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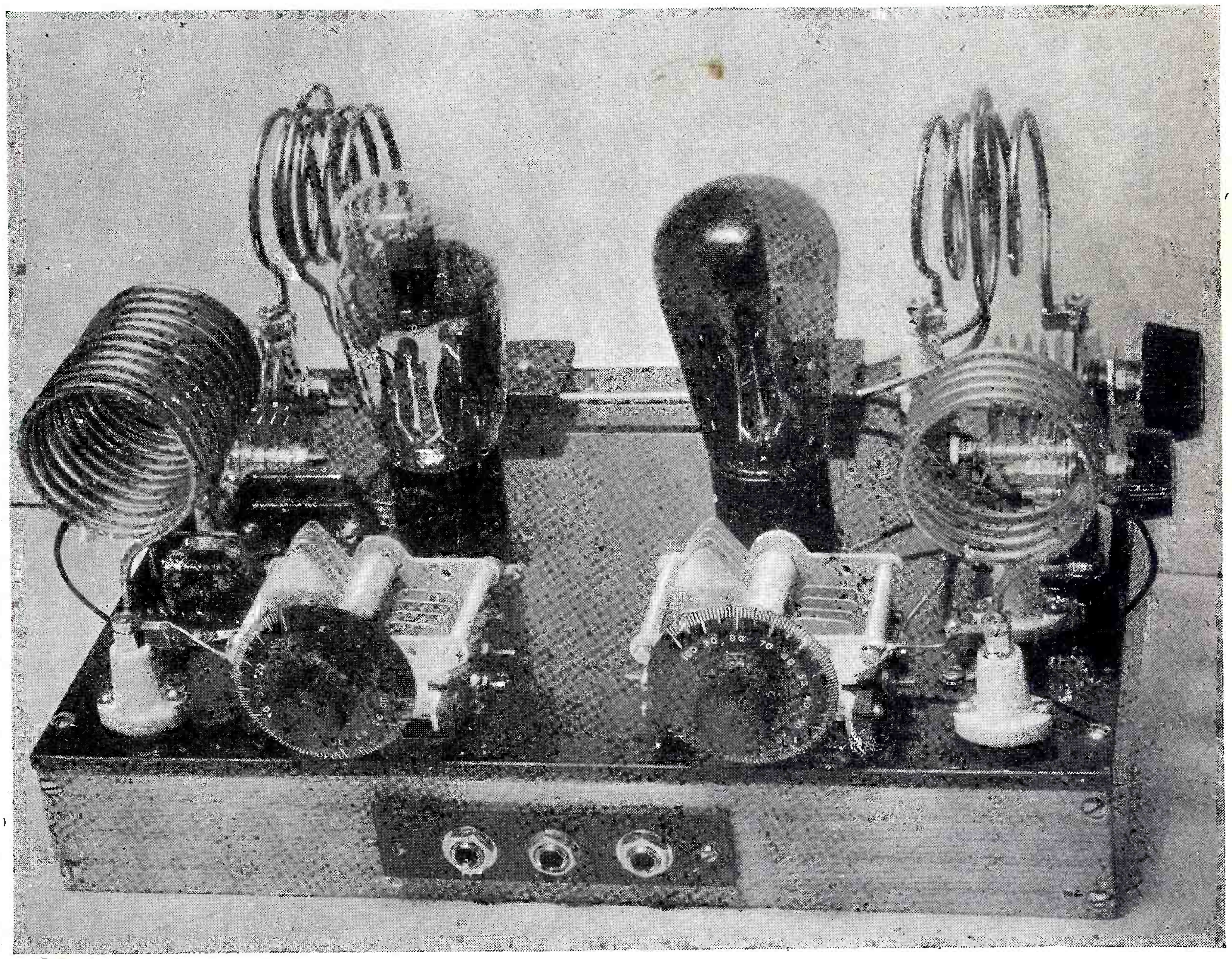

Feature Articles In This Issue By . . .

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COL. CLAIR FOSTER • ALBERT F. HOEFLICH
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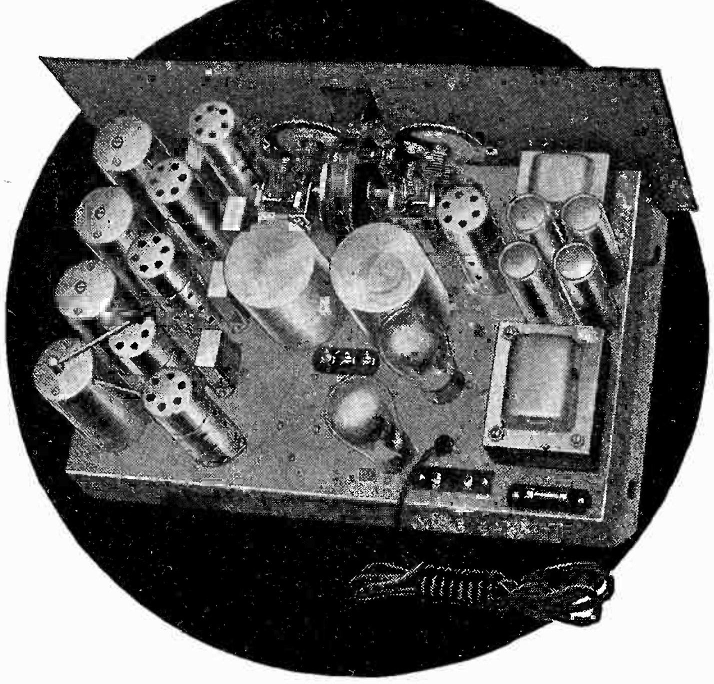

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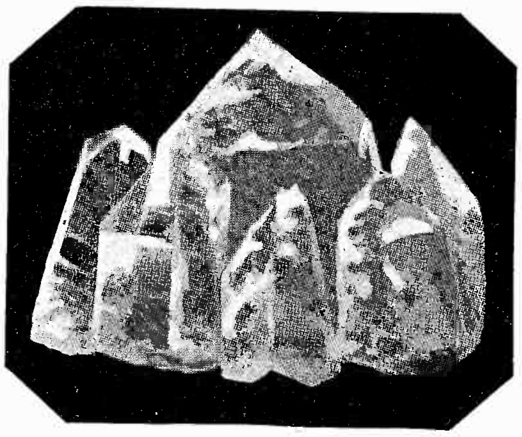

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Vol. 15 SEPTEMBER, 1933 No. 9

Radiotorial Comment

THE F.R.C., or whoever it is that writes the examinations for a radio operator's license, is being subjected to some adverse criticism because of the ambiguous questions which are asked in the new examination papers. Some of them are so confusing with regards to the intended answer as to lead to the suspicion that the examiner is an addict of crossword or jig-saw puzzles, or worse. Either that, or he may be seeking a vicarious revenge for his own suffering when he passed a similar ordeal!

For instance, the aspiring and perspiring amateur is asked "What are the regulations concerning the radiation of harmonics?" Now there are a lot of things that a beginner in radio does not know about the technicalities of harmonics. But he does know that they interfere with the reception of broadcast programs and that many an ambitious amateur has been jerked on the R.I.'s carpet, (or is it linoleum?), for this heinous offense. So he naturally answers the question by telling what a good boy am I and that he will never be guilty of allowing his transmitter to radiate a single harmonic that will take the joy out of the life of his BCL neighbor who is listening to Walter Winchell's latest dirt.

But this answer is all wet. The correct answer, the only one whereby he gets proper credit, is: "Transmitters must be designed and adjusted so as to radiate a minimum percentage of harmonics, so far as the state of the art permits. This is accomplished by proper circuit design and by the use of loose coupling." The candidate knows this, of course, and in answer to a self-respecting question like: "How is a transmitter adjusted so as to radiate the least number of harmonics?" he would have no hesitancy in replying: "By loosening the coupling."

But such a simple and self-respecting question does not suit the riddle-propounding examiner; the right answer is too apparent. He wants the sadistic pleasure of watching a squirming boy who is trying to imagine what kind of an answer is intended, instead of the straightforward answer which he knows is right. These catch questions are of the same ilk as what was asked in a recent examination for firemen in New York City: "What piece of fire apparatus may, under no circumstances, proceed in a wrong direction through a one-way street on Sunday?" The answer is: "A fire-boat."

The would-be proud possessor of an amateur license is by no means the only victim of brain-teasers in the examination questions. An applicant for a commercial ticket must answer: "What is a motor?" Although a gasoline or a Diesel motor may have been in the examiner's mind, the applicant correctly guesses that an electric motor is meant, and proceeds to answer: "A motor is a machine for converting electrical energy into mechanical energy", or words to that effect.

Yet, according to a ruling from the department, he cannot be given full credit value for his answer, simply because he neglected to state: "An electric motor, etc." The question can be as loose and uncertain as the examiner's prospect of going to heaven, but the answer must be as precise and tight as the hinges of hell.

But this is only half the story of the same question and its answer. For on the second count the given answer is wrong because it does not include a description of the construction of a motor, which was the intended answer. Why, in the name of Maxwell, not to mention Hertz and Marconi, does not the question say so? Is a successful examination-passer supposed to be a mind-reader as well as an electrical expert?

There is a different kind of a catch in the old question, no longer used: "If the receiving set is known to be in perfect operating condition, and yet you hear no signals, what is the probable reason?" The official records contain the name of no man who had the guessing ability to give the intended answer: "No signals are being transmitted."

If these radio examinations are to be a guessing contest, why not say so at the start? Let it be a sort of a game where both sides can have a little fun, instead of the fun being all so one-sided. The Greeks had a name for this sort of a question when they called it an enigma, meaning that which is spoken darkly, that which hides its meaning under obscure or ambiguous allusions. But the Greeks had the good sense to take their enigmas in fun, whereas the radio examiner takes his seriously.

Although this custom of giving examinations which include catch questions or conundrums is only a minor evil in radio, it can be so readily corrected that one wonders why it has been allowed to persist so long. Why can't these equivocal questions be eliminated from the examinations? Or least, why not give full credit for equally equivocal answers?

Commercial Operators Ask Recognition

COMMERCIAL radio operators, most of whom are former amateur operators and whose ranks will some day be filled by many present-day amateurs, have never been given what they consider to be a square deal from station owners. Their pay was a pittance, even during the boom period. They were often required to perform the duties of a shipping-clerk in addition to their own work and responsibility as a radio operator. They were rated with, but after, the flunkies. Consequently, any action tending to improve their economic and social status will be most welcome.

Such improvement is promised in the code of fair practice which the American Radio Telegraphists Association has submitted to the NRA at Washington. This code stipulates a maximum of eight hours per day for work aboard ship and 36 hours per week at land stations, with a minimum wage of $165 per month. It puts a stop to the practice of assigning two jobs to one man, such as mate-operator, purser-operator, etc.; no longer will the "brass-pounder" be required to "double in brass", as they used to say in the old nigger-minstrel days when a minstrel played in the band when they paraded. The code also eliminates the custom of requiring an operator to sleep in his radio shack, as it calls for separate, commodious sleeping quarters for each operator.

Approval of this code and its subsequent enforcement will have a far-reaching effect in helping the operators who are now employed and in giving jobs to operators who are now on the beach. It is estimated that at least 150 jobless ship-operators on the Atlantic coast, not to mention the Pacific, the Gulf and the Great Lakes, will thus get back to work. A corresponding improvement will be made in the unemployment situation as regards land station operators.

Nor is the code one-sided in the benefits which it confers. The radio companies, the Government, and the public they serve, will thereby gain the whole-hearted efforts of a more contented group of workers. Contentment among workers is an oft-neglected factor in economic production, even in such a commodity as milk. And above all, the code is in full accord with the unified plan for pulling the nation out of the depression ditch by increasing the purchasing power of the consumer of manufactured products.

Great interest and enthusiasm followed the announcement that this code had been submitted to the NRA. Many licensed operators have applied to the association's headquarters at 20 Irving Place, New York City, for active membership, and many unlicensed individuals, who have a real interest in the welfare of the radio operator, have applied for associate membership. President H. S. Haddock states "I never before realized the genuine interest of the general public in radio operators as a class and in their unselfish service in times of distress."

It is greatly to be hoped that all parties concerned will agree upon the adoption of such a code. The commercial operator deserves all that he can get and has the best wishes of every amateur operator.

Notable Achievements of the Radio Amateur

By LOUIS R. HUBER *

ONE instance of the valuable place amateur radio has in the lives of the citizens of that far-off wonderland, Alaska. A story of how a score or more of lives were saved by the timely installation of amateur radio, by two of those several score of faithful people who, often without thanks and sometimes to their own financial loss, vigilantly protect their respective communities from any kind of calamity that may befall.

KODA sat before the window and watched the golden-copper disc of the sun sink behind the snow peaks. Behind him, in the waning light, under the rumpled quilts of a wide bed, lay the lumpy forms of Yarna, his wife, and three of his sons. A fourth son was lying outside the little hut in a shallow grave.

Diphtheria—the dread of Arctic settlements—had come to Ugashik. Thirty other inhabitants of the little native village also lay ill, and three, including Koda's little son, had died in the last 24 hours. Koda himself felt his mouth drying and, reaching for the white-enameled cup beside the water pail, he thought to himself: "If I take sick, who will care for Yarna and the three over there?" The rim of the cup touched his lips and, as he drank, he looked out over the roofs of the scattered huts, far across the Bay to Dillingham, as if imploring help from the gray hills rising in the distance.

Farther up the slope from Koda's house the beams of light from a gasoline lamp lit the windows of the school teacher's house. Inside, kneeling before a collection of condensers, coils and tubes, the school teacher, S. C. Hanson, and his son, Virgil, were following the diagram of a radio transmitter.

"Well, it's all connected and tuned just as Jack told us, I'm sure," the father was saying. "Now let's try it out." Together they lifted the apparatus and set it on the table beside the receiver, connected the high-voltage leads to the motor-generator and the filament leads to a storage battery beneath the table.

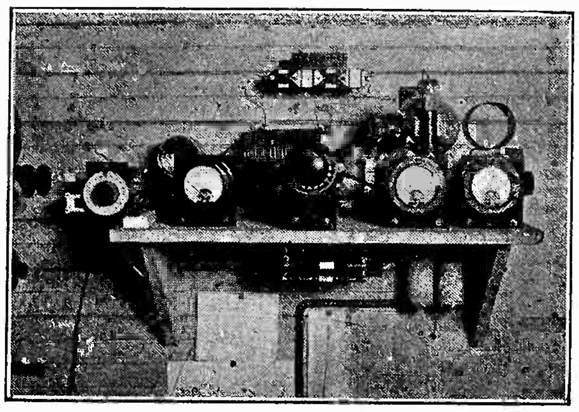
Occasionally the Alaska amateur is visited by celebrities. Father Bernard Hubbard, S. J., "glacier priest," and his party pass through Seward and visit K7AHK, author of this article. Father Hubbard, second from left, standing; K7AHK, lower left.

Hanson put on the headphones, listened a while and then, closing the power switch, heard the rising hum of the motor. All seemed well. He paused a moment longer, remembering the words of Jack Anderson, W6ACV, the operator at the cannery the summer before.

"Take your time," Jack had said, "and think before you hit the key. It is not speed that counts, but brains. The speed will come later."

Slowly then, in the stilted manner of a beginner but with the assurance of one who has been well trained, Hanson called: "CQ URGENT CQ URGENT CQ URGENT de K7BOE K7BOE K7BOE." Twice he repeated this call. Then he pulled the power switch and, as the dying rhythm of the motor-generator left silence in the room, slowly he turned the dial of his receiver, hesitating slightly as he crossed each signal. At the sixth one he stopped. Was it . . . ?

It was—the beautiful bell-like ring of a crystal-controlled transmitter — calling him.



K7BOE's transmitter. This set was destroyed by fire and is now replaced by a new one.

Hanson's hand trembled a little as he adjusted the beat control to 1000 cycles. He marked the regular swing of a practised telegrapher; somehow, it seemed to him, the tempo of an Unseen Hand guided the impulses of that cadenced repetition. Long the call came, bearing the insistence of one who knows, when called, he can serve.

"K7BOE K7BOE K7BOE K7BOE . . ." Hanson moved paper and pencil before him. Virgil, at his side, bent closer. Finally the break came. ". . . K7BOE K7BOE de K7ASM K7ASM K7ASM . . . K7BOE K7BOE K7BOE de K7ASM K7ASM K7ASM AR."

While Hanson threw switches to reply, Virgil thumbed through the call book.

"Here it is, Dad," he almost shouted, "Anchorage, Alaska! Feller named Hal Noggle!" The older man nodded. He was talking to Noggle.

". . . epidemic struck us three days ago. Thirty sick now. Three dead. Need diphtheria antitoxin and doctor and nurses. Please wire Governor Parks in Juneau at once and have plane sent from Dillingham."

"OK," came the reply. "Will 'phone the Signal Corps station at once. QRX."

Hanson leaned back in his chair and smiled at his son. "By the gods, Virgil, what a blessing! Put on your coat and run to the houses. Tell them we have help on the way."

A few minutes later, K7ASM in Anchorage, some 400 miles from the little village of Ugashik on the shore of Bristol Bay, called K7BOE with the news that the message was on its way to the Governor. "If you will stand by on my wave," K7ASM said, "I'll give you a buzz when the reply comes through."

It was not long in coming. The words "Diphtheria . . ." or "Typhoid . . . epidemic" have a sinister significance in the land up next the North Pole. Hearing them, one remembers Seppala and his renowned dash to Nome by dog team with life-saving serum.

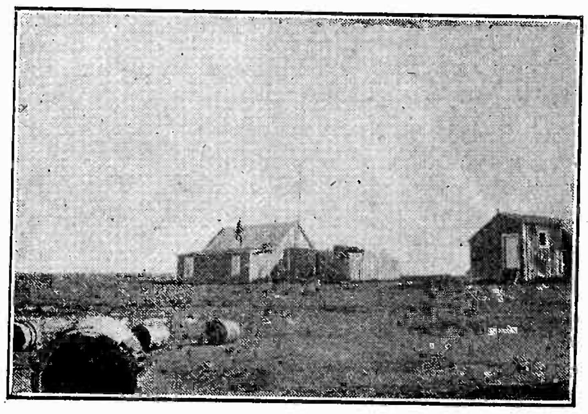
Within the hour, K7ASM was telling K7BOE ". . . plane will leave Dillingham at earliest opportunity with antitoxin, doctor and two nurses from the Dillingham hospital. . . . Boy, sure a good thing you got that set hooked up as soon as you did!"

"Well, I'll say," said Hanson, and then, in the manner of a typical dyed-in-the-wool radio amateur, he proceeded to tell K7ASM all about himself and how he came to be one through the influence of another dyed-in-the-wool radio amateur.

The plane arrived in due time. The doctor and the nurses bent to their task of saving the stricken natives and, as a result of their presence and their merciful work, further deaths were forestalled and the sick village recovered.

This incident occurred several years ago but today, not only K7BOE is on the air, but K7BND, the call letters of Virgil Hanson, are regularly heard in the amateur bands. No longer does the little village of Ugashik fear the terror of stalking death from diphtheria. Now, the simple natives have come to look on Hanson and his son as father and brother to them and their young ones.

"We want Hanson here," they say. "He save our lives. He teach our children. He teach us gospel." If the natives of Ugashik have anything to say about it, the Hansons will live there a long, long time.



The shack of K7BOE when the events in this story occurred. The transmitter was located in the house, just beneath the mast.

Last winter a disastrous fire destroyed the Hansons' home, ruining most of the radio equipment. In spite of this, Virgil put together what was left and what he could repair, and got back on the air. Perhaps his signal was a bit weaker, perhaps he could work on only one band for a while, but he was still there, keeping schedules with his old friend, Jack Anderson, W6ACV, in San Jose, California, and with Hal Noggle, K7ASM, in Anchorage, Alaska.

And not only that—Virgil has other schedules with other Alaskans. For instance, he keeps one every night with Lily and Eleanor Osterback, K7ANQ, on Wosnessenski Island across the peninsula. But that's another story . . . !

* K7AHK, Seward, Alaska.

How The Commercials Attempted To Cripple The Rights of the Amateur

By COL. CLAIR FOSTER, W6HM

AFTER the act of 1927—the present radio law—came into effect, the Federal Radio Commission asked its General Counsel for an opinion on the question of an amateur's handling a message of a "business" character. His opinion summed up in effect that an amateur could legally handle any type of message whatsoever so long as not done for hire. But the commercial people felt that they simply must have a toe-hold from which to thrust at amateur message-handling. So, when the new amateur regulations came out under the Act of 1927, this one appeared as Regulation No. 365:

"The term amateur radio communication means radio communication between amateur radio stations solely with a personal aim and without pecuniary interest."

You may be sure that if there had been any legal ground on which the commercial people could have hung a flat prohibition against amateur message-handling the regulations would have stated the prohibition in plain English instead of jargon. The "solely with a personal aim" was included for two purposes. One was to give the amateurs themselves the impression that the only communications they might conduct must be on subjects personal to themselves. The other was to make the regulation susceptible of that interpretation the next time the question came up regarding the amateurs' right to transmit messages for the public.

And soon we had an instance in point. On January 31, 1932, Secretary Baldwin of the Federal Radio Commission sent out a letter stating that amateur stations set up at conventions, athletic meets, flower shows and such gatherings would no longer be permitted to accept messages from the general public, and quoting Regulation No. 365. In conclusion he said, ". . . **Amateurs may do all things that are reasonably necessary or incident to the service permitted. The solicitation of messages from the general public in the manner suggested, even though no charge is made and delivery is not guaranteed, is not a reasonable or necessary incident to the service and is therefore not permissible.**" After that the F.R.C. issued permits to several amateurs to set up their stations at such gatherings, but in each case restricted by, **"On condition that no messages are transmitted for the general public."** We don't know whether Secretary Baldwin wrote by order of the Commission or on his own, but in either event it was an outrageous assumption of authority on the part of those who were hired to administer the Radio Act, not MAKE laws. Secretary Baldwin has now gone over to the commercials. He has a nice position in the National Broadcasting Company.

Making such a regulation in the first place, and then putting such an unwarranted construction on it, was an infringement of the Constitutional rights of 35,000 citizens of the United States and of the public which wishes to avail itself of the service of amateur stations. Moreover, it was a violation of the Radio Act itself, in that it aimed to prevent 35,000 amateurs from compliance with the fundamental of the ACT; viz., that every station must be operated for "public interest, convenience or necessity." In just what manner could a station set up at a convention or a flower show be of interest to the public, or serve the public convenience, or meet a necessity of the public, if it is forbidden to act as a means of communication for the public! What transpired was what I pictured in my own mind when first I noted the labored phrasing of Regulation No. 365. For when a man (some one man, of course, made the original draft of it), goes out of his way to avoid the use of unequivocal English you may be sure that he either is uncertain of his ground or else is not saying precisely what he wishes his readers to infer.

A New Amateur Code

Col. Foster, the publishers of "RADIO" and a number of prominent radio amateurs are engaged in formulating a new CODE for the Amateur. When completed, it will be published in these columns. Every reader of this magazine is asked to send his suggestions to the publisher. A nation-wide drive will be launched in an attempt to gain wider recognition for the amateur. It is hoped that Congress will uphold the rights of the amateur . . . give back to him some of the territory which has been taken from him . . . open new and wider territory in the Continental Frequency bands. Every licensed amateur will receive a copy of the proposed CODE, . . . will be asked to send his comments to "RADIO" . . . persuade his Congressman to support it. Thus a great national drive will begin . . . the first concerted movement of amateur radio to gain the recognition it so rightfully deserves.

Admiral Byrd's Protest Was Blow to Commercials

WHILE I was in Washington in the spring of last year the Radio Corporation had a plan afoot to get the Commission to prohibit all private vessels, yachts and expeditions from communicating with amateur stations. It was reported to me that members of the Commission's staff were more than willing. This prohibition would mean that ships such as Admiral Byrd's, or any of the many private expeditions that sail forth to the little-known parts of the earth, must acquire radio equipment from a commercial company, have it manned by commercially paid operators and pay a toll on every word received or transmitted by such means. It is well known that for years such expeditions have enjoyed their right to be served by amateur stations. They have gone forth equipped by amateurs and manned by operators from the amateur ranks; and amateur stations in the United States and various other parts of the world have carried on their communications. These exploring, or scientific, or plain adventurous people depend upon amateur service for reasons other than those of economy. They have learned that amateurs can be relied upon to maintain interest in the movements and welfare of the expeditions, that the amateurs become familiar with the families and affairs of an expedition's personnel, that amateurs can be depended upon to keep schedules at all sorts of hours and execute no end of important commissions—acts that commercial people couldn't do if they would and wouldn't if they could—even if they were paid for them.

The Radio Corporation tried to drive a wedge into this type of amateur traffic when Byrd's ships, the "New York" and the "Eleanor Bolling," were making trips from New Zealand to the Antarctic, carrying men and supplies. RCA, through Lindh, their San Francisco superintendent, protested to the Government against 6XBB's working these ships. He charged that 6XBB was an amateur station and that, as such, it had no right to communicate with ships. Byrd was then at his base, Little America, while his overladen ships were plowing their dangerous way through stormy seas and floating ice. The protest of RCA was transmitted to him by 6XBB. Byrd immediately sent a message of expostulation to Washington. So that there could be no doubt of the authenticity of it he relayed it by Navy channels—through NPU at Samoa and NKF at the Naval Bureau of Radio Research in Washington. He said that 6XBB was his ships' one best contact with the world, that 6XBB was handling thousands of words for him, and he insisted that this contact be not disturbed. And that was that. The sum total of achievement on the part of RCA was that for a while Lindh's stations were stuck with a hookful of paid messages that couldn't be transmitted because the amateur operators on Byrd's ships were so angry they wouldn't answer an RCA call.

Just fancy! The consummate cheek and inhumanity of trying to stop those poor fellows, fighting storms and ice, from communicating with their families in the United States except by paying through the nose to the Radio Trust. No, such a prohibition would be absolutely AGAINST the public interest, convenience or necessity.

An account of all the attempts of the commercials to cripple the amateur traffic would fill a book. I here recount only a few. In October, 1932, I received a message from one of the Army Signal Corps officers in the Philippines saying that a letter had been sent from the Philippines Bureau of Posts to Washington requesting to be advised whether possible to apply international regulations to Philippines amateur stations. The significance is this: Under the terms of the International Radiotelegraph Treaty each country controls its amateurs as it sees fit. Most foreign countries prohibit amateurs from handling messages. There is a certain measure of justice in this; for in most of the foreign countries the communications systems are the property of the government and the revenues derived from them are applied to the support of these governments. But in the United States and possessions tolls exacted from the public go into private pockets—are not used for the benefit of our citizens as a whole; so in the United States and possessions the public has never yet been forced to pay tribute to the private communications corporations by a ban on amateur message-handling.

Now, what the Philippines Bureau of Posts had in mind was the possibility of stopping the Philippines amateurs from handling messages with the mainland, and thus diverting as much traffic as it could to the commercial radio and cable corporations. My informant conveyed to me later just which commerical representatives were back of this effort of the Bureau of Posts. If these commercial men could put their scheme over then all amateur trans-Pacific message service to the thousands of our own people in the Philippines would be stopped and a great public service destroyed. And all to no earthly end except to constitute a brutal and unwarranted exploitation of the public by private corporations.

(Continued on page 23)

Comments on 10-Meter Phone

By CLAYTON F. BANE *

IT CAN easily be imagined that the much neglected ten-meter band will become increasingly popular as the winter months draw near. The new regulations allowing the use of phone on a portion of this band, coupled with the fact that DX conditions appear to be unusually favorable, would seem to give strength to such an assumption. However, there are a number of requirements that must be complied with, if good phone communication reasonably free from QRM, is to be enjoyed.

