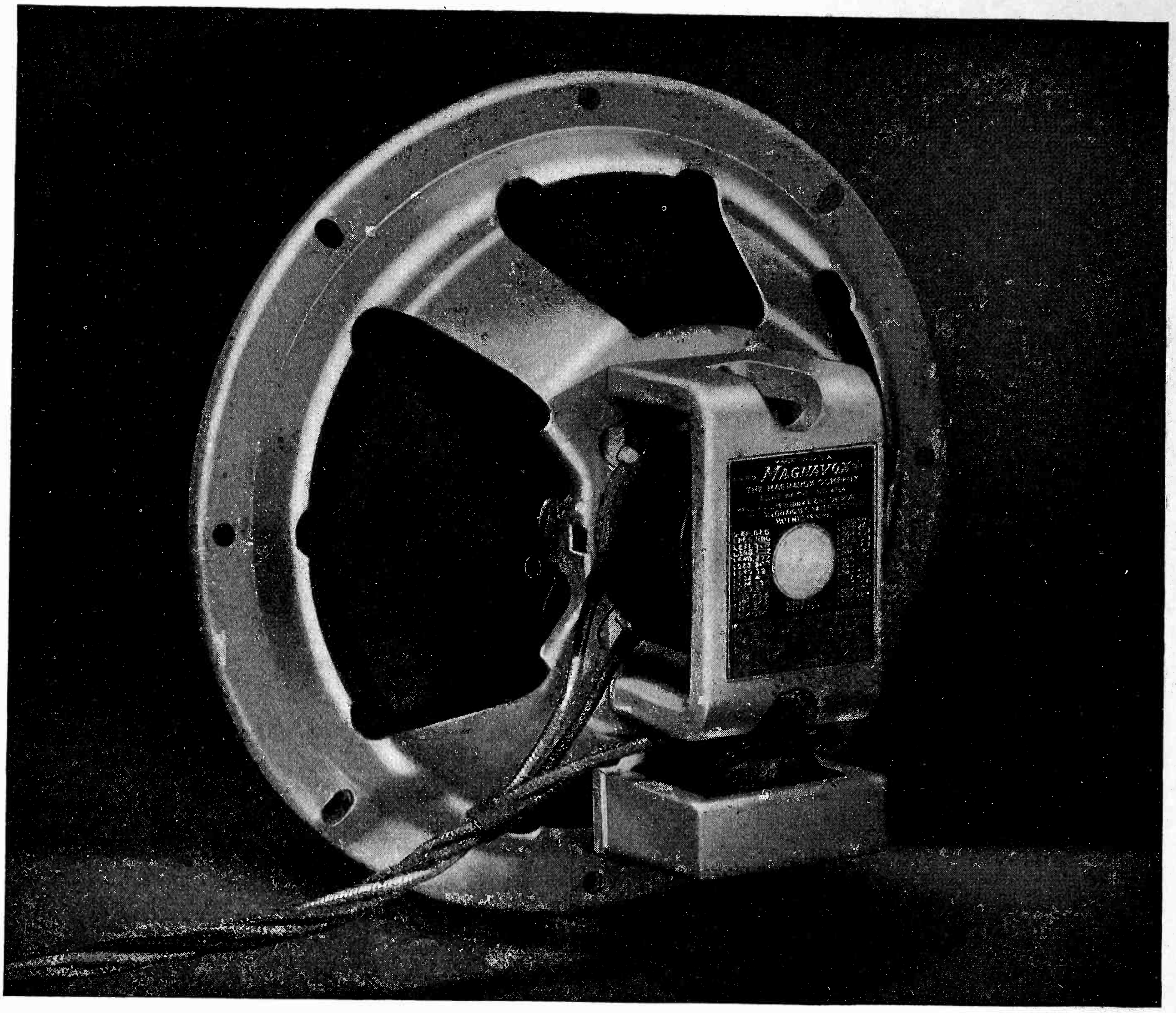

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★ EFFICIENCY!
★ QUALITY!

