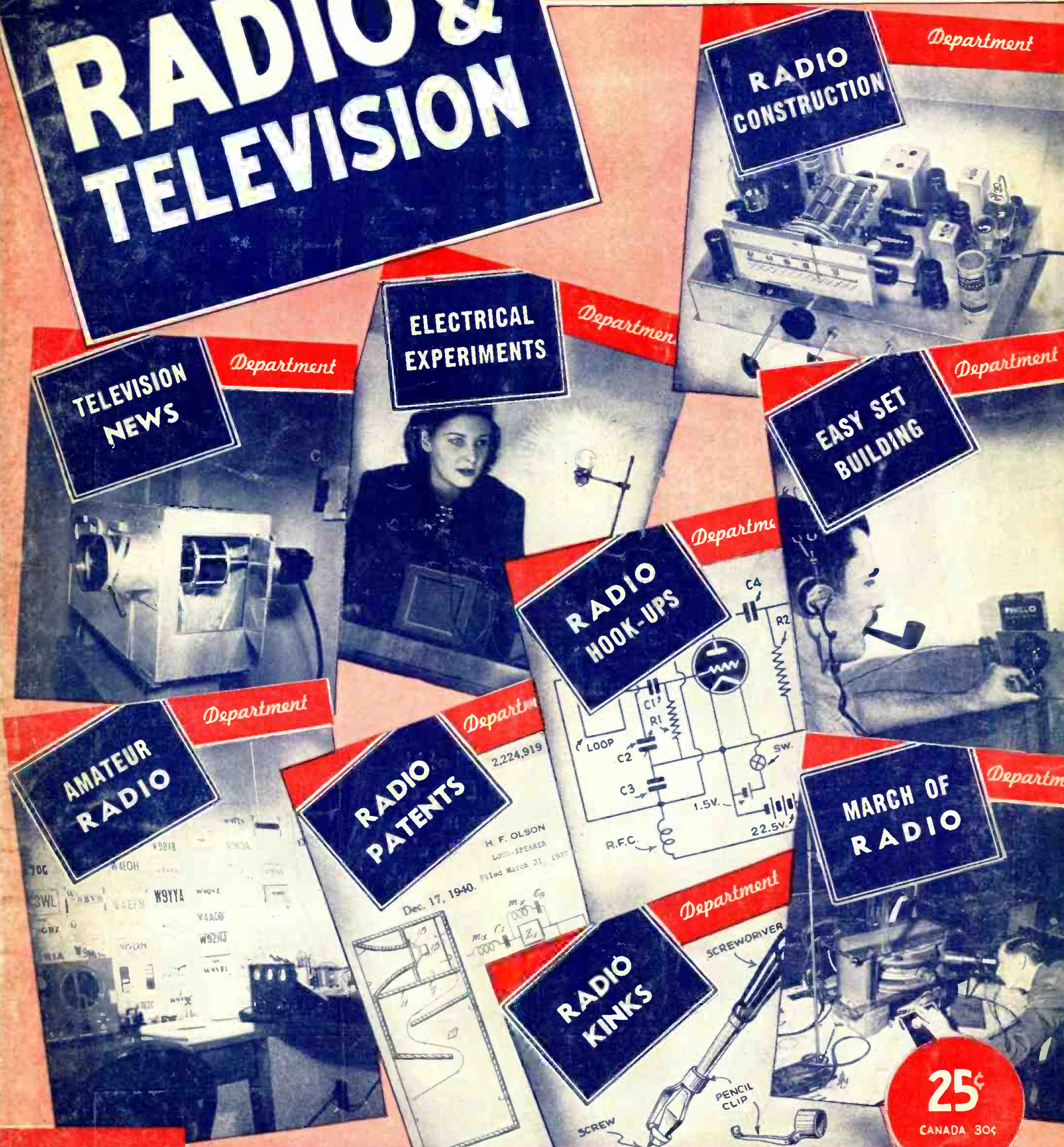
RADIO'S *Complete* MAGAZINE

RADIO & TELEVISION



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HUGO GERNSBACK
EDITOR

AMATEUR & EXPERIMENTAL RADIO

MAR.

CONSTRUCTIVE RADIO ARTICLES

1941

NATIONAL RECEIVERS

HRO

NC 200

NC 100 XA

NC 44

National Receivers give maximum performance in every price range, at all frequencies. There is the HRO which has become the standard of comparison among fine communication receivers for performance, versatility and reliability. There is the little SW-3 which is still a favorite after ten years, noted for three-tube simplicity combined with proven capability.

There is the brand new NC-200, which is making a reputation for itself week by week. There are older favorites like the NC-100 and the NC-44, each bringing top performance to its price class.

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NATIONAL COMPANY, INC.

MALDEN, MASSACHUSETTS

SW-3

ONE-TEN

NHU

Is this what you want to know?

1. How to read diagrams and analyze them.
2. How to use test instruments.
3. How to get started in professional Radio.
4. Hints on how to run your service business profitably.
5. How to install P.A. equipment.
6. How to install inter-communicating systems.
7. How to figure charges.
8. What servicing instruments to buy.
9. How to locate parts in a chassis with and without service data.
10. How to know the cause of receiver trouble from observed effects.
11. How to make tests which isolate the defective stage and parts.
12. How to check for defects in a chassis.
13. How to align receivers without reference to service manuals.
14. How to appraise receiver performance from a circuit diagram.
15. How to plan your service bench and shop.
16. How to develop a time-saving servicing technique.
17. Short cuts in servicing midget universal receivers.
18. How modern electronic television receivers operate.
19. How to install and service television receivers.
20. How to practice servicing Radios to gain needed experience.
21. Practical demonstrations that show how basic Radio circuits operate.

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RADIO & TELEVISION

The Popular Radio Magazine

HUGO GERNSBACK, Editor
H. WINFIELD SECOR, Manag. Editor
ROBERT EICHBERG, Television and Digest Editor

March — 1941
Vol. XI No. 11

In April Issue

How to Erect Television Receiving Antennas to Prevent Interference—Thornton Chew
A Real "High-Fidelity" Phono Amplifier—Milton T. Putnam, Chief Engineer, Station WDWS
A Simple "Signal Tracer"—H. L. Carpenter
Construction of a Short-Wave "Signal-Booster"—Charles R. Leutz
Pull-Swing Frequency Modulation-Set Construction—Ricardo Muniz, E.E., Donald and Warren Oestreicher
Latest Television News
"Airplane Spotting" by Super-Sensitive Sound Receiver

In This Issue

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Cover Composition by Hugo Gernsback and Thomas D. Pentz

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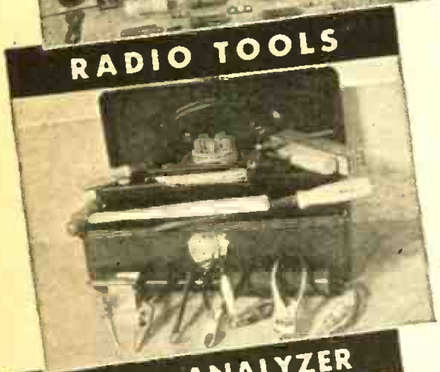

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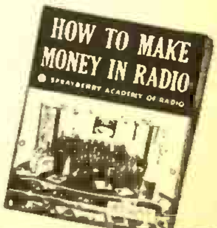

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RADIO & TELEVISION

Editorial

RADIO, the Unknown

By HUGO GERNSBACK, Editor

● DESPITE the fact that the average man believes that everything about radio is known or pretty well understood, we sometimes should stop and consider how vast and almost limitless the area of the unknown in radio really is.

We frequently fail to consider that in this material world we only know an infinitesimal percentage of what has yet to be known, and indeed it is quite within the realm of possibility that we shall never know the ultimate of most of the world that surrounds us.

It is true that we do know many things, when it comes to the theory and application of materials and forces in nature, but when we come to the real fundamentals, nature seems to interpose an almost insurmountable barrier. As electricity is used in radio at every turn, naturally we should start at that point. So if we ask the old question—*what is electricity?*—we are baffled just as were the early investigators of the phenomenon known as electricity. Almost every year a new theory is propounded, but as yet we have not progressed very far and know little or nothing of what the electrical current really is. We glibly talk about electrical effects, electrified particles, electrons that move about a conductor—and we talk learnedly on other similar points, but the real fact is that very little, if anything, is known and that one theory can be refuted by another one with equal ease.

It is equally true of radio—of which we know practically nothing. True enough we know how to build radio transmitters and radio receivers—but what goes on inside them and how the waves travel, is still an unknown quantity. We can design all sorts of radio circuits but what the radio waves themselves are we know but little. Certainly, not much more than when Heinrich Hertz first demonstrated radio waves way back in 1886. Hertz certainly knew as much about radio waves as anyone knows nowadays and our total knowledge of radio waves from the days of Hertz has not greatly changed.

Hertz first demonstrated his radio oscillator and was able, by using a single loop of wire, to make sparks jump between the two ends of the wire. No ground was used. Later on when Marconi came along, a ground connection was used for better results. Right now we are going back to Hertz and are beginning to discard the orthodox *ground* connection. As the sensitivity of our radio sets increases, a ground is no longer necessitated. Thus in automobiles, airplanes, etc., no real ground is used. You will say that we use an artificial ground by "grounding" one of the connections to the frame of the car or the airplane, as the case may be. But the point is that we use no real ground connection. Indeed Nikola Tesla pointed out many years ago that the engineers' conception of radio was all wrong, and that a radio ground on an airplane worked simply as one electrode of a condenser. According to Tesla, therefore, a radio set is nothing but a condenser which you charge and discharge by means of radio waves, which pass through open space. Whether this view will prevail in the end no one knows.

The whole subject becomes very much involved, as the following will show: As everyone knows the earth (ground) and ocean water are excellent conductors. Not only for electricity but radio waves as well, yet it is possible to receive powerful radio signals and operate radio sets far underground, and modern submarines receive and transmit radio signals when deeply submerged in the ocean. According to the best theories the ground and salt water certainly should *short-circuit* the radio waves, but they do nothing of the sort. This demonstrates how little we know of the subject.

We might ask quite properly—*when is an insulator?* An ordinary bakelite tube for all practical purposes is an insulator. Yet it has been demonstrated that under certain conditions a bakelite or other insulating tube will make an excellent conductor for radio waves, and it is now possible to pipe radio waves through insulated tubes, just as you would pipe water through a metal tube. This is merely another instance of how little is known about the subject of radio.

And when it comes to radio waves in open space, our knowledge is practically nil. What happens for instance to the radio wave after it leaves the radio station's aerial, until it strikes your aerial, we have only the slightest of notions. Engineers will talk learnedly of reflected waves, standing waves, refracted waves, and many others but none can give you a very concrete idea of just what the wave is composed of, as it travels through the air or through your set. Is it an electrical charge composed of electrons? Is it an oscillating current or series of currents? No one really knows. Then again it is one thing to predict that long waves behave in one way, and quite another thing when we consider for instance *micro-waves.* While we do know that as the waves get shorter and shorter they behave like light, we do not know much about it; finally—when it comes to light—we know still less, because nothing much about the ultimate composition or nature of light is known.

The shorter radio waves are supposed to follow certain rules; for example, a six meter wave is not supposed to go further than the horizon. Yet these same waves have been received across the Atlantic Ocean, for reasons unknown, as they certainly are not supposed to bend around the surface of the earth as do the longer waves, 15 meters and upwards.

Ever so often we have complete revolutions in radio, simply because we change our minds as to what we think radio waves are or are not—are supposed to do but don't.

Only a few short years ago, we talked constantly about "low-loss" coils, a term entirely in the discard today. Every radio engineer could prove to you that a coil for a radio set would have to be at least three inches in diameter and at least that high. A tuning coil for a radio set not coming within these dimensions, was simply unthinkable, because to the radio engineers a smaller coil would have too great losses.

Look at the coils in any receiving set today and what do you find? They have shrunk to the size of a pencil—less than an inch high. There is indeed no reason why they cannot be even much smaller than this, and strange to say these microscopic tuning coils work better than the earlier vintage. What has become of the high losses inherent in these small coils? Evidently no one cares, and it is not even good manners to talk about it, because it seems to make so little difference. So as we go along we change our ideas, not because we know any more, because we really don't, but we proceed mostly by the "hit and try" method which seems to get results.

All of which goes to prove how little we really know and why there are such unlimited possibilities in *radio—the unknown!*

"Editorials" by our readers will appear next month.

GOLDSMITH GETS I.R.E. MEDAL


Honored by Institute

For "his contribution to radio research, engineering and commercial development, his leadership in standardization, and his unceasing devotion to the establishment and upbuilding of the Institute and its proceedings," Dr. Alfred Norton Goldsmith, famed radio consulting engineer, was awarded the 1941 medal of honor of the Institute of Radio Engineers. Dr. Goldsmith has secured numerous patents, on radio, television, facsimile, and photographic equipment and methods. His most recent, a means of using numerous small tubes to build up a single large image, was described in the last issue of RADIO & TELEVISION. Dr. Goldsmith has received numerous other honors, such as an honorary degree of Doctor of Science from Lawrence College, the National Pioneer Award for achievement in the field of science, and many other degrees. He is a former professor of electrical engineering at C.C.N.Y. and later was vice-president in charge of engineering for RCA.

NEVER A DULL MOMENT AT THE FCC

Some time ago the east coast was put in a turmoil by an SOS. No ship was found in trouble and the FCC began an inquiry. They found that a New England amateur had sent this signal as part of a dramatic program he was presenting for fellow Hams. The Commission said, "Naughty, naughty."

In response to an inquiry from Indiana, the Commission makes it known that while there is no regulation to prohibit the reception of police calls, it is unlawful for any unauthorized person to use the intercepted information for his own benefit.

As you may recall, Jimmy Stewart was assigned KH*JIM* for his private airplane, and a couple of other stars have received similar consideration. The latest is Robert Taylor, who was given KH*ASB*. According to the Commission, the last three letters are the initials of Taylor's real name, "Arlington Spangler Brough." Some ardent movie fans may question the accuracy of the name as given by the FCC.

NEW CALL SYSTEM FOR FM

A new system of call letters with interposed numbers has been adopted for frequency modulation broadcasting. The first letter—in some cases the first two letters—of the call will indicate the station's nationality; the United States, under international agreement, has been assigned K, N and W. N is reserved for the exclusive use of the Navy and Coast Guard, while K will be used for stations west of the Mississippi and W for those east of this great river. If any FM station does not fit in with this system you will know it was licensed before the system was put into effect.

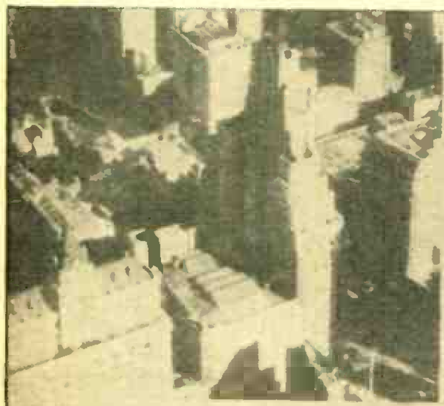
Following the first letter or pair of letters will be a number to indicate the frequency assignment. This is possible because all FM stations are in the 42 to 50 mc. band, and all frequencies are assighed on the odd hundreds in kilocycles. Thus, the first figure and last two figures of the assignment can be dropped. For example, if a station is assigned 43,500 kc., its number should be 35.