A comparison of the five and ten-meter bands may possibly serve to illustrate this point. This comparison is probably timely, due to the fact that the amateurs on five have already acquired a degree of proficiency in the operation of ultra high frequency equipment. It is logical to assume that these men will be among the first to migrate to this new and virgin phone territory. The first point to observe is that the ten-meter phone band is only about one-eighth as wide as that of its higher frequency neighbor. (The whole five-meter band is open to phone but only 500 kc. on ten meters.) The extreme width of the former band and the difficulty of obtaining easy frequency stabilization probably justify the use of self-excited, modulated oscillators. The quasi-optical effect is also a further justification for their use because stations even short distances away are at times unable to hear one another. On ten, the story is somewhat different. Stations within a ten-mile radius (and probably even greater) are able to carry on communication at any time, day or night. This greater ground wave range and the potential DX possibilities further add to the interference problem. It rather goes without saying then, that the use of self-excited, modulated oscillators and their attendant broadness (due to frequency modulation) are definitely out. All of which leads us to the crux of the whole matter—frequency stabilization.

Probably the best method of achieving frequency stabilization is by the use of crystal control. This method should present no particular difficulty to the 20-meter phone men who have all the necessary equipment, with the possible exception of another frequency doubler; but it is a hard nut to crack for the five-meter boys, most of whom have only self-excited rigs. However, crystal control isn't the only answer. Its cousin, the Electron Coupled Oscillator, is a very able substitute.

The property of an electron coupled oscillator to deliver high harmonic output makes its use particularly feasible for ten-meter work. By taking advantage of this peculiarity (or is it a blessing) it becomes possible to operate the grid circuit, which largely determines the frequency drift, on a lower frequency where its action is apt to be more stable. Then, by doubling in the plate circuit, there is developed a nice, steady signal on the band where it is wanted. This, incidentally, eliminates doublers and their attendant apparatus—and evils. Having decided on the type of oscillator we wish to use, the next thing to consider is the choice of a suitable tube.

There are on the market at the present time several tubes that are suitable as electron coupled oscillators; among these, the 59, 2A5, 57, and 24A are the best bets. The writer selected the 59 over the others because of its ability to deliver larger output. It was found, though, that the 59's made by different companies varied greatly in their ability to perform the required task, some refusing to operate at all after running about five minutes. This should not be a deterrent, however, because tubes made by the leading manufacturers were found to be entirely satisfactory. Now, having disposed of the oscillator tube, our next step is to decide what our amplifier tube is to be.

It is hardly good practice to attempt to select our amplifier tube without first considering the carrier power desired and the percentage of modulation we intend to use. In fact, it is much more important that we first consider what modulator tube to use. We will worry about the amplifier later. The good book tells us that for 100 per cent modulation it is necessary to have half as much audio power as we have carrier. There are very few audio tubes in the low price class that can furnish more than about three watts of reasonably undistorted output. This means, simply, that we cannot allow our r.f. carrier to be higher than six watts, if we want to come even close to doing a good, high percentage job of modulating. The 59, as a pentode, will deliver three watts and has the further advantage that it can be driven directly by a good high gain single button mike, no speech amplifier being necessary. In the case of a double button mike (almost a necessary refinement) a stage of speech is needed, a 56 being used for this purpose. In the writer's opinion the speech amplifier should be used even with the single button mike because it insures sufficient swing to the modulator and allows a finer adjustment of that swing. (An essential factor in a distortionless Class A amplifier.) By limiting our carrier to six watts the selection of the final r.f. tube becomes a very simple matter. A 46 was used because, with the two grids tied together, the tube works very near to cutoff, thereby requiring only a small amount of bias to operate the tube as a Class C amplifier. It has the further advantages of being easily capable of standing the modulation peaks (24 watts) and being an easy tube to excite. It is conceivable that some slight amount of amplitude distortion is likely to be present, due to the fact that no buffer tube is used to build up the excitation. This distortion, however, should be limited to a very small amount if the oscillator is adjusted for maximum output.

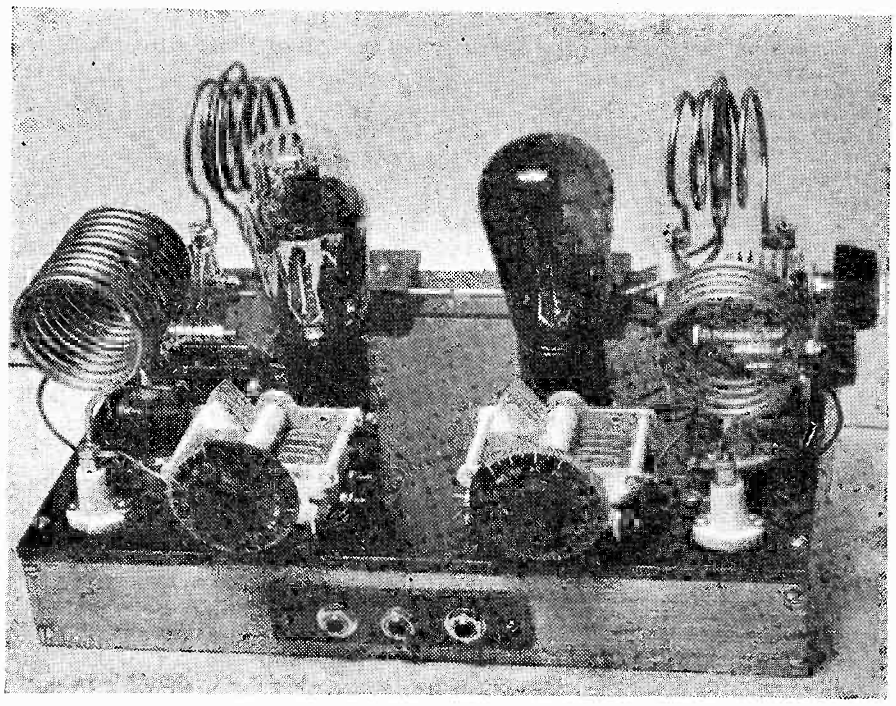
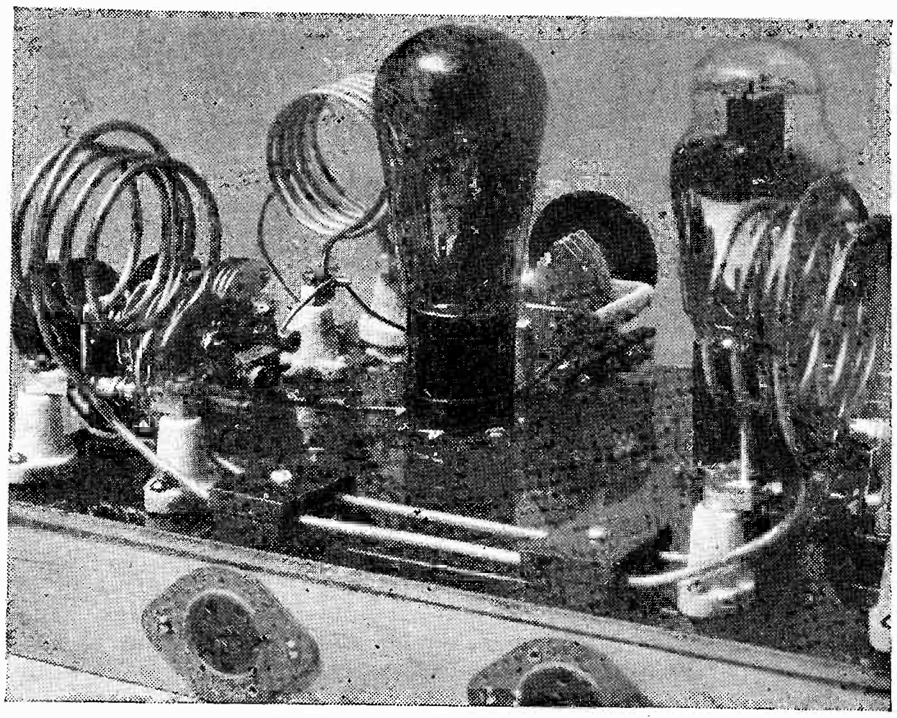


Fig. 1. Front View of 10-Meter Transmitter.

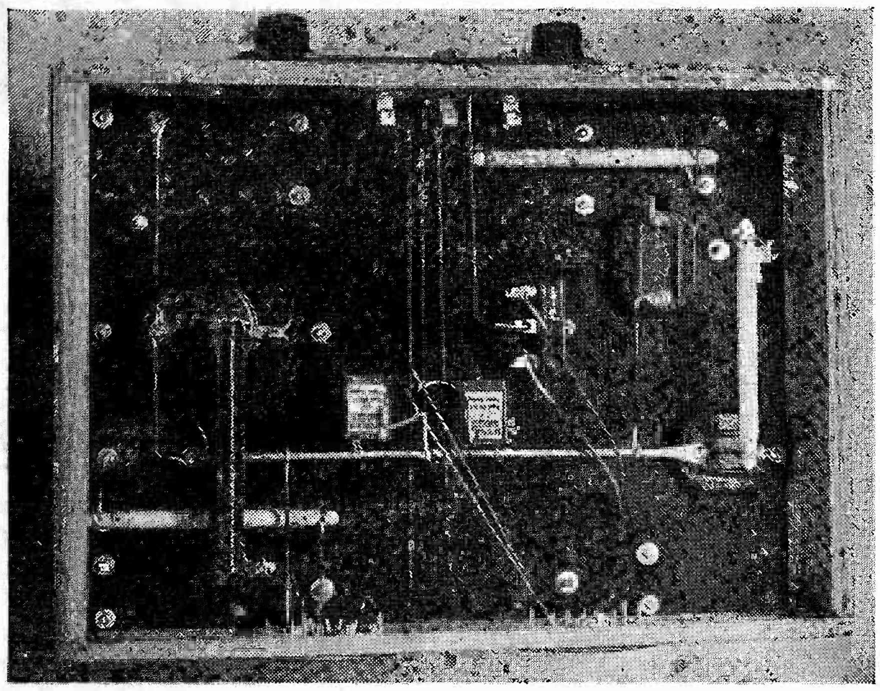


Rear View, Showing Coil Supports and Coupling Arrangement.

Fig. 1 shows the r.f. portion of an outfit built by the writer. It incorporates some features not usually considered. Where the oscillator is self-excited (as it is in this case), the utmost care must be taken to avoid any mechanical vibration. No matter how stable the oscillator may be, the whole thing can be ruined by mechanical vibration. With this fact in mind, extreme care was taken to make all leads as short and direct as possible, without recourse to the fancy bends and twirls sometimes used. The tubing on the inductances is heavy enough to do justice to a well loaded ten with about ten times the input used on the 46. A special mechanical arrangement was used to anchor the coupling loops and the feed line between the

* W6WB.

oscillator plate tank and the amplifier grid tank. No fly alighting on that feed line will cause any bass voice to take on a tenor quality. All midget condensers are double-spaced to lessen the likelihood of change in capacity, due to vibration. The coils were not made plug-in but were fastened permanently to the stand-off insulators. In the case



Bottom view of 10-meter phone transmitter, showing neat arrangement of parts.

of the oscillator coil it would probably be advisable to mount a hard rubber strip across the top to lessen the tendency for this coil to start vibrating. The ten-meter coils have so few turns that no trouble is experienced from this source. The outfit is tuned in the conventional manner, the only precaution being that the tap on the oscillator coil (cathode) has a great effect on the harmonic output, and consequent excitation to the amplifier stage. Three turns from the ground end was found to be the best position in this unit, though this will probably vary in other arrangements. The three jacks shown on the front baseboard are, respectively, C bias lead of final, Center-tap of final (to insert key in case of CW), and High Voltage lead of final. The meter can be plugged into the C bias lead to determine the correct adjustment of the excitation from the oscillator, and the grid meter can further be used to neutralize in the conventional manner. No trouble was experienced in neutralizing, though it might be well to point out that the high voltage clip on the final will go more toward the center of the coil than is usual in other tubes.

For the benefit of those lazy chaps who don't like to figure, it might be stated that the proper value of load resistance the Class C

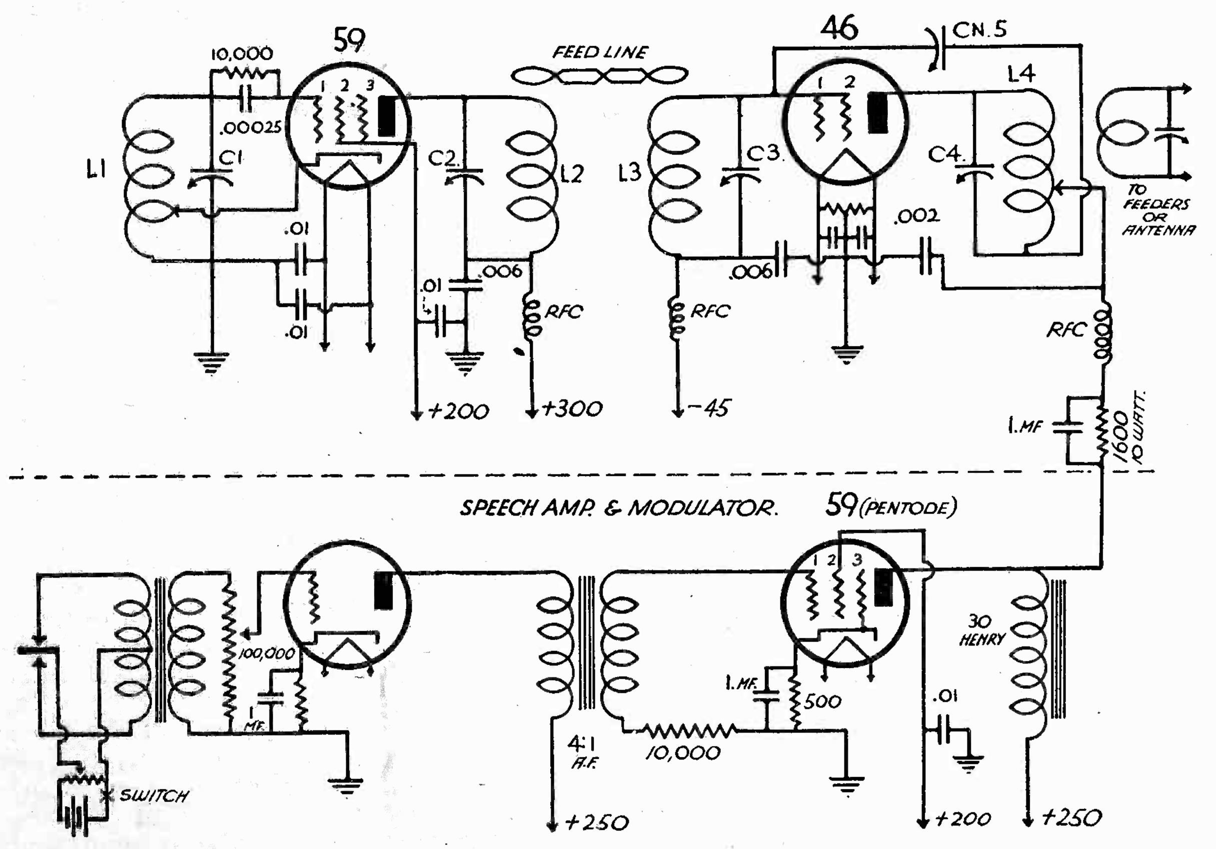


Fig. 2. Circuit Diagram, showing all values, for 10-meter phone.

A Type 56 is used as speech amplifier.
L1—9 turns, 2-in. dia., ⅛-in. copper tubing.
L2, L3, L4—4 turns each, 2-in. dia., ⅛-in. copper tubing.
C1, C4—13 plate condensers, with alternate plates removed. Cardwell Type 405-B.
C2, C3—100 mmfd. Pilot Midget Variables with alternate plates removed.
CN5—5 plate Pilot Midget, single spaced.
RFC—Radio Frequency Chokes, No. 36 D.C.C. wire, ¼-in. form, winding space 2½-in. long, single layer of wire.

amplifier offers to the modulator is obtained at 30 mills at 200 volts (6666 ohms—close enough to the value of load resistance for maximum output from the 59, i.e., 6000 ohms.) These values of current and voltage when multiplied give the required input of six watts. See Fig. 2 for proper value of drop resistor and other details.

It has not been the purpose of this article to dictate any particular type of equipment but to merely suggest some things that may be of use to those who attempt to use phone on the ten-meter band. It is the belief of the writer that this band will some day be as popular as twenty meters, and it very greatly behooves the pioneers to set a good example to the many others who will inevitably follow.

Interpreting the News of the Month

—— "For a period of one year from the date of the adoption of this chapter no new radio receiving tubes will be introduced, except for experimental purposes, by the radio tube industry without the approval of the executive Committee," states the Code of Fair Competition for the Radio Manufacturing Industry as submitted by the Radio Manufacturers Association.

Radio receiving and/or television sets selling for/or less than $30.00 list will carry a discount of 36 per cent to the dealer. On each part for radio receiving and/or television set sold separately the dealer's discount will be 40 per cent. The jobber's discount on sets in the $30.00-or-less price-class will be 40 and 15 per cent. Low-priced merchandise carries with it a correspondingly lower discount, whereas a receiver selling for $31.00 to $50.00 is subject to a dealer discount of 40 per cent. The maximum discount to dealers is 40 and 10 per cent and this applies to receivers selling for $101.00 and over.

All this means that the Gyp has had his day. When merchandise is offered for sale at "bargain prices," a plausible reason must be given (and advertised) as to why the price has been lowered.

Says another chapter of the proposed Code: — — — "Distributors may sell for a lesser price but only when necessary to close out distributor's stock for the purpose in good faith of discontinuing his radio business or in disposing of radio products in good faith when damaged, deteriorated or soiled with prominent notice to the public that such is the case, or without such consent when sold by a receiver, trustee or other officer acting under the order of any Court." But that's not all. When a close-out is to be made the distributor must first advise the manufacturer and give him the option to buy back his merchandise at the same price which the distributor would otherwise secure for it in the open market.

It is believed that "dumped" merchandise will hereafter revert to those who built it, rather than find its way into the hands of an unsuspecting public, long gypped by gyps who have boasted that their profits have been as much as 600 per cent on some of the trash that has been sold and which should rightfully have found its way into a public incinerator. "What you get for nothing amounts to nothing," is just as true in radio as in other lines of merchandising.

The use of a giant trademark of a reputable manufacturer and a microscopic catch-phrase such as "licensed" when reference is made to products other than those made in the shops of the manufacturer whose trademark is used, will unquestionably be a violation of the law when the Code is signed by the President.

Tube Queries

By JAYENAY

2A5 Or 47 As XTAL Oscillator?

I like the 2A5 better because of the indirectly heated cathode which helps in new xtal doubler circuits. The cylindrical elements distribute the space current more evenly than the flat elements in the 47.

● ● ●

Dual Purpose 6F7

The 6F7 is designed to do the same job as the 6A7 in that it is a combination oscillator and first detector. However there is no internal coupling between the triode and pentode portions of the tube. This means that some form of external coupling is necessary to conduct the local oscillations to the detector portion of the tube. This tube should be better for high frequency use than the 6A7 because the electron coupling of the 6A7 is too close at high frequencies. The best way to judge the desirability of a tube for use as a first detector is to measure its Conversion Transconductance. This mouthful describes the ability of a heterodyne detector to produce a beat frequency from a combination of signal and oscillator voltage. In the case of the 6F7 this transconductance is 300 micromhos. Practically speaking, this means that a voltage gain of about 40 is possible at broadcast frequencies. Not so long ago most engineers were satisfied if the first detector held its own and did not provide a loss, and it is evident that gains in the neighborhood of 40 are most welcome as the first detector is often a prolific source of set noise and gain at this point can materially improve the signal to noise ratio.

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Graphite Plate 50 Watters

New 211, 203A and 845's have a special plate structure which is said to consist principally of graphite. These 50 watters dissipate more heat with less secondary emission than the older types. The 203A's for class B use are especially good because there is less chance of parasitic oscillation, which roughens the quality of so many audio amplifiers which use this tube.

● ● ●

Effect of High Voltage On Coated Filaments and Heaters.

High plate voltages soon destroy the active coating on the filaments of tubes, such as the 46, 47, 59, 2A5, etc. The protons bombard the oxides on the cathode and remove it faster than it can be resupplied. This explains why these tubes suddenly go haywire when used with over 400 volts on the plate. However they are not all alike. Some 47's have operated for nearly two years with 550 volts on the plates without going soft, while others of the same make went out after only a few hours service at this voltage. It should be noted that the space current has nothing to do with this phenomena. It is entirely a matter of voltage. Of course, a 47 won't last long if the space current is 100 mills no matter what the plate voltage is, but few amateurs drive their 47's to the point where they draw more than 40 milliamperes.

Pentagrid Tubes As Super-Regenerative Detectors.

The pentagrid series is said to make efficient super-regenerative detectors on 5 and 10 meters. The triode portion is used as the quenching oscillator and a tickler is used in the plate circuit to provide the feedback. Has anyone tried it?

● ● ●

Pentagrid Tubes As Second Detector.

The various dual purpose tubes such as the 2A7, 6A7, and 1A6 make good sensitive second detectors in supers, and the triode portion is used as the beat frequency oscillator. They would not have much power-output and would overload easily but they would be very sensitive. Electron-coupling is the ideal way to couple the beat and the signal.

● ● ●

Did You Ever Hear of the 850?

This is a very rare tube and is used in few commercial transmitters. It is a great tube below 10,000 KC, however, and requires very little excitation. It is a screen-grid 50 watter and is made by RCA. The 860 is a better tube at the higher frequencies, however.

● ● ●

Why Not a 2A3 As a XTAL Oscillator?

The 2A3 would work but the extal RF current would be quite high unless the plate voltage, and output, were reduced. For amateur purposes a high mu tube makes the best xtal oscillator and the 2A3 has a very low mu.

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How About a 2A3 As RF Amplifier?

No, because of the high shunt capacity across the plate tank and because it is a low mu tube, which means it is hard to excite. The non-cylindrical elements and the low plate-filament spacing would cause the plate to heat in spots, instead of evenly, assuming that we ran it at maximum output. (And who doesn't?)

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What Is the 2A3 Good For?

Don't think that the 2A3 isn't a good tube. Few of the new tubes represent such an improvement over the older types. As an audio output tube it can give over ten watts of audio power, in class A prime, with less than 1% total harmonic distortion. 18 watts can be obtained if more harmonic distortion is allowed. (Push-pull in both instances).

● ● ●

58 and 78 Are Not Identical Except For Heater Voltages.

The 78 is not much better than the 39-44 at 7000 KC because it uses the 24 type of screen grid, rather than the external screen shield used with the 58 and 57. If you want to use six volts on the cathodes then get a 6D6.

● ● ●

6.3 V. Cathodes Just As Free From Hum As 2.5 V. Cathodes.

On the newer six-volt heater tubes the hum and noise level is every bit as low as with the two-and-a-half volt cathodes. All of the new Philco BCL sets standardize on the six volt tubes for both AC and DC use.

5-Z-3 For Class B

The 5-Z-3 may be operated in the conventional form of full-wave rectifier circuits; however the choke input form of filter is to be preferred as the peak plate current is very much less than with the condenser input system at equal a.c. plate voltages, thus reducing the load on the tube. This arrangement introduces an improved over all voltage regulation, a factor to be desired in Class "B" amplifier operations.

● ● ●

The New 6C6 and 6D6 Tubes.

At last we have a tube with a six volt heater which is as good as the 58 at high frequencies. The 6C6 is a screen grid pentode receiving tube which has a 6.3 v. heater and fairly low interelectrode capacities. The 6D6 is the same, but that it has a variable mu control grid, which allows us to control volume or sensitivity by varying the control grid bias. Of course, the sensitivity of any tube could be controlled, to a certain extent, by varying the bias on the control grid. However, under high bias, ordinary screen-grid tubes have a strong tendency to act as plate detectors. As a result cross-modulation occurs, which is a particularly pernicious form of interference because no amount of selectivity will reduce it, once it is present. At broadcast frequencies the 77 and 78 are just as desirable as the 6C6 and 6D6 and are somewhat more stable. However, above 3000 KC the advantages of the 6C6 and 6D6 become evident.

● ● ●

How About the 2A7, 6A7 and 1A6 At High Frequencies?

These tubes are all very much alike in that they belong to the Pentagrid Convertor family. They are all designed to act as combination oscillators and first detectors in superheterodynes. They differ largely in the fact that their cathode voltages are designed for different services. The 2A7 has a 2½ volt heater and is used for AC only. The 6A7 has a 6.3 volt heater and can be used equally well on AC or DC. This tube is becoming common in automobile receivers where the number of tubes must be kept at a minimum. The 1A6 is designed to be used with dry batteries, and the 2 volt filament only draws 60 milliamperes. At broadcast frequencies these tubes leave little to be desired, but at high frequencies they have certain disadvantages. While electron-coupling is used between the oscillator and detector portions of the tube, even this coupling shows a tendency to "interlock" above 10 megacycles. This means that tuning the detector portion of the tube also has an effect on the oscillator tuning and tends to make the oscillator oscillate at the frequency to which the detector portion is tuned, instead of a frequency which is higher than the detector frequency by the amount of the intermediate frequency. This is due to the fact that the coupling is too close at the higher frequencies. A separate oscillator would eliminate this difficulty.

Neutralizing the Stubborn Amplifier

By ROBERT S. KRUSE

The following is an excerpt from one of the talks given before the world-wide Radio Amateur Convention which was so capably conducted by an organization of Chicago amateurs known as the World's Fair Radio Amateur Council, the same organization which provided the very excellent amateur radio exhibits at the Fair itself.

Ballantine Neutralization

ASIDE from overload difficulties the r.f. amplifier of a transmitter can get into many sorts of odd difficulties. One that is heard from almost every week at the Answer Factory is a push-pull r.f. amplifier stage that "refuses to neutralize properly"—or else "refuses entirely to neutralize."

These stages are almost without exception of the Ballantine type, that is one tuned cir-

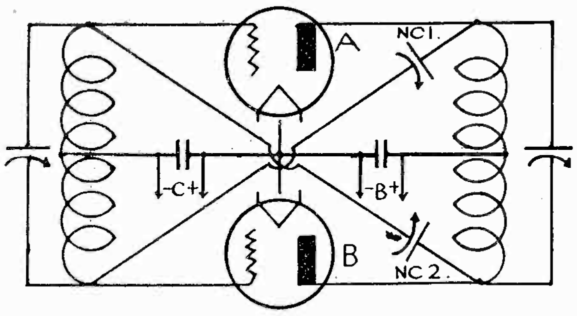


FIG. 1
A Ballantine Cross-Neutralized Amplifier

cuit feeds the grids and another tuned circuit joins the two plates together, with the plate supply fed in at the center and neutralization is accomplished by connecting a neutralizing condenser from each plate to the grid of the OTHER tube.

It sounds simple. There are several snags.

For instance, if the two tubes are not alike the two neutralizing condensers must be set differently to give complete neutralization. If we set them alike in the usual way there will be a perfectly fine chance for several unpleasant things to happen. One is that the stage may oscillate weakly at a wavelength between 5 and 15 meters, heating the tubes to no advantage whatever. Another is that if we modulate the stage it will be non-linear and queer quality results. A third one is that the B plus lead is no longer free from r.f. voltages as it should be. Start by thoroughly bypassing the B plus to the filaments, then neutralize the tubes one at a time—each one being done while the other tube is out of its socket and has its neutralizing condenser disconnected. Then replace the first tube and condenser (not losing the condenser setting) and do it again for tube number 2. Don't forget that the plate and grid tuning have to be changed slightly to maintain resonance whenever the neutralizing condenser is moved.

Now you have two sets of condenser settings BOTH OF WHICH ARE WRONG. Suppose one neutralizing condenser was found to be right at 56 on its scale and the other at 42—which is a difference of 14 scale divisions. When both tubes and condensers are restored we will find that the stage can be neutralized with these two condensers the same 14 divisions apart but at a different place in the condenser range—maybe the readings will be 64 and 50. This gives a slightly better efficiency and a good deal better modulation linearity than if we simply split the difference and set both at 57, and the extra work is worth while. It usually also avoids the need for extra gadgets to stop ultra-short wave oscillation.