NEW MAGNAVOX
● MODEL 136 ●
SIX INCH DYNAMIC

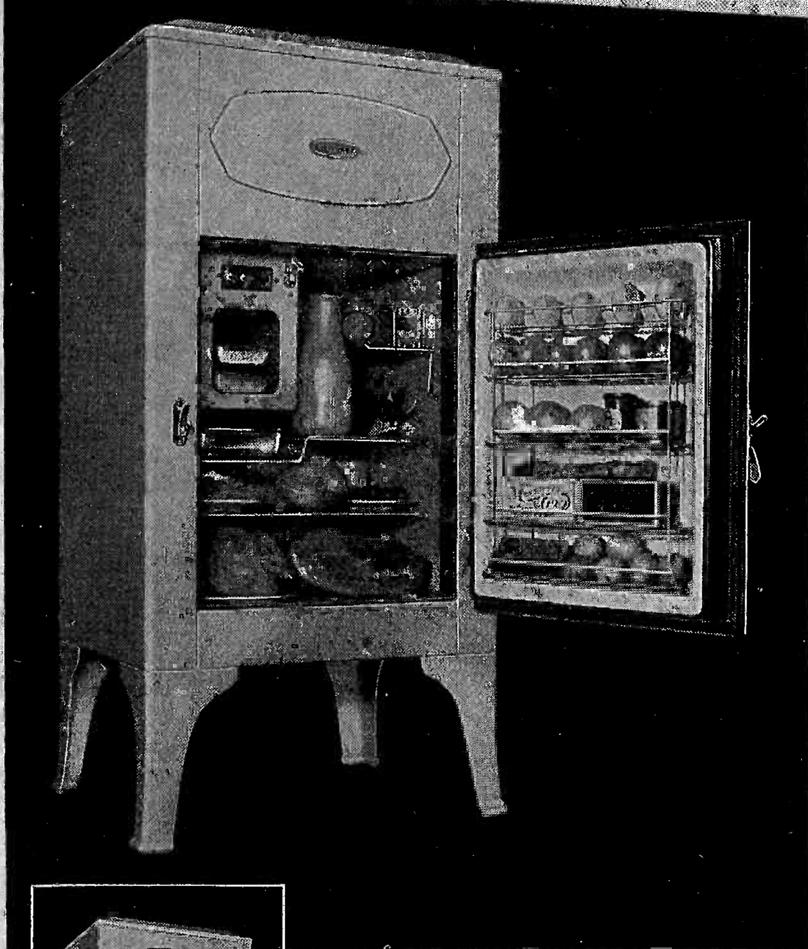
MAGNAVOX offers this new six inch Dynamic . . . low in cost but high in efficiency . . . with exceptional tone quality for a speaker of its size! Unusually sensitive, it solves the problem of the small set manufacturer, enabling him to put real quality into his automobile and midget sets. Write for sample and prices today.

The Magnavox Company

FORT WAYNE, INDIANA

MAGNAVOX
REG. U.S. PAT. OFF AND THROUGHOUT THE WORLD

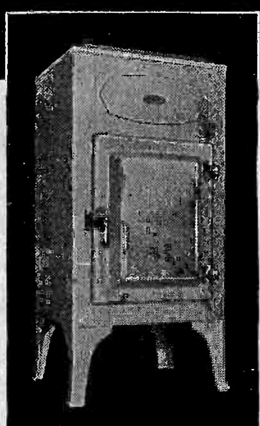
HERE'S THE SALES CLINCHER YOU'VE BEEN LOOKING FOR!



The SHELVADOR

U. S. PATENT 1898922

An exclusive patented feature of the New CROSLEY *Electric* REFRIGERATOR



Here is the most sensational selling feature ever thought of in ELECTRIC REFRIGERATION . . . the most sensational advance in cabinet design since the first ice-box was brought out . . . a feature so self-evident, so new, so convenient and helpful that every housewife after one glance will say: *"That's what I must have!"*

The Shelvador doesn't need explaining. One glance and the story is told. What a show-room and show-window feature!

With the Shelvador you're a mile ahead of competition. You have something every housewife wants in her new electric refrigerator or is sorry she hasn't in her present one.

Increases "Usable" Capacity 50%

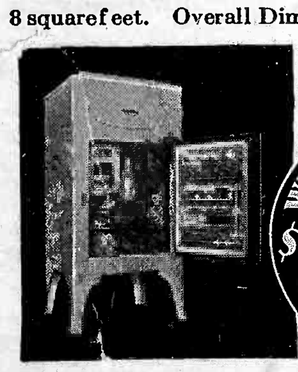
Shelvador actually makes the "small" refrigerator "larger" by increasing the "usable" space. It saves the annoyance of "feeling around" for small, hard-to-find objects . . . puts them where they are easily reached.