The second letter, or a combination of second and third letters, will indicate the location of the station. For example, stations in Boston will terminate with the letter B, while those in New York will end with NY, those in the District of Columbia with DC, etc.

So if you see station K43SF, you will know it is a San Francisco station operating on 44,300 kc.

Stations with the letter E in their calls will be non-commercial educational stations, for which 5 channels are open.

FINCH DEMONSTRATES 2-WAY MULTIPLEX FROM PLANE TO GROUND



The transmission of news and pictures simultaneously with voice, using a 2-way multiplex radio system between a plane in flight and a ground station, was recently demonstrated by Finch Telecommunications, Inc. The voice was carried on an FM system. According to Mr. Finch, he is able to transmit an entire news report at a speed of 300 words per minute along with news and pictures.

The signals were carried by radio from the plane to the ground station and thence by direct wire to a remote point. One advantage claimed by this system is that positive pictures, ready for reproduction, are taken off the receiving end.

One test was made over the Times Square area of New York and the illustrations herewith show, first, how the camera recorded the terrain below in the plane and, second, how the facsimile receiver reproduced it on the ground. The pictures were processed in the plane and transmitted over 250 watt station KHWGF on 1305 kc. They were picked up at Bendix Airport and sent by wire to the Finch plant in Passaic, New Jersey. The other illustrations show one of the transmitters installed in the flying laboratory and at the field.

NEW FM STATIONS COMING

Seven additional FM stations authorized by the FCC will provide programs in Connecticut, Rhode Island, about half of Massachusetts, part of Tennessee, and the Pittsburgh, Chicago and Metropolitan New York areas.

LAMP 1/5 AS BRIGHT AS SUN

A *mercury* vapor lamp 1/5 as bright as the surface of the sun has been developed by engineers of Westinghouse. The picture herewith shows Dr. S. G. Hibben, director of the company's Applied Lighting

Division, setting a piece of paper afire at some distance away from the lamp. In order to confine the heat as much as possible, the entire lamp is surrounded by a water jacket through which running water continually circulates in order to keep it cool. Despite this protection, enough infra-red escaped to fire the paper.

RADIO GOES TO THE RACES

After a month's search, government inspectors tracked down an unlicensed radio transmitter which was used at a Charleston, West Virginia, race track to broadcast sure tips to favored bettors while the horse races were still being run. About three weeks before the two operators were arrested, FCC field men discovered that two portable transmitters were being used illegally. One man in the grandstand at the track had a transmitter concealed under his coat and used it to relay tips on the races to a colleague in a nearby shack. This second man used another and more powerful transmitter to flash bulletins on the race to subscribers at outside receiving stations.

The whole business was carried out in code. At the start of the race, the man at the transmitter would whistle on a certain frequency followed by the words, "Oh Johnny," repeated several times, and then a few bars from such songs as "Beer Barrel Polka" and "Maryland, My Maryland." Towards the end of the race, the voice suddenly cut in with a number, repeated several times, after which a stronger signal on another frequency (from the transmitter in the cabin) would repeat the same number a dozen or more times followed by such expressions as "testing," or "testing for modulation."

On checking the race results, the investigators discovered that the number repeated was that of the winning horse! The man in the grandstand had the transmitter under his overcoat with the microphone concealed in his cuff, and would raise his hand to scratch his neck when he wished to speak into it. The transmitter in the cabin was concealed in a trunk and used a hidden antenna. Nevertheless, the FCC scouts were able to track down the equipment and make the arrests.

Another case of this kind, in which a woman figured, was described in R. & T. some months ago.

ANOTHER LOOK AT THE FCC MAIL

Even Christmas did not bring peace to the FCC. One Californian went so far as to ask the FCC to do something about the radio interference caused by a flash unit a neighbor was using on his Christmas tree lights. "No can do," said the FCC.

The same answer was given to another chap complaining of interference from Mexican stations. However, he was told that the North American Regional Broadcasting Agreement goes into effect on March 29th, and after that reception should be better.

Other complaints which got *"no"* for an answer were from a Schenectady man who complained that a station is using the national anthem as part of a commercial continuity, a Philadelphian who objects to certain programs which he feels "appeal to greed," and an Indianapolis music fan who wants a station compelled to carry a certain classical program.

Still the Christmas woes poured in. One kind lady in Louisiana wants the stations cautioned not to infer that there is no Santa Claus, because it may disillusion children.

And besides that, the FCC had to make a tour of television stations late in January! But they saw some remarkable developments and got a free lobster dinner, though.

BROADCASTS FROM ARMY CAMP

Brigadier General Clifford R. Powell speaks into the new WOR microphone specially designed for use in a new weekly series, "This is Fort Dix." General Powell

is commander of the 44th Division and the army post at the Fort.

This is an adaptation of MBS's World's Fair microphone (in which the mike was made to represent the perisphere). And that was an adaptation of the famous Westinghouse "8-Ball" mike.

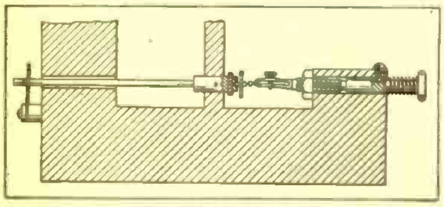
INTERNATIONAL ALLIANCE

Despite the fact that their countries are at war—or in some cases making faces at each other—the four young ladies shown herewith got together in peace and amity to broadcast holiday greetings to their families abroad over WGEO and WGEA. They were part of a group of 80 girls who broadcast such messages. After the transmission, these four were *televised* together with a world globe in which each was able to find her country—*or what was left of it.* Left to right are Vassar students Joyce Hallinan, of London, and Zosia Znamiecka of Poland; Bennington student Marion Krentz from Germany; and Russell Sage student Sumiko Yamaguchi from Japan.

LOW VOLTAGES FORM FILAMENTS

That air breaks down and becomes conductive at voltages lower than sparking potential was proven in experiments conducted by G. L. Pearson of the Bell Telephone Labs. At voltages as low as 15 volts

it was found that tiny particles of metal were torn from small electrodes to form a conducting bridge. However, the potential at even these low voltages was actually about 10,000,000 volts per centimeter of electrode area. As the metallic bridge formed, the resistance across the electrodes dropped greatly. Various types of electrodes were used, experiments being conducted with gold, steel and carbon. Separation was extremely minute, being on the order of millionths of an inch. At these small separations, voltages were gradually applied



until the metallic filaments were formed and the breakdown occurred. The accompanying pictures show Pearson with the equipment and, in the drawing, a diagram of the apparatus.

NBC ANTENNA GOES ON TRIPLE SHIFTS

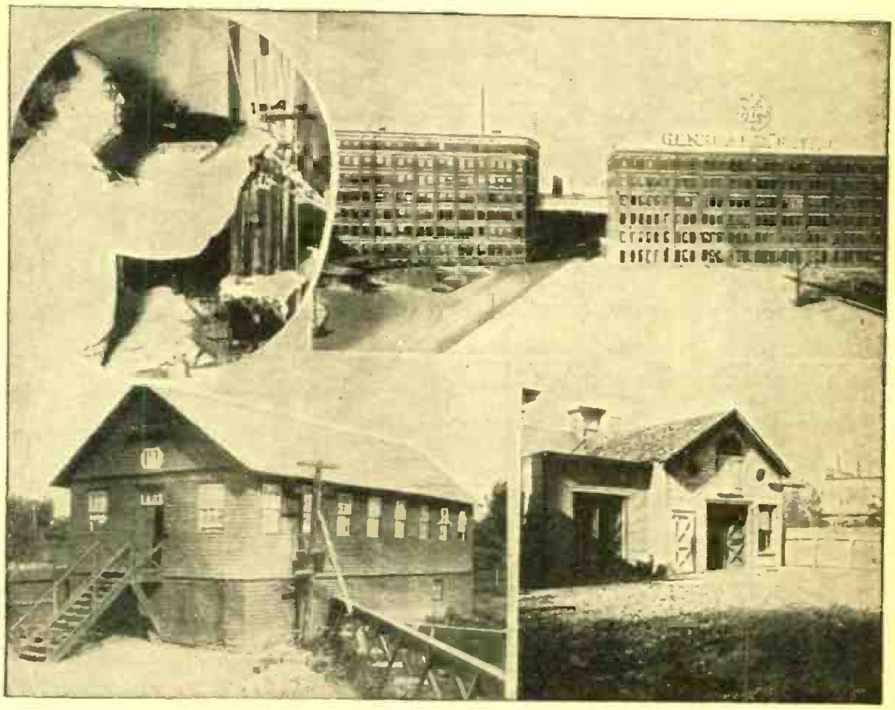
The big television and FM aerial NBC operates atop the Empire State building in New York City is being given a new set of special filters.

Within a short time a third transmitter, used for cue transmissions, also will be hooked into the system, and the three signals, on separate frequencies, will travel through the same antenna without impinging on each other.

By thus eliminating the temporary FM antenna in use up to this time, reception of FM programs will be improved in many sections of the metropolitan area, as the big main antenna over which these programs are now transmitted delivers the FM signals with equal strength in all directions.

RESEARCH LABS CELEBRATE 40TH ANNIVERSARY

Forty years ago Albert G. Davis, then head of G.E.'s patent department, and Dr. Charles P. Steinmetz, noted scientist, suggested to E. Wilbur Rice, Jr., then vice-president in charge of engineering and manufacturing, that the company should have a research laboratory. He concurred and the laboratory was voted into being by the Board of Directors. Dr. W. R. Whitney, then professor of M.I.T., was engaged as director. The lower right picture below shows the barn used as the first laboratory. It was at the rear of Dr. Steinmetz's house, but was burned down some time in 1901. After the fire the lab was moved to the old G.E. standardizing laboratory, also pictured, and remained there until floods drove it out shortly thereafter. It moved again and again, finally landing in its present home, the two massive brick buildings shown. The oval picture illustrates Dr. W. R. Whitney, the first laboratory head, as he appears now at the age of 70. He is vice-president in charge of research for the company.



HAMS HELP OUT IN AN EMERGENCY

When wire lines went out in Amarillo, Texas, amateurs Tex Smith and Fred Trotter moved the former's portable short-wave transmitter to the office of the Amarillo *Globe News*. Then, when the power failed, they borrowed a gasoline generator from E. W. Glenn and kept Smith's station, W5CYX, running. For several hours it was the only communication between the city of Amarillo and the rest of the world. In addition to handling messages for the paper, Tex (left) and Fred handled several hundred messages for public utilities and private citizens during the shut-down.

REVIEWS RADIO'S 1940 DEVELOPMENTS

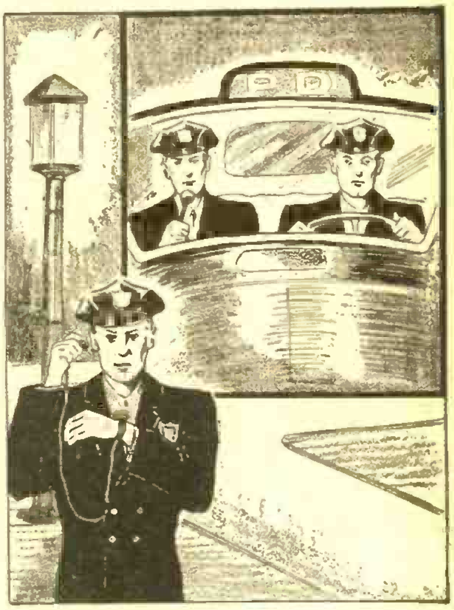
In a year-end roundup, Dr. W. R. G. Baker, manager of General Electric's radio and television department, summarized the industry's advances for the past year. Two of these are illustrated below.

In the first picture, an engineer is seen observing the invisible—a shadow shows carbon dioxide gas (which cannot be seen by the human eye) snuffing a candle as it is poured from a beaker. The other illustrates an engineer observing the action of an induction electron accelerator which gives to these minute particles a velocity almost equal to that of light.

Summarizing Dr. Baker's address. TELEVISION has been through a tempest in 1940, and a national committee sponsored by the RMA is soon to submit suggestions on acceptable standards, in the hope that the FCC will then permit commercial operation; FREQUENCY MODULATION made many advances, a large number of commercial, educational and other stations being allocated to some 35 channels; STANDARD RECEIVERS have developed, particularly as to the midget portable models, de luxe high-fidelity models, FM receivers and FM-AM combinations; ANTENNA ELIMINATION also received more attention from the manufacturers. Also getting a great deal of attention, but not much publicity, are the advances in reception and transmission for military purposes. FACSIMILE has also made some steps forward.

NEW YORK POLICE USE SECRET SETS

To enable detectives entering or keeping suspicious premises under surveillance, the New York Police Department, in cooperation with RCA, has developed portable transmitting and receiving equipment with which a man on foot may keep in communication with radio cars in the vicinity. This apparatus is so small and compact that it can be worn under the clothing, where it is invisible to passersby. The microphone is strapped to the operator's wrist, much like a wrist watch, and is always convenient and inconspicuous.



The whole apparatus weighs but 10 lbs. and is capable of a transmitting range of about ¼ mile. Its cost is approximately $175 for the complete unit.

The equipment was demonstrated to New York City's Mayor La Guardia, who expressed deep interest in the project which was developed under the supervision of Superintendent Gerald S. Morris of the Police Telegraph Bureau. Some three years have been required to bring it to its present state of perfection.

W2XB BUILDS NEW TELEVISION STUDIO IN CLUBHOUSE

Although some authorities in the industry do not believe that the real television boom will come until after the war has ended, the General Electric Company has taken over a large clubhouse in Schenectady, which it is remodeling into a mammoth television studio layout. Work on the building has already started and company engineers hope that it will be ready for operation by late spring or early summer. When completed the station will be devoted exclusively to television, embodying many special features, impossible to undertake in buildings previously used for such purposes.

Features of the installation will include an antenna 125 feet high for relaying programs to the main transmitter in the Helderberg mountains 12 miles outside of Schenectady. This antenna will be heated electrically in winter to prevent ice formations which might interfere with the successful operation of the station.

The main studio will be 70 feet long by 46 feet wide by 18 feet high and will occupy virtually the entire main floor.

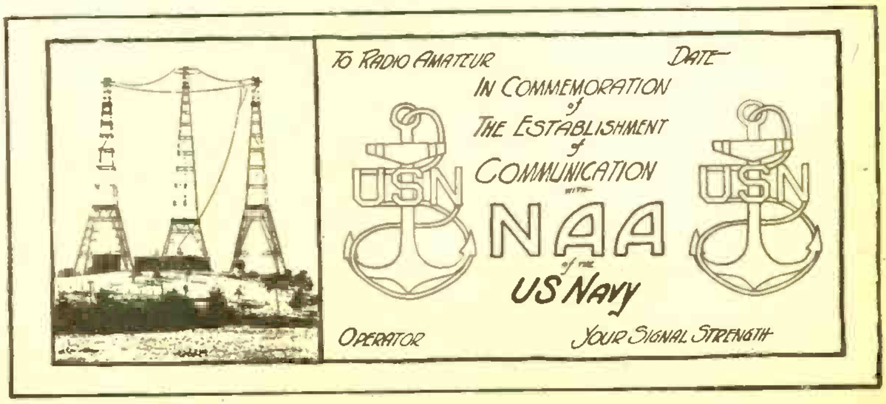
All windows of the main studio will be blocked off, and illumination for the room will be provided by three-phase water-cooled mercury lights using the midget cigarette-type of lamp newly developed by G.E. These lights will provide 1000 foot-candles of illumination at any point within the room where action is going on during the televising of a program.

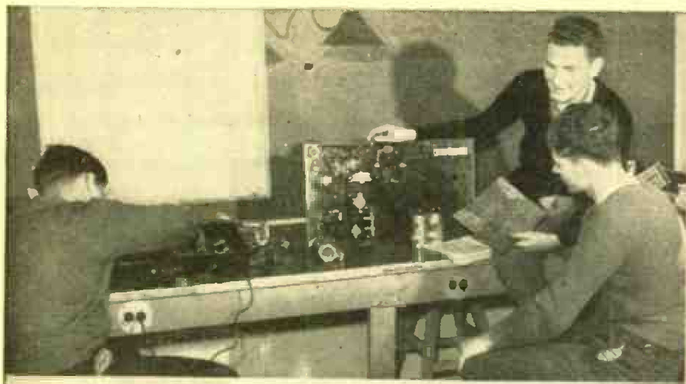
The ground floor or basement of the station will be occupied by the staff offices, scenery shop and modern heating equipment. The entire building will be air conditioned.

There will also be a large rehearsal room and adequate dressing room facilities for men and women.

NAVY ISSUES QSL CARD

The Navy Department, which is communicating with amateurs throughout the United States four times weekly, has designed an attractive card for QSLs. The first contact made was with W1AW, operated by George W. Bailey, president of the ARRL in West Hartford, Conn.





Top left photo—instructor is pointing out to the student on the blueprint, that the short parallel lines in the circuit diagram indicate the condenser he is pointing to with his right hand.

Radio station W1MII was the only "connecting link" between Eastport, Me., and the mainland, during the hurricane storm of last spring. This station was constructed and is now operated by the boys.

Photo at left shows one of the NYA radio students making resistance tests.

NYA Builds Fine Police Radio in Maine

CORNERSTONES in the nation-wide radio project of the *National Youth Administration* are the units in the State of Maine. There, young people employed by the NYA have already set up the pivot of a nation-wide shortwave radio network of amateur stations. There, also, NYA youth are constructing a state-wide network for the State Police, with the first two units already completed, and they are helping other public agencies to improve their radio communications facilities.

The nucleus of radio work being carried on in Maine is the National Youth Administration's regional project located at Quoddy Village, Eastport. Here approximately 500 needy young men from the New England States, New York, and New Jersey live, work for wages, and get practical experience in a variety of occupations. Eastport is a small village in northeastern Maine, just south of the Canadian border and adjacent to Passamaquoddy Bay. When work was stopped on the Passamaquoddy Bay Tidal Power Project, a model village constructed by the U. S. Army Engineers was left with no occupants. The National Youth Administration, taking advantage of the availability of these facilities, has established at this village a regional work center, designed to enable young men who are unable to find jobs in private industry to work for wages and acquire the practical experience they will need to get private employment. Young men between the ages of 18 and 24, inclusive, are given the opportunity to get practical experience in a number of occupations by doing productive work. Radio has been one of the most popular and most successful of the types of work offered at the Quoddy NYA center.

Beginning with a nucleus of station W1MII at Quoddy Village, which was licensed by the FCC, effective April 23, 1940, NYA youth have already established a series of amateur club stations which form a link down the entire Eastern Seaboard of the United States, including the strategically important island of Puerto Rico. In addition to the Quoddy Village radio club, five NYA youths at the project hold individual private amateur licenses.

Quoddy radio has already demonstrated its value to the public in furnishing emergency communications. In April 1940 a 68 mile easterly gale and blizzard destroyed the electric and telephone facilities in this part of the State, including the near-by Canadian islands. Near-by wharves and local shipping suffered heavy damage. Quoddy radio was the only link to the outside world. On the first day of the storm messages were relayed by amateurs down the coast at Millbridge, Ellsworth, and Southwest Harbor. On the second day of the emergency one of the partially built State Police car transmitters, powered by storage batteries, was placed in operation and was used to relay messages to the Quoddy Head Coast Guard station and thence down the coast. Messages were also relayed to the Coast Guard cutter *Travis*. Messages were also relayed for the Eastport Weather Bureau, which was important in compiling data for mariners at sea. A father in Canada, whose daughter had died at Eastport, got his sad but important message through the facilities of the Quoddy radio project.

"You can't do it" was what various radio experts told Sam Freedman, the National Youth Administration's Radio Engineer for Maine, when it was proposed that a relatively inexperienced crew of boys from the Quoddy radio unit undertake the construction of a state-wide network for the Maine State Police. The NYA Engineer had proposed to begin the system with two fixed transmitters, one at Wells and one at Thomaston, operating on frequencies of 1642 kcs. and 39,900 kcs., and providing communications with 15 mobile units. It was planned to operate the Thomaston station WSTR with 300 watts power and the Wells station WSWD with 100 watts power.

"How are you going to get enough signal strength with that low power? It ought to be kilowatts, instead of watts. How are you going to overcome the poor ground conductivity without an elaborate network of buried ground wires?"

By utilizing the enormous sensitivity inherent in super-regenerative receivers, the distances were covered very successfully with low power. Signals which were entirely inaudible on a superheterodyne receiver came in full power on the super-regenerative receiver. Although a super-regenerative circuit is the most sensitive circuit known, it is not generally used, due to the fact that it is broad-tuning. This defect was of no great importance in the State of Maine, however, since there is very little traffic on ultra high frequencies in that State.

Sam Freedman stuck to his contention that he had enough power, and, as for the poor ground conductivity, that was easy. The answer was to use no radial ground wire system at all, but instead to use a few driven copperweld ground rods made of steel and coated with copper, which were buried alongside the mast and attached to the mast. It would have been physically impossible to have a radial wire ground system, because buildings, driveways, highway, and private property intervened.

When the word got around that the NYA planned to install a guyed mast, instead of a self-supporting one, and that there would be 18 guys with about a mile of wire involved, many experts were certain that by the time the vertical mast, which acts as the aerial, radiated its signal through the guy wires, the latter would absorb so much energy that there would be nothing to listen to. This was solved by inserting 300 insulators in the guy wires, so that they were broken up into conducting lengths of such dimension that they would not respond to any wavelength being used, or to any harmonic or fraction of that wavelength. The first 15 feet of the three top guy wires were left uninsulated and made part of the mast radiator, so that the actual antenna was supplemented by the first 15 feet of three different guy wires. This resulted in 3 x 15 feet of top-loading, which caused a tendency for the radiated signal to keep more of its sky wave signal component closer to the earth and available, rather than dissipated in space at heights or distances beyond the pick-up of cars and other stations.

After plans for solution of the various technical difficulties involved in the project were explained, the argument that "This was no job for a bunch of green kids" was advanced.

But the people of Maine had faith in the ability of these NYA youth. They had seen it demonstrated at Quoddy and elsewhere in the State that these young people were good workers, and that all they needed was a chance. The State agreed to be the "guinea pig" in this experiment and was willing to venture $10,000 (the approximate amount needed to buy materials and equipment) that it was guessing right. So in February 1940, while critics were saying, "Heaven help the State Police by the time they get these sets and try to make them work with a bunch of green NYA kids building them," work was started on the State Police network.

In spite of the dire predictions of the calamity croakers, the NYA youth completed all work on schedule, and the equipment when finished could not be distinguished from a factory job from the standpoint of appearance and performance. This proves again the contention so often voiced in NYA administrative circles that the sole limitation of excellence of production is the supervisor who directs the work and not the youth who performs it.

Under the cooperative arrangement between the State of Maine and the National Youth Administration, the State was to supply all materials and equipment, knocked down, and NYA youth were to do the assembly, construction, and installation work. The first unit in the system provided for the two fixed transmitters at Wells and Thomaston and 15 mobile units operating with 10 watts power on 39,900 kcs. for two-way operation, installed in police scout cars. This made possible car-to-car communication of an 80-mile radius, operating via one of the headquarters or direct car-to-car communication up to distances of 20 miles.

The antenna system for the fixed transmitters includes a 205 foot tower, founded on a steel plate which is kept in place by bolts protruding from a cement foundation. Several driven copperweld ground wires around the foundation were used to ground the steel plate. All lighting conduit and coaxial transmission lines go into the transmitter building underground with allowance for frost. This method was used because overhead conductor material might have disturbed the radiation pattern with a condenser effect between the overhead lines in relation to the earth.

The mast is a 101 wind charger type and was delivered to the NYA in about 6000 pieces. A crew of seven NYA youth, although without previous experience in this type of job, assembled the mast absolutely correct at the rate of one running foot every half minute.

The first part of the system, which included station WSTR at Thomaston and seven mobile units, was completed in August 1940, and the second part of the system, which included WSWD at Wells and eight mobile units, was completed in October 1940. The success of the work done was such that in November 1940 Governor Barrows of Maine requested expansion of the system, with a new fixed transmitter at Augusta. This will be a 1000 watt transmitter and will operate on 1642 kcs. for one-way transmission and will include two-way facilities on 39,900 kcs. There will also be additional mobile units.

On the basis of its work for the Maine State Police, the National Youth Administration has been asked to undertake a project for the installation of four frequency modulation stations for the city of South Portland, Maine, and a system of seven frequency modulation stations for the city of Bangor. The system proposed for Bangor will be a coordinated one, serving possibly the adjacent communities of Brewer, Orono, and Old Town. There is also under consideration a proposal to build ten stations of 25 watts output for a NYA chain in Maine.

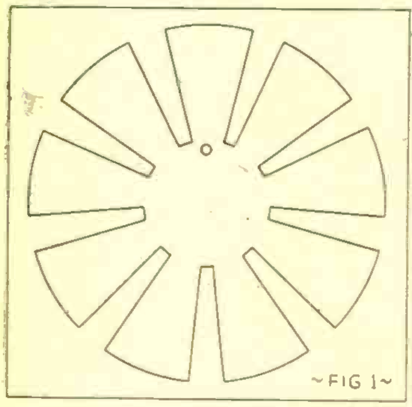
Starting in January 1941, the NYA in Maine is setting up a new radio unit at Bangor which will give up to 60 young people experience in construction, repair, and communications work. Frequency modulation work has already started for NYA youth in Maine, and that is what they are going to tackle on a bigger scale in the future.

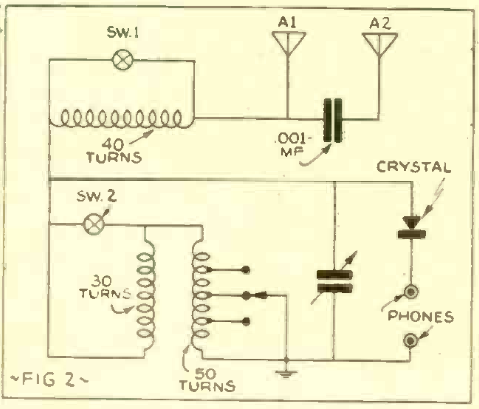
The three photos show—left, interior of the "fixed" S-W police radio station at Thomaston, Me., built by NYA members; right, below, portable transmitting and receiving equipment in rear deck of police car, controlled by flexible cable; installation built for state police use by NYA boys. Photo, right, shows NYA operator tuning a Hallicrafter receiver. This station's call is W1MII and the composite transmitter was built by the NYA group in Maine.

Simple Improved Crystal Set

● A CRYSTAL set for which great things are claimed ("It is the last word in efficiency.") has been designed by L. T. Moore and is described in *The Australasian Radio World.* He says that by manipulating the various tuning controls, one can obtain the best results possible from a crystal receiver.

The first step is the construction of the tapped spider web coil, which is made on a form 5½ inches in diameter and shaped as shown in Fig. 1. This coil is wound with No. 22 enameled wire which is started in the small hole shown under the bottom of one of the vanes. Every turn must be pressed down to the bottom of the slot. When 10 turns have been wound on, the wire must be doubled back for about 1 inch and twisted to provide a tap; then 10 more turns are wound and another tap made. The winding is continued until a total of 50 turns have been wound with a tap at each 10 turns so that you have 50 turns, with 4 taps and 2 ends. The coil is finished by punching a hole in the vane and threading a wire through it once or twice, leaving 6 inches for connections.





Above—Coil form and also hook-up for a simple "crystal" receiving set.

The 40 turn coil is wound next on a separate, identical form, using No. 18 enameled wire. There are no taps in this coil—it merely has 40 turns.

The 30 turn coil is now wound not on a spider but on a tubular form 3½ inches in diameter. This may be a round bottle or a cardboard tube. No. 20 enameled wire is used for this coil, and after it has been wound it is given a coat of some adhesive (such as collodion or nail polish) and removed from the form. An 8 inch end should be left.

The .0005 or .00035 mf. variable condenser is mounted on the panel and, by means of a strip of wood, the tapped spider coil is mounted with its axis vertical and its face parallel with the panel. The other spider coil is mounted on an arm so that it can be brought closer to or further from the tapped coil. The 30-turn coil is fastened on the base directly under the two spider web coils, which must be mounted high enough to clear it. A strip of wood placed across the coil will hold it down very nicely. A tap-switch on the panel is connected to the taps on the 50 turn coil, and separate switches are provided to short the 40 turn and 30 turn coils when desired.

The crystal may be of the inexpensive cat whisker type or the slightly more expensive and convenient fixed detector. An efficient outdoor aerial is used. It should preferably be from 25 to 50 feet long, but the author states that he was able to pull in 5 stations with only an 8-foot wire lying on the floor. Some stations will be received better with the antenna in position A1, and others with a connection as at A2. Some experimenting in tuning will be necessary in order to secure best results. (This reviewer suggests that connecting a .00025 mf. fixed condenser across the phones may also increase the set's efficiency.) The variable condenser is connected across the tapped coil for tuning in the stations.

SIMPLIFYING TONE CONTROL

● AN extremely simple phono tone control is described in *The Australasian Radio World.* It consists merely of a specially wound coil, a 50,000 ohm variable resistor and a .01 mf. condenser. It is for use with moderate priced mechanical pick-ups, most of which says the author, A. Earl Read, have a prominent resonance peak at about 3,000 cycles. The control is claimed to level it off without unduly increasing the highs, and also to reduce needle scratch greatly.

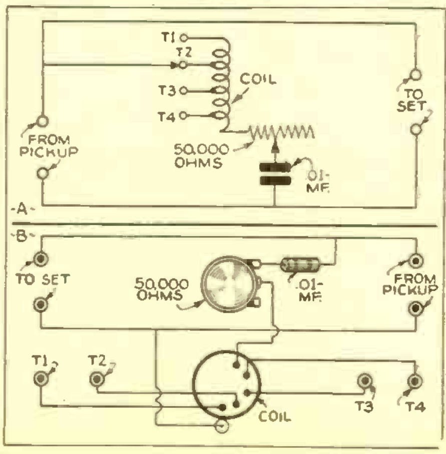
The parts required are a panel about 3 x 4 inches, 50,000 ohm potentiometer, a .01 mf. tubular condenser, a "4-pie" bobbin for use as coil form, 1 oz. of No. 42 enameled wire, 8 banana jacks and 5 banana plugs. The bobbin is held in the clinch of a hand drill which is clipped to the device, and 1,600 to 2,000 turns of the wire are wound in each section of the bobbin. Taps are brought out at each end and between each pair of "pies." It is not necessary that the turns be accurately counted as the variable resistance has sufficient range to compensate for errors.

In use, the pick-up is plugged into one pair of jacks and the output to the other pair. The jacks across the bobbin afford taps so that the impedance load in parallel with the pick-up and input can be varied. Cut-off can be had at approximately 3,500, 2,500 and 1,500 cycles by moving the banana plug from one type to another. In operation, the resistance is placed at maximum and the banana plug inserted in various jacks until the tone is most greatly improved, after which the resistor is adjusted. The output of the pick-up will be slightly reduced at all frequencies so that a moderate increase or stepping up of the volume control will be necessary. However, experiments can be carried out by substituting other values for the tubular condenser. The author suggests anything from .002 to .1 mf.

IN NEXT ISSUE!

How to Get ELECTRONIC Music Through Your Radio Set

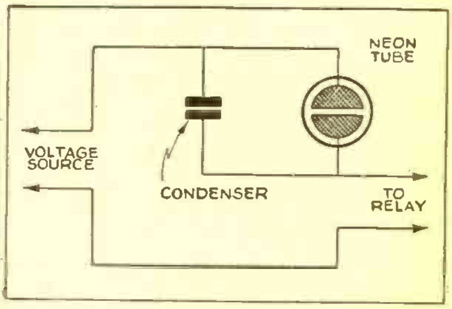
by H. G. Cisin, M.E.



A simplified tone control circuit.

NEON TUBE AS PHOTO CELL

● A WRITER in a British publication—*Electronics and Television and Short-Wave World*—brings up an interesting phenomenon whereby a gas filled discharge tube, such as a Neon lamp, can be used as a photo-electric cell. He points out that tubes of this sort are often used to discharge a condenser automatically when the voltage between the plates of the condenser has risen to a pre-determined value. Under observation such circuits have sometimes been found to operate differently in various locations or at various times of the day. He explains this, saying "the striking potential of the tube depends, among other things, on the amount of light that falls on the tube. Thus, a tube designed to have a striking potential of 90 volts in daylight may not strike until 123 volts are reached in complete darkness." He suggests that the striking voltage can be stabilized at the daylight



Hook-up of Neon tube used as a photo cell.

figure by putting a small dab of radium-activated luminous paint on the outside of the bulb. It can also be stabilized at the night figure by putting the tube in a light-proof container or painting it black.

However, these characteristics bring forth an interesting basis for an experiment. If a tube having such characteristics is given an applied potential of say 115 volts and is shielded from the light, it will not strike, but if a beam of light is then permitted to fall upon it the tube will become conductive and current will flow in its circuit. This characteristic could be made use of to actuate a relay in order to start apparatus functioning when a beam of light is directed upon the tube. Many other experiments will suggest themselves.

Wavelength Checking Centre

● THE task of checking and reporting on the wavelengths of European broadcasting stations, which has for many years been carried on at Brussels by the *Union Internationale de Radiodiffusion*, was abruptly terminated by the German invasion of the Low countries. M. Raymond Braillard, the director of the Brussels checking center, was faced with the task of evacuating the apparatus or risking its destruction.

We now learn from the Bulletin of the U.I.R. (says *The Wireless World*, London), that the task of evacuation was successfully accomplished. On May 16th it was removed from Brussels and eventually, after many vicissitudes, it arrived safely at Geneva, the headquarters of the Union. Some of the expert staff of the Brussels center were able to resume their observations, and reports have been sent out to all members of the U.I.R. and to the various Administrations through the intermediary of the International Telecommunications Union at Berne.

Superheterodyne for Automobiles

● AN extraordinarily sensitive and selective superhet for use in automobiles has been designed by the engineers of the *Laboratorios UCOA* and is described in the latest issue of Argentine's *Radio Revista*. The circuit is a simple one as shown in the diagram. Filaments of the two 6K7's, 6A8, the 6Q7 and 6K6G are connected in parallel, drawing their current from the starting and lighting battery. The "B" power is derived from a vibrator pack and, while the one specified is of South American make, any equivalent domestic eliminator may be substituted.

The specifications as given in the South American magazine are as follows: Intermediate frequency 252 kc.; antenna filter built in; automatic sensitivity control; special antenna coupling to permit the use of any type of auto antenna; sensitivity about 15 milliwatts, better than half a microvolt; high power output due to the use of the 6K6.

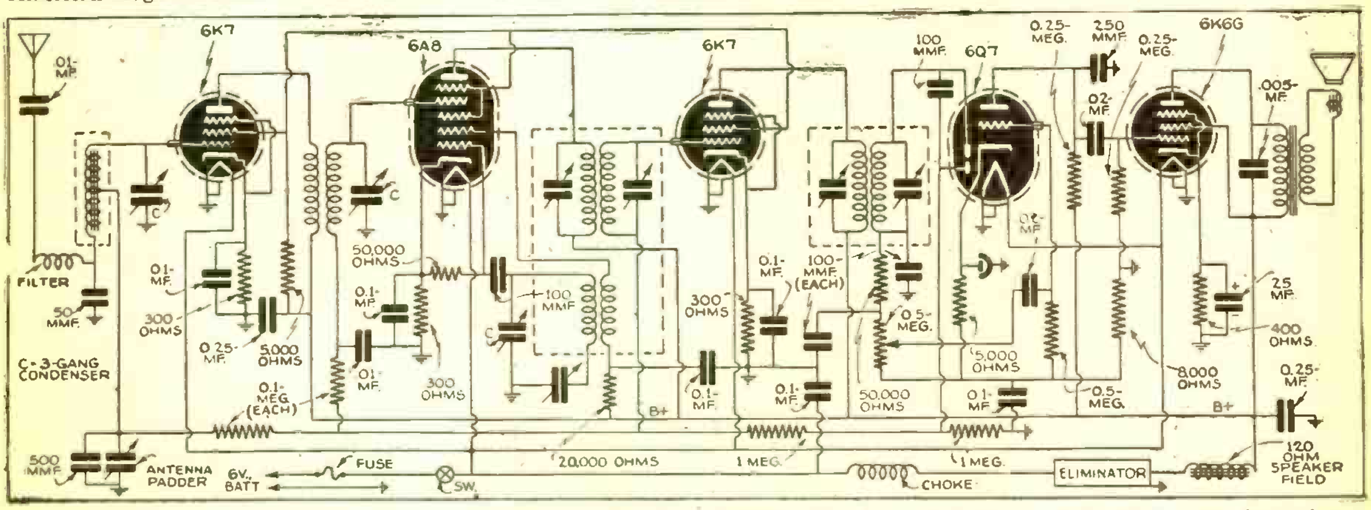
As an inspection of the diagram shows, the circuit includes one stage of RF followed by an 6A8 frequency converter after which is the intermediate stage. Both the IF and RF stages make use of 6K7's. The modulator and automatic sensitivity control and audio pre-amplifier are obtained from the use of the 6Q7, and finally the power stage appears in the 6K6G. The loudspeaker used is of the new permanent magnet type.

While the antenna coupler is of a special type, this need not be used, and any standard antenna coupler available on the American markets may be substituted.

The construction of the set is simple and straightforward, the usual precautions as to short and direct leads being observed. As all the cathodes are indirectly heated, it is not necessary to watch polarity on the heaters as is necessary when low voltage, direct heating filament tubes are used.

A list of the parts follows:

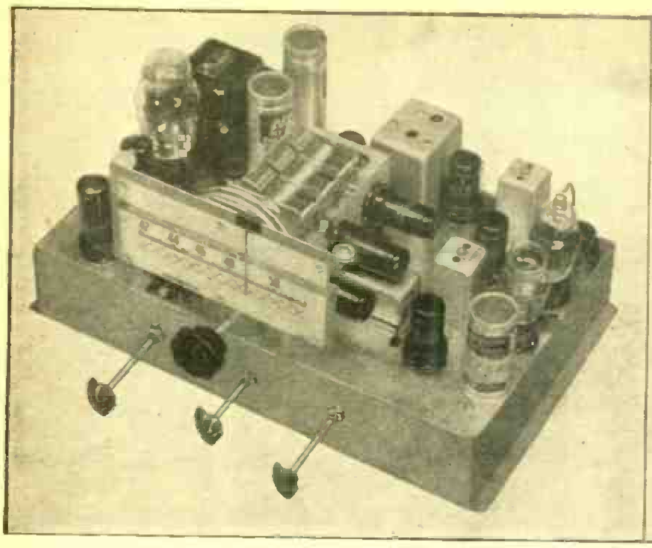
5 octal sockets; 1 vibrator type B eliminator, loudspeaker; 1 3-gang .00041 mf. condenser with trimmers; 1 metal cabinet;

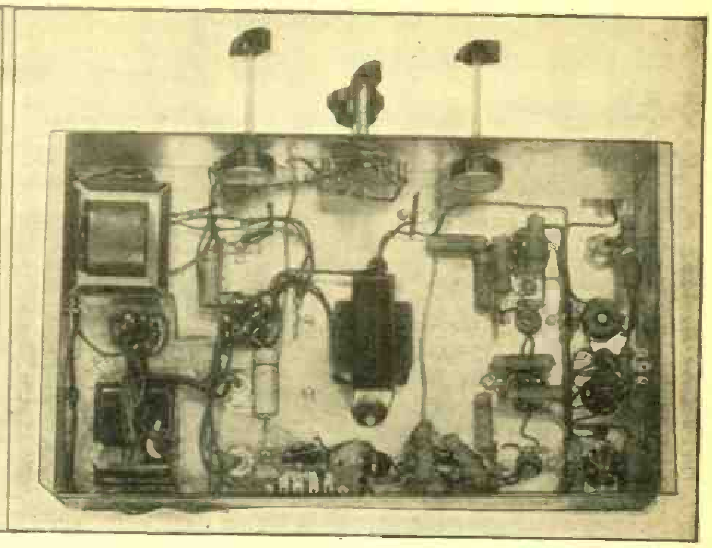


1 chassis; 1 remote control with dial; 1 volume control; 5 tubes 2-6K7, 1-6A8, 1-6Q7 & 1-6K8G; 3 cond. .01 mfd. 400 v.; 5 cond. .1 mfd. 400 v.; 2 cond. .25 mfd. 400 v.; 1 cond. 5 mfd. 200 v.; 2 cond. .62 mfd. 500 v.; 1 cond. .005 mfd. 600 v.; 1 cond. .00005 mfd. mica; 1 cond. .0005 mfd. mica; 1 cond. .00025 mfd. mica; 4 cond. .0001 mfd. mica; 2 cond. .25 mfd. Elect. 25 v.; 3 Resistors, 300 ohms ¼ w.; 2 Resist. 100 M. ¼ w.; 1 Resist. 20 M. 1.0 w.; 1 Resist.; 15 M. 1.0 w; 1 Resist. 5 M. ¼ w.; 1 Resist. 8 L. ¼ w.; 2 Resist. 1 meg. ohms ¼ w.; 2 Resist. 50 M. ¼ w.; 2 Resist. 50 M. ¼ w.; 2 Resist. 250 M. ¼ w.; 1 Resist. 250 M. ¼ w.; 1 Resist. 500 M. ¼ w. 1 Resist. 400 ohms ½ w. A fuse protects the circuit as the diagram shows.

Can YOU Answer These Radio Questions?

1. Who demonstrated multiplex facsimile recently and where? *(See Page 646)*
2. What practical use was made of the apparatus built by Maine NYA youth? *(See Page 650)*
3. How can a Neon tube be used as a photo-electric cell? *(See Page 652)*
4. Can you explain simply how to connect several loudspeakers having different impedances across the output of an amplifier? *(See Page 659)*
5. Can you describe briefly how to align intermediate frequency stages of a superhet? *(See Page 660)*
6. What was the real story behind the fake S.O.S. report recently investigated by the FCC? *(See Page 666)*
7. What is the purpose of the crystal control oscillators in the Muniz system of "pull-swing" frequency modulation? *(See Page 670)*
8. Name three important factors to be watched in laying out a "Ham" station. *(See Page 674)*
9. In the Scophony large image television system, is the picture projected from behind or in front of the screen? *(See Page 679)*
10. Can you draw a diagram showing how to modernize an old Pilot receiver, to use the modern metal tubes? *(See Page 688)*





F-M Receiver for the HOME

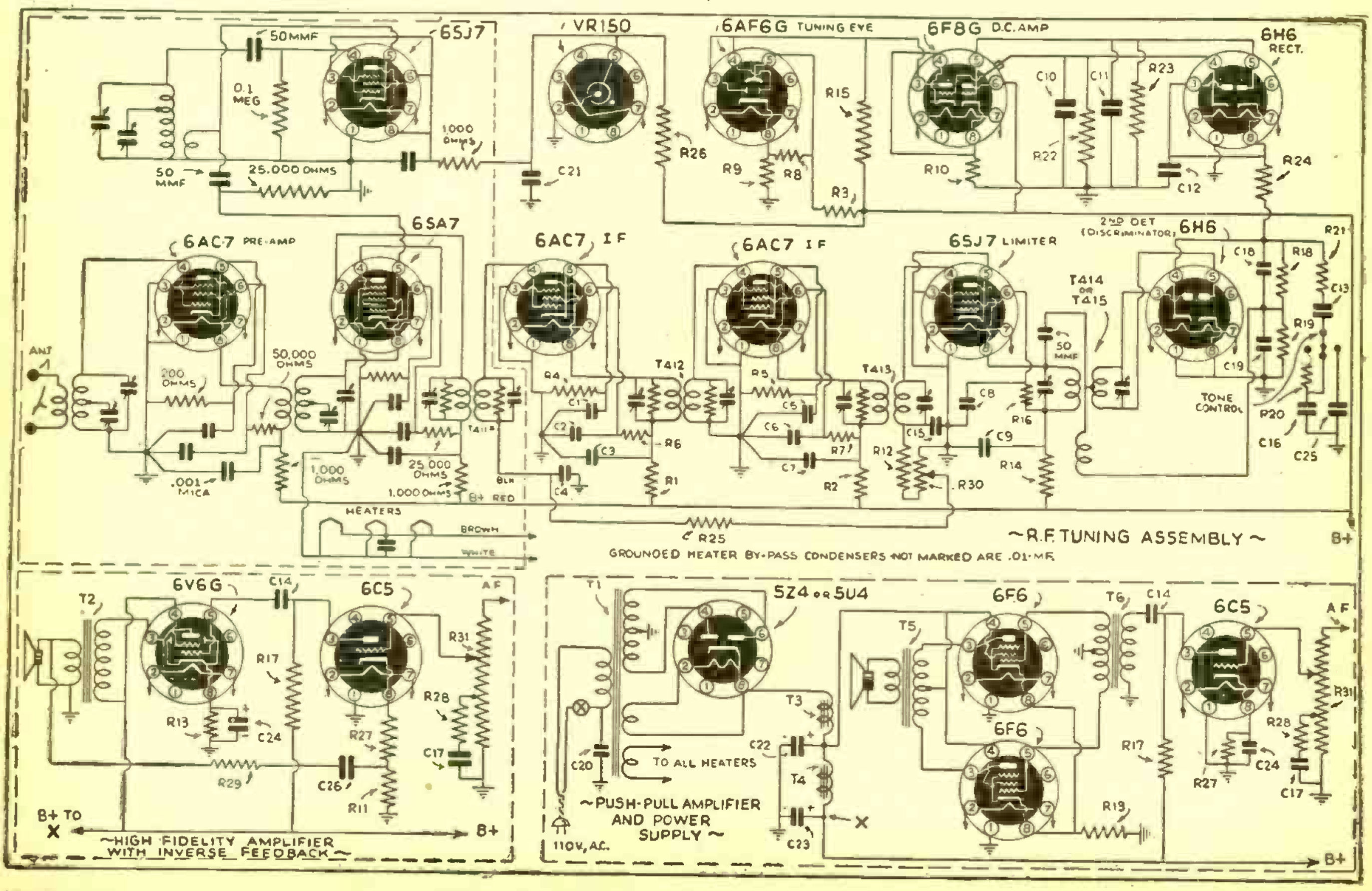
L. M. Dezettel, W9SFW*

● MOST FM articles in the past have been based upon the construction of an adapter which may be used for existing AM receivers. The presumption has been that the audio system in your present radio is of high enough fidelity to warrant the addition of an FM adapter. This is a false presumption, however, as the manufacturers of AM receivers have never taken into consideration the reproduction of musical notes whose frequencies exceed 5,000 cycles per second. The construction of the FM receiver which we are about to describe was undertaken because of the many requests received by the author for a complete receiver.

You are already acquainted with the many features of FM transmission and reception. The higher fidelity and absence of noise made possible by this method of

*Engineer, Allied Radio Corp.

Diagram of the Frequency Modulation Receiver.



reception has been proven to be so far superior to the AM method now used that the interest is sweeping the country like wild-fire.

R.F. Pre-Amplifier

While this set has a few innovations not found in receivers described previously, fundamentally it is straight-forward and very much standard as to circuit and parts used. The 6SA7 converter tube is preceded by a 6AC7 *pre-amplifier* to help build up the signal level above the first detector tube noise generally encountered and to reduce response to images. Two 6AC7 I.F. stages further amplify the signal at 4300 kc. The 6AC7 tubes are high-gain pentodes especially developed for television work where design considerations were similar to that in FM. A 6SJ7 tube adds a little to the amplification, following the I.F. stages, although used principally as a *limiter*, levelling out the carrier strength and taking out all noise both above and below the carrier level. This tube is followed by 6H6 second detector, or a *discriminator*, as it is called in a FM receiver. The signal for the tuning eye is taken off at this point, rectified, directly coupled to a 6FAG tube which acts as a D.C. amplifier for the 6AF6G dual tuning eye. Also following the 6H6 discriminator is a tone control network and the audio system. The tone control has four positions, the first of which is *no control* which, due to the method of transmission of FM signals, amounts to boosting the higher frequencies. The second position is a slight attenuation of high frequencies, the net effect of which is to give a flat frequency response. This would be the *normal* position for average reception. The next two are two increasing steps of high attenuation which give music the bass boost effect that most people seem to prefer. A choice of audio channels is shown, both of which were tried and found successful. For highest possible fidelity we suggest the use of push-pull 6F6's.

As punched and drilled chassis are available for this receiver, assembly is very simple. All parts should be mounted as shown in the photograph with the exception of the high frequency tuner. This is left for the last in order to avoid possible damage to the dial and the gang condenser. Obviously, you may make up your own layout as long as you keep in mind that short leads from one part to another are essential and that the power supply and audio channel are well isolated from the R.F. circuit. The layout used in this receiver was carefully planned with these considerations in mind.

Possible to Build It Yourself

A diagram shows the complete wiring circuit, and the values of resistors and capacities for the various components are listed at the end of this article. Although we use a special Carron R.F. tuning assembly which is available completely assembled and wired and with six leads coming out of it for connection to the rest of the circuit, the values used in the R.F. tuning assembly are shown in the diagram; and it should be possible for you to build your own. The value of extremely short leads cannot be stressed too much in a receiver of this type. The peculiar horizontal mounting of the tubes used in the high-frequency portion of the set was used because of the necessity for having very short leads in this portion of the circuit. Even the I.F. channel operates at a fairly high frequency; so care is required in wiring this part of the circuit also. The long lead from the 6H6 discriminator to the tone control is a single-conductor shielded wire, as is also the lead from the grid return of the first 6AC7 I.F. circuit to the center arm of the R30.

The electric tuning eye is wired with five flexible leads out of a hole in the top of the chassis. These leads may be as long as necessary to locate the electric eye on your cabinet, according to your own choice.

Alignment Is Simple

Now we come to the problem of alignment. The success or failure of proper FM operation can be determined upon the way the set is aligned. Yet, in spite of the importance of this procedure, it is not at all difficult to do. In this receiver adjustment of the R.F. tuning assembly is eliminated by purchasing the completely wired and aligned factory assembly. I.F. coils, too, are pre-tuned at the factory to 4300 kc. It is best, however, to re-trim them just a little. If possible, this should be done with a signal generator as it is best accomplished with an amplitude modulated carrier input. In the absence of a signal generator, the broadcast station carrier can be used instead. Connect a 0-1 ma. meter in the grid return of the 6SJ7 limiter stage. This would be between I.F. transformer T413 and resistor R12. Now, tune in the station until a reading is obtained on the milliammeter, and carefully trim each of the I.F. transformers for maximum reading on the milliammeter. Do not touch the discriminator coil, however. At this point it might be well to say that for good limiter action there should be at least .4 ma. of current in this circuit. If you cannot obtain this much of a reading on the milliammeter, and assuming that the receiver is properly wired, it means that you are located too far from the FM station or that you require a higher or better antenna.

During these adjustments you will be hearing a signal in the speaker from the amplitude modulated signal generator. Turn down the signal generator until the tone is barely audible and adjust the primary of the discriminator transformer (T414) for maximum output in the speaker. Now adjust the secondary trimmer on the discriminator transformer until *no* signal is heard in the speaker. It is important that you get an absolute null point in this adjustment.

That's all there is to the adjustment. If a station signal is used for these adjustments the results will be the same up to the point of adjusting the secondary of the discriminator transformer. At this point you cannot get a null from a frequency modulated carrier. You simply adjust for best tone quality, checking your adjustment by rocking the main tuning condenser back and forth and observing whether or not the rushing sound each side of the peak carrier setting is equally spaced on the dial.

Incidentally, we found that the usual bone or fiber neutralizing condenser was not satisfactory for adjusting the discriminator transformer. A neutralizer made of polystyrene was the only thing that would not give a capacity effect when touched to the trimmer condenser.

We found this arrangement of a tuning indicator to be one of the best. The shadow angles are minimum when you are tuned to exact station resonance. This is important for best program fidelity.

The importance of using a good speaker for full realization of the high fidelity transmissions made possible by FM cannot be over-emphasized. Until recently, even quality speakers lacked the ability to reproduce frequencies above 5,000 cycles. Now, however, the better speaker manufacturers are producing speakers whose cones are designed to carry a very wide band of audio frequencies.

If you are not located very close to a FM station, it will be necessary for you to exercise extreme care in constructing a good antenna for your receiver. FM antennas are available commercially which have low impedance, properly matched feeders, and are the best type to use. Erect the antenna as high as possible. If it is of the simple di-pole type, it should be erected so that its length is vertical to the plane of the direction of the FM station. Directional type antennas will further increase the signal strength. In general, follow the same procedure that amateurs use for operating on the ultra high frequencies, except that the length of the antenna must be equal to one-half wave length of the transmitting frequency, as measured in meters.

Parts List

1—Complete R.F. Assembly (shown within dotted lines on schematic) Carron T156
1—4300 kc. interstage I.F. transformer
1—4300 kc. output I.F. transformer
1—4300 kc. discriminator transformer
1—Single pole, 4 contact rotary switch
1—Calibrated slide rule dial, Carron T158
1—9½" x 15" x 3" chassis (available punched)
13—.05 mf. 400 volt tubular condensers, C1, 13
3—.001 mf. mica condensers, C15, 16, 17
2—.0001 mf. mica condensers, C18, 19
1—4 mf. 450 volt upright electrolytic condenser, C21
1—.002 mf. mica condenser, C25
3—1000 ohm, ½ watt resistors, R1, 2, 3
2—200 ohm, ½ watt resistors, R4, 5
3—50,000 ohm, ½ watt resistors, R6, 7, 21
2—10,000 ohm, 1 watt resistors, R8, 9
1—500 ohm, ½ watt resistor, R10
1—10.000 ohm, ½ watt resistor, R12
1—25,000 ohm, ½ watt resistor, R14
1—200,000 ohm, ½ watt resistor, R15
6—100,000 ohm, ½ watt resistors, R16, 17, 18, 19, 20, 28
4—1 meg., ½ watt resistors, R22, 23, 24, 25
1—4000 ohm, 3 watt resistor, R26
1—25,000 ohm potentiometer with switch, R30
11—Octal sockets
1—Tuning eye assembly
1—.1 mf. 600 volt tubular condenser, C14
1—.01 mf. 600 volt tubular condenser, C20
1—8 mf. 450 volt upright electrolytic, C22
1—16 mf. 450 volt upright electrolytic, C23
1—10 mf. 25 volt tubular electrolytic, C24
1—250 ohm, 3 watt resistor, R13
1—2000 ohm, ½ watt resistor, R27
1—1 meg. potentiometer, R31
1—Power transformer, 750 V.C.T., 150 ma., 5 V., 3 A., 6.3 V., 5 A., T1
1—Input choke, 8 hy., 150 ma., 200 ohms, T3
1—Filter choke, 30 hy., 110 ma., 200 ohms, T4
1—Output transformer, 14,000 P to P: 6-15 ohms, 40 ma., T5
1—Input transformer, single plate to PP grids, Class A, T6
15—Tubes, per diagram, and miscellaneous hardware

D'ARSONVAL PASSES AWAY

PROFESSOR JACQUES ARSENE D'ARSONVAL, famous French scientist, recently died on his estate near Limoges at the age of 89 years. Professor D'Arsonval was well known throughout the world for his many contributions in the fields of electrical measuring instruments and electro-therapeutics. By the early use of Tesla high frequency coils, D'Arsonval developed a series of therapeutic apparatus, as reported in the *New York Times*, which have not been modified in principle in more than 40 years, but have been used more extensively each year in the treatment of various physical elements.

As far back as 1890 he saw possibilities in the apparatus devised by another physicist, Hertz, to prove the existence of the waves that we now use in radio. Strange to say, it was with medical apparatus devised by D'Arsonval that Ferrie in 1898 sent wireless signals from the Eiffel Tower in emulation of Marconi.

D'Arsonval, when experimenting with alternating current in 1888, noticed that, with a constant strength of current, the more rapidly the interruptions occurred, the more vigorous were the resulting muscular contractions. When, however, a frequency of from 2,500 to 5,000 excitations a second was reached, a decrease in the vigor of the contractions occurred and progressively decreased with the increased frequency of excitation.

At this time the instruments at D'Arsonval's disposal did not permit a further increase of frequency, but two years later, by employing the wireless apparatus of Hertz, he obtained what he called "billions of oscillations a second." With these frequencies he was able to pass a current of two or three amperes through the human body, without producing any muscular contraction or other sensation than that of heat, and thus obtained the clinical high frequency currents.

D'Arsonval in 1882 introduced the first reflecting *moving-coil* galvanometer. It consisted of a light rectangular coil of fine wire, suspended by the thinnest possible wires between the poles of a vertical horseshoe magnet. (The forerunner of the meter construction used everywhere today.)

In 1891 D'Arsonval presented his data, gathered from his experiments during the three preceding years, to the Société de Biologie. His material also included references to the use of currents with frequency higher than 1,000,000 cycles per second.

After he had conducted numerous experiments to determine the physiologic effects of these currents, D'Arsonval made experiments on unicellular organisms such as yeast and bacteria, and found that these, as well as vegetable cells, could be killed by the current. He was also able to attenuate the toxins secreted by the micro-organisms.

"This fact," he stated, "is important in that it holds out the hope that this attenuation can be made to work inside the body of the patient."

While D'Arsonval finally concluded from his own experiments that "high frequency currents penetrate profoundly into the body, instead of accumulating on the surface," medical men did not make use of his work in Europe nor of Tesla's in America until, in 1906 and 1907, men like de Kraft, von Berndt and Nagelschmidt added to the knowledge of the effect of the current, and the World War finally gave impetus to its therapeutic use.

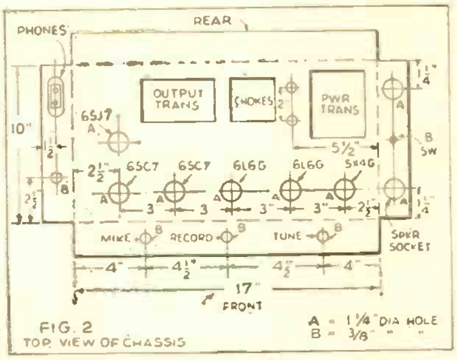
A Compact, High-Fidelity 20-Watt Amplifier

Harry D. Hooton, W8KPX

Here's a high-fidelity audio amplifier with plenty of power, which may be used with a radio tuner for general reception or for public address work. Hams will find it interesting for use as an inexpensive plate modulator. A pair of 6L6G's is used in the push-pull class A output stage.

● THE "HF-20" amplifier answers the need for an extremely compact audio system capable of considerable power output with *high* fidelity. Giving a full undistorted output of 20 watts this amplifier is excellent for phonograph or radio amplification, or for general *public address* work. It may also be used as an inexpensive plate modulator for the amateur transmitter, running an input of 60 watts or less; or a cathode modulator for the "rig" running 200 watts or less input to the final. For modulator application it is, of course, necessary to use the proper type plate or cathode modulation transformer in place of the output transformer shown in Fig. 1.

The tube lineup consists of a 6SJ7 input voltage amplifier, a 6SC7G intermediate amplifier and electronic phonograph mixer, a 6SC7G *phase inverter* and a pair of 6L6Gs in the push-pull class A output. Current requirements for these tubes fall within the power capability of a single 5X4G rectifier. The 6SJ7 tube has its control grid conveniently located at the bottom, eliminating a long grid lead to the top of the tube as necessitated by the older type 6J7.



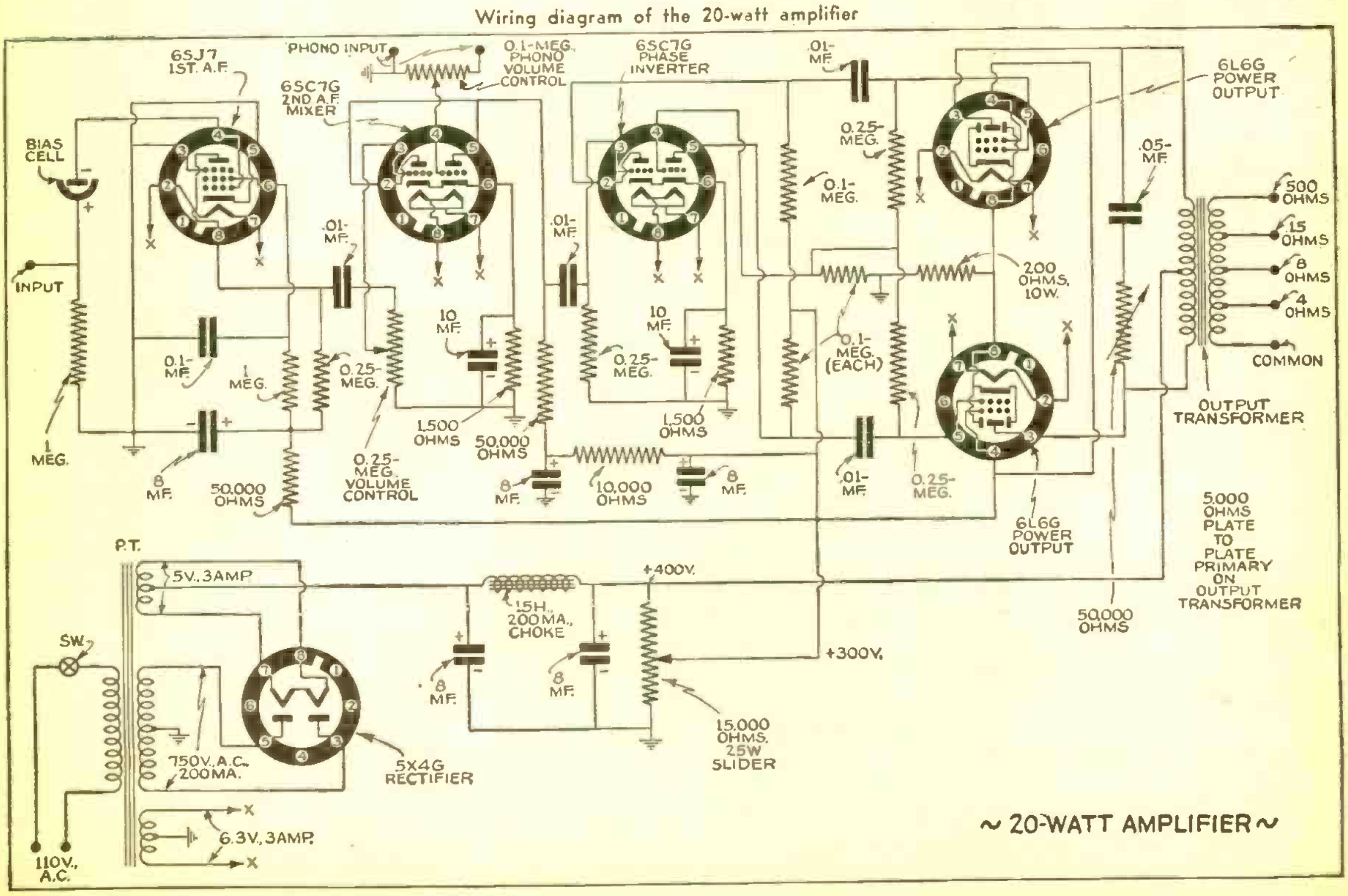
Details for laying out chassis.

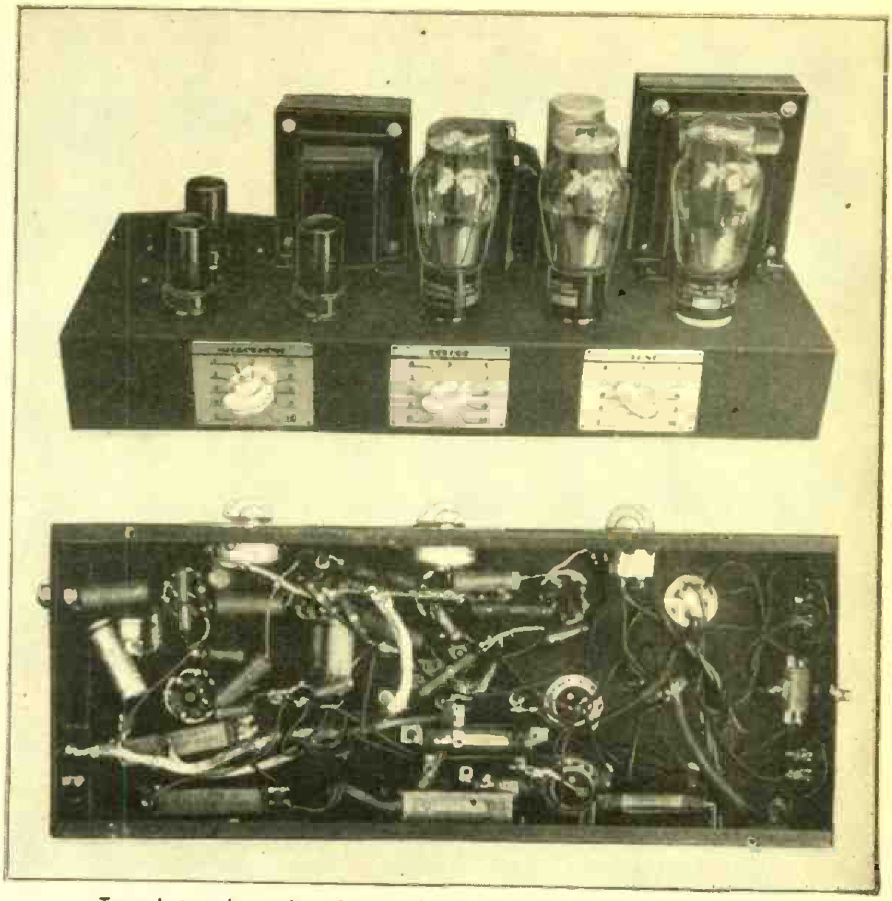
Two Input Circuits

Two *input* circuits are provided. One is a high impedance, low-level input for dynamic, velocity or crystal microphones; the other is a high impedance high-level input for phonograph pickups. The frequency response is practically flat (within ±2 db.) from 60 to 15,000 cycles per second. If an extremely high-level microphone is used, such as the Brush "HL" and similar types, the 6SJ7 input stage may be omitted, the mike being connected directly to the first 6SC7 grid. The space normally occupied by the 6SC7 may then be devoted to a peak limiting circuit for automatic percentage modulation control.

In the construction of this amplifier, it should be pointed out from a hum level standpoint it is advantageous to bring *all* ground circuits to a common point on the chassis. This is easily accomplished by connecting all component grounds to a grounding bus wire, which is connected to the chassis at one central point. This precaution will eliminate the possibility of high gain

Wiring diagram of the 20-watt amplifier





Two photos above show front and bottom views of the audio amplifier.

circuits amplifying small A.C. circulating currents on the chassis.

Matching Speaker Impedances

One or more speakers may be connected to the output of the amplifier, as long as the combined voice coil impedances conform closely to those offered by the output transformer. For instance, two 8 ohm speakers of the permanent magnet type may be con-

At left — Two views taken from opposite ends of the 20-watt amplifier here described by Mr. Hooton. The tube lineup in this amplifier consists of 6SJ7 input amplifier, a 6SC7G intermediate amplifier and phonograph mixer, a 6SC7G phase inverter, and a pair of 6L6G's in the push-pull class-A output stage. The rectifier tube is a 5X4G. The amplifier has frequency response practically flat from 60 to 15,000 cycles per second.

nected in parallel across the 4 ohm impedance output, or two 15 ohm speakers may be connected in parallel across the 8 ohm output. On the other hand, if desired, two 4 ohm speakers may be connected in series across the 8 ohm output, or two 8 ohm speakers may be placed in a series connection across the 15 ohm output. Any single speaker of 4, 8 or 15 ohms may be connected directly to these respective impedances offered by the output of the amplifier. In the event that a 5000 ohm output is desired, connection to the two plate ends of the output transformer through 0.1 mf., 600 volt condensers, as shown in the diagram, may be made.

Regardless of the particular service for which this amplifier is used, use only the best quality parts throughout. This is especially true of the output transformer and the associated speaker. The author used a type PM15B Jensen for phonograph record reproduction although almost any good make of 10 to 18 inch permanent magnet dynamic speaker will be satisfactory. The auxiliary speaker shown in the photograph is small 8 inch type designed to handle about 8 watts.

List of Parts

KENYON (Transformers)

1—Power transformer, 750 v. A.C. center-tapped, 200 ma., 5 v. at 3 amp. and 6.3 v. at 3 amperes
1—Filter choke, 15 henries, 200 ma.
1—Output transformer, 5000 ohms primary; secondary 4, 8, 15 and 500 ohms

I.R.C. (Resistors)

2—Metallized fixed resistors, 1 megohm, ½ watt
4—Metallized fixed resistors, ¼ megohm, ½ watt
2—Metallized fixed resistors, 50,000 ohms, ½ watt
3—Metallized fixed resistors, 100,000 ohms, 1 watt
2—Metallized fixed resistors, 1500 ohms, 1 watt
1—Metallized fixed resistor, 10,000 ohms, 1 watt
1—Wire-wound bleeder, 15,000 ohms, 25 watts, Slider type
1—Wire-wound bleeder, 200 ohms, 10 watts
1—Volume control, ¼ megohm
1—Volume control, 100,000 ohms
1—Volume control, 50,000 ohms

MALLORY (Condensers)

4—Paper tubular condensers, .01 mf., 600 volts
1—Paper tubular condenser, .05 mf., 600 volts
1—Paper tubular condenser, .1 mf., 600 volts
3—Electrolytic condensers, 8 mf., 450 volts. Cardboard
2—Electrolytic condensers, 8 mf., 450 volts. Can, heavy duty
2—Electrolytic condensers, 10 mf., 50 volts. Tubular

PAR METAL

1—Black crackle steel amplifier chassis foundation 10 x 17 x 3" with bottom plate

CROWE

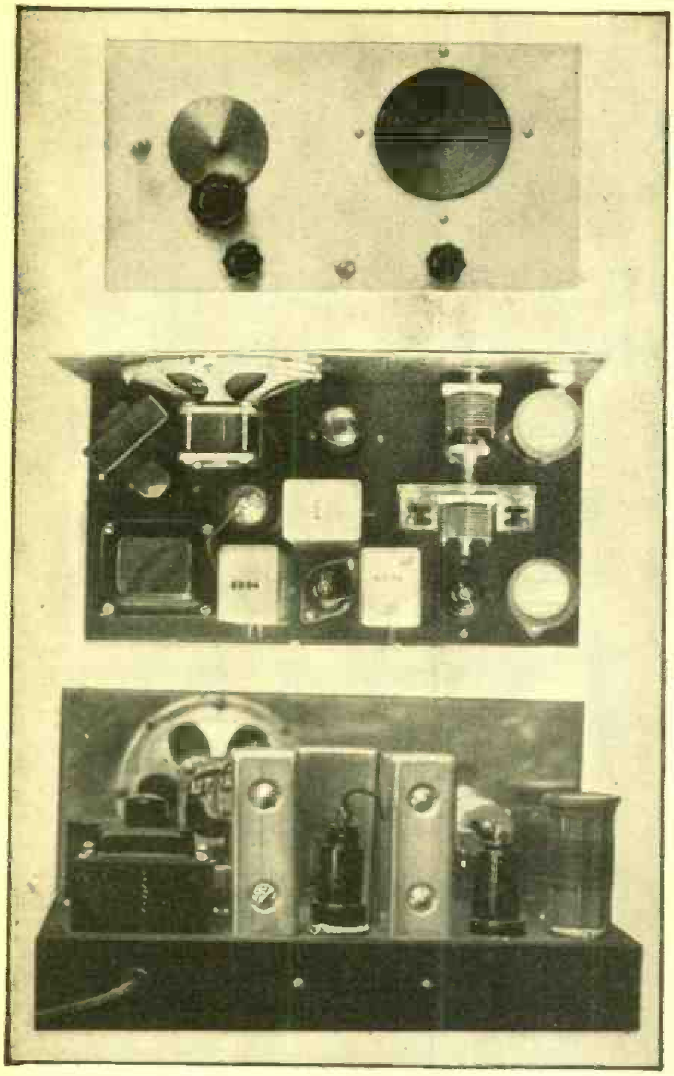
3—Knobs
3—"Mike," "Phono" and "Tone" dial plates

AMPHENOL

6—Octal sockets
2—4-prong sockets
1—Microphone chassis connector

In the Next Issue

How to Erect Television Receiving Aerials so as prevent interference and distorted images, by Thornton Chew.



A 5-Tube Compact Receiver

R. W. Baetz

The author has done considerable experimenting with different type tubes in superhet circuits and here gives the reader the benefit of his experience. This set comprises a 5-tube superhet hook-up, using a 6K8 as the mixer-oscillator, followed by a 6K7 I.F. stage; a 6C8G second detector—B.F.O., followed by a 6V6GT output stage, feeding a 5-inch PM speaker. A 5W4 rectifier tube is used.

Left—front, top and rear views of the 5-tube compact superhet — a very neat and particularly efficient job.

FOR a period of years the author has experimented with numerous multiple purpose tubes with only partially satisfying results. The manufacture of the 6K8 seemed to fill a definite need in a converter tube and gives much better all-around service than the older 6A8.

A 6K8 was therefore chosen as the mixer-oscillator tube of this compact receiver followed by a 6K7 I.F., 6C8G second det.-BFO, 6V6GT output feeding the 5 inch PM speaker and a 5W4 rectifier.

The parts are substantially mounted on the standard 7x13 inch black crackle chassis. A glance at the accompanying chassis photo will clearly show the location of all above-chassis parts. Directly behind the ganged tuning condenser is the 6K8 and midway between the two edge-mounted I.F. transformers is the 6K7 followed by the 6C8G to the right of the BFO transformer. The 6V6GT is mounted in front of the BFO transformer and the 5W4 rectifier is directly in front of the power transformer. It was necessary to mount one of the small filter chokes above the chassis and at an angle so as to make room for the small speaker.

The two 100 mmf. tuning condensers are ganged by means of a flexible coupling and the front section is mounted directly to the front panel while the rear is mounted on a piece of Mycalex, simply because this was on hand. A piece of aluminum might have been more efficient due to its shielding properties but the author experienced no difficulty due to insufficient isolation of the detector and oscillator sections of the converter tube.

A glance at the photo of the front panel will readily show location of parts. Just below the speaker is the A.C. switch-volume control, next in line is the BFO toggle switch. The small trimmer is next, just below the tuning dial and finally the feed-through insulator to the left of the tuning dial.

The receiver was primarily built for *overseas* reception and therefore no effort was made to get a broad band-spread. The coils, located on the extreme left of the chassis cover from about 16-32 meters. No additional coils were wound for other bands as most European reception comes through in this frequency range.

All parts are standard and little difficulty should be had with the wiring and the set should play immediately after completion provided the diagram has been carefully followed.

For best results it is suggested that the I.F. transformers be lined up in the conventional manner—that is by the use of a signal generator set at 465 kc. Incidentally, the I.F. transformers are the new permeability tuned, iron core type and once set to the proper frequency they will keep their original settings for long periods of time despite severe changes in temperature.

I.F. Alignment

In order to properly align the I.F. stage, a signal generator must be used. The procedure is simple but care should be taken to get the setting right on the nose.

The detector and oscillator coils are plugged in so as to prevent open grid oscillation during the lining up. The signal generator is set at 465 kilocycles and the modulated-unmodulated switch is thrown to the modulated position. The ground lead of the generator is clipped to the chassis of the receiver and the R.F. lead is clipped to the grid of the 6K7. An output meter is hooked up in conventional manner in the output of the 6V6GT and the actual alignment can now be started.

Both receiver and generator are turned on and the trimmers on the last transformer are adjusted until a modulated signal is heard on the speaker and is finally peaked as indicated by a maximum voltage reading on the output meter. As the circuits come into line and as the signal increases in intensity, the attenuator on the signal generator is backed off.

The R.F. lead is then taken off the 6K7 and clipped to the grid of the 6K8. The trimmers on the first transformer are then adjusted and when peaked the last transformer is given a going over again. This is done several times so as to make certain the circuits are in resonance.

Set Operation

After the set has been turned on and has been permitted to heat for a few minutes, the volume control is advanced and the small detector condenser is rotated until a definite hiss is heard in the speaker. The tuning dial is then turned until the desired signal is heard. The dial should be turned slowly as the set has no real band-spread and the stations are fairly close together.

The setting of the detector trimmer will vary with the setting of the tuning dial and so will have to be changed slightly when tuning over a large portion of the dial.

Parts List

RCA (Tubes)
1—6K8 tube
1—6K7 tube
1—6C8G tube
1—6V6GT tube
1—5W4 tube

CENTRALAB (Resistors)
1—100,000 ohm, ½ watt resistor
1—300 ohm, ½ watt resistor
1—50,000 ohm, ½ watt resistor
1—500 ohm, ½ watt resistor
1—500 ohm, 2 watt resistor
1—10,000 ohm, ½ watt resistor
3—50,000 ohm, 1 watt resistors
2—1000 ohm, 1 watt resistors
1—500,000 ohm volume control and switch

THORDARSON
1—T13R11 power transformer
2—T13C28 filter chokes

AMPHENOL (Sockets)
2—Bakelite octal sockets
3—Isolantite octal sockets
1—4-prong isolantite socket
1—5-prong isolantite socket

SICKLES
2—465 kc. I.F. transformers, #6504
1—BFO transformer, #6577

CARDWELL
2—100 mmf. variable condensers, ZU100AS
1—25 mmf. variable condenser, ZR25AS
1—Flexible coupling

MALLORY
3—8 mfd. 450 volt electrolytic condensers, BB61
2—10 mfd. 50 volt electrolytic condensers, BB13

CORNELL-DUBILIER (Condensers)
10—.1 mfd. 400 volt tubular condensers
1—.05 mfd. 400 volt tubular condenser
1—.006 mfd. mica condenser
1—.0001 mfd. mica condenser
1—.004 mfd. mica condenser

UTAH
1—5-inch PM speaker

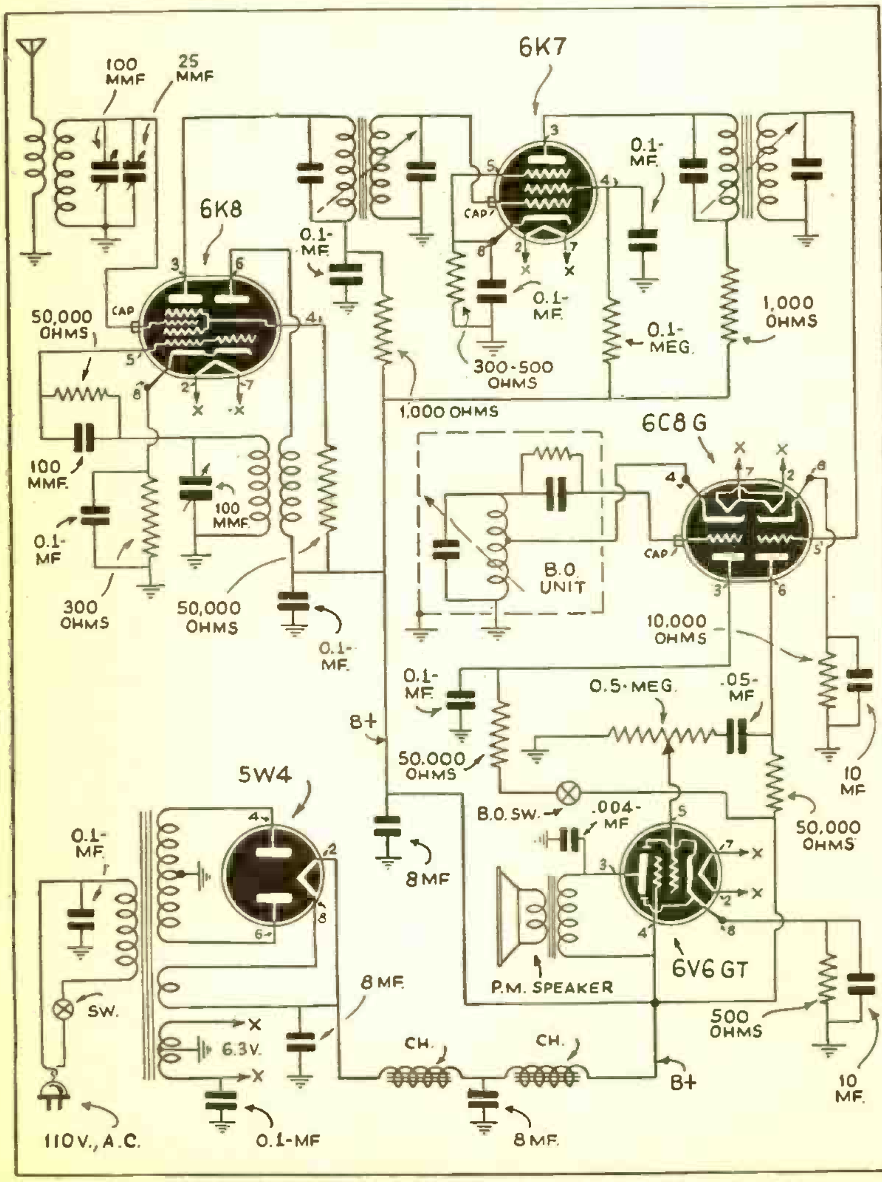
MISCELLANEOUS
1—Rubber covered line cord
1—Dial (ICA)
3—Knobs
1—S.P.S.T. toggle switch
3—Grid caps (National)
1—7x13x2 crackle chassis (Bud)

Coil Data

All coils are wound on Hammarlund SWF forms.
Detector—8 turns #22 enamelled for grid
4 turns #34 dsc for antenna winding
Oscillator—8 turns #22 enamelled for grid
5 turns #34 dsc for tickler

The coils cover the range from about 16-32 meters. Coils for other frequency ranges can be readily wound and no difficulty should be experienced here.

Diagram of the compact 5-tube superhet receiver is given below, and can easily be followed by the average set-builder. Method of aligning the I.F. stage is explained.



Adapting Mobile Equipment to New Regulations

Howard G. McEntee, W2FHP

In the accompanying discussion, Mr. McEntee describes how he improved the 10 meter mobile transmitter, described some months ago in this magazine, so that it could be used for both 5 and 10 meters. Only part of the mobile unit has to be rewired, following the information and diagram provided herewith, the R.F. Section.

● THE ten meter mobile installation described in this magazine about a year ago had been in service several months when the new regulations drastically curtailing 10 meter mobile work were announced. Due to press of other business the equipment was set aside for a time, but later work was begun to change the apparatus so that it could be used both for 5 and 10 meters. Five meters was then, and of course still is, unhampered by operating regulations of the type imposed on 10. Still it was felt that the latter band *might* some time be usable and of course it is useful under certain conditions for emergency work, so the decision to use the outfit on both 5 and 10 was arrived at.

For the *converter* the same chassis, panel and control circuits as specified in the aforementioned articles were used, only the R.F. circuits being rebuilt.

The first layout used a 7G7 mixer and a 7A4 oscillator. These tubes are of loctal design and seem well fitted for high frequency work. The results on 10 were considerably better than with the 6J8G previously used, but on 5 the output was rather mediocre.

The next step was to use an 1852 mixer with the same 7A4 oscillator. To give better input circuit conditions the mixer grid was tapped down a few turns on both grid coils. The circuit with values used is here reproduced. This layout seemed somewhat better on both bands than the previous one (although possibly mainly due to the down-tapped grid of the mixer—a system not tried on the 7G7). As the illustration shows, the two tubes were mounted side by side with the 7A4 next to the tuning condenser, and with the oscillator coils on a polystyrene rod between the two. The band switch was placed on the front panel in the spot originally occupied by the mixer grid tank condenser. The two 30 mmf. grid coil trimmers were mounted on the case side on an insulating strip and were screwdriver tuned.

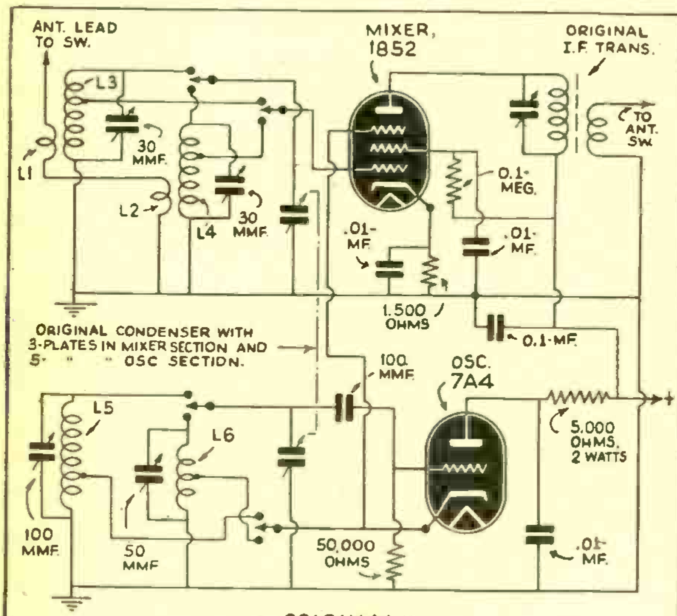
The band switch is a four-position double-throw type and with the circuit used there was no section available for changing the primary coils. These were therefore connected in series directly to the antenna switch. No particular disadvantage of this series connection could be noticed when each primary was connected in circuit alone, so the idea seems satisfactory. The primaries were wound with ordinary push-back wire coiled small enough to slip inside the ground end of the secondary, with the turns held together by duco.

After using this rig for a while the urge to use the ultimate in U.H.F. tubes was felt and hence a third version was built up using an RCA 954 mixer and RCA 955 oscillator.

A cut of this is shown as well as the circuit. Considerable time was spent in condensing the layout so as to obtain short leads, with the result that the band switch was mounted at the rear of the set and the antenna trimmer went back to its original place on the panel. As a result the leads are about as short as possible considering the physical "shape" of the converter. The whole thing was cleaned up as far as possible in order to cut down stray capacity.

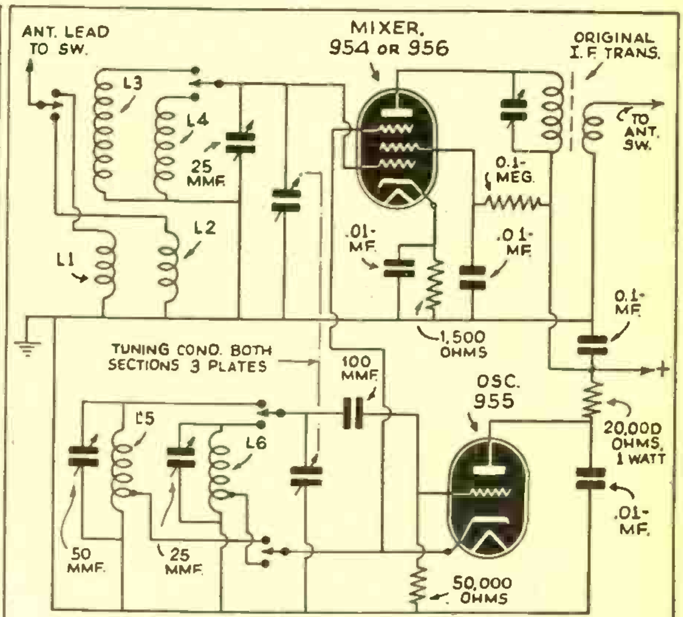
The results were worth the trouble, as the final version is much more sensitive than the others, besides being more stable. The oscillator "pulling" on 10 meters is negligible and is not too bad on 5, while with the conventional tubes it was rather troublesome on both bands.

Wiring diagrams of the original as well as the latest revised model of the 5 and 10 meter mobile converter.



~ ORIGINAL ~

L1 = 4 TURNS, L2 = 3 TURNS, INSIDE L3 & L4 RESPECTIVELY. L3 = 15 TURNS, 1/2" DIA., 1 3/8" LONG, TAP 4 TURNS FROM GRID END. L4 = 5 1/2 TURNS 3/4" LONG, TAP 2 TURNS FROM GRID END. L5 = 6 1/2 TURNS, 1" LONG TAP 1 1/2 TURNS FROM GND. L6 = 3 1/2 TURNS 5/8" LONG TAP 1 1/4 TURNS FROM GND.
ALL No.16 BARE TINNED COPPER WIRE.



~ REVISED ~

L1 & L2 = SAME DATA AS IN "ORIGINAL"
L3 = 15 TURNS, 1/2" DIA., 1 1/4" LONG. L4 = 6 TURNS 1 1/8" LONG
L5 = 9 3/4 TURNS, 13/16" LONG - TAP 1 1/2 TURNS FROM GND. END.
L6 = 5 TURNS 1/2" LONG - TAP 1 1/2 TURNS FROM GND. END.

The acorn version is also noticeably more quiet as far as hiss goes, so much so in fact that the writer was rather disappointed when the set was first tried as it sounded so dead. Doubts soon disappeared, however, when signals began to roll in, for then the high signal-to-noise ratio could be appreciated.

The mixer tube is mounted almost directly over the antenna tank condenser while the oscillator is set on edge. The latter is placed backwards in its socket as this gives the shortest lead arrangement. The mixer goes into its socket with its grid (the short end) down. The grid dip is soldered directly to the condenser stator, so that when the tube is correctly seated in its socket the grid makes proper connection as well.

As in all the different layouts, the oscillator coils are mounted on an insulating pillar for stability while the mixer coils are self-supporting. The hot ends of the latter connect directly to the switch lugs and all the coils are of No. 16 tinned copper wire. The 10 meter mixer coil has several "lines" of duco along the turns to stiffen them, and the 5 meter coil is held by strips of celluloid cemented on. The primaries are of push-back inside the ground end of the secondaries as before. They should not be pushed too far into the secondary or the antenna loading will cause the grid circuit to become overly broad.

There is not much to placing one of these converters in operation if the coils are made as shown. With the tuning dial at midscale, rotate the oscillator *band-setting* or tank condenser until a signal of the desired frequency is heard. Then peak the mixer grid circuit with its tank condenser. The best way to do this is to use some external noise such as a vacuum cleaner or auto ignition at a point on the dial where no regular signal comes in. There will, of course, be two points on the oscillator tank condenser where the same signal can be gotten in, corresponding to the signal frequency plus or minus the I.F. (the latter is around 1500 kc.). Usual practice is to have the oscillator higher in frequency than the mixer on 10 and lower on 5 but there is not much difference one way or the other. Troublesome images due to commercial or police stations adjacent to the amateur bands can be eliminated by selection of the proper oscillator tuning point.

The high voltage on the converters shown was 180 V. and the only precaution to observe is to keep the mixer screen voltage rather low. About 40 V. seemed optimum for the 954 but an RCA 956 that was tried became noticeably noisier and less sensitive with the screen higher than 20 V. Both tubes seemed about equal in operation with proper voltages.

In line with the rebuilding, the antenna cable fittings were replaced from converter to transmitter chassis with the same type, using polystyrene insulation and high grade flexible coaxial cable was used for this lead and for that to the antenna itself.

It was found during tests that the antenna, which is mounted on the rear bumper of the car, should be more than the theoretically proper ¼ wave for best results. At 10 meters it was pulled to its full length of 10.5 feet and worked well even up to 12 feet. For 5 meters, of course, the lengths are halved. The coaxial cable gave a very

In The March 1941 Issue of RADIO-CRAFT

- Fluorescent Lighting — Latest "Sideline" for Serviceman—Part II
- Radio Service Data Sheets
- Recent Improvements in F.M. Receiver Design
- A General Utility Tester for Servicing Electrical Appliances
- Vacuum-Tube Voltmeters—Theory and Practice
- Build Your Own Versatile Modern Multi-Tester
- Sound Engineering
- Home Recording—Theory and Practice of "Sound-on-Disc"
- Vacuum-Tube Oscillators and How They Work
- New Circuits in Modern Radio Receivers
- Operating Notes
- Modern Microphone Technique—Part II, The Microphone and Its Relation to the Manufacturer
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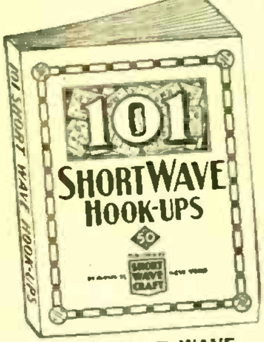

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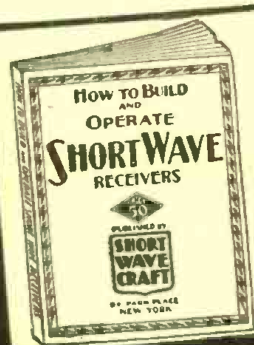

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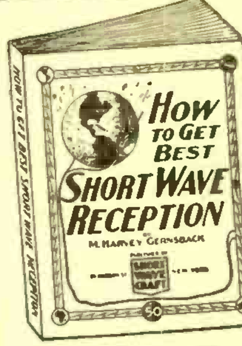

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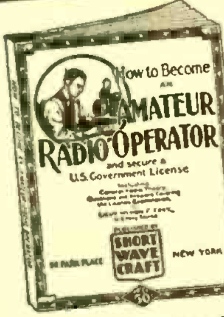

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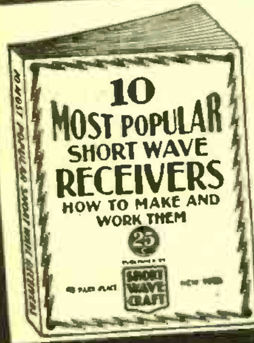

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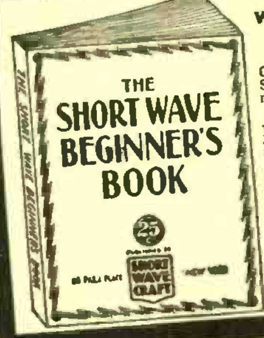

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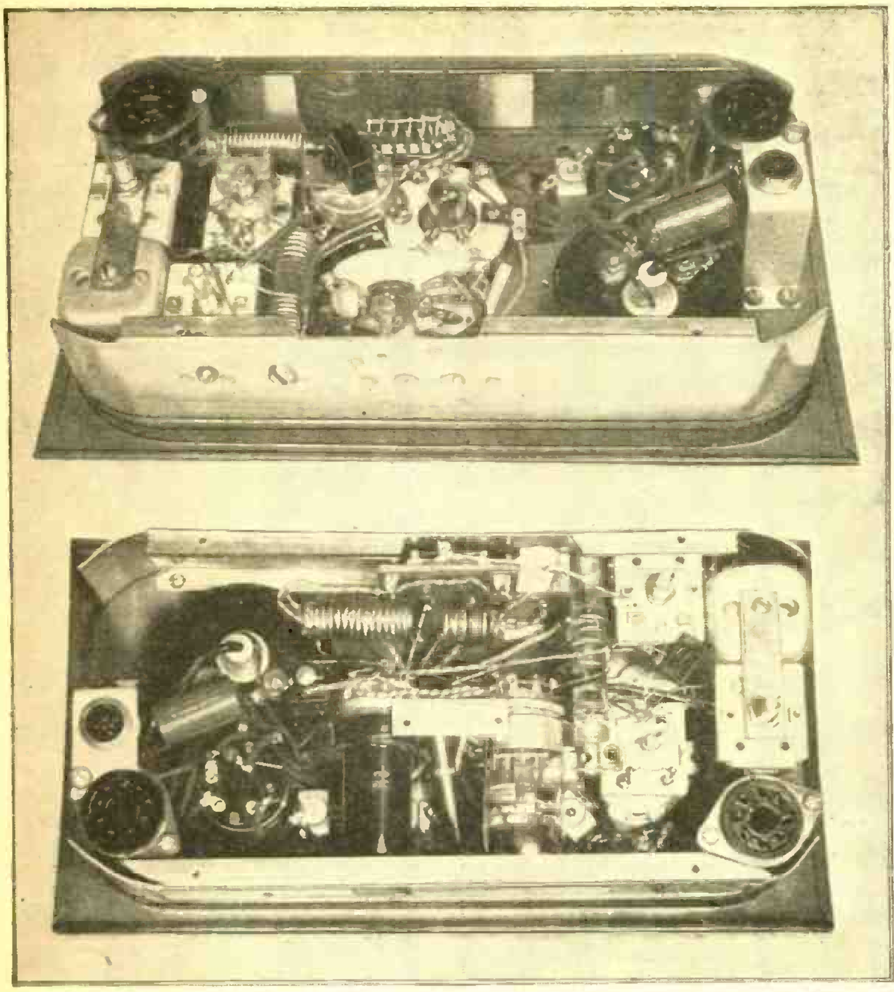


Top—Final version of the mobile converter with Acorn tubes. Bottom view—Original set with 1852 mixer.

near perfect match between antenna and set when the original No. 12 center wire was replaced by No. 18.

Not much was done with the transmitter but to cut a 5 meter coil to the proper size. Three turns 1⅛" diameter and ⅞" long are about right. The coil is interchangeable with the ten meter tank coil since they are both on plug-in bases. The same antenna coupling coil is used for both.

The power output was increased somewhat by using an HY61 in place of the HY60 originally used. This allows the plate current to be run up to 65 ma. with greatly increased output. The tube acts as a doubler on 5 meters, of course, and much better doubling may be had by raising the power amplifier grid-leak to 50,000 ohms; operation on 10 meters is hardly affected by this change.

The revamped outfit is a better performing one all around and has in addition the advantage of both 5 and 10 meter operation.

The parts shown include tubes and sockets used for all the various converters, but of course only two of each are used for any one circuit. Many parts of the original converter were used, only strictly new parts being listed.

List of Parts

BUD
1—5 meter coil (OCL5)
1—25 mmf. variable condenser (LC1642)

RCA
1—954 acorn tube
1—955 acorn tube

HAMMARLUND
2—Acorn tube sockets (S900)

AMPHENOL
2—Loctal sockets (#54-8L) for 7G7 and 7A4
1—Cable end with cap (93-M5 and 90-15) for antenna cable
1—Chassis connector (93C) for antenna
1—Cable connector (93M)
Coaxial cable as needed for particular installation (72-12W)
Coaxial receiving cable to converter (76-22S)
2—Connectors for above (80M with 912 insulation)
2—Chassis connectors (80C with 912 insulation)

NATIONAL UNION
1—7G7 mixer tube
1—7A4 oscillator tube

HYTRON
1—Power amplifier (HY61)

MALLORY
1—Four-position, double-pole switch (3242 J)

NEXT MONTH—

Inexpensive Test Instruments for the Experimenter and Amateur—by William J. Vette

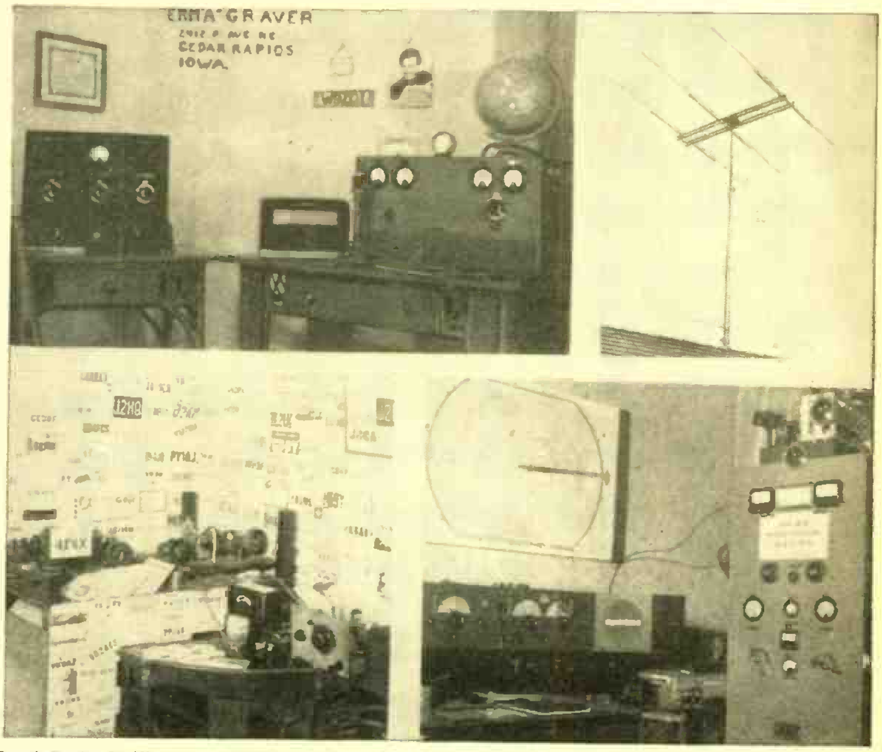
New "HAM" Circuits and Kinks

"CQ" by Larry LeKashman, W2IOP

—And a Host of New Ideas for the Junior HAM

"CQ"

Larry LeKashman, W2IOP



Top left: An R9 YL station, W9ZQI of Cedar Rapids, Iowa. Top right: The neat looking 3 element beam belongs to W2LKC. Lower left: W4EVX, Lawrenceburg, Tenn. Low power DX is a specialty with 96 countries worked using under 50 watts. Lower right: The station of W8OXO, SCM of West Virginia. The map and pointer are for Tab's rotary.

● UNLIKE cooks, too many authors can't spoil the broth. When "CQ" was first introduced, it was stressed as a column of, by, and for all radio fans. So far, with the exception of two or three dozen amateurs and several SWL's, "CQ" has been a personal diary. Don't be surprised if "CQ" becomes "QRT."

The *Amateur Radio Defense* reports on a FCC investigation of a fake SOS. Considerable work revealed a W1 amateur as the offender. The SOS was part of a program by the ham, put on for code practice. This particular case may, or may not, have been malicious, since there are countless cases on record of signals getting out without any antenna on the transmitter. Using nothing but a *Signal Shifter*—without any connections, within 50 feet of the ECO output, *I have worked 50 to 100 miles!*

Now above all times we should take every precaution against operating violations. Under no circumstances should the distress call be sent for mere amusement. Unless code practice is being sent in the prescribed manner on the air, it is best to use a code oscillator—*not the oscillator stage in the transmitter!*

Aside from accidental infringements of current regulations, there has been a deliberate and serious type of offender working the DX bands. These offenders, and there are many, have been working Central and South Americans, and in some instances even Europeans. Not quite as serious, but also offenders, are the DX men working old friends out of the country with blind transmissions. At this stage of the game, regardless of personal feelings and desires, any deliberate violation of the law is extremely serious. Amateurs overheard violating rules should be reported to the ARRL, who will take appropriate action. The feeling, or attitude, that you are talking out of turn is foolish, since failure to prevent such violations will soon result in wholesale *revocation* of amateur tickets.

If I don't put this in, life won't be worth living—at least near W2JEH. Ed is a father—the lucky harmonic—Andrea Lois. The event took place 15 months ago, but this will serve as official notification to the public at large.

W4GNQ, ex-W2ESO, surprised most of the gang by taking for himself an XYL.

NCR members throughout the country are being called up for active duty. Since most of them are amateurs it is a splendid example of the genuine service amateur