While on this subject it may be just as well to explain why a Ballantine stage can be given more or less workable neutralization with incorrect condenser settings. The explanation is a bit messy but perhaps we can make it simpler by asking you to remove one neutralizing condenser entirely, whereupon you will find that if grid bias and plate supply are well bypassed a fair neutralization (for c.w.) can be obtained with the other condenser alone. If you think over the diagram a while you will see that with only ONE balancing condenser tube B is now stabilized by the Hazeltine method and tube A by the Rice method. The system as a whole is NOT very stable because the Hazeltine and Rice methods do not change in the same way with changes of voltage or

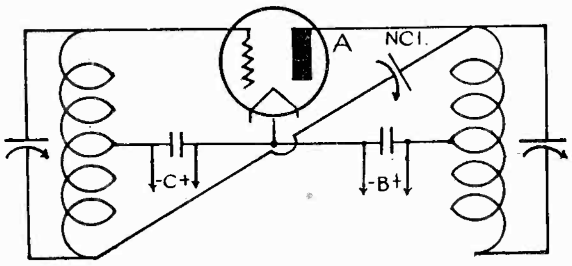
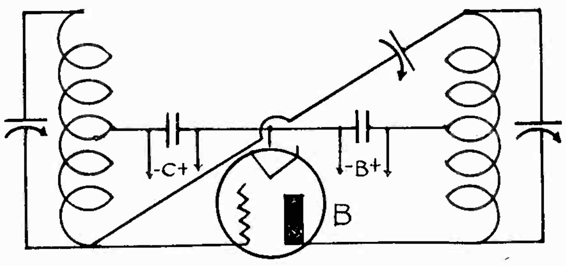


FIG. 2
With NC2 removed we can see that NC1 Rice-neutralizes Tube A



Also that the same condenser Hazeltine-neutralizes Tube B

frequency, and the Rice method, especially, is quite unstable at ultra-short wavelengths when balanced at ordinary waves—so oscillation may follow at once in a c.w. set or almost surely) in a voice set, when modulation starts.

If we use two equal neuting condensers things are a little better, but why not have them right? The step-at-a-time scheme just described will easily neutralize even the 204A stages which are commonly reported to be untameable.

Other Feedbacks

ALL of you who have done radio service work know that a broadcast receiver has to be neutralized one stage at a time to work decently; one simply cannot turn the whole thing on at once with several amplifiers oscillating and then try to find out how to neutralize one stage. I have finally been forced to learn this, but you'd be surprised to know how many copies of "How To Neutralize a Transmitter" I have sent out because that point was overlooked.

Every once in a while a transmitter refuses to neutralize when all of the above has been taken care of. Again we can find the cure in the broadcast receiver by recalling that neutralizing is intended to take care of CAPACITY feedbacks THROUGH THE TUBES—not magnetic feedbacks between different coils or feedbacks caused by omission of de-couplers.

In receivers of the neutrodyne type, you will remember that the coils were all placed to prevent coupling between them. It was done by putting them a certain distance apart and then leaning all of them 57½ degrees—what Budlong called "The Sacred Angle." But! If the spacing or coil shape was changed, so was the sacred angle, therefore if this stunt is to be tried in a transmitter one must find the proper angle. Setting the coils at right angles is almost NEVER right. Instead, connect one coil across the secondary of a filament transformer with a 60-watt

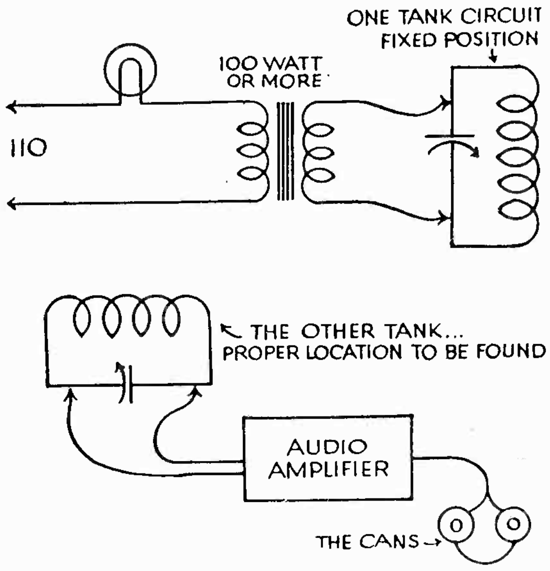


FIG. 3

lamp in the primary to prevent the transformer from burning up. You now have from 5 to 15 amperes of 60-cycle a.c. in the coil. Then connect a pair of phones across the other coil and try moving the pair around in the various positions that are possible in the transmitter, hunting for "dead" positions where the phones make no sound. Better use a simple audio amplifier between the second coil and your phones to make sure that you are not fooling yourself. The audio system of your receiver is o.k.

Having one pair of coils satisfied go on to the next coil in the transmitter and make sure that it has zero coupling with BOTH of the first coils—and so on.

Of course, in later receivers we no longer use the sacred angle. Instead we use screen-grid tubes and shielding, but for some reason transmitters are badly behind the times and keep on trying to get along without enough shielding—and then blame the neutralizing condenser for being unable to pinch-hit for the missing tinware.

A surprising lot of good can be done by simple open-topped boxes bent up from quite thin sheet metal, especially if the seams are soldered instead of using screws or rivets. It is a pity that copper is so heavy and expensive. An even simpler, but somewhat clumsy, construction is to set up a big square sheet of metal between each pair of stages. This is quick and easy for a transmitter that is strung out along a table top, or one that goes up skyscraper fashion.

I don't care for overdoing the shielding, though. As long as the early stages are shielded there isn't much to be gained from shielding the final stage. Its coils are larger and clumsier, hence a shield is too costly. It is exactly as good to leave the antenna coil, the last plate tank, and also the tuned coil feeding this last stage, all out in the open. We have already described the way of finding how to set them for least feedback.

QUARTZ CRYSTALS AND THEIR APPLICATIONS

Effect of Temperature on the Frequency of Crystal Oscillators

By A. F. HOEFLICH

CHAPTER III

WHILE room temperature is an important factor in frequency control with a quartz crystal, this is only one of several factors, and is far from the most important of those to be considered.

The frequency temperature coefficient of a crystal is best rated in cycles change per million cycles per degree centrigrade. Given a certain frequency tolerance, the required temperature tolerance can be found, and from this the basis of the temperature control chamber design can be studied.

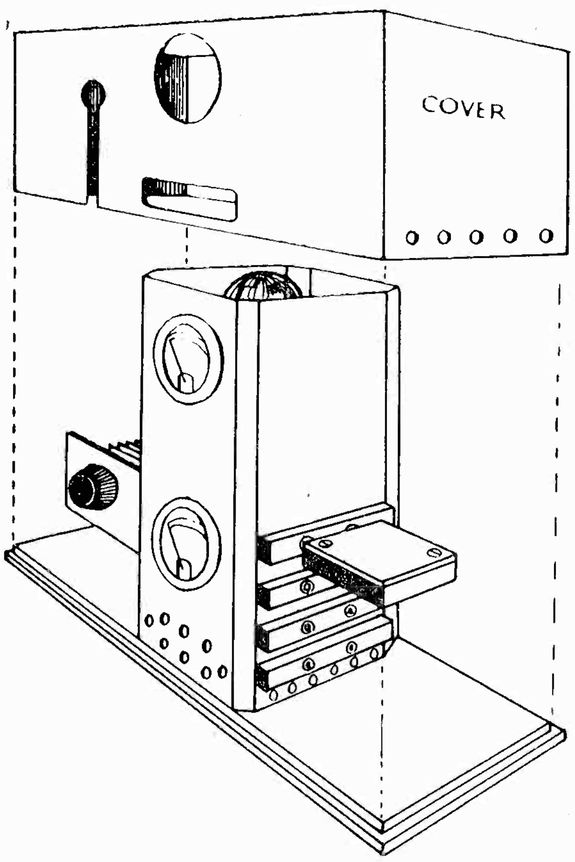
The use of temperature control chambers increases the cost of the oscillator. It also takes power to operate. Experiments have been made, therefore, in the search for reasonably good frequency stability without the use of a temperature control chamber, and several enlightening points are here presented.

Looking over the temperature coefficients of the two available cuts for the oscillator crystal it was seen that the average temperature coefficient of the **X** cut crystal is in the neighborhood of 30 parts in a million per degree centigrade. That of the **Y** cut is, on the average, 100 parts in a million per degree centigrade, in the stable part of the curve. The **X** cut plate has a practically constant value for the temperature coefficient while the **Y** cut has a variable value depending upon the part of the curve at which it is operated. Either cut may be operated as a temperature controlled crystal, but the **Y** cut plate should be ground for the temperature at which it is to be used if good results are to be obtained. From the check up on the temperature coefficient it is evident that the **X** cut crystal has a considerable advantage over the **Y** cut, as the temperature tolerance for a given frequency tolerance is much greater and therefore much easier to obtain.

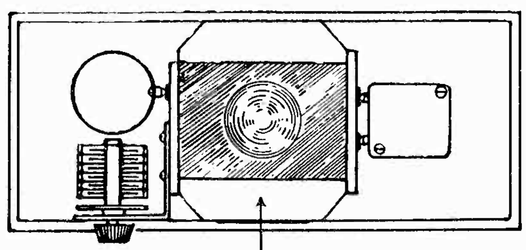
An investigation of the oscillator circuit shows that the cause of change in crystal temperature (and the consequent change in frequency) is due to (1) passage of grid r.f. current through the crytsal, heating the latter; (2) heat from the resistors, tubes, etc., which is conducted to the crystal through the air and other media, and (3) variation of the room temperature which affects the crystal temperature by conduction from the air.

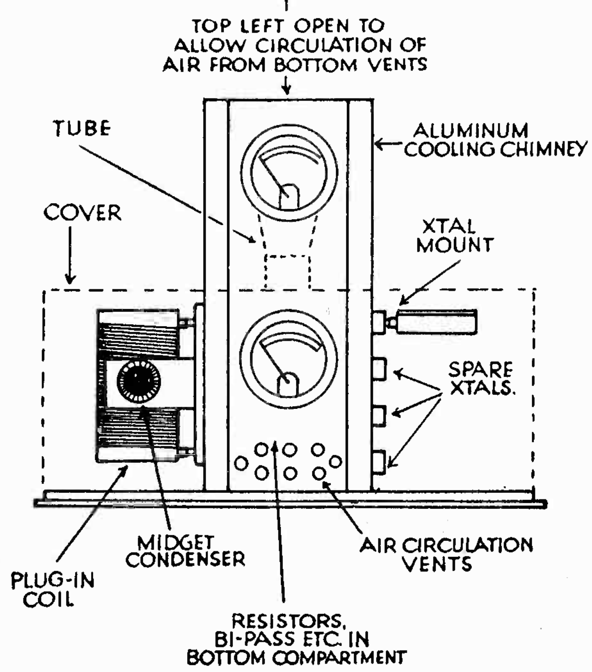
It is possible to improve the frequency stability by reducing the effect of these factors upon the crystal and the circuit. The r.f. grid current, which is the greatest factor affecting the heating, can be reduced by using the tube which has the greatest power sensitivity. Or it can be reduced by loading the oscillator plate circuit to such an extent that the voltage developed across the plate tank is reduced to a low value.

The latter method, developed by Boyd Phelps, allows a considerable output to be obtained from the crystal oscillator for a given rise in temperature, but the factor of safety is small and the method requires careful operation. The use of a tube having a high power sensitivity is the better method at present. Such a tube requires a small grid power with the result that the crystal is called upon to do less work than ordinarily. The strain on the crystal is therefore smaller. That is to say, the r.f. current flowing through the crystal to the grid is smaller. The crystal current can be shown to be proportional to the amplitude of vibration of the crystal plate; therefore, when the current is reduced the vibration is reduced, and the heating effect is lowered.



TOP VIEW





The pentode has a higher power sensitivity than the triode or tetrode and receives the bid for this position in the modern high frequency transmitter. Apparently the '47, 2A5, and 59 tubes are about equally good performers as crystal oscillators, and should be selected for this job in place of the triode whenever possible.

The heating of the crystal having been reduced by the use of a pentode, we may still further equalize the temperature by carefully designing the mounting. One of the electrodes should be fairly large in size and exposed to the air. Heat is conducted away from the crystal by this plate and radiated into the air.

The effect of the heat radiated from the resistors and the tubes can be eliminated by carefully designing the circuit, electrically and mechanically. All the resistors should be grouped and placed in a location as far away from the coils and the crystal mounting as possible. The oscillator tube should be mounted above and as far away from the crystal mounting as possible, and the circulation of air should carry the heat away from the tube and not in the direction of the crystal. If the parts are properly placed the heat developed in them will not influence the temperature of the crystal or the coils, and a noticeable reduction in the frequency drift should result. Metallic surfaces or baffles will reduce the heat transmitted to the coils or crystal mounting, also. The design in Fig. 1 shows a set-up incorporating these ideas.

With such an arrangement and with a plate voltage of about 350, and a screen voltage of about 150, the crystal temperature rise should be about one-half a degree centigrade. The frequency drift under these conditions will be practically dependent upon the room temperature, and if the latter can be held to 60 degrees F. + or — 5 degrees F., the above oscillator design with an X cut crystal should hold the operating frequency within better than 500 cycles in the 80-meter band. This requires that all other factors be steady, as discussed in previous articles on this subject.

Drift

BEFORE discussing a few practical examples of frequency control work, a review of the drift coefficients is again in order. As already mentioned, the **X** cut plate has a practically constant value for the drift coefficient while the **Y** cut has a variable value and an unstable region on the curve where two frequencies exist, each having a different value for the drift coefficient. This is shown in Fig. 2. The change effected

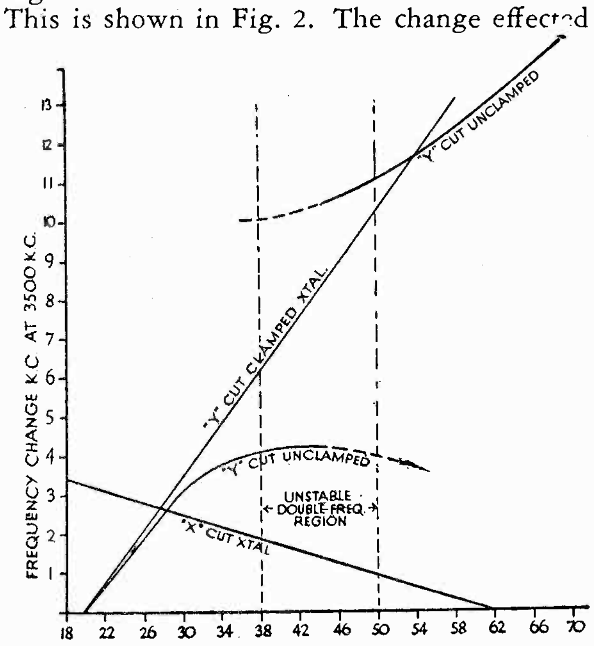


FIG. 2 Frequency-Temperature Coefficients
The position of unstable (2 frequency) operation for Y-cut can be placed at any position on the crystal's F-T curve by suitable grinding of the length dimension.

by the use of a clamp type holder such as the one in P. R. Fenner's article in August "RADIO," is shown as Curve "C." Evidently the use of such a holder effectively damps out the standing wave across the surface of the crystal plate, and thus removes the coupling from the harmonic from this source, which causes the irregularity in the curve. The unstable region of operation is removed by clamping, as the result of reducing the degree of freedom in the direction of the low frequency fundamental. With the clamp holder it is no longer possible to use the **Y** cut plate near the bend of the curve to take off the near zero temperature coefficient at this point. This is a small loss, however, as such operation in a high frequency plate is very critical and difficult to control.

The **Y** cut plate has a positive coefficient. That is, it raises its frequency with an increase in temperature, while the **X** cut has a negative coefficient. This is shown in Fig. 2. As the **Y** cut drifts three times as far as the **X** cut for a given temperature change the advantage of the latter is obvious. It is suggested that a thermometer be mounted with the bulb in contact with the lower plate of the crystal mounting, and a temperature frequency curve be drawn and mounted on the crystal oscillator panel. The exact frequency is read and included in each log entry.

In the practical use of these ideas the results have been excellent. Several transmitters were changed over with an easily noticeable improvement in the ease of operation and frequency stability. The first transmitter, with a '52 final stage, originally used a 210 oscillator with 450 volts on the plate and a **Y** cut crystal. The crystal mounting warmed noticeably and the drift was about six kilocycles during the warming up period. Changing over to an **X** cut plate lowered the drift to about two kilocycles, but the crystal persisted in heating because of excess crystal current. Substituting a '47 pentode with the same plate voltage as used in the 210, the drift was reduced to the neighborhood of ½ kilocycle. The transmitter frequency was in the 7000 kc. band. The crystal oscillator was well arranged in this set so no mechanical changes were necessary to eliminate transfer of heat from the tube and heat producing parts of the circuit to the crystal.

The second transmitter, with a 203A final stage, used a 210 oscillator with a **Y** cut plate. The drift was 3½ kc. in the first ten minutes, after which a constant frequency was held. The same changes were made (use of an **X** cut crystal and pentode) and the drift was reduced to a few hundred cycles. This transmitter was on 80 meters.

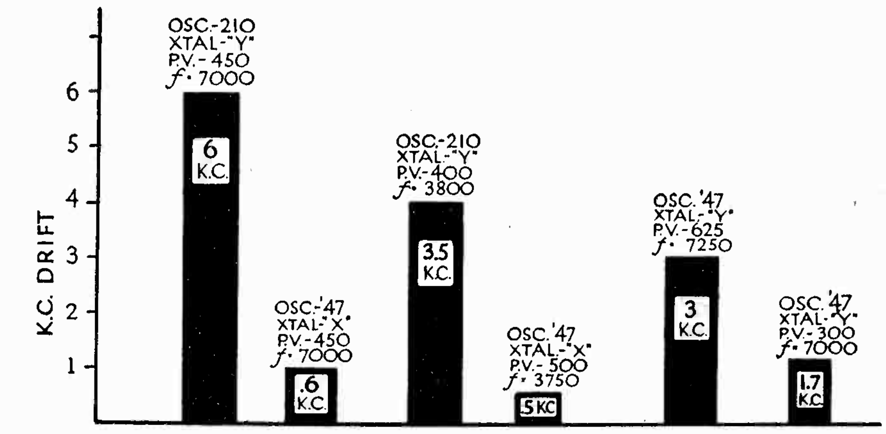
Several combinations of crystal cuts and oscillator tubes were checked from a number of stations and the results are shown graphically in Fig. 3. A short-wave field transmitter used by two of the San Francisco broadcast stations was furnished with an **X** cut crystal by the writer, and equipped with an oscillator similar to the type discussed here. The frequency, as checked by a local monitoring station, has been found to be at all times well within the allowable tolerance, in spite of the fact that the crystal is not temperature controlled.

It should be noted that the room temperature should be fairly steady to attain such results, as large temperature changes, which can influence the temperature of the mounting, will most certainly show up in frequency variations.

For frequency control of high accuracy it is necessary to hold the temperature constant to a small fraction of a degree. Temperature ovens for this purpose have been developed along two distinct lines, which might be classified as the transmitter type oven and the frequency standard type oven. The transmitter type is generally less refined in design, and takes into account the fact that the transmitter crystal is usually operated at a high power level (compared with the standard crystal), and that a certain amount of heat is therefore generated at the crystal. The design is such that a low thermal impedance exists between the crystal and the thermostat.

The standard frequency type oven usually consists of an attenuating box of a material having a high heat capacity and a small heat conductivity, such as cedar, in which the crystal is mounted, surrounded by a box made of material having a high value of conductivity but a small heat capacity, such as aluminum. The controlling thermostat is placed outside the aluminum box, which is surrounded by the heating pads, and the whole assembly enclosed in a heat insulating chamber. This usually consists of balsa wood, which has the lowest heat conductivity of the commonly available materials.

FIG. 3
Frequency Drift observed with various tube and crystal combinations (without temperature control).



40-Meter Plates

A WORD on 40-meter plates. On the average it has been found that the 40-meter plate has a tendency to overheat because of the fact that it tends to use a large crystal current. The use of a small top plate, with a bottom plate of the usual size, gave fairly good cooling, although brushing at the center raised the temperature at that point. Use of a small top plate gives considerable increase in circuit efficiency, but the problem of crystal heating should be carefully considered if such a plate is used. It is suggested that the crystal current be carefully checked when a 40-meter plate is used. Any heating of the crystal which is noticeable to the touch is a sign that the crystal is being overworked and that the drift is probably excessive. In any case, a large temperature rise in the electrodes, which is discernible to the touch, is a warning that the crystal plate is probably on the verge of fracture because of the large amplitude of heat because of the fact that it tends to use vibration corresponding to the high crystal current.

The first described oven will ordinarily hold the temperature of the crystal within about 1/2 to 1/5 degree C. of the required temperature, while the second will hold the temperature within better than .1 degree, and when two stages are used, within better than .01 degree. When double staged, the oscillator equipment is usually housed in the outer chamber, which holds the temperature of that circuit to within .1 degree, thus eliminating the variation caused by the change of circuit constants due to change in circuit temperature.

The first design will ordinarily hold the temperature of the crystal constant enough so that the frequency will remain within 5 parts in a million of the selected frequency, or better when an **X** cut plate is used. The staged design will hold the bar, if it is an **X** cut-**Y** wave, to within 5 parts in a million or better, and is suitable for secondary standards.

(Continued on page 25)

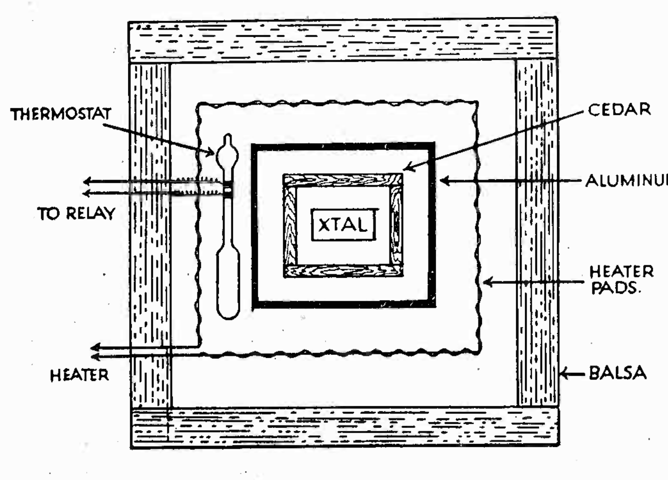
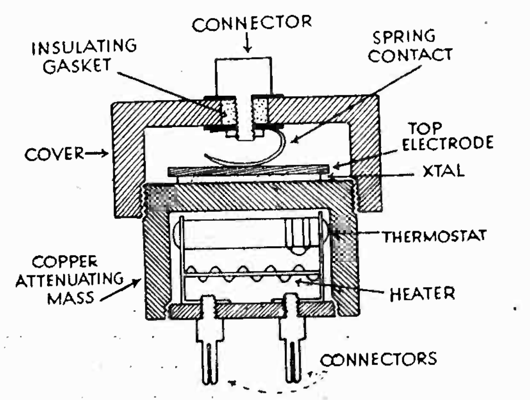


FIG. 4
Diagram of Single Stage Oven for frequency standards



Transmitter Crystal Oven

Further Data on the Sargent 9-33

By E. M. SARGENT

IN the July issue of RADIO the Sargent 9-33 Receiver was described in detail. Since the writer has been in receipt of a number of inquiries asking for further data on some of the salient circuit features, this article will cover the ground more completely.

Probably the feature that aroused the most interest was the use of two frequencies in the i.f. Strictly speaking, this is not really as new as it seems, because any broadcast-frequency superheterodyne with intermediate on 175 k.c. and with a S.W. converter ahead is the same thing in circuit principle. However, this is the first time, to the writer's knowledge, that the possibilities of this arrangement have been developed to their fullest extent.

In the article in July RADIO it was stated that the kilocycle selectivity that could reasonably be expected from an intermediate amplifier varied approximately in inverse ratio to the frequency. Thus, if at a given frequency, 600 k.c. for example, the possible selectivity were 10 k.c., a selectivity of 3.3 k.c. could be expected by equal care in design on 200 k.c. In order to check these statements a set of actual curves was taken on the 465 and 175 k.c. transformers used in the receiver. The circuit with which the test was made is shown in Fig. 1 The

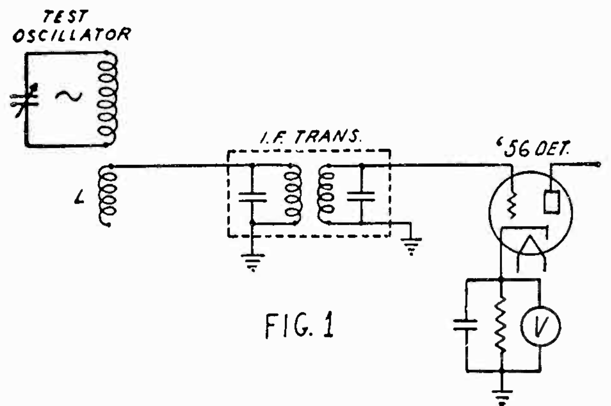
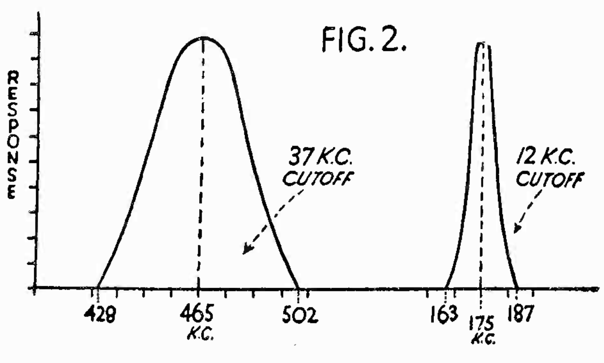


FIG. 1

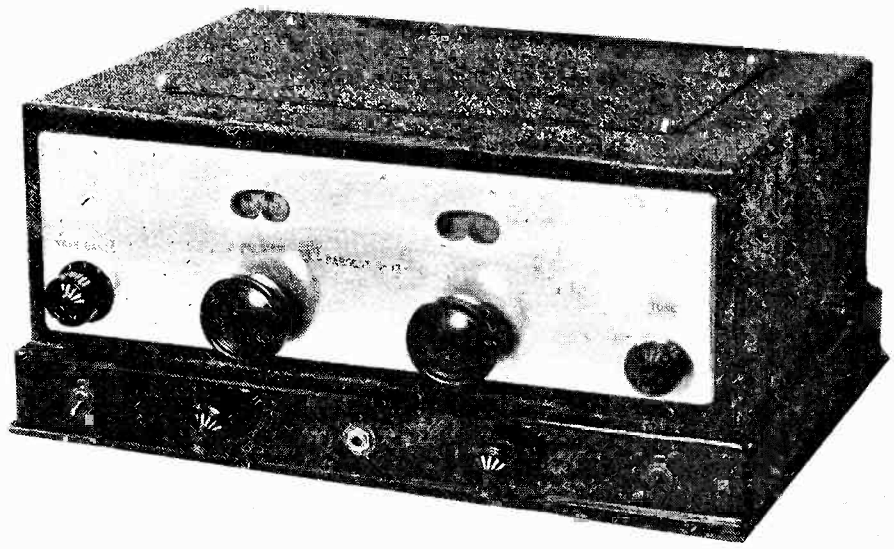
test oscillator was loosely coupled to coil L which was unilaterally connected to the i.f. transformer to be tested. This transformer was connected to the 56 bias-detector, and a milli-volt meter placed across the 56 cathode resistor was used for an indicator.

The transformer was first carefully tuned to the frequency of the oscillator, 465 or 175 k.c., depending upon which transformer was being tested. The oscillator coupling was adjusted so as to give the same milli-volt reading at exact resonance with each transformer, and the oscillator frequency was then varied sufficiently to give data for the curves shown in Fig. 2. To make the com-

FIG. 2.



parison more obvious, the two curves have been drawn to the same scale and placed side by side. At 465 k.c. a frequency change of 37 k.c. was necessary to drop the signal indicator to zero, whereas on 175 k.c. the frequency change to completely eliminate the same signal was only 12 k.c. In this case the increased selectivity due to frequency decrease is slightly greater than the amount predicted, and this may be due in part to the greater amplification possible at 175 k.c. The transformers were of identical construction (both being Litz wound with the same size wire) and having about the same coupling ratio so the results as shown by the curves can therefore be taken as quite accurate. The 12 k.c. is of course the selectivity of a SINGLE I.F. TRANSFORMER, not of the entire 175 k.c. part of the amplifier. The selectivity of this latter is many times greater.



The new Sargent 9-33 Receiver in its steel cabinet with aluminum front panel.

The system of changing wave-bands by means of tapped coils has brought favorable comment and also a number of inquiries as to how losses are minimized. The subject of dead-end loss in coils is one which is not too well understood and a few words on this may be of interest. Fig. 3 is a schematic

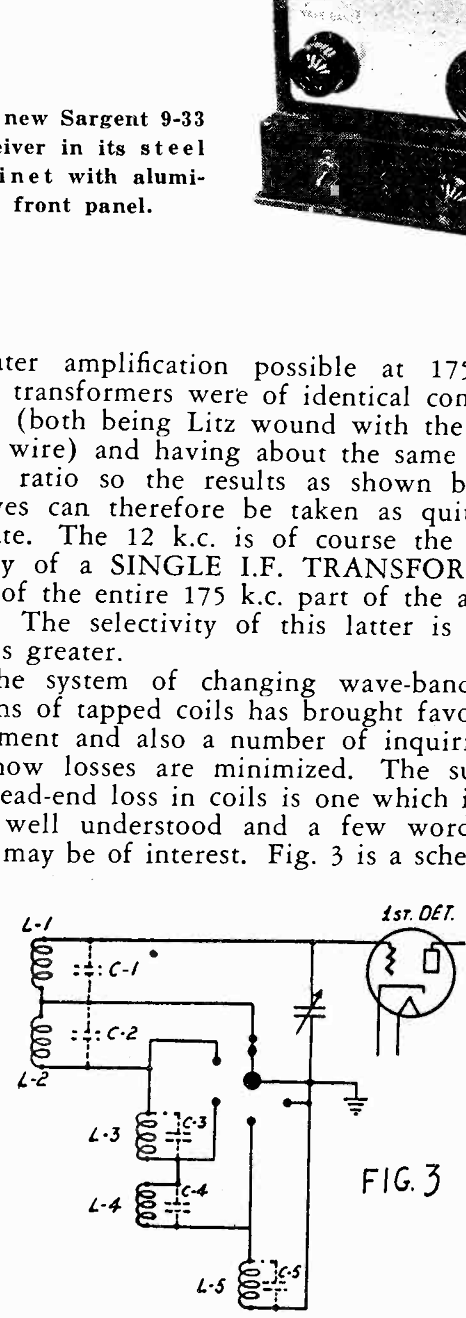


FIG. 3

of the input circuit to the first detector. Three coil forms are used; coils L-1 and L-2 being wound on one, L-3 and L-4 on another, and L-5 by itself. In Fig. 3 the dotted lines indicate the distributed coil capacity.

A dead-end is damaging only when it resonates within the wave-band of a coil to which it is inductively coupled. There is of course a very small loss at any frequency due to the presence of the metal wire and the insulating material in the field of the coil, but this is of the same order and no more serious than the loss in a plug-in coil, due to the coil contacts and form material being in the same position. It is a loss that is bound to occur in almost any system of inductance-changing that can be devised, and is not sufficiently serious to be of consequence. However, in Fig. 3, if the tap switch were set for the lowest wave-band, so that the only inductance L-1 were in use and if L-2 had enough capacity to resonate at some wave-length within the band covered by the tuning condenser and L-1, then at this resonant frequency, a serious loss would be introduced into the tuning circuit and for a fairly wide frequency band to either side, nothing except strong signals could be heard. Let us now consider some specific values in the following table which gives the wave-band coverage and inductance value for each tap in the Sargent 9-33.

Tap No.	Approximate Wave-Band (meters)	Approximate Inductance (microhenries)
1	14 to 31	1.35
2	27 to 62	5.4
3	57 to 126	22.4
4	120 to 250	80.0
5	240 to 550	425.0

It should be noted that the above are NOT the individual values of L-1, L-2, L-3, L-4 and L-5, but are the TOTAL inductance values used in the circuit for each tap switch setting. The individual values of the inductance sections are given in the table below, together with the capacity value necessary to resonate at the lower end of the wave-bands below the one on which it is used.

Coil section L-1 being the lowest, it does not, of course, resonate by itself within the band of any other coil and is therefore not included in the table. L-2 is wound on the same form as L-1, and, although separated from L-1 by twice the length of the coil, could still conceivably cause damage in the L-1 wave-band unless the capacity of the L-2 section is kept well below the 13.5 mmf. shown in the table. For a coil of only 4.1 microhenries this is not difficult. In the 9-33 both L-1 and L-2 are space-wound, and this keeps the resonant wave-length of L-2 well below 10 meters (by actual measurement).

L-3 consists of 25 turns of No. 24 DSC wire, close-wound on a 1-in. bakelite form. This section, which has an inductance of 17 microhenries, needs 3.2 mmf. to resonate at 14 meters and 12 mmf. at 27 meters. A close wound coil of this size is certain to have more than 3.2 mmf. distributed capacity, and it is therefore obvious that special precautions must be taken to keep L-3 well removed from L-1. If the capacity of this section is at all excessive, it is possible that its resonant wave-length might even fall within the band covered by L-2. For this reason L-3 is carefully isolated from both.

L-4 is wound with 61 turns of No. 28 DSC wire on the same form with L-3 but spaced ¾ in. away. To cause trouble within the L-3 wave-band, L-4 would need 14 mmf. capacity. The use of the smaller size wire helps to make certain that L-4's capacity will be considerably below this amount. L-4 is,

(Continued on page 22)

A Good "5 and 10" Receiver

By FRANK C. JONES

OPENING up the 10 meter band for phones makes the use of a super-regenerative receiver desirable until such time as the band becomes crowded, or sufficient time and data are available for really efficient superheterodyne receiver construction. Nearly any five meter receiver can be made to operate on ten meters by winding slightly over twice as many turns in the inductances in the same winding length. The reason for slightly more than twice is that there is a certain amount of fixed inductance in the leads that is not doubled when changing to ten meters by means of plug-in coils.

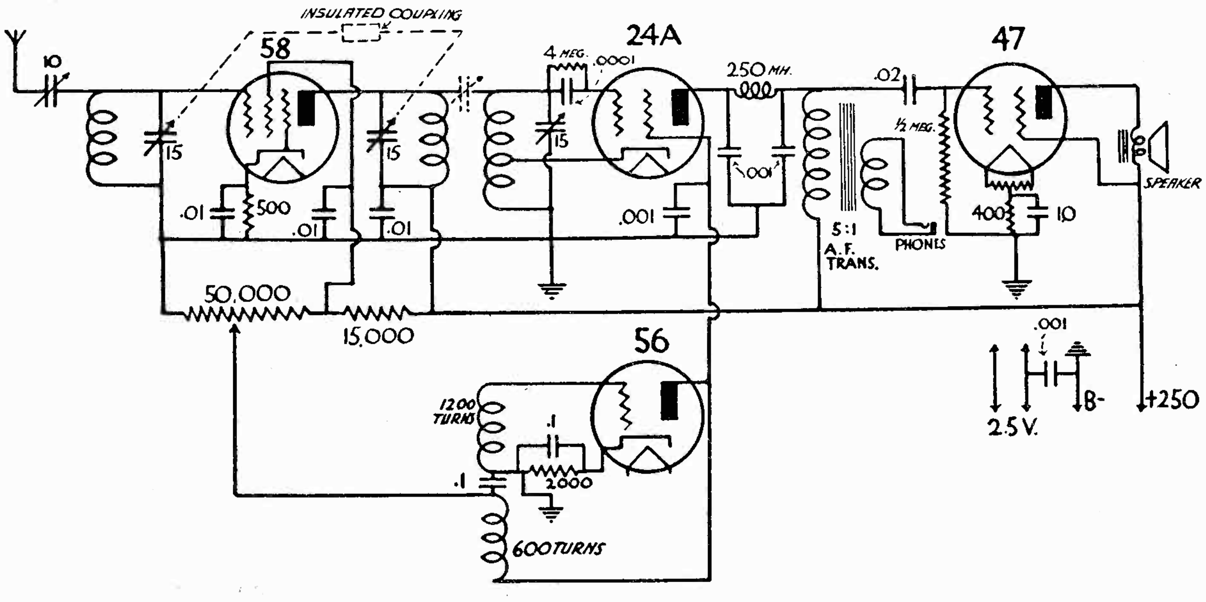
The circuit shown has certain desirable characteristics. An electron-coupled screen grid detector of the 2½ or 6 volt heater series is used because of greater sensitivity and less tendency of cross-talk from broadcast stations. The latter is true because the interfering signal has a low impedance path to ground, which is not the case for the more usual form of split Colpitts coil detector circuit. The screen grid detector has more audio gain as a grid-leak detector than a triode, and when this circuit is used the plug-in coils are simple in construction.

All super-regenerative detectors radiate strongly. Some form of r.f. amplifier was deemed necessary. The one shown has proved quite satisfactory and actually gives some gain on both five and ten meters. Both grid and plate circuits are tuned in order to give a high impedance to these circuits. If the plate of the r.f. amplifier is coupled through a very large capacity of even five or ten micro-microfarads to the detector coil, the loading effect becomes noticeable and the additional capacities make a very small coil necessary. This high C to L ratio reduces the detector sensitivity and r.f. gain. The use of a separate tuned plate coil allows a very small coupling capacity, such as a piece of No. 18 wire, run parallel for a half inch to the detector grid leak at a distance of about a half inch. This coupling must be adjustable as too much capacity coupling will cause the detector to stop oscillating when the r.f. amplifier is tuned to the same frequency.

The r.f. tuning condensers can be ganged-up on a drum dial or common shaft, provided an insulating coupling is used between rotors. This is necessary even though both rotors are grounded in order to prevent a common link circuit coupling between the r.f. amplifier grid and plate with r.f. oscillation. In the receiver used, no attempt was made to gang-up this control with the detector tuning, though this could be done. The two r.f. condensers are tuned by means of a drum dial and the r.f. tube is mounted horizontally in order to have the grid and plate leads as short as possible. The mica type by-pass condensers are grouped around the tube socket base for the same reason. The "coupling condenser lead" from the r.f. tube to detector grid is about 4 inches long and simply acts as a small antenna to the detector.

An adjustable screen grid voltage and interruption frequency plate supply was used in order to allow operation of the screen grid detector in its most sensitive condition of super-regeneration. It also allows the use of the tube as a straight regenerative detector on ten meters where occasionally greater selectivity and less sensitivity may be desirable. The super-regeneration effect, with its loud hiss, takes place with from 50 to 80 volts on the screen, while critical regeneration on ten meters takes place at about 30 volts. Super-regeneration will take place without the extra interruption frequency tube if the grid leak is small enough, a quarter or half megohm. This grid leak form of super-regeneration is not as simple to get into operation and cannot be loaded up by the r.f. stage coupling as much, and is harder to filter out of the detector plate circuit. A quarter henry r.f. choke and a couple of .001 mfd. condensers will filter out the super-regenerative voltage from the audio amplifier when using the separate 37, 27, or 56 tube with a moderately low interruption frequency. The latter is determined by the size of the detector screen by-pass condenser, .001 mfd., and the i.f. plate coil. Apparently, the i.f. grid coil is not critical, providing it is large enough to give strong oscillations.

By using an old A.F. transformer with a 4 or 5 to 1 turns ratio, the small primary can be used when headphone operation is desired. The step down ratio matches the receivers fairly well to the screen grid tube plate circuit. The audio volume control is not effective then, and for this purpose it should be connected as a variable resistance across the detector plate circuit. Normally, this receiver is used with loudspeaker reception at W6AJF and the pentode tube, loudspeaker and power supply are obtained from an old broadcast receiver on top of which the short wave "converter" rests.



5 and 10 Meter Super-Regenerative Receiver. See text for coil data.

The r.f. coils for five and ten meters were wound of No. 12 enameled wire on a ¾-inch diameter and are self supporting. The ends of the wires plug into phone tip jacks, mounted on a small insulating strip near its tuning condenser. The detector coils could be plug-in, although here they were soldered to a four prong coil base and plugged into a tube socket mounted by the detector tuning condenser. No super-regeneration could be obtained when the coils were wound on old tube bases because of dielectric losses in the coil field. Five meter oscillations could be obtained quite easily with these old tube base coils but the oscillation strength was insufficient for super-regeneration.

For ten meters, L_1 and L_2 are similar, and are 1½ inches long, ¾ inch diameter, of No. 12 wire with 14 turns. For five meters these coils are ¾ inch long, ¾ inch diameter, of No. 12 wire with five turns. The detector coil for 10 meters has 14 turns of No. 14 wire ¾ inch diameter, 1¼ inches long, tapped 4 turns from the ground end. For five meters the latter has 6 turns ¾ inch diameter, 1 inch long, of No. 12 wire tapped one turn from the ground end. These coils are conveniently made by close winding the turns on a form, then spacing the turns to the desired coil length by means of a small screw driver.

For ordinary regenerative action on ten meters, an additional ten-meter detector coil should be tapped about one turn from the ground end in order to be able to use a reasonably high screen grid voltage before oscillation starts. The signal strength on CW is low unless an additional audio stage is used, because the sensitivity of an ordinary regenerative circuit is so much less than a super-regenerative one. However, super-regeneration is unsatisfactory for ten-meter CW reception. Sometimes the amount of interruption frequency signal, and also detector grid leak, has to be adjusted in order to get maximum sensitivity on ten or five meters. In most locations, ignition QRM from passing automobiles or electrical power noises are useful in making these preliminary adjustments.

The receiver was built up with this circuit in order to eliminate radiation and to obtain the greatest possible sensitivity for use later in a poor 5 and 10-meter location. The sensitivity is apparently better than that obtainable from a superheterodyne, though of course it does not compare with the latter from a selectivity standpoint. Several superheterodyne receivers have been built here for tests on five meters, but none of them have been as sensitive to a weak signal as a properly adjusted and operated super-regenerative receiver. Ten meters may be a different story which time alone will prove.

●●●

Match Your Push-Pull 2A3s.

The plate resistance of a 2A3 is only 765 ohms but the mutual conductance is 5500 micromhos. It is evident that small variations in plate resistance will affect relatively large changes in mutual conductance. Therefore, distortion will result if the two tubes in a push-pull stage are not perfectly matched. Service men should sell two new ones when and if one goes bad, because it would be rare to find an old tube that would match up with a new one. Note that the quality of Pentodes cannot compare with the quality given by a properly designed triode audio amplifier. However, gain and cost must be considered.

HAM HINTS

By JAYENAY

Two in One. The 53.

The 53 has two triodes in one envelope and is principally used as a class B audio amplifier. The two triodes are usually connected in push pull but can be connected in parallel for use as a class A driver stage. It is interesting to note that the two tubes in one can be connected in cascade as a two stage audio amplifier and gains of over 700 have been realized in this connection. This is with resistance coupling between the two stages. The output of a moving coil microphone connected to the input of this amplifier gave enough output to overload the grid of a '45 with 300 volts on the plate. This is more gain than was realized from three stages of transformer coupled 27s. (See diagram.)

●●●

10 Meter Receiving Tubes.

The 24 and 35 show practically an absence of gain at 30 MC. The 36, 39-44 and 77 or 78 show very little and the 57, 58, 6C6 and 6D6 show up fairly well but short grid and plate leads and low C tuning coils are essential. Super-regeneration is about the best bet, although a well made super will work down there. A tuned radio frequency amplifier is more trouble than it is worth above 25 MC until such time as RCA decides to make new ultra-high frequency receiving tubes. My ideal 10-meter super would have one stage of push-pull RF amplification and a push-pull super-regenerative first detector. (Push-pull reduces the input and output capacitance and allows the use of lower C tanks).

●●●

Safety First.

It has been a long time since I have heard anyone talking about fuses, etc. Therefore, I might mention to the newcomers that ordinary flashlight bulbs located in the negative high voltage lead may save a tube or RF choke when things start happening. Where meters are concerned it is better to use fuses designed for the purpose. They are cheap and effective. All of us have burned out expensive meters at one time or another, and fuses would have saved us the two to five dollars which meter repairs cost.

●●●

What Tubes To Use On 10 Meters?

None of the lower-powered tubes are very efficient on ten meters. Of course, the 10, 45, 12A, 71A, etc., will work but they all have flat elements and a high input and output capacity. The 2A5 might do well as a triode with the screen either left open or tied to some other element but we need something like an 865 with the screen grid left out. The 52, 831, de Forest 571 and the new Federal 175 watter are FB. The screen grid transmitting tubes, such as the 865, 860 and 861 can be made to work, but it is hard to make them amplify properly, and they have a strong tendency to oscillate unless well shielded or neutralized.

●●●

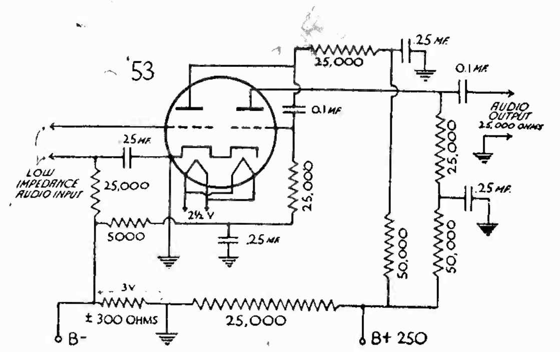
At Last: A New Tube With Real High Frequency Performance.

The 6C6 outdoes even the 57 at frequencies above 3000 KC because of lower interelectrode capacities. At broadcast frequencies it is very much like the 77. The 6D6 is the same thing with a variable-mu control grid.

How To Get More Receiver Gain.

A 58 or a 6D6 shows a surprising increase in gain when the plate voltage is raised to 350 volts and the screen voltage to 140 volts. The bias should be raised to the point where the tube mills are at or below the recommended value. This high bias causes a cloud of electrons to be stored between the cathode and control grid. This is thought to reduce tube noise caused by uneven emission from the cathode. At any rate, the signal to noise ratio seems higher, which is what we want.

●●●



The '53 as a two-stage cascade amplifier. Only one tube is used. The '53 has two grids and two plates, with a common filament and cathode structure. One grid and one plate is used to feed the other grid and plate, resulting in a two-stage amplifier that uses but one tube.

●●●

The Grid Current Milliammeter.

If I could only have one meter in my transmitter, I would want a grid meter in the last stage. It is more sensitive than a plate milliammeter and is hard to beat for tuning and neutralizing.

●●●

How High Is High C?

Little stability is added to an oscillator when using more than 200 MMF. on frequencies above 7000 KC. On frequencies below 7000 KC capacities above 350 MMF. merely reduce efficiency without adding much noticeable stability. Of course, Low C is essential at all tanks except the one that determines the frequency of oscillation, especially in the plate circuit of a doubler stage.

●●●

Do You Want a Quiet Receiver?

Then do not use more than one stage of audio amplification. Many of the real DX stations use no audio at all but plug the phones in the plate circuit of the detector. Audio amplification is a very noisy way to get gain. It is far better to increase the RF gain to get the same effect. What good does it do to strain your ears listening to a loud-speaker when modern phones are light, efficient and cheap? (Also reduces local QRM from the OW).

●●●

Don't Turn the Mike Battery Off Without Reducing the Current Through the Mike Buttons.

A terrific inductive wallop occurs every time the mike button current is turned on or off unless we reduce the current to less than one milliampere with a rheostat. This inductive kick tends to fuse the carbon buttons together and packs up the mike. This reduces the sensitivity of the mike and affects its fidelity of reproduction. Instead of a switch it is better to use a rheostat of about 1000 ohms which has an off position beyond the point of maximum resistance. Many good two button and single button mikes have been ruined by this inductive surge.

●●●

How To Estimate the Audio Output Of Your Modulators.

We know that the audio output must be about 60% of the DC input to the modulated RF amplifier to produce 100% modulation without carrier shift, but how can we tell how much audio output we are obtaining? The best way to estimate the audio output is to measure the DC input to the modulator plate or plates and then divide that input by the probable efficiency of the modulators. Provided the modulator tubes are suitable for use as modulators we can assume that class A modulators are 20% efficient. If the modulators operate in class A prime then we should take 35% as the efficiency. If they operate in class B we can assume that they are 50% efficient. We should take the peak DC input in class A prime and class B stages. In pure class A the input is constant and does not vary. If the DC mills of class A modulators swing more than 5% when we talk into the mike, then either the bias or the load is wrong and serious distortion is being produced.

●●●

Use Phones To Bias the Audio Stage.

The DC resistance of a pair of phones is about 2000 ohms, which is about right to bias a 56 or 27 when used as an audio amplifier in a receiver. Connect the B plus directly to the plate and the phones in the B (—) minus leg. This does away with a bias resistor and by-pass condenser. One side of the phones is grounded, so they won't bite you if you should happen to touch the terminals.

●●●

Electron Coupling, When?

The main advantage of electron-coupling occurs when it is desirable to use a high powered oscillator either to directly excite an antenna or to drive a high powered stage such as a 1000 watt final amplifier. There is little benefit in using a 24 or even an 865 as a low powered oscillator and then use a long string of amplifiers to build up the output, unless the ability to QSY is of great importance. Crystals are cheap, so unless we want 75 watts or more from the oscillator we might as well use a crystal. For receivers and frequency meters electron coupling has no equal.

●●●

Crystal Controlled Doubler

Lamb's xtal oscillator-doubler works best with an 865 or WE 254B but will work with a 2A5 if it is neutralized. I arrived at the same answer by putting a crystal in the grid circuit of an electron coupled oscillator. The plate tank MUST be low C if we want to get much harmonic output. The LC ratio of the cathode tank has a marked effect on the output but varies with different tubes and xtals. Try low C first. Another big advantage of this circuit is that it starts oscillating almost instantly even with a loggy crystal. This allows us to key the crystal or kill the carrier for break-in on phone.

30-Watt Radiophone at W9USA

IN the photo herewith is seen George Mack, Chief Operator K7HV of Juneau, Alaska, operating the thirty-watt radiophone built by McMurdo Silver, Inc., for Station W6USA at the amateur radio exhibit in the Century of Progress in Chicago.

The receiver he is tuning is the Silver Type 3A Ham Super, while at its right is the microphone and type 4A electron coupled frequency meter.

The transmitter, assembled in an aluminum rack, is seen at the right of the photo. Its four 7 x 19-inch panel units are, bottom to top, r.f. power supply, fifteen-watt modulator, thirty-watt crystal oscillator, buffer and r.f. amplifier, and at the top, the antenna tuning panel.

The transmitter is operated in the 3900 kc. phone band, but by the change of a single Bliley plug-in crystal C.W. operation can be had in the 20, 40, and 80 meter bands—or the 20 meter phone band if desired.

The circuit diagram and parts list of the transmitter is given herewith, for those who may desire to build a highly efficient, yet simple and inexpensive, 15-watt radiophone and 30-watt C.W. transmiter.

●●●

W9USA-W9USB News

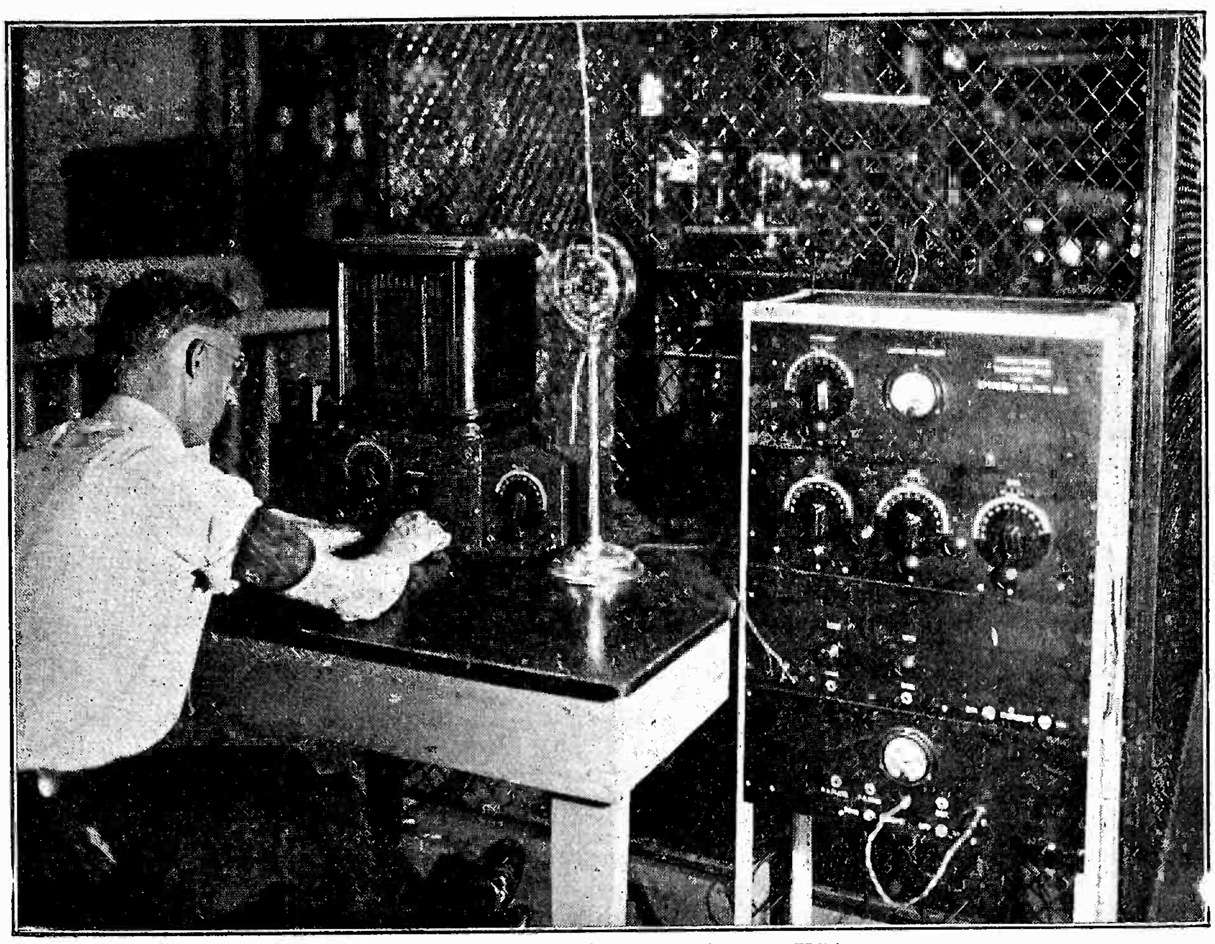
MANY hams are asking how to get in touch with Chicago amateurs when they hit town for the fair. The Chicago Radio Traffic Assn. meets right in the Loop every first and third Thursday, at the Atlantic Hotel, Clark Street, near Jackson. There is a big sign on the hotel and the gang can't miss it. Bulletin board gives meeting room number. If not in on a Thursday, grab a phone and try one of the following hams, during the daytime: W9APY—RAndolph 5208, W9DDE—WABash 3077, W9FO—WABash 1903. All of the above are right downtown in the Loop district.

W9USA and the Amateur Radio Exhibit are located toward the north end of the Travel & Transport Building, just south of the 31st Street entrance to the Exposition grounds.

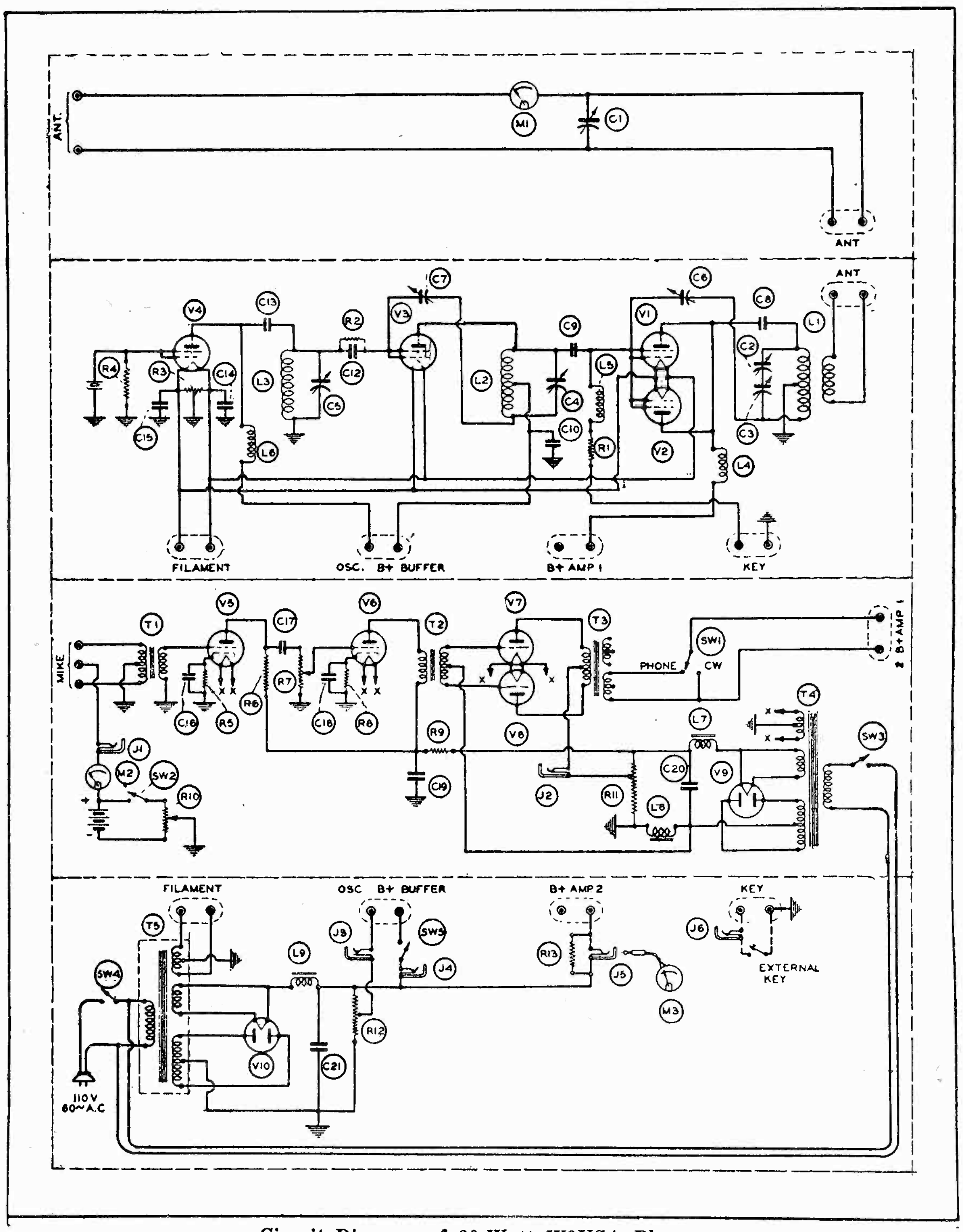
●●●

Legend and List of Parts Used In W9USA Transmitter

C1, 365mmfd. dual condenser.
M1, 0-1 Thermoammeter.
L1, L2, L3, L4, L5, L6, Silver 18-A Coils and 17A R.F. Chokes.
C2, C3, 365mmfd. dual condensers.
C4, 365mmfd. single condenser.
C5, 140mmfd. single condenser.
C6, C7, 50mmfd. neutralizing condensers.
C8, C9, .0005mfd. mica condensers.
C10, .002mfd. mica.
C11, .00025mfd. mica.
C12, .00025mfd. mica.
C15, C16, .002mfd. mica.
R1, 10,000 ohms.
R2, 15,000 ohms.
R3, 20-40 ohm C.T.
R4, 10,000 ohms.
V1, V2, V3, V4, Type '46 tubes.
L9, Input filter choke, Silver 1485.
C21, 2 12mfd. dry electrolytics.
R12, 20,000 ohm, 55 watts.
R13, Shunt resistor to double range of 0-100 MA meter.
V10, 5Z3 Tube.
J3, J4, J5, J6, single closed circuit jacks.
SW4, SPST switch.
M3, 0-100 MA meter.
T1, Silver 1122E Mike transformer.
T2, Silver 1194 push-pull audio trans.
T3, Silver MC3A output trans.
T4, Silver 2004 Power Trans.
L7, Silver 1485 Input Choke.
V5, V6, Type '56 Tubes.
V7, V8, Type 2A3 Tubes.
R5, 3000 ohm, 1 watt Resistor.
R6, 30,000 ohm, 1 watt.
R7, 500,000 ohm Volume Control.
R8, 3000 ohm, 1 watt.
R9, 10,000 ohm.
R10, 200 ohm Potentiometer.
C16, C18, 4 mfd. 150v. dry Electrolytic.
C17, .025mfd. 400 volt Paper Condenser.
C19, C20, 12mfd. 450v. dry Electrolytic.
J1, J2, Single Closed Circuit Jacks.
SW1, SW2, SW3, Toggle Switches.
NOTE: Meter M2 not needed. M3 in power supply serving.



George Mack, K7HV, operating W9USA



Circuit Diagram of 30-Watt W9USA Phone

RCA-RADIOTRON CUNNINGHAM

NEW TUBE

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE (Values to right give operating conditions and characteristics for indicated typical use)	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICROMHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYP
RCA-1A6	PENTAGRID CONVERTER ◘	SMALL 6-PIN	FIG. 26	4 17/32″ x 1 9/16″	D-C FILAMENT	2.0	0.06	180	67.5	CONVERTER	180	−3.0 min.	67.5	2.4	1.3	500000	Anode-Grid (#2) 135 Max. Volts, 2.3 Ma. Oscillator Grid (#1) Resistor, 50000 Ohms. Conversion Conductance, 300 Micromhos.				C-1A
RCA-2A3	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	5 3/8″ x 2 1/16″	FILAMENT	2.5	2.5	250	—	CLASS A AMPLIFIER	250	−45	—	—	60.0	300	5250	4.2	2500	3.5	C-2A
										PUSH-PULL AMPLIFIER	300 300	−62 −62	Self-bias Fixed-bias		40.0 40.0	Power Output is for 2 tubes at stated load, plate-to-plate			5000 3000	10.0 15.0	
RCA-2A5	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	4 11/16″ x 1 13/16″	HEATER	2.5	1.75	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.5	34.0	100000	2200	220	7000	3.0	C-2A
RCA-2A6	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	FIG. 13	4 17/32″ x 1 9/16″	HEATER	2.5	0.8	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250✖	−1.35	—	—	0.4	—	—	Gain per stage = 50-60			C-2A
RCA-2A7	PENTAGRID CONVERTER ◘	SMALL 7-PIN	FIG. 20	4 17/32″ x 1 9/16″	HEATER	2.5	0.8	250	100	CONVERTER	250	−3.0	100	2.2	3.5	360000	Anode Grid (#2) 200 Max. Volts, 4.0 Ma. Oscillator Grid (#1) Resistor, 50000 Ohms. Conversion Conductance, 520 Micromhos.				C-2A
RCA-2B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	FIG. 21	4 17/32″ x 1 9/16″	HEATER	2.5	0.8	250	125	PENTODE UNIT AS R-F AMPLIFIER	100 250	−3.0 −3.0	100 125	1.7 2.3	5.8 9.0	300000 650000	950 1125	285 730	—	—	C-2B
										PENTODE UNIT AS A-F AMPLIFIER	250┼	−4.5	50	—	0.65	—	—	—	—	—	
RCA-6A4 *also LA*	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 6	4 11/16″ x 1 13/16″	FILAMENT	6.3	0.3	180	180	CLASS A AMPLIFIER	100 180	−6.5 −12.0	100 180	1.6 3.9	9.0 22.0	83250 45500	1200 2200	100 100	11000 8000	0.31 1.40	C-6A *also L*
RCA-6A7	PENTAGRID CONVERTER ◘	SMALL 7-PIN	FIG. 20	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	250	100	CONVERTER	250	−3.0	100	2.2	3.5	360000	Anode Grid (#2) 200 Max. Volts, 4.0 Ma. Oscillator Grid (#1) Resistor, 50000 Ohms. Conversion Conductance, 520 Micromhos.				C-6A
RCA-6B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	FIG. 21	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	250	125	PENTODE UNIT AS R-F AMPLIFIER	100 250	−3.0 −3.0	100 125	1.7 2.3	5.8 9.0	300000 650000	950 1125	285 730	—	—	C-6B
										PENTODE UNIT AS A-F AMPLIFIER	250┼	−4.5	50	—	0.65	—	—	—	—	—	

◘ Grids #3 and #5 are screen. Grid #4 is signal-input control-grid.

┼ Applied through plate coupling resistor of 200000 ohms.
✖ Applied through plate coupling resistor of 250000 ohms.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	FIL. VOLTS	FIL. AMPERES	PLATE MAX. VOLTS	SCREEN MAX. VOLTS	USE	PLATE SUPPLY VOLTS	GRID VOLTS	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICROMHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD OHMS	POWER OUTPUT WATTS	TYP
RCA-6F7	TRIODE-PENTODE	SMALL 7-PIN	FIG. 27	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	100	—	TRIODE UNIT AS AMPLIFIER	100	−3.0	—	—	3.5	17800	450	8	—	—	C-6
								250	100	PENTODE UNIT AS AMPLIFIER	250	−3.0	100	1.5	6.5	850000	1100	900	—	—	
										PENTODE UNIT AS MIXER	250	−10.0	100	0.6	2.8	Oscillator peak volts = 7.0. Conversion conductance = 300 micromhos.					
UX-200-A	DETECTOR TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16″ x 1 13/16″	D-C FILAMENT	5.0	0.25	45	—	GRID LEAK DETECTOR	45	Grid Return to (−) Filament			1.5	30000	666	20	—	—	CX-3
RCA-01-A	DETECTOR★ AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16″ x 1 13/16″	D-C FILAMENT	5.0	0.25	135	—	CLASS A AMPLIFIER	90 135	−4.5 −9.0	—	—	2.5 3.0	11000 10000	725 800	8.0 8.0	—	—	C-
RCA-10	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	5 5/8″ x 2 3/16″	FILAMENT	7.5	1.25	425	—	CLASS A AMPLIFIER	350 425	−31.0 −39.0	—	—	16.0 18.0	5150 5000	1550 1600	8.0 8.0	11000 10200	0.9 1.6	C-
WD-11 WX-12	DETECTOR★ AMPLIFIER TRIODE	WD 4-PIN MEDIUM 4-PIN	FIG. 12 FIG. 1	4 1/8″ x 1 3/16″ 4 11/16″ x 1 7/16″	D-C FILAMENT	1.1	0.25	135	—	CLASS A AMPLIFIER	90 135	−4.5 −10.5	—	—	2.5 3.0	15500 15000	425 440	6.6 6.6	—	—	C- CX-
UX-112-A	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16″ x 1 13/16″	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	−4.5 −13.5	—	—	5.0 7.7	5400 4700	1575 1800	8.5 8.5	—	—	CX-1
RCA-19	TWIN AMPLIFIER	SMALL 6-PIN	FIG. 25	4 1/4″ x 1 9/16″	D-C FILAMENT	2.0	0.26	135	—	CLASS B AMPLIFIER	135 135	0 −3.0	—	—	Power output value is for one tube at stated load, plate-to-plate.				10000 10000	2.1 1.9	C-
UX-120	POWER AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/8″ x 1 3/16″	D-C FILAMENT	3.3	0.132	135	—	CLASS A AMPLIFIER	90 135	−16.5 −22.5	—	—	3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	0.045 0.110	CX-2
RCA-22	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	FIG. 4	5 1/32″ x 1 13/16″	D-C FILAMENT	3.3	0.132	135	67.5	SCREEN GRID R-F AMPLIFIER	135 135	−1.5 −1.5	45 67.5	0.6* 1.3*	1.7 3.7	725000 325000	375 500	270 160	—	—	C-2
RCA-24-A	R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	FIG. 9	5 1/32″ x 1 13/16″	HEATER	2.5	1.75	275	90	SCREEN GRID R-F AMPLIFIER	180 250	−3.0 −3.0	90 90	1.7* 1.7*	4.0 4.0	400000 600000	1000 1050	400 630	—	—	C-2
										BIAS DETECTOR	275●	−5.0 approx.	20 to 45	—	Plate current to be adjusted to 0.1 milliampere with no signal.						
RCA-26	AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16″ x 1 13/16″	FILAMENT	1.5	1.05	180	—	CLASS A AMPLIFIER	90 180	−7.0 −14.5	—	—	2.9 6.2	8900 7300	935 1150	8.3 8.3	—	—	C-2
RCA-27	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 5-PIN	FIG. 8	4 11/16″ x 1 13/16″	HEATER	2.5	1.75	275	—	CLASS A AMPLIFIER	135 250	−9.0 −21.0	—	—	4.5 5.2	9000 9250	1000 975	9.0 9.0	—	—	C-2
										BIAS DETECTOR	250	−30.0	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
RCA-30	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/4″ x 1 9/16″	D-C FILAMENT	2.0	0.06	180	—	CLASS A AMPLIFIER	90 135 180	−4.5 −9.0 −13.5	—	—	2.5 3.0 3.1	11000 10300 10300	850 900 900	9.3 9.3 9.3	—	—	C-3

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.

● Applied through plate coupling resistor of 250000 ohms or 500-henry choke shunted by 0.25 megohm resistor. *Maximum

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	FIL. VOLTS	FIL. AMPERES	PLATE MAX. VOLTS	SCREEN MAX. VOLTS	USE	PLATE SUPPLY VOLTS	GRID VOLTS	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICROMHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD OHMS	POWER OUTPUT WATTS	TYP
RCA-31	POWER AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/4″ x 1 9/16″	D-C FILAMENT	2.0	0.13	180	—	CLASS A AMPLIFIER	135 180	−22.5 −30.0	—	—	8.0 12.3	4100 3600	925 1050	3.8 3.8	7000 5700	0.185 0.375	C-3
RCA-32	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	FIG. 4	5 1/32″ x 1 13/16″	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN GRID R-F AMPLIFIER	135 180	−3.0 −3.0	67.5 67.5	0.4* 0.4*	1.7 1.7	950000 1200000	640 650	610 780	—	—	C-3
										BIAS DETECTOR	180♥	−6.0 approx.	67.5	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
RCA-33	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 6	4 11/16″ x 1 13/16″	D-C FILAMENT	2.0	0.26	135	135	CLASS A AMPLIFIER	135	−13.5	135	3.0	14.5	50000	1450	70	7000	0.7	C-3
RCA-34	SUPER-CONTROL R-F AMPLIFIER PENTODE	MEDIUM 4-PIN	FIG. 4A	5 1/32″ x 1 13/16″	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN GRID R-F AMPLIFIER	135 180	−3.0 min.	67.5 67.5	1.0 1.0	2.8 2.8	600000 1000000	600 620	360 620	—	—	C-3
RCA-35	SUPER-CONTROL R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	FIG. 9	5 1/32″ x 1 13/16″	HEATER	2.5	1.75	275	90	SCREEN GRID R-F AMPLIFIER	180 250	−3.0 min.	90 90	2.5* 2.5*	6.3 6.5	300000 400000	1020 1050	305 420	—	—	C-3
RCA-36	R-F AMPLIFIER TETRODE	SMALL 5-PIN	FIG. 9	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	250	90	SCREEN GRID R-F AMPLIFIER	100 180 250	−1.5 −3.0 −3.0	55 90 90	— — 1.7*	1.8 3.1 3.2	550000 500000 550000	850 1050 1080	470 525 595	—	—	C-3
										BIAS DETECTOR	100● 250●	−5.0 −8.0	55 90	—	Plate current to be adjusted to 0.1 milliampere with no signal.						
RCA-37	DETECTOR★ AMPLIFIER TRIODE	SMALL 5-PIN	FIG. 8	4 1/4″ x 1 9/16″	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	90 180 250	−6.0 −13.5 −18.0	—	—	2.5 4.3 7.5	11500 10200 8400	800 900 1100	9.2 9.2 9.2	—	—	C-3
										BIAS DETECTOR	90 250	−10.0 −28.0	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
RCA-38	POWER AMPLIFIER PENTODE	SMALL 5-PIN	FIG. 9A	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	250	250	CLASS A AMPLIFIER	100 180 250	−9.0 −18.0 −25.0	100 180 250	1.2 2.4 3.8	7.0 14.0 22.0	140000 110000 100000	875 1050 1200	120 120 120	15000 11600 10000	0.27 1.00 2.50	C-38
RCA-39-44	SUPER-CONTROL R-F AMPLIFIER PENTODE	SMALL 5-PIN	FIG. 9A	4 17/32″ x 1 9/16″	HEATER	6.3	0.3	250	90	SCREEN GRID R-F AMPLIFIER	90 180 250	−3.0 min.	90 90 90	1.6 1.4 1.4	5.6 5.8 5.8	375000 750000 1000000	960 1000 1050	360 750 1050	—	—	C-39
UX-240	VOLTAGE AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16″ x 1 13/16″	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	135✖ 180✖	−1.5 −3.0	—	—	0.2 0.2	150000 150000	200 200	30 30	—	—	CX-34
RCA-41	POWER AMPLIFIER PENTODE	SMALL 6-PIN	FIG. 15A	4 1/4″ x 1 9/16″	HEATER	6.3	0.4	250	250	CLASS A AMPLIFIER	100 180 250	−7.0 −13.5 −18.0	100 180 250	1.6 3.0 5.5	9.0 18.5 32.0	103500 81000 68000	1450 1850 2200	150 150 150	12000 9000 7600	0.33 1.50 3.40	C-4
RCA-42	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	4 11/16″ x 1 13/16″	HEATER	6.3	0.7	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.5	34.0	100000	2200	220	7000	3.00	C-4

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
■Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D. C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.

● Applied through plate coupling resistor of 250000 ohms or 500-henry choke shunted by 0.25 megohm resistor.
♥ Applied through plate coupling resistor of 100000 ohms.
✖ Applied through plate coupling resistor of 250000 ohms.
*Maximum.

TUBE SYMBOLS AND BOTTOM VIEWS OF SOCKET CONNECTIONS

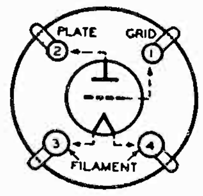


FIG. 1

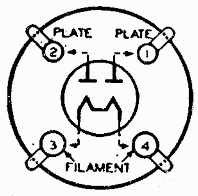


FIG. 2

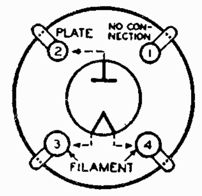


FIG. 3

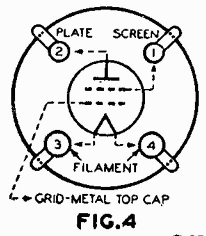


FIG. 4

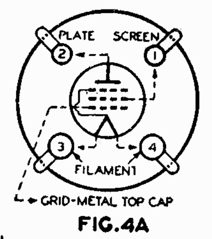


FIG. 4A

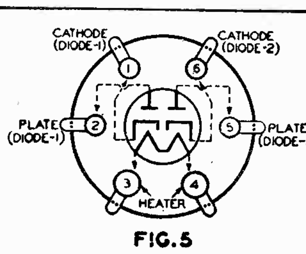


FIG. 5

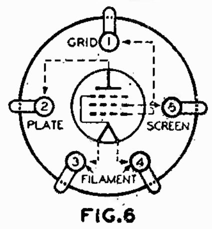


FIG. 6

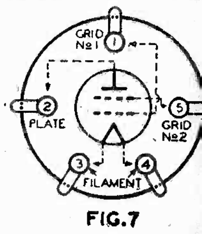


FIG. 7

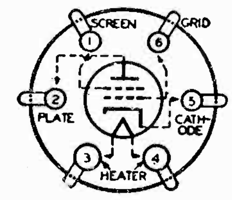


FIG. 15

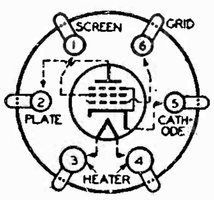


FIG. 15A

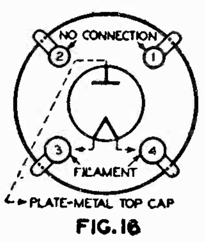


FIG. 16

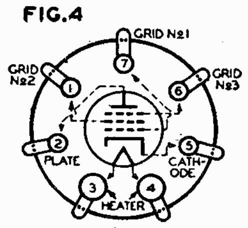


FIG. 18

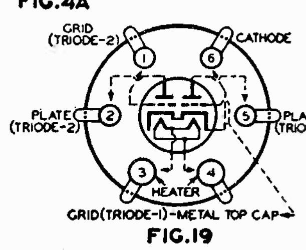


FIG. 19

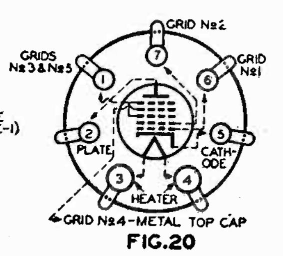


FIG. 20

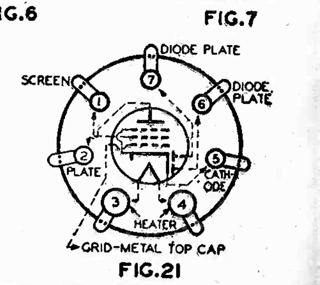


FIG. 21

CHARACTERISTICS

RCA-RADIOTRON CUNNINGHAM

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH X DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE (Values to right give operating conditions and characteristics for indicated typical use)	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
RCA- 43	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	HEATER	25.0	0.3	135	135	CLASS A AMPLIFIER	100 135	−15.0 −20.0	100 135	4.0 7.0	20.0 34.0	45000 35000	2000 2300	90 80	4500 4000	0.90 2.00	C - 43
RCA- 45	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	FILAMENT	2.5	1.5	275	—	CLASS A AMPLIFIER	180 250 275	−31.5 −50.0 −56.0	180 250 275	—	31.0 34.0 36.0	1650 1610 1700	2125 2175 2050	3.5 3.5 3.5	2700 3900 4600	0.82 1.60 2.00	C - 45
RCA- 46	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 7	$5\frac{5}{8}''$ x $2\frac{3}{16}''$	FILAMENT	2.5	1.75	250	—	CLASS A AMPLIFIER □	250	−33.0	—	—	22.0	2380	2350	5.6	6400	1.25	C - 46
								400	—	CLASS B AMPLIFIER ♦	300 400	0 0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				5200 5800	16.0 20.0	
RCA- 47	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 6	$5\frac{5}{8}''$ x $2\frac{3}{16}''$	FILAMENT	2.5	1.75	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.0	31.0	60000	2500	150	7000	2.7	C - 47
RCA- 48	POWER AMPLIFIER TETRODE	MEDIUM 6-PIN	FIG. 15	$5\frac{3}{8}''$ x $2\frac{1}{16}''$	D-C HEATER	30.0	0.4	125	100	CLASS A AMPLIFIER	95 125	−20.0 −22.5	95 100	9.0 9.0	47.0 50.0	10000 10000	2800 2800	28 28	2000 2000	1.6 2.5	C - 48
RCA- 49	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 7	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	D-C FILAMENT	2.0	0.120	135	—	CLASS A AMPLIFIER □	135	−20.0	—	—	5.7	4000	1125	4.5	11000	0.17	C - 49
								180	—	CLASS B AMPLIFIER ♦	180	0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				12000	3.5	
UX -250	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	$6\frac{1}{4}''$ x $2\frac{11}{16}''$	FILAMENT	7.5	1.25	450	—	CLASS A AMPLIFIER	300 400 450	−54.0 −70.0 −84.0	—	—	35.0 55.0 55.0	2000 1800 1800	1900 2100 2100	3.8 3.8 3.8	4600 3670 4350	1.6 3.4 4.6	CX-350
RCA- 53	TWIN-TRIODE AMPLIFIER	MEDIUM 7-PIN♯	FIG. 24	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	HEATER	2.5	2.0	300	—	CLASS B AMPLIFIER	250 300	0 0	—	—	Power output value is for one tube at stated load, plate-to-plate.				8000 10000	8.0 10.0	C - 53
RCA- 55	DUPLEX-DIODE TRIODE	SMALL 6-PIN	FIG. 13	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	2.5	1.0	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	135 180 250	−10.5 −13.5 −20.0	—	—	3.7 6.0 8.0	11000 8500 7500	750 975 1100	8.3 8.3 8.3	25000 20000 20000	0.075 0.160 0.350	C - 55
RCA- 56	SUPER-TRIODE AMPLIFIER DETECTOR★	SMALL 5-PIN	FIG. 8	$4\frac{1}{4}''$ x $1\frac{9}{16}''$	HEATER	2.5	1.0	250	—	CLASS A AMPLIFIER	250	−13.5	—	—	5.0	9500	1450	13.8	—	—	C - 56
										BIAS DETECTOR	250	−20.0	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
RCA- 57	TRIPLE-GRID AMPLIFIER DETECTOR	SMALL 6-PIN	FIG. 11	$4\frac{15}{16}''$ x $1\frac{9}{16}''$	HEATER	2.5	1.0	250	100	SCREEN GRID R-F AMPLIFIER	250	− 3.0	100	0.5	2.0	exceeds 1.5 meg.	1225	exceeds 1500	—	—	C - 57
										BIAS DETECTOR	250	− 3.9	100	Cathode current 0.97 ma.		—	Plate coupling resistor 250000 ohms. Grid coupling resistor 250000 ohms**.				
RCA- 58	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	FIG. 11	$4\frac{15}{16}''$ x $1\frac{9}{16}''$	HEATER	2.5	1.0	250	100	SCREEN GRID R-F AMPLIFIER	250	{− 3.0 min.}	100	2.0	8.2	800000	1600	1280	—	—	C - 58
										MIXER IN SUPERHETERODYNE	250	−10.0	100	—	—	Oscillator peak volts = 7.0.					
RCA- 59	TRIPLE-GRID POWER AMPLIFIER	MEDIUM 7-PIN♯	FIG. 18	$5\frac{3}{8}''$ x $2\frac{1}{16}''$	HEATER	2.5	2.0	250	—	AS TRIODE ¶ CLASS A AMPLIFIER	250	−28.0	—	—	26.0	2400	2600	6.0	5000	1.25	C - 59
								250	250	AS PENTODE ■■ CLASS A AMPLIFIER	250	−18.0	250	9.0	35.0	40000	2500	100	6000	3.00	
								400	—	AS TRIODE ⊛ CLASS B AMPLIFIER	300 400	0 0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				4600 6000	15.0 20.0	
RCA- 71-A	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	−19.0 −43.0	—	—	10.0 20.0	2170 1750	1400 1700	3.0 3.0	3000 4800	0.125 0.790	C - 71-A
RCA- 75	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	FIG. 13	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250✖	−1.35	—	—	0.4	—	—	Gain per stage = 50-60			C - 75
RCA- 77	TRIPLE-GRID AMPLIFIER DETECTOR	SMALL 6-PIN	FIG. 11	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.3	250	100	SCREEN GRID R-F AMPLIFIER	100 250	− 1.5 − 3.0	60 100	0.4 0.6	1.7 2.3	650000 1500000	1100 1250	715 1500	—	—	C - 77
										BIAS DETECTOR	250	− 1.95	50	Cathode current 0.65 ma.		—	Plate coupling resistor 250000 ohms. Grid coupling resistor 250000 ohms**.				
RCA- 78	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	FIG. 11	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.3	250	125	SCREEN GRID R-F AMPLIFIER	90 180 250 250	{− 3.0 min.}	90 75 100 125	1.5 1.0 2.0 3.0	5.4 4.0 7.0 10.5	315000 1000000 800000 600000	1275 1100 1450 1650	400 1100 1160 990	—	—	C - 78
RCA- 79	TWIN-TRIODE AMPLIFIER	SMALL 6-PIN	FIG. 19	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.6	250	—	CLASS B AMPLIFIER	180 250	0 0	—	—	Power output value is for one tube at stated load, plate-to-plate.				7000 14000	5.5 8.0	C - 79
RCA- 85	DUPLEX-DIODE TRIODE	SMALL 6-PIN	FIG. 13	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	135 180 250	−10.5 −13.5 −20.0	—	—	3.7 6.0 8.0	11000 8500 7500	750 975 1100	8.3 8.3 8.3	25000 20000 20000	0.075 0.160 0.350	C - 85
RCA- 89	TRIPLE-GRID POWER AMPLIFIER	SMALL 6-PIN	FIG. 14	$4\frac{17}{32}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.4	250	250	AS TRIODE ¶ CLASS A AMPLIFIER	160 180 250	−20.0 −22.5 −31.0	—	—	17.0 20.0 32.0	3300 3000 2600	1425 1550 1800	4.7 4.7 4.7	7000 6500 5500	0.300 0.400 0.900	C - 89
										AS PENTODE ■■ CLASS A AMPLIFIER	100 180 250	−10.0 −18.0 −25.0	100 180 250	1.6 3.0 5.5	9.5 20.0 32.0	104000 80000 70000	1200 1550 1800	125 125 125	10700 8000 6750	0.33 1.50 3.40	
										AS TRIODE ⊛ CLASS B AMPLIFIER	180	0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				13600 9400	2.50 3.50	
UV -199 UX -199	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-NUB SMALL 4-PIN	FIG. 10 FIG. 1	$3\frac{1}{2}''$ x $1\frac{1}{16}''$ $4\frac{1}{8}''$ x $1\frac{3}{16}''$	D-C FILAMENT	3.3	0.063	90	—	CLASS A AMPLIFIER	90	− 4.5	—	—	2.5	15500	425	6.6	—	—	C -299 CX-299
RCA-864	AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	$4''$ x $1\frac{3}{16}''$	D-C FILAMENT	1.1	0.25	135	—	CLASS A AMPLIFIER	90 135	− 4.5 − 9.0	—	—	2.9 3.5	13500 12700	610 645	8.2 8.2	—	—	C -864

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
♯Requires different socket from small 7-pin.
□Grid next to plate tied to plate. ♦Two grids tied together. **For grid of following tube.

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
■Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D. C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.
♯Requires different socket from small 7-pin.
■■Grid #1 is control grid. Grid #2 is screen. Grid #3 tied to cathode.
¶Grid #1 is control grid. Grids #2 and #3 tied to plate. ✖Applied through plate coupling resistor of 250000 ohms.
⊛Grids #1 and #2 connected together. Grid #3 tied to plate. **For grid of following tube.

RECTIFIERS

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	VOLTS	AMPERES	PLATE	SCREEN	RATINGS	TYPE
RCA-5Z3	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	$5\frac{3}{8}''$ x $2\frac{1}{16}''$	FILAMENT	5.0	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....250 Milliamperes	C -5Z3
RCA-12Z3	HALF-WAVE RECTIFIER	SMALL 4-PIN	FIG. 22	$4\frac{1}{4}''$ x $1\frac{9}{16}''$	HEATER	12.6	0.3	—	—	Maximum A-C Voltage per Plate....250 Volts, RMS Maximum D-C Output Current.... 60 Milliamperes	C-12Z3
RCA-25Z5	RECTIFIER-DOUBLER	SMALL 6-PIN	FIG. 5	$4\frac{1}{4}''$ x $1\frac{9}{16}''$	HEATER	25.0	0.3	—	—	Maximum A-C Voltage per Plate....125 Volts, RMS Maximum D-C Output Current....100 Milliamperes	C-25Z5
RCA-1-v°	HALF-WAVE RECTIFIER	SMALL 4-PIN	FIG. 22	$4\frac{1}{4}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.3	—	—	Maximum A-C Voltage per Plate....350 Volts, RMS Maximum D-C Output Current.... 50 Milliamperes	C-1v°
RCA- 80	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	FILAMENT	5.0	2.0	—	—	A-C Voltage per Plate (Volts RMS) 350 400 550 D-C Output Current (Maximum MA.) 125 110 135 The 550 volt rating applies to filter circuits having an input choke of at least 20 henries.	C - 80
UX -281	HALF-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 3	$6\frac{1}{4}''$ x $2\frac{7}{16}''$	FILAMENT	7.5	1.25	—	—	Maximum A-C Plate Voltage....700 Volts, RMS Maximum D-C Output Current.... 85 Milliamperes	CX-381
RCA- 82	FULL-WAVE► RECTIFIER	MEDIUM 4-PIN	FIG. 2	$4\frac{11}{16}''$ x $1\frac{13}{16}''$	FILAMENT	2.5	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....125 Milliamperes Maximum Peak Inverse Voltage....1400 Volts Maximum Peak Plate Current.... 400 Milliamperes	C - 82
RCA- 83	FULL-WAVE► RECTIFIER	MEDIUM 4-PIN	FIG. 2	$5\frac{3}{8}''$ x $2\frac{1}{16}''$	FILAMENT	5.0	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....250 Milliamperes Maximum Peak Inverse Voltage....1400 Volts Maximum Peak Plate Current.... 800 Milliamperes	C - 83
RCA- 84 *also 6Z4*	FULL-WAVE RECTIFIER	SMALL 5-PIN	FIG. 23	$4\frac{1}{4}''$ x $1\frac{9}{16}''$	HEATER	6.3	0.5	—	—	Maximum A-C Voltage per Plate....225 Volts, RMS Maximum D-C Output Current.... 50 Milliamperes	C - 84 *also 6Z4*
RCA-866	HALF-WAVE► RECTIFIER	MEDIUM 4-PIN	FIG. 16	$6\frac{5}{8}''$ x $2\frac{7}{16}''$	FILAMENT	2.5	5.0	—	—	Maximum Peak Inverse Voltage....7500 Volts Maximum Peak Plate Current....0.6 Ampere	C -866 (CX-366)

►Mercury Vapor Type. ° Interchangeable with type 1.

PHOTOTUBES

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	RATINGS	TYPE
RCA-868	PHOTOTUBE	SMALL 4-PIN	FIG. 28	$4\frac{1}{8}''$ x $1\frac{3}{16}''$		Max. Anode Supply Voltage, 90 Volts. Max. Anode Current, 20 Microamperes. Static Sensitivity, 55 Microamperes per Lumen. Dynamic Sensitivity, 50 and 48 Microamperes per Lumen at 1000 and 5000 Cycles per second, respectively.	C -868

TUBE SYMBOLS AND BOTTOM VIEWS OF SOCKET CONNECTIONS

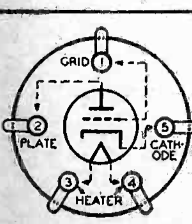


FIG.8

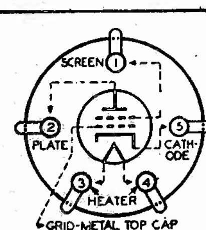


FIG.9

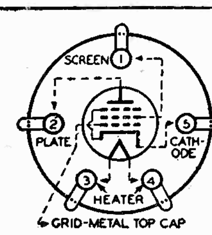


FIG.9A

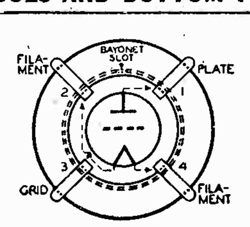


FIG.10

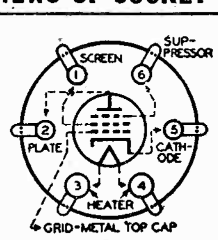


FIG.11

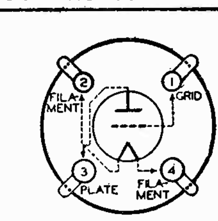


FIG.12

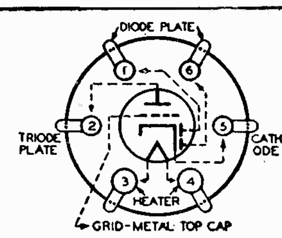


FIG.13

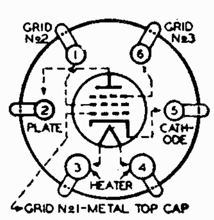


FIG.14

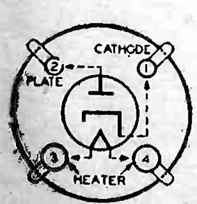


FIG.22

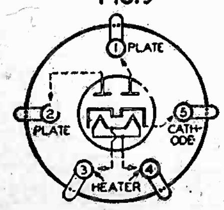


FIG.23

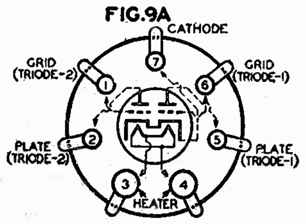


FIG.24

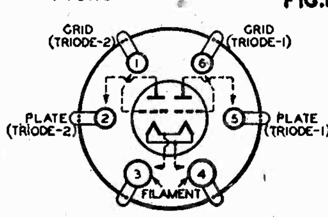


FIG.25

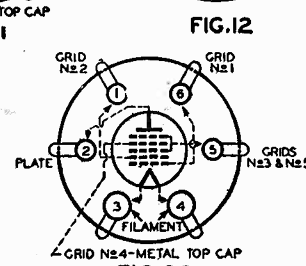


FIG.26

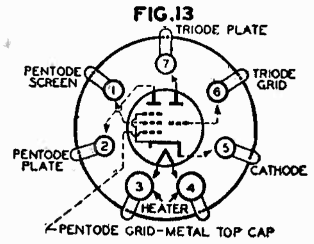


FIG.27

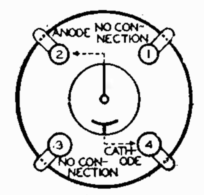


FIG.28

The Superheterodyne—Its Theory and Operation

By D. B. McGOWN

LESSON IV

THE circuit diagram of Fig. 7 shows two tubes and their associated circuits, operating as 50 kc. amplifiers, followed by a 50 kc. detector known as the "second detector." The phones can be placed in the output of the second detector or audio amplification can be added and a speaker used. This receiver is a **heterodyne** receiver because the heterodyne or beat method has been used. It is, however, also a **superheterodyne** because it goes beyond the simple heterodyne by the addition of the fixed frequency amplifier. Hence we see that the outstanding distinguishing features of the superheterodyne are the use of the heterodyne or beat method to produce a signal lower in frequency than the received signal, but higher than audio frequencies, and the use of an amplifier functioning at the beat frequency produced by the incoming signal and the locally generated frequency. This amplifier, operating at the beat frequency, is the **intermediate amplifier.**

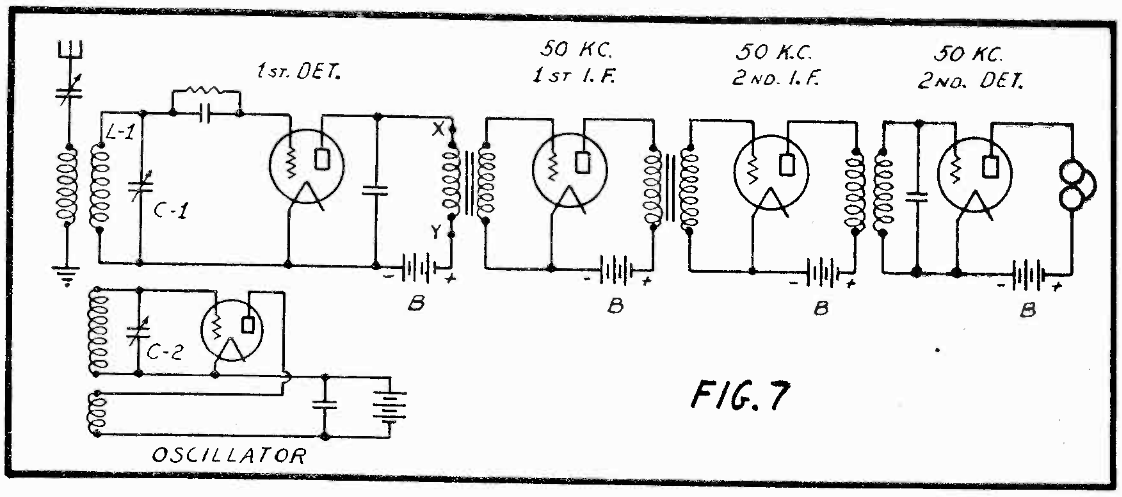


FIG. 7

The action in the circuit can be briefly described as follows: The incoming signal is impressed on the grid of the first detector or mixer tube, having first been picked up by the antenna system; from there transferred to the tuned circuit consisting of L1, C1. The oscillator circuit is tuned by means of condenser C2 to a frequency differing from the received frequency by an amount equal to the intermediate frequency (50 kc. in this case). Since the oscillator is coupled to the first detector it introduces into the input circuit the oscillator frequency. A current is produced in the plate circuit of the first detector tube at the intermediate frequency. This intermediate frequency is passed into and amplified in the intermediate amplifier, and finally rectified to the **second detector** circuit. It must be mentioned that any modulation present in the received signal will be retained in the intermediate or beat frequency and hence in the intermediate-frequency amplification. The audio frequency component of the intermediate frequency will be present in the plate circuit of the second detector and can be made audible by means of phones or amplified further in an audio frequency amplifier.

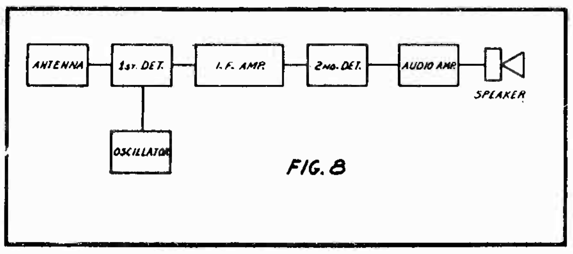


FIG. 8

FIG. 8 shows a block arrangement of the essential units in the superheterodyne. They are, as indicated (1) The antenna, to provide pick-up of energy from the transmitters. It may be either an outside structure or a loop. (2) The first detector or "mixer". (3) The high-gain intermediate-frequency amplifier. (4) The second detector. (5) The audio frequency amplifier. And (6) The loudspeaker. Although the arrangement of parts may differ in various superheterodynes the general principles of operation are the same, and all incorporate the basic components listed above and shown in Fig. 8.

Intermediate frequencies from 40 kc. to more than 500 kc. have been or are being successfully used commercially.

The superheterodyne is a receiver of high sensitivity. Even very weak signals can be easily heterodyned and brought up to sufficient strength. The high gain in the intermediate amplifier allows even a very weak signal to be heard with good volume from the second detector.

The superheterodyne receiver has a great advantage in the matter of selectivity. If an interfering signal reaches the grid of the first detector from the antenna it will not beat with the oscillator frequency to produce the intermediate frequency. The oscillator has been tuned to beat with the desired frequency to produce the beat frequency. Since the selectivity of the intermediate amplifier is high, the interfering signal will not get beyond the first detector circuit. By properly designing the first detector circuit it may be made very selective and further proof against interfering stations operating on frequencies other than the frequency it is desired to receive. Very strong interfering signals may be audible. They may be so strong as to even modulate, or change the frequency of the local oscillator and thus "ride through" into the second detector. The action of the receiver in this respect is a function of the design of the entire circuit and will later be further discussed.

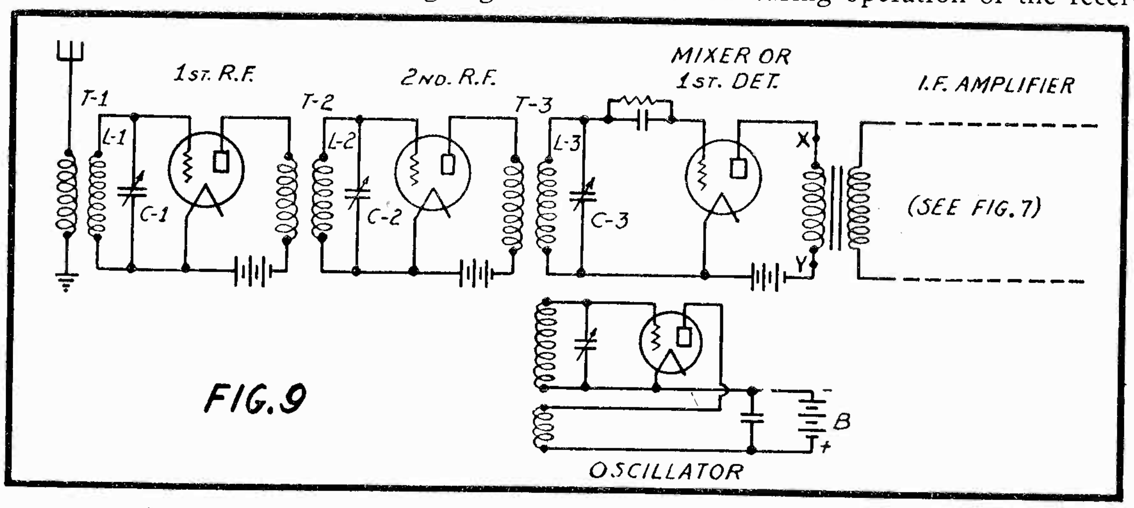


FIG. 9

Another characteristic of the superheterodyne which is in its favor is its inherent differentiation between c.w. signals and interference such as that due to static, power line noises, etc. Such interference usually reaches the receiver in the form of damped waves, the nature of which is different from that of c.w. signals. Even if such interference were three times as loud as the desired signal it would still have in the output of the superheterodyne a ratio to the desired signal of three to one, whereas if a form of detector other than the beat detector were used an input ratio of interference strength to signal strength of three to one would appear in the output as a ratio of nine to one with the result that the desired signal might be drowned out entirely if it were at all weak. This is due to the fact that in the superheterodyne, using beat reception, the detector output is directly proportional to the input signal strength, whereas other methods of detection provide output signal strength proportional to the square of the input signal.

Thus the sensitivity and selectivity of the superheterodyne are very great and surprising results can be obtained using circuit arrangements similar to those described. The diagrams do not pretend to show actually operative systems. Several faults from an operating standpoint are actually present in the simple superheterodyne arrangements shown.

Tuned radio frequency receivers are, as a class, those utilizing one or more stages of amplification at the frequency of the received signal followed by a detector and one or more stages of audio frequency amplification. The radio frequency amplifiers are "tuned" to the frequency of transmission of the station to be received during operation of the receiver.

Radio frequency amplification can be used to advantage preceding the first detector of a superheterodyne and will not only increase its sensitivity but will lessen the possibility of interference from undesired signals. When radio frequency amplification is used it is possible to hear radio signals satisfactorily which would otherwise be so weak as to be unsatisfactory or possibly even completely inaudible.

THE diagram of Fig. 9 shows a tuned radio frequency amplifier used ahead of the first detector of the theoretical type of superheterodyne. The antenna is coupled to the input circuit of the first radii frequency amplifier tube through the coil L1. The circuit L1, C1 is tuned to the frequency of the incoming signal by means of the condenser C1 and the incoming signal is impressed upon the grid of the first tube. This signal produces variations in the plate current of the tube. This plate current flows through the primary of an air-core or radii frequency transformer connected between it and the second tube and induces a voltage at the frequency

(Continued on page 26)

SOUND

By D. B. McGOWN, Technical Editor

CHAPTER III

POPULAR definitions of the word "sound" consider it from the effect it has upon the human ear, or as a source of vibrations that thus affect the ear. The technical definition, however, classifies sound as the disturbance in the medium between the source of vibrations and the ear. Sound, in this sense, is a series of alternate compressions and rarefactions, set up in the medium by a vibrating body, that causes the membrane in the ear to vibrate in the same manner as the source of vibrations.

Various sounds are identified by the character of the original vibration, and this character is determined by the density of the body, the size, shape, and several other factors. The waves that compose the sound are very complex, and we are able to recognize the nature of the sound-producing body by the characteristics that make one sound different from another. Sound may be produced and transmitted through all substances, whether they be solids, liquids, or gases, but the transmitting medium in which we are most interested, of course, is air.

These sound-producing vibrations in a body are usually generated by some external force applied to the body. The vibrations may be incidental, or the action may be carried out for the primary purpose of producing sound. The blacksmith's hammer, striking the anvil, causes a sound which is entirely incidental to the shaping of the horseshoe. The musician's hammer, striking the anvil in the "Anvil Chorus" of the opera "Il Trovatore," causes a sound for which the musician gets paid. When the breath from the lungs is forced past certain muscular ledges in the wind-pipe they vibrate, producing a sound we have come to recognize as the human voice. The sound produced by these vibrations is communicated to the surrounding air, in the form of the above-mentioned alternate compressions and rarefactions of air. When they reach our ears they cause the ear-drums to vibrate, and this vibration is interpreted by the brain as sound.

It is not necessary for our ears to be in the vicinity of a vibrating body, however, in order to classify these waves as sound. A sound could be produced in a sound-proof chamber, picked up by a microphone, amplified, and projected through a loud speaker, and then heard by an auditor. It would be sound, whether we heard the waves caused by the original vibrations or not.

The production of sound is not limited to solid bodies, or to any particular substances. Liquids have their own identifying characteristics, such as the lapping of waves, the rush of the waterfall, etc. Gases also have their own characteristic sounds, the most familiar of which is the moan of the wind. In any case, there must be a vibration of some substance, for this is what causes sound.

The amplitude of sound waves set up by vibrating bodies is exceedingly small. It varies, according to estimates, from 0.00000005 inch for a sound barely audible, to 0.004 inch for a very loud sound. That is, for a very weak sound the air particles move to and fro but 0.00000005 inch, while for a very loud sound, the air particles may move as much as 0.004 inch. Air, as we have already mentioned, is not only the substance that will transmit sound; that is, that will pass the sound waves along. The walls of buildings are set into vibration from street noises, so that we can hear the noises on the inside of the room, with all the doors and windows closed. One of the most difficult problems in the sound-proofing of buildings is to reduce the motions of the walls and floors, so they will transmit as few vibrations as possible, either from those passing through the air, and striking the walls or floors directly, or those which pass through the earth, and building foundations, thus setting the building into vibration.

Sound waves set up by vibrating bodies are propagated through the surrounding medium, whether it be gaseous, liquid, or solid, with considerable velocity. The velocity, V, depends upon the elasticity, E, and the density, d, according to the formula:

$$V = \sqrt{\frac{E}{d}}$$

And because the elasticity and density differ in various media the velocity of sound differs in various media. The velocities of sound in certain common substances are shown in the following table:

Substance	Velocity (ft. per sec.)
Air	1,088
Water	4,728
Pine wood	10,900
Brick	11,980
Steel	16,360

This table shows that, compared to the motion of the physical bodies with which we are accustomed to deal, sound waves have quite a high velocity. It shows, also, that it takes a measurable time for a sound to pass from the source to the listener's ear, or to a pickup device. The figures given above should be taken only as average values, because the elasticity and density of a medium vary with temperature and other conditions. In ordinary practice it can be assumed that sound travels at a velocity of about 1100 feet per second in air.

Sound may be reflected, refracted or absorbed. Reflection is the act of throwing back from a surface, while refraction is the act of bending, or changing the direction of the sound wave. The type of surface on which the sound falls, as well as the angle of incidence, affect this action. Hard, solid surfaces, such as glass, metal, concrete, brick, etc., reflect a considerable portion of the sound falling on them, while matted, porous substances, such as felts and wool masses, absorb almost all of the sound waves that reach them. In general, the action of the sound is to set up vibrations in the molecules of the substances upon which it impinges, and this vibration is actually used up in the form of friction. This friction, like the friction in a mechanical shaft, produces heat, although in the case of sound friction the heat is extremely small.

The reflection of sound can be easily understood if one considers a large empty room, such as a concrete warehouse, or storeroom. A vibration in this room sets up sound waves that take a number of seconds to die away. They continue to be audible long after the original wave has passed the ear. This is due to the fact that a considerable amount of reverbration is present in such an enclosure. This reverbration actually consists of a number of multiple reflections from wall to wall, and floor to ceiling; back and forth, first in one direction and then in another. Each time the sound is reflected from a wall it becomes weaker, and finally dies away to a point where it is no longer audible. If the same room were lined with some kind of material with a rough, uneven or matted surface, such as flax straw, hair felt, carpet, sugar-cane-fibre board, or a similar substance, the sound would be absorbed by these surfaces and the reverbration condition would be greatly reduced, if not eliminated. This type of work constitutes the fundamentals of acoustical correction, which will be considered in detail later, with reference to the proper conditions to be obtained in broadcast studios, recording rooms, and the like.

Sound may be identified by three primary characteristics: loudness, pitch, and quality. Loudness is a function of the energy content of a sound, and this is determined by the original intensity and the distance from the source. As a sound moves away from the source it weakens in intensity until it has died out altogether. In fact, the intensity of a sound varies as the square of the distance from the source. The energy content, or original loudness, depends upon the power available to set up the vibrations, and the actual amount of this energy that is transmitted into the air. A man hammering on a block of wood with a mallet will not create as loud a sound as if he hammered with equal force on the bottom of an open-ended barrel. This is because the barrel is so constructed that it vibrates more easily and more vigorously than the block of wood. The coupling, or transmission, of sound through the medium also determines the loudness.

The sensation of loudness, transmitted from the ear to the brain, is an important factor in all sound work, and a sharp distinction exists between this sensation and the actual energy content present in any sound. The sensation of sound is transmitted to the brain with a "loudness" which is logarithmic in intensity (The Weber-Fechner Law.) This means that the ear is enormously more sensitive for sounds of low intensity than for sounds which are very loud. This relationship is one of the most important in all sound work, whether it is sound recording, radio broadcasting, public address, or any other of the allied fields. This relationship is the reason for the more or less misunderstood "decibel" system of sound current measurement, which actually is a measurement of sound, as well as electrical energy, in the modern physical sense.

Field Problems in Microphone Placement*

PART I—BROADCASTING

THE microphone is the electric ear of the sound system, and what it "hears" depends a great deal on its location just as the auditory impressions of a listener are determined by his position relative to the source of sound and the acoustic nature of the surroundings. A good pair of ears will not serve their owner very well if the desired sound reaching them is faint and partially masked by noise. Likewise, even the best obtainable microphone will function very poorly unless it is properly placed to intercept the desired sounds to best advantage. However, the principles of microphone placement are not solely concerned with the intensity of the sounds produced by the speaker, artist or musical group, since it is also important that the electrical translation be similar to the original sound in frequency content or musical range, and balance or "acoustic perspective". As the reader well knows, the problems and methods of solution vary considerably with individual cases and some experimenting is almost always necessary to secure best results. A knowledge of the basic principles and methods employed in the more common cases of microphone placement, however, will enable the engineer to solve these field problems with a minimum loss of time.

Studio Pickups

The most elementary problem in broadcast microphone placement involves a single speaker or artist. The speaker should have the option of sitting or standing while reading his continuity, the decision being entirely a matter of personal preference. If he elects to stand, the microphone will be mounted in a floor stand, preferably of the type which allows the height of the microphone to be adjusted easily. The center of the microphone should be two to three inches below the level of the speaker's mouth. Best results are obtained by talking across the diaphragm at an angle of 45 degrees or so, with the mouth about six to twelve inches away from the diaphragm. This tends to reduce the pickup of sibilants or "es" sounds, fricatives and breath noises due to the directional characteristics of diaphragm-type devices at the higher speech frequencies. Fig. 1 is an excellent example of correct positioning of artist and microphone. If the speaker sits at a desk, a short desk stand is advantageous.

Vocal soloists almost invariably stand when singing. Some artists with considerable experience before the microphone find it helpful to partially counteract volume differences by moving back from the normal position before the microphone for loud passages and closer for soft passages. This is due, of course, to the fact that the electrical level of the program must be kept within rather definite limits for best transmission. Singers who play their own piano accompaniments often use a microphone suspended from the ceiling, since it is not good practice to place the microphone stand on the piano due to the vibration and the relatively great distance to the artist's mouth. In one prominent station, a floor stand with a long horizontal boom provides a convenient suspension of the microphone within range of the singer but without obstructing the keyboard or surrounding floor space in any way. A single microphone placed in this manner results in good balance between voice and piano pickup.

When the singer is accompanied on the piano, a single floor stand microphone for the artist, located within about four feet of the piano, is usually a satisfactory arrangement. It is always advisable, however, to try several different placements, during rehearsals so that

FIG. 1. Thurston, the Magician, illustrates the proper position before the microphone.

the best effect may be obtained. The actual distance between the singer's microphone and the piano differs with the type of music, and depends on the relative prominence that is to be given the accompaniment.

Orchestra or dance-band music, with solo vocal chorus, is frequently picked up without special microphone facilities for the singer. The band plays rather softly and the singer steps close to the microphone so that the voice will be well above the musical background. It is preferable, however, to provide a separate microphone for the singer, for a great deal of confusion and moving about is eliminated and in addition, it is possible to control the balance between voice and orchestra electrically in the studio mixing panel. This independence of control enables the operator to make frequent readjustments, if necessary, for the correct volume balance during the program, whereas with the single microphone pickup, the results are dependent on highly accurate performance by both singer and orchestra leader, both of whom are at a disadvantage in judging the correctness of the final result. The proper placements for orchestra pickups will be discussed later.

It is often difficult to pick up all the members of a group of four or more people with a single microphone. The reason is that the end members of a quartet, for instance, are considerably farther from the microphone diaphragm than those in the middle, and in addition they face the diaphragm at a wider angle than those in the center. Since the sound pressure at a point is inversely proportional to the square of the distance from the sound source, there is an appreciably lower sound level from the artists located farthest from the microphone. In addition to the loss of volume due to the greater distance,

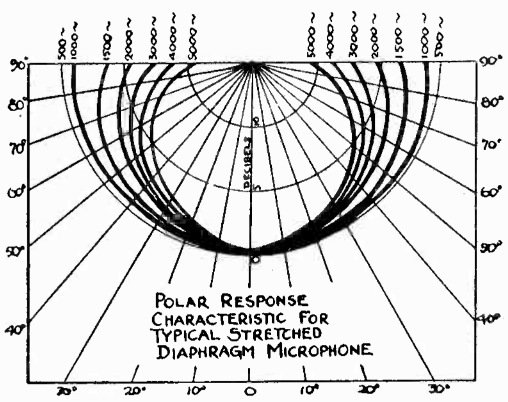


FIG. 2

the high-frequency response will be somewhat impaired due to the directional characteristics of the microphone in the upper end of the audio spectrum. Fig. 2 shows a typical directional characteristic, applying to both condenser and carbon type stretched-diaphragm instruments. The directional effect is not apparent below about 1,000 cycles per second; at 90 degrees from the "head-on" position, the 5,000 cycle response is about 10 db below that obtained when facing the microphone at normal incidence. One means of minimizing this directional frequency discrimination is to increase the distance from the microphone until all of the artists are included within an angle of 30 degrees either side of the microphone axis, making a total angle of 60 degrees. This will reduce the 5,000-cycle directional loss to about 2 db. If it is feasible to have the artists stand in a circle around the microphone, highly satisfactory pickup can be obtained with a condenser microphone by placing the transmitter diaphragm in a horizontal plane. It should be remembered that the carbon microphone must always be operated with the diaphragm in a vertical plane, and this type of pickup is out of the question with the carbon transmitter.

Dramatic productions require a detailed analysis of the continuity when considering the microphone requirements. Almost invariably a number of microphones will be necessary. At least one microphone must be provided for dialogue pickup from the radio actors, and if the production is a large one, as many as three or four microphones may be devoted to this purpose. Additional microphones will be required for theme-song or intermission selections by the orchestra. If the script calls for sound effects, still other microphones will be used for this purpose. Due to the widely differing conditions in such broadcasts, it is evidently impossible to outline any definite microphone technique which would apply to all cases. A point which should be noted, however, is that the dramatic production always entails more or less moving about on the part of the actors, despite the fact that the audience gains its impressions entirely through the sense of hearing. If the action calls for a character to begin a speech after entering a room, the artist will probably begin his lines across the studio, advancing toward the microphone so as to convey the desired effect to the listeners who must hear rather than see the action. In general, the problem is one of providing enough microphones so that all members of the cast will be able to deliver their lines promptly and smoothly without crowding or other disconcerting confusion. The musical part of the production is a straightforward problem in orchestra pickup.

Sound Effects

Even if sound effects are to be produced in the same studio with the dramatic cast, one or more separate and distinct microphones are always devoted exclusively to this purpose. Sound effects are designed and worked out to produce the correct **character** and **quality** of sound without particular regard to **intensity** or **volume**. The use of distinct microphones allows the control operator to properly proportion the sound-effect volume to the general level of the program through adjustment of the mixing controls. For the most part, sound effects are produced "artificially" by mechanical devices, and since the sound level is usually very low, the microphone must be placed very close to the source of sound. An amusing example of this technique is the imitation of the noise of a splintering beam by breaking a match stick close to the diaphragm. The characteristic sounds

(Continued on page 28)

*Engineering Bulletin, Shure Brothers Co.

Circuit Analysis of the Power/ack Receiver and Data on Beat Frequency Oscillators for S-W Receivers

By NAT POMERANZ, W2WK, W2APD, W2RM *

THE subject of this article relates to the construction and operation of a Beat-Frequency Oscillator to be used with a short-wave super-heterodyne and, although primarily designed to be used in conjunction with the POWER A/CK SHWA-37-1001 receiver, it can be applied to any short-wave superheterodyne for the purpose of receiving C.W. signals.

The POWER A/CK SHWA-37-1001 receiver which covers from 14 to 575 meters and uses seven tubes in all was designed by Mr. Frank Squire, chief engineer of the POWER A/CK TELEVISION & RADIO CORP. (subsidiary of RADIO CHASSIS, INC.) with the primary purpose in mind of producing a receiver to be used and enjoyed by Mr. Broadcast Listener who has heard of the thrills experienced on the shorter waves, who knew nothing about carrier-waves and beat-frequencies, and who thought (and still thinks) that every whistle, frying noise, static and fading is caused by those crazy radio "bugs" known as amateurs.

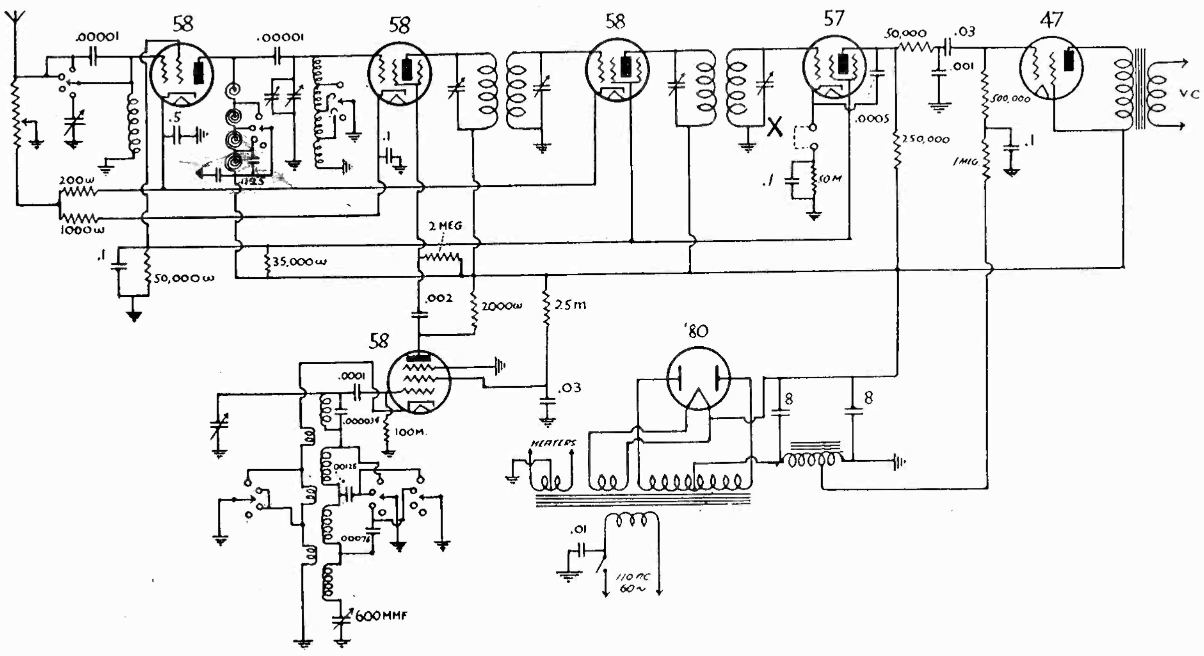
Mr. Broadcast Listener is even a funnier object of pity to us than we amateurs are to him. He shudders at the sound of a "squeal" which to us may be the sweetest sort of crystal D.C. note; he founders at the crash of "static," which is nothing more than a machine tape transmitter hooked to a 50 K.W. final stage which sounds more like a bum connection than a conglomeration of dots and dashes, every tenth word being "love." He passes out with the "frying noises" which, likely as not, are the "weather-proof" 500-cycle signals from one of our over-anxious commercials.

And so the POWER A/CK SHWA-37-1001 was born. It is de-squealized, de-fryed and de-staticed. The only way one can get a whistle on it is to tune in a Bing Crosby or Morton Downey yodel and even this, if the proper legislation goes through, will be stopped by special permission of the N.R.A.

One tunes it as he would an ordinary broadcast receiver. It has a volume control and tuning dial. In addition, there is a band selector switch which can cut in any of these bands: 14 to 30, 30 to 90, 80 to 210 and 200 to 575 meters. The last knob is just a balancing condenser, and there is nothing complicated about turning it for maximum signal strength. That, part and parcel, gives Mr. Broadcast Listener the same mode of tuning and the same type of signal as he would get on his broadcast midget or console. Foreign short-wave signals are tuned in just the same as one would tune for KFI or WJZ on the regular wavelengths.

One might ask why a beat frequency oscillator was not incorporated in the receiver itself and a switch supplied to cut it either in or out. The answer is simple and obvious. It makes a more complicated receiver and brings in a lot of stuff that cannot be understood and has no entertainment value.

There is nothing more simple (with the possible exception of getting an R9 from a newly licensed "hamateur") than the construction of a beat frequency oscillator. The only accuracy needed is in shielding and the selection of a 24A tube that has some vacuum left in the glass envelope. The circuit diagram is shown here:



Showing (at "X") where the Beat-Frequency Oscillator is connected

L1 and L2 are the secondary and primary of a short-wave I.F. transformer. Two-thirds of the primary winding is removed and connected at that point to the secondary winding (if the coil is honey-comb wound, the inside of one coil is connected to the outside of the other) at the point where it connects to the cathode. The secondary padding condenser, which is semi-tunable by use of a screw driver, is connected across both windings. The primary tuning pad, if any, is disconnected and demounted and presented to the local R.I. on Christmas in exchange for a two-letter call.

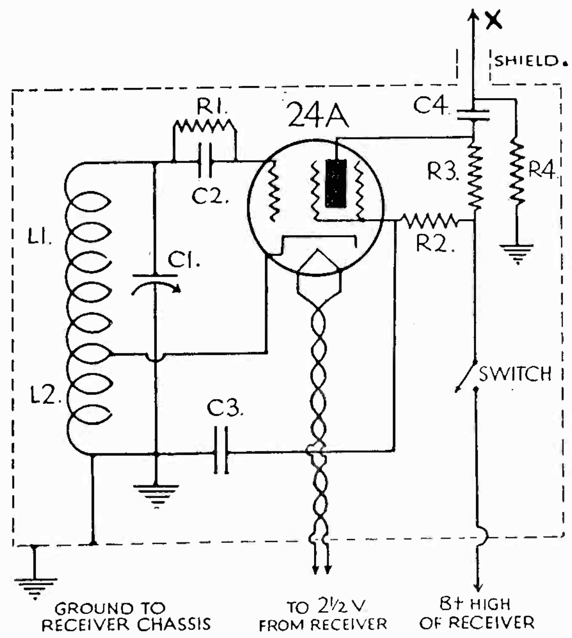
The 24A tube derives its filament voltage from the same transformer which lights the tubes of the receiver proper. In the SHWA-37-1001, the transformer is an over-size one and will easily stand the drain of an additional tube. The B-plus high from the oscillator is connected to the high output of the power supply.

The oscillator is grounded to the chassis of the receiver to complete the plate supply and feed circuit.

Th oscillator at point "X" is coupled to the grid return going into the second detector on the receiver. Since it is grounded at this point, it is removed from ground completely. The resistor R4 compensates for this circuit change. Point "X" on the oscillator diagram is hooked to point "X" on the receiver diagram.

The Intermediate Frequency used in the POWER A/CK SHWA-37-1001 is 462 K.C. It is naturally expected that the constructed oscillator will beat near that frequency. Most short-wave receivers use frequencies near to this and therefore almost any I.F. transformer designed for short wave work will do the trick.

The switch controls the use of the oscillator. When C.W. reception is desired, the switch is closed. A C.W. signal is tuned in and, with one hand on the tuning control and the other one manipulating a screw driver, the condenser C1 is rotated to a point where the C.W. signal is at its best. The tuning dial on the receiver must be adjusted to hold the signal while this is being done. When the best point is obtained, it will be right for any band.



L1, L2—See text	**C4—.0001 MFD.**
C1—See Text	**R1—100,000 ohms**
C2—.00025 MFD.	**R2—250,000 ohms**
C3—.05 MFD.	**R3—100,000 ohms**
	R4—1 megohm.

At point "X" in the large diagram, disconnect the ground from the intermediate transformer. Now run a wire from point "X" in the oscillator, and connect it to point "X" on the large diagram.

Special Announcement!

Beginning in October "RADIO" there will be a series of exclusive feature articles on FARNSWORTH CATHODE-RAY TELEVISION. Subscribe now!

* Radio Chassis, Inc.

Sargent 9-33 Receiver

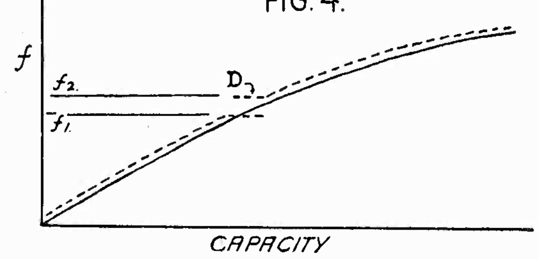
(Continued from page 12)

Coil Section	Inductance	Capacity Needed To Resonate at 14 mtrs.	27 mtrs.	57 mtrs.	120 mtrs.
L-2	4.1 microH.	13.5 mmf.	—	—	—
L-3	17.0 "	3.2	12.0	—	—
L-4	66.0 "	.8	3.1	14.0	—
L-5	337.0 "	—	—	2.7	12.0
		All capacity values are in mmf.			

of course, well removed from L-2, in which wave-band it would be troublesome. L-5, due to its high inductance, could conceivably cause trouble in the L-4 band and for this reason L-5 is on a form by itself.

A considerable amount of experimenting, checking and rechecking was necessary to get the coil combination exactly right. At one stage, coils L-1, L-2 and L-3 were all grouped on the same form, with the result that a very decided dead spot appeared in the band of L-1. The curve, Fig. 4, shows the tuning effect that appeared. The solid line is the curve as it should have been, while the dotted line with the break at D is the actual curve as plotted. Frequencies between values f-1 and f-2 could not be received at all. Removal of L-3 to another form smoothed out the curve to that shown by the solid line. At another time various impregnating materials were tried, and a certain coil varnish that was used gave the coils such a high capacity that dead-end trouble was experienced in each case from the next higher section. The cause of this was obvious and easily corrected. The existence of dead-end loss is definitely located by carefully plotting a tuning curve over the entire condenser range for each tap switch setting, taking readings only a few degrees apart. This will plainly show any undue variation in the shape of the curve. When the coil and tap switch combination is free from dead end loss, all curves will be like the solid line in Fig. 4.

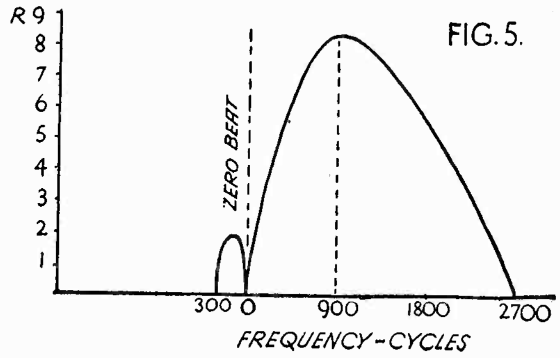
FIG. 4.



Some questions have been asked regarding the possibility of harmonics from the 290 k.c. fixed oscillator causing freak signals and other troubles in the receiver. (This is the fixed oscillator used to change from 465 k.c. to 175 k.c. i.f.). During process of development some trouble was encountered from this source, especially at the higher wave-lengths and in the broadcast band. It was easily eliminated by grouping the bypass condensers and isolation resistors right at the 2A7 socket, and by connecting a 500-turn r.f. choke in series with the lead to the No. 1 grid of the 2A7 tube. This is the oscillator grid lead, and the choke reduces the harmonic amplitude to a point where its effect is entirely negligible.

SINGLE SIGNAL RECEIVING

Due to its extreme selectivity, the Sargent 9-33 is an extremely good single-signal receiver for C.W. In fact, while its single-signal capacities are not quite equal to what can theoretically be expected from a series crystal filter, in actual practice and in side-by-side tests, it has shown greater single-signal effect than any receiver against which it has been tested. Fig. 5 is an actual curve of a C.W. signal showing the relative proportion of the parts to the two sides of zero beat. The vertical scale is divided into the familiar R-1 to R-9 divisions. It will be noted that the response is approximately in the ratio of R-9 to R-2, while the frequency cut-off on the strong side is at 2700 cycles and on the weak at about 300 cycles. The



signal in question peaked at about 900 cycles. This clearly shows the possibility of reading an R-1 signal separated only 300 cycles from an R-9, a performance which is considered plenty good in any company.

Some actual selectivity measurements on the 80-meter phone band may also be of interest. A local test was made on W6CBF's phone, situated one mile distant, air line. CBF puts out a modulated carrier of about 100 watts on 3951 k.c. Using an 80-foot flat top antenna, 50 feet high at the receiving end, it was possible to cut through CBF at 3941 and 3960 to pick up R-1 signals from a nearby modulated test oscillator. On DX signals in the amateur phone band, R-6, R-7, and weaker, the average cutoff frequency is 2.6 k.c. to either side of dead center. This explains why, in nearly all cases, it is possible to completely isolate the desired signal even in the crowded phone band. This set covers the broadcast band and selectivity here is also very good, locals being cut off at 10 to 15 k.c. to either side of center. The short-wave input is used on the broadcast band and this makes for very good selectivity with a possible slight loss of DX. This however, is strictly in line with present day requirements on the wave-band of 200-550 meters.

SORRY!

but space did not permit the publication of several promised articles in this issue. . . . The Short-Wave Course; Beginner's Transmitter; Super-Heterodyne Questions and Answers, and Filter Systems will all be in the next issue.

OLD TIMER'S --CORNER--

Answers to Last Month's Old-Timer's Questions

(1) The "RESONOPHONE" was a receiving set in which was included the controls for a sealed-in electrolytic detector. It was used by the old Massie Wireless Telegraph Company in the "spark" days.

(2) Some receiving sets, chiefly those used by the British and Belgian Marconi Companies, used "Magnetic Detectors," consisting of an endless band of fine silk-insulated soft iron wire. It was necessary to keep the wire band in motion, the wire traveling over spools which were rotated by a spring-wound clock-work.

(3) The "Sealed-In-Point" electrolytic detector used a fine "Wallaston" wire which was sealed into the end of a small glass tube. Contact with the electrolyte, usually a solution of dilute nitric acid, was made by the Wallaston wire which protruded from the end of the glass. Strong signals would burn the sensitive point from the wire and it was then necessary to resharpen the point on an oilstone.

(4) Some types of audion (vacuum tube) detectors were unstable and erratic in performance. The use of a permanent magnet, placed close to the tube, helped make the detector more stable in operation because of the influence of the magnet on the electron stream within the tube.

(5) Prior to 1912 there was no law limiting the operation of amateur or any other kind of station. The power limit of an amateur station was usually determined by the size of the pocketbook.

(6) "X" was a designation used by the British Marconi Company to denote static. "X", an unknown quantity, was chosen because it indicated the unknown source of interference, the origin of static not being known at the time.

(7) The DeForest exhibit at the Panama Pacific International Exposition in 1915 was one of the first through which the public was given the opportunity to see the newest radio invention, the vacuum tube. Audion bulbs, as they were then called, were expensive and were sold, usually, only as original equipment when receiving sets were purchased. Renewals of burnt-out bulbs were made only upon return of the defective bulb. Although the exhibit was under close guard, many of these bulbs mysteriously disappeared and for this reason burnt-out bulbs were exhibited. Those who stole the burnt-out bulbs could not secure replacements unless proof was shown that the owner of the bulb had a DeForest receiver in his possession.

(8) In 1906 a group of four executives of a nation-wide radio-telephone communication system were placed under arrest in Chicago. These men were accused of selling watered stock. Three were convicted and sent to the penitentiary. The fourth, a capable and honest radio engineer, was subjected to ridicule and criticism by the judge who presided at the trial. He failed to convince the magistrate that the human voice could be sent by radio, although he offered to install a working model of his equipment in the courtroom. After listening to the arguments of the radio engineer, the judge issued an order committing him to the insane asylum and it was only after considerable pressure had been brought to bear by other engineers that the "victim" was released.

(Continued on page 25)

Col. Clair Foster

(Continued from page 5)

Commercials Are Copying Amateur Traffic

WE LEARN from commercial operators that the RCA and Mackay (as the International Telephone & Telegraph Company is known among radio men), have been copying the amateur trans-Pacific traffic to build up a record of amateur messages that they may claim should have been sent through commercial channels. How absurd! It would be just as rational for the amateurs to copy the commercial traffic to find out just how many paid messages could just as well have been transmited free of charge by amateur stations to the great advantage of the public! In this enterprise RCA and Mackay aren't exhibiting even ordinary intelligence. If they had it they would know that not one out of a hundred of these amateur messages would ever come into their hands. For, as I have said before, even though the need be urgent the people simply haven't the money to pay the price demanded by the commercials. Amateurs don't permit themselves to be made use of by business houses. We know we have a perfect right to handle any type of traffic but we do not relish being worked for suckers. We don't purpose to maintain stations and give our time to business men who are merely trying to save themselves some money.

The latest and most serious threat to amateur trans-Pacific traffic comes in the form of a change in the international regulations, adopted at Madrid last autumn but not yet ratified by the United States. The change was launched and steered by representatives of United States commercial corporations. The former international regulations respecting the exchange of messages by amateurs were perfectly satisfactory to the foreign governments. They left each government free to control its own amateurs in its own way. There could be no fairer arrangement for all concerned than just that. Nothing different was wanted or needed. But our commercial representatives had to nose into other people's business and tell the foreigners what they should do in a matter that rested purely with each individual government. They didn't do it to help the foreign governments; their aim was to force the United States to treat her amateurs as the foreign governments treat theirs — to force the United States, where the communications systems are privately owned, to treat her amateurs as do those governments where communications are the property of the state.

The Madrid Treaty Should Not Be Ratified!

THE so-called Madrid Treaty is really not a treaty at all. It is more the nature of a trade agreement made by commercial interests. The 1927 "treaty," a similar agreement similarly made, has been broken time and again by people most active in its making. This Madrid concoction maladroitly removes the discretionary feature and makes compulsory that every country prohibit its amateurs from exchanging messages with amateurs of foreign countries until governments concerned shall have entered into formal agreements to the contrary. To illustrate, under the 1927 treaty we United States amateurs may transmit messages to China because China does not prohibit it; while under the Madrid restrictions we could not transmit to China unless our two governments got together and made a mutual agreement to that effect.

You see, the commercials could not force into our United States regulations a prohibition against amateur message-handling because the Constitution bars any such "class legislation"; but they could make a prohibition effective against our exchanging messages with a foreign country because if our Senate ratifies without reservation the Madrid treaty the regulations of that treaty will automatically be read into the United States amateur regulations. You see now by whom, and just why, the international regulations respecting amateurs were made still more stringent at Madrid. The United States commercials wanted to reach out and control the arrangements of such foreign countries as do permit amateur message-handling. Our Senate, let me remark, is being well acquainted with the situation by this magazine.

Pacific Division Convention Will Discuss Plans For Betterment of Amateur Conditions. Large Attendance Assured

AMATEURS who bring their operator's licenses with them to the 14th annual Pacific Division convention in San Jose September 2, 3, and 4, will have the chance to operate one of the most powerful "ham" stations on the Pacific Coast.

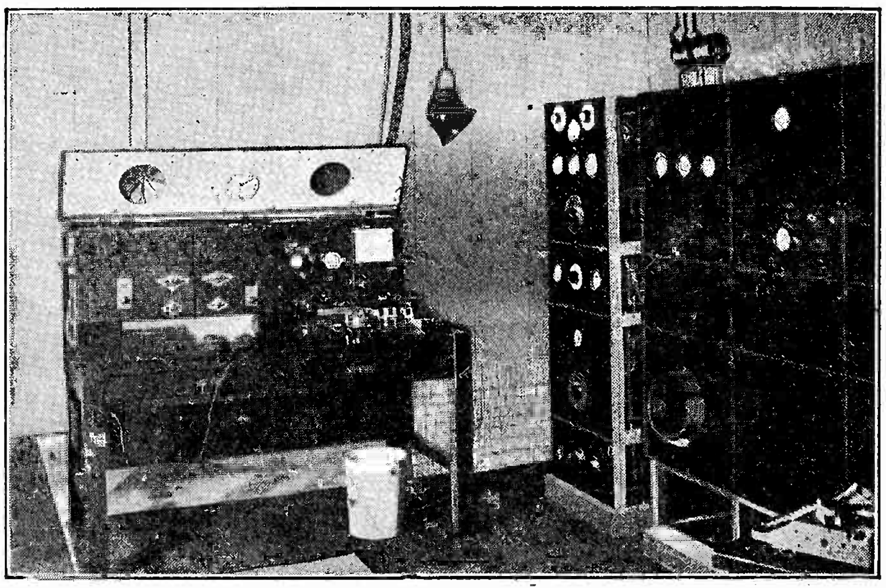
The station is W6HTB, located at the picturesque national headquarters of the Rosicrucian Order on Naglee Avenue, San Jose. Its antenna masts, of the conventional steel broadcast type, rise 110 feet above the floor of sunny Santa Clara Valley. They support the 40-meter matched impedance doublet which receives the most consistent use of the two antennas now in service.

This "ideal" antenna provides an outlet for a 500-watt transmitter consisting of a temperature-controlled '47 crystal oscillator, 210 harmonic amplifier, 210 first intermediate amplifier, 852 second intermediate amplifier, 204-A third intermediate amplifier, and a pair of 204-A's in the final stage.

Rectified, filtered a.c. is used in the oscillator and first intermediate stages, the power supply for the second, third and final stages being a 2700-volt motor generator.

The station is completed by the receiver and frequency meter and monitor. The former has one stage of tuned-radio-frequency using a 235, a 235 detector, 56 first audio, and a pair of 56's in the final stage. The latter, like the receiver, is a.c. but uses a 224-A oscillator and 56 detector.

W6HTB is the control station of section 6, Volunteer Communication Reserve, a branch of the Naval Reserve and commanded by Lieut. j.g. Frank Quement, of W6NX. It was built and is chiefly operated by Don Bellis, W6DBK. The operating desk is patterned after those used aboard United States battleships. Naval Reserve traffic is handled on Tuesday evenings, when the station operates on 3887.5 kilocycles, using a half-wave Zepp antenna with a 120-ft. flat top and 69-ft. feeders.



Official Ham Station for Pacific Convention, September 2nd, 3rd and 4th

During the first two weeks in which Don had the station on the air he worked the following DX: all U. S. districts, J1, VK, ZL, PK3, CM, K4, K5, K6, VE 4 and 5, and KA1.

And that's what the station hams will be able to use during the convention! At that time it will be on the air 24 hours per day, remote controlled from convention headquarters at the Hotel Sainte Claire by Terry Hansen, W6KG, veteran operator and convention technician. If satisfactory arrangements cannot be made for the use of ground lines, 5-meter equipment will be pressed into service to control the transmitter at W6HTB.

Should any visiting ham be unable to get in touch with the gang at home, it won't be because they can't hear 'em! So those who expect to be in San Jose on September 2, 3, and 4 should bring their operators' tickets or photostatic copies. It will be an experience they may wait a long time for again.

Many Valuable Prizes

Among the prizes to be awarded at the Convention are: 1 McMurdo Silver 3A Ham Super, 1 Hammarlund Comet Pro Receiver, 1 Silver-Marshall Bear Cat Receiver, condenser and other type microphones, high-voltage filter condensers and transformers, National 204-A transmitting tube, Duovac 50-watt tube, Electrad grid leaks, Bliley and Precision crystals, Cardwell and Hammarlund transmitting variable condensers, radio books, speed keys, choke coils, resistors, meters, fuses, QSL cards, batteries, insulators, sockets, Trimm phones, relays, '66 tubes, short-wave coils, adaptors, midget receiving condensers and a long list of other valuable prizes. The total value of these prizes is more than $900. In addition there will be a $25 cash prize offered by Ralph Heintz for the best working model of an ultra-short wave ¾-meter transmitter.

The convention opens on Saturday, Sept. 2. Registration at 9 a.m. At 1:15 p.m. the code speed contest takes place, followed with a meeting of the phone men. At 3:30 there will be a lecture on ribbon microphones, another lecture at 4:00 p.m. on audio amplifiers. On Sunday, September 3, registrations will be accepted from 9 a.m. till noon. At 8:30 a.m. there will be breakfast for the ORS-RMS. At 10:00 a.m. Frank C. Jones will talk on ultra-short wave equipment. At 11:00 a.m. D. B. McGown will tell about the newer types of tubes and their application to amateur practice. Open forum

(Continued on page 25)

for The RADIO NOTE BOOK

DOUBLERS

WHEN using crystal control to operate on the 40 or 20 meter band, some sort of doubling circuit is required to make an 80 or 160 meter crystal oscillator excite the grid of the 40 or 20 meter amplifier stages. This frequency change, or frequency doubling as it is called, is accomplished by means of doubler circuits. These circuits are not complicated. They are the same as any ordinary amplifying circuit except that the tube itself is biased in such a way that its plate current contains a high percentage of harmonics of the grid wave. The plate circuit is then tuned to the desired harmonic (preferably the second harmonic), and thus we have the grid operating at one frequency and the plate of the same tube operating at twice that frequency. In other words, the grid of the tube may be operating in the 160 meter band and the plate circuit is resonant in the 80 meter band; or the grid circuit may be operating in the 40 meter band and the plate circuit of the same tube in the 20 meter band.

Here is presented for your ready reference a group of satisfactory circuits giving the operating voltages that proved most successful for doubler use with the respective circuits. The list of component parts applies to all four circuits.

List of Component Parts for Doubler Circuits

C1—.00025 fixed mica condenser (Sangamo)

C2—.00025 variable tuning condenser. (Receiving type will be satisfactory)

C3, C4, C7—.006 mfd. fixed mica condensers (Sangamo)

C5, C6—.002 mfd. fixed mica condensers

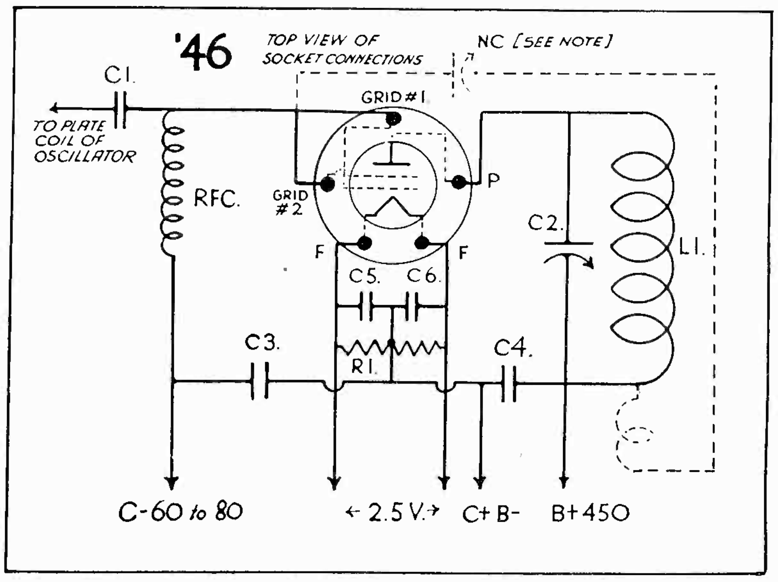
RFC—Radio Frequency choke coil, designed to operate at the frequency of the oscillator or preceding doubler stage plate coil.
For 1750 k.c. Osc. Plate Coil, use: 400 turns No. 38 D.C.C. wire on 1/2-in. form.
For 3500 k.c. Osc. Plate Coil, use: 200 turns No. 38 D.C.C. wire on 1/2-in. form.
For 7000 k.c. Osc. Plate Coil, use: 100 turns No. 38 D.C.C. wire on 1/2-in. form.

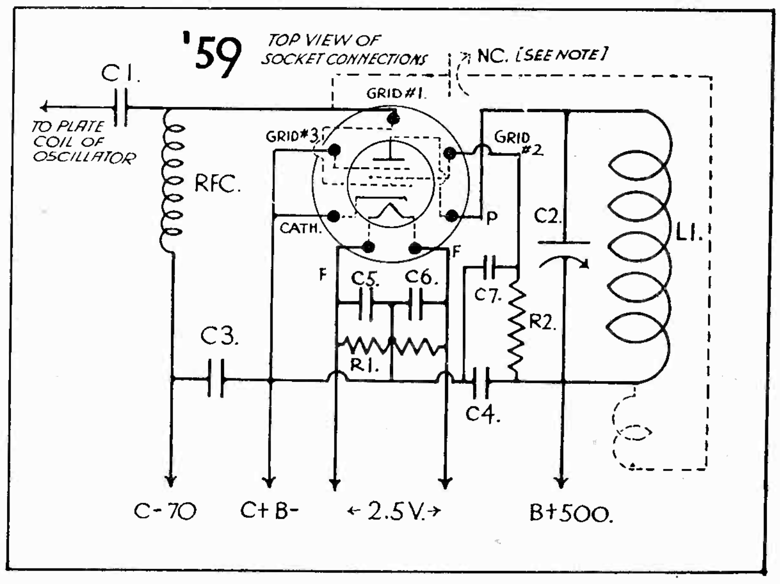
R1—100 ohm C.T. Resistor

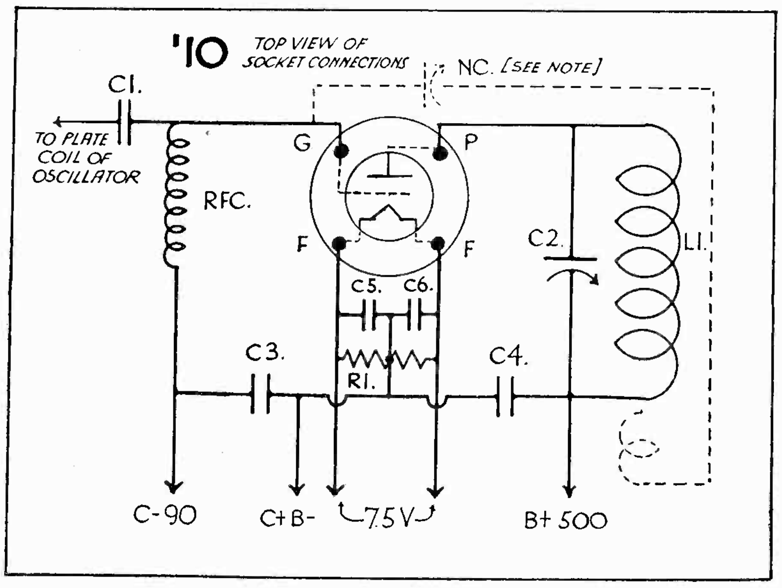
R2—50,000 ohm 10 watt Resistor.

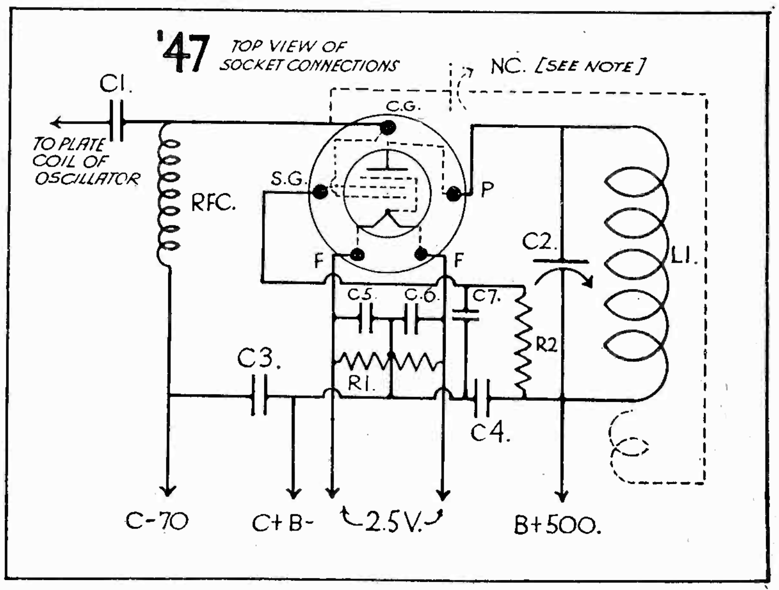
L1—Designed to tune to twice the frequency of the oscillator plate coil.
To tune in 3500 k.c. band, use: 35 turns No. 24 D.S.C. wire on 1 1/2-in. form
To tune in 7000 k.c. band, use: 18 turns No. 24 D.S.C. wire on 1 1/2-in. form
To tune in 14000 k.c. band, use: 9 turns No. 24 D.S.C. wire on 1 1/2-in. form

NOTE: If the RFC coil is resonant at the frequency of C2-L1, it will be necessary to neutralize the doubler stage to keep it from oscillating. To neutralize: add about 3 to 5 turns to the lower end of L1 and connect a small 50 mmfd. variable midget tuning condenser as shown by the dotted lines.









Old-Timer's Questions: How Many Can You Answer?

1. Why do many foreign radio telegraph operators stand up when telegraphing?
2. Where, and under what circumstances, were living trees used as receiving aerials?
3. What kind of a detector used solid gold wires for its operation?
4. What kind of a device was a "Bellini-Tosi goniometer?
5. How do the total power input to radio transmitters of the present day compare with those of the earlier transmitters?
6. What was the most difficult problem for the early radio telephone experimenters to solve?

The answers to these questions will be in the next issue.

Quartz Crystals and Their Applications

(Continued from page 11)

For amateur work an oscillator similar to the design discussed in the first part of this article should be suitable for most purposes. For those who want something a little better, however, it is suggested that the oscillator shown be provided with an oven of the single stage type, and the whole assembly be shielded from drafts with the use of a metal cabinet. For working the transmitter near the end of the band (within a few hundred cycles) such an arrangement will show its worth.

The operating temperature is usually set at about 50 degrees centigrade. The higher the temperature, within limits, the more satisfactory the operation of the thermostat, and the easier to maintain the crystal chamber temperature against variations in ambient temperature. High temperatures, however, reduce the piezo-electric effect and it is desirable to operate the crystal at as low a temperature as can be maintained by the control assembly on this account.

Even though carefully constructed and adjusted apparatus is used in the temperature control equipment, this does not eliminate the necessity of monitoring the frequency. For frequency checking, use a frequency meter having a known error less in magnitude than the required accuracy of the frequency check. The simplest proposition at present for making accurate frequency measurements is a temperature-controlled 100 kc. electron-coupled crystal oscillator with a frequency meter of the electron-coupled type, preferably micrometer reading, for interpolating.

Pacific Division Convention

(Continued from page 23)

at 1:30 p.m. and ladies' bridge at 2:00 p.m. Another open forum at 7:30 p.m., a lecture by Ralph Heintz, followed with technical movies.

On Monday, Sept. 4: 9:00 a.m., Naval Reserve meeting; 10:00 a.m., cathode ray television lectures by Arthur H. Halloran and A. H. Brolly; 11:00 a.m., lecture by Norris Hawkins, "Some Notes on Electron Coupled Oscillators"; 1:00 to 6:00 p.m., trip to the Air Base, KPO and Stanford High-Voltage Laboratory. At 7:00 p.m. the big banquet will be held and the prizes awarded. The Southern Pacific's 1c-per-mile railroad rate will be in effect.

The Superheterodyne

(Continued from page 18)

of the received signal in the input circuit L2, C2 of the second tube. The circuit L2, C2 is tuned to the frequency of the received signal by means of the condenser C2. The received signals are thus transferred to the grid of the second tube and cause variations in its plate current at the frequency of the received signal. This alternating plate current passes through the primary of a radio frequency transformer located between it and the first detector tube and induces in the secondary of the transformer L3. The circuit L3, C3 is tuned to the frequency of the received signal by means of the condenser CE. From that point on the action is that of the previously described superheterodyne. Each of the tuned radio frequency circuits being tuned to the frequency of the desired signal contributes to the overall selectivity of the receiver and each radio frequency tube provides gain as a voltage amplifier and hence adds to sensitivity.

The modern superheterodyne receiver uses in some form the following units:

(1) Radio frequency amplifier
(2) Mixer or detector
(3) Local oscillator
(4) Intermediate frequency amplifier
(5) Second detector
(6) Audio system.

The physical arrangement of parts, circuit constants and types of tubes used will depend upon the individual manufacturer. In some of the very modern "supers" it may be found that several circuit functions are performed by a single tube. The usual commercial superheterodyne generally incorporates a power supply system, generally a tube rectifier with its associated equipment and a low-voltage filament supply source for the tubes. However, both battery and complete A.C. operation are possible.

The superheterodyne is generally thought of only in connection with broadcast reception, but very satisfactory receivers of that type are finding use in long-distance high-frequency reception, both telephone and telegraph, and in allied fields. These receivers are necessarily of special design and construction but basically they are the same as those used for broadcast reception.

List Price $55.50

Complete with Cabinet, R.C.A.-Cunningham Tubes and Government Tax.

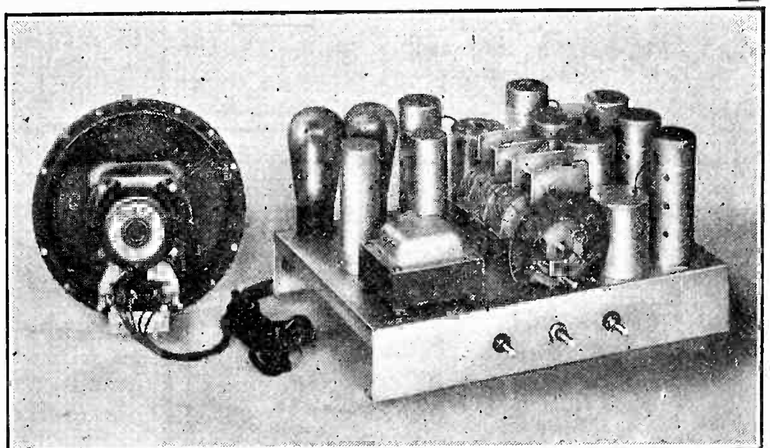
Combination Short-Wave and Broadcast Seven-Tube Super-Heterodyne

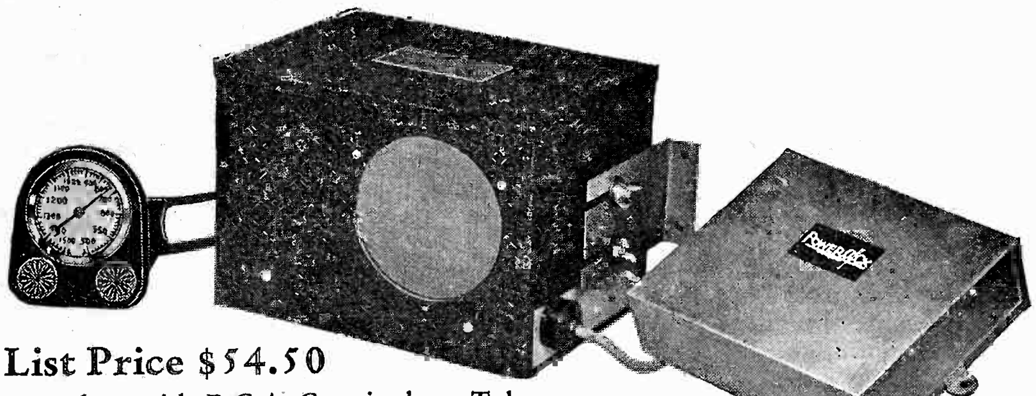
MODEL SHWA-37-1001 — **14 TO 575 METERS**

APPROVED BY EDITORS OF "RADIO-MODERN RADIO"

For the first time the reception of foreign short-wave stations, amateurs, police alarms, aircraft news, weather reports, ship-to-shore signals, phone stations, etc., is brought out of the experimental stage and into the home in an easy-to-operate and fool-proof receiver. It is tuned just as ordinary broadcast home radio—no plug-in coils are used—all waves from 14 to 575 meters are controlled by just one band selector knob. Its keynote is simplicity and gives the uninitiated broadcast listener the same opportunity to enjoy the thrills of short-wave reception as the dyed-in-the-wool short-wave experimenter. And, in addition to this, the receiver when adjusted to the broadcast band (200-575 meters) performs as well as any home radio.

The circuit, designed by Frank M. Squire, uses 4—C58, 1—C57, 1—C47 and 1—C80. In addition to the C80 full-wave rectifier and the C47 Pentode Audio Output, it uses a C58 as a tuned R.F. stage and a C58 as the first detector. A C58 acts as the intermediate R.F. stage and a C57 as the second detector. Another C58 rounds out the circuit as the oscillator. The output from the Pentode to the Rola Dynamic 8" Speaker is 2.5 to 3 watts. The parts used in the manufacture of this receiver are well known, nationally advertised and accurately made. The four position wave-band switch can select any of these bands: 14 to 33, 30 to 90, 80 to 210 and 200 to 575 meters.





List Price $54.50

Complete with R.C.A.-Cunningham Tubes and Suppression Kit.

RCI POWERA/CK V-6 Auto Radio Receiver

APPROVED BY EDITORS OF "RADIO - MODERN RADIO"

Never before in the history of radio reception in automobiles has a receiver been made which combines the sensitivity, automatic volume control and range and tone reproduction of the POWERA/CK V-6. Having less than two microvolts sensitivity over the entire band from 200 to 575 meters (not one particular frequency) is the latest victory to the engineering feats of Frank M. Squire, chief engineer of POWERA/CK TELEVISION & RADIO CORP. It is an absolute fact: you can receive stations up to 3000 miles away with comfortable intensity while RIDING. It will detune stations only 10 K.C. apart. And it does not require an elaborate antenna system, an antenna placed under the running board of the car being sufficient. The Automatic Volume Control provides a uniform signal and compensates for fading and dead spots.

The receiver uses 2—C78, 1—C6A7, 1—C75, 1—C41 and 1—C84. The receiver proper, which includes the Dynamic Speaker, is housed in a crystalline finished case which is only 9¼" long, 6½" high and 6½" wide and mounts to the fire wall of the car by two brackets and four wing-lock nuts. The entire assembly can be made in under one-half an hour. The "B" eliminator is a full-wave vibrator with tube rectifier and is noiseless and constructed so as to be least troublesome. A full vision, Airplane Type dial remote control completes the receiver equipment. Here again, the parts used are well known, nationally advertised and accurately made. A six cylinder suppression kit including an oversized by-pass condenser is part of the standard equipment.

RADIO CHASSIS, Inc.

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Send me full detailed information on your complete line together with your net dealer prices. It is understood that this in no way obligates me and there will be no charge for the delivery of this information.

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Field Problems In Microphone Placement

(Continued from page 20)

heard in bowling have been successfully reproduced with the aid of child's toy pins set up in another studio. The balls were merely rolled along the floor in the usual manner. It was necessary in this particular case to use two condenser microphones, one placed on the floor close to the point where the balls were released and the other placed at the end of the "alley" but some distance from the pins. Most of the pickup came through the microphone farthest from the pins, but the additional transmitter was necessary to obtain the characteristic high-frequency components resulting from the tumbling of the pins against each other. Rather complicated machines are used to produce sound effects automatically, and sometimes entire studios are devoted exclusively to this purpose in the larger stations.

Orchestra Pickups

The technique of orchestra pickups has received a great deal of study since the inception of broadcasting. The problems encountered in remote pickups are considerably different from those in the studio, due to differences in noise level of the surroundings and practical limitations on microphone location in remote work.

Both single and multiple microphone setups are used in the studio. Recently there seems to have been a trend toward the use of a single microphone but not all productions can be handled in this way. When using a single microphone, it is important that the group be included within an angle of about 60 degrees to mitigate the effects of directional frequency discrimination as explained previously. The great distance required to fulfill this condition when the group is large may cause the carbon noise level to become apparent if carbon type transmitters are employed. This objection is eliminated by the substitution of condenser microphones with their inherently low noise level. Furthermore, the orchestra director is entirely responsible for the musical balance with the single microphone pickup. Some experienced leaders prefer this arrangement, since the transmitted program will sound very much as it does to the leader in the studio. On the other hand, it is contended that proper reproduction should closely resemble the effect which the listener gets at a distance, and this effect can be approached by using a number of microphones located across the front of the orchestra. Careful control operation is necessary when using more than one microphone. The multiple microphone system is probably preferable with carbon transmitters, while either the single or multiple system may be used with condenser type transmitters. Fig. 3 shows the general seating arrangement for

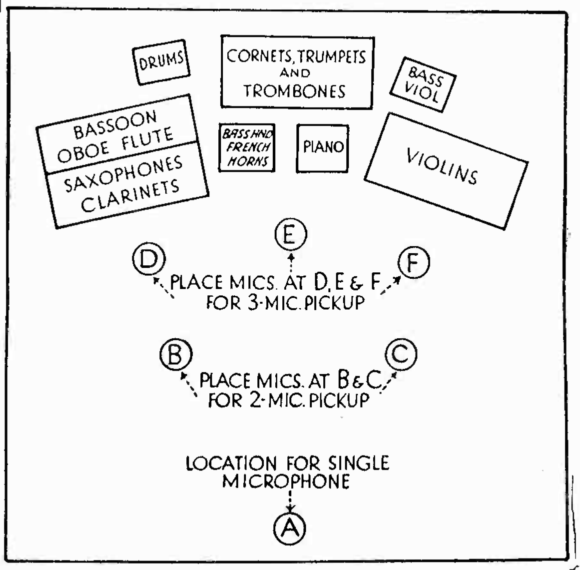


FIG. 3

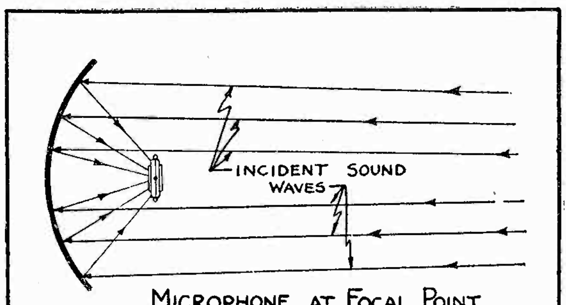
the various sections of the orchestra and suggested locations for microphones, which should be from five to eight feet above the floor. Floor stands, adjusted to maximum height, are satisfactory in the studio.

Remote Pickups

Remote pickups, as contrasted with studio pickups, always take place under the existing conditions of noise and local acoustic peculiarities. Sometimes the noise background lends interest and creates atmosphere for the broadcast, but this is probably the exception rather than the rule, and the microphone facilities are usually placed to minimize noise pickup. The most obvious method of accomplishing this is to locate the microphones very close to the source of sound, so that the desired sounds will have a higher level than the unwanted noise. This procedure is followed for broadcasts of speeches and similar events. If there are to be a number of speakers, it is obviously necessary to provide enough microphones so that each speaker will come within the required distance of the transmitter. It is usually not permissible to move the microphones about at banquets and similar functions. The unused microphones are switched out of the circuit so as not to contribute unnecessary noise.

Dance orchestras are picked up with a number of microphones which are placed rather close to the musicians. The close placement is often necessary due to the limited space on the band stand, as well as to minimize the noise background. The multiple microphone system is, of course, essential with close placement in order to secure proper balance and to keep down directional frequency discrimination.

Other types of musical programs do not lend themselves to the multiple pickup. This is particularly true of large symphony orchestras and opera. The symphony orchestra is conducted so as to produce the proper effect to the audience at considerable distance from the musicians. A single microphone pickup near the conductor is not feasible due to the large space occupied by the musicians. A highly satisfactory solution of this problem has been worked out using a parabolic reflector on a microphone located in a balcony or box. The use of the reflector results in a very directional pickup and the device must be accurately pointed at the source of sound. Since the distance between microphone and orchestra is large, the reproduction is well balanced and closely approaches what would be heard by a listener located near the microphone. The directional feature also tends to reduce the pickup of local noise and minimizes the effect of acoustic peculiarities of the hall. Fig. 4 shows the principle of the parabolic reflector. Note that the microphone diaphragm faces the reflector rather than the source of sound. This device has been used



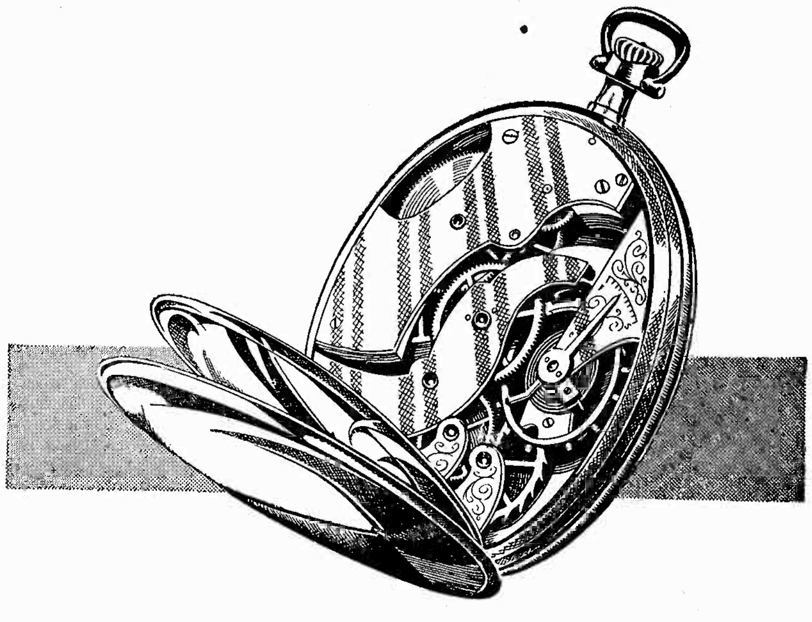
MICROPHONE AT FOCAL POINT

in sound picture recording for some time, where it possesses some advantages for many purposes over the ordinary non-directional pickup.

(To be continued)

Editor's Note: Forthcoming issues will continue the discussion of microphone placement problems in public address work, sound-picture recording, and other applications.

LIKE A DELICATE TIMEPIECE



FOR hundreds of years a fine watch has been a symbol of care and precision and accurate workmanship.

Yet, the radio tube engineer knows that his materials are just as fine, his design just as important, his tolerances as close, as those of a timepiece. And that the finished product must be just as reliable.

Every Sylvania radio tube is built with these facts in mind. Sylvania engineering is modern, scientific, constructive. It gave radio a new and efficient group of tubes for automobile receiver use. It adapted these tubes to all other types of service other than dry battery. in both instances it pioneered in radio. And always . . . this service is at the free disposal of manu facturers . . . to help with circuit problems, design problems, sales problems!

Sylvania quality inspection is also up to the highest and most modern standards. It does more than sort tubes into firsts and seconds. It demands all firsts. It *rejects and destroys* tubes that are not as good as the best.

There is a reason for these high standards in Sylvania Tubes. The Hygrade Sylvania Corporation is management owned. It is run by men whose only goal is the success of their company and its customers.

Hygrade-Sylvania Corporation,
Emporium, Penna.

NRA MEMBER U.S. WE DO OUR PART

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

THE SET-TESTED RADIO TUBE