Only Crosley Offers It

And remember—only the Crosley Electric Refrigerator can use the Shelvador; for it is an exclusive, patented Crosley feature. Insulation is not sacrificed in the Shelvador—the exterior of the door is extended to permit the use of a standard thickness of insulation.

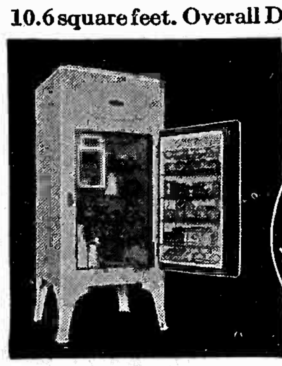
In addition to the Shelvador, the Crosley Electric Refrigerator—famous last year for its trouble-free, service-free operation, has been refined in several points to make it even better. See your nearest Crosley distributor or write direct to factory.

MODEL D-35 NET contents — 3½ cubic feet. Shelf area—8 square feet. Overall Dimensions: Height, 50⅝"; Width, 23⅞"; Depth, 24"; Leg Height, 10⅞" No. ice trays, 2; No. ice cubes, 42.



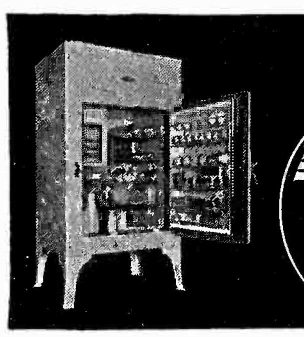
WITH SHELVADOR $89.50

MODEL D-45 NET contents — 4½ cubic feet. Shelf area—10.6 square feet. Overall Dimensions: Height, 56⅞"; Width, 23⅞"; Depth, 24"; Leg Height, 10⅞" No. ice trays, 3; No. ice cubes, 63.



WITH SHELVADOR $99.50

MODEL D-60 NET contents—6 cubic feet. Shelf area—11.5 square feet. Overall Dimensions: Height, 57½"; Width, 29½"; Depth, 25⅞"; Leg Height, 10⅞"; No. ice trays, 3; No. ice cubes, 63.



WITH SHELVADOR $130

ALL PRICES INCLUDE DELIVERY..INSTALLATION..ONE YEAR FREE SERVICE

Montana, Wyoming, Colorado, New Mexico and west, prices slightly higher

The Crosley Radio Corporation - Cincinnati

POWEL CROSLEY, Jr., *President.* Home of *"the Nation's Station"*-WLW

CROSLEY *Electric* REFRIGERATOR

WITH SHELVADOR

U. S. PATENT 1898922

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Pulling...

Their weight in the boat

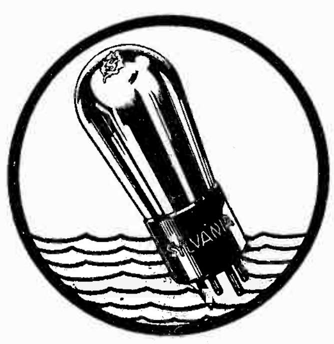
ABSENTEE owners have never controlled the destinies of the Hygrade Sylvania Corporation.

The men who own the major portion of the stock are all active in managing the business. They work hard. They put the success of their company above all else. They pull their weight in the boat.

This unswerving loyalty to one ideal is a large part of the reason why Hygrade Sylvania has increased its financial and dealer strength, even during the years of depression. Throughout 1930, 1931, 1932 . . . and today . . . the company's credit rating has always been AAA1.

The radio set owner has been given a high quality, carefully inspected tube. The radio set manufacturer has had expert technical help and advice. It was Hygrade Sylvania who first pioneered the development of new and more efficient tubes for automobiles . . . and later, the new 6.3 volt group of tubes.

Dealers and jobbers have had the support of continued advertising, of fair price protection policies. Strong selling pressure from popular musical radio programs, and the fine quality of Sylvania Tubes themselves, provide unmatched sales opportunities.



The support of a company like the Hygrade Sylvania Corporation can mean much to your business. Write us for further details. A letter puts you under no obligation. Hygrade Sylvania Corporation, Sylvania Division, Emporium, Penna.

Sylvania

(Reg. U. S. Pat. Off.)

THE SET-TESTED RADIO TUBE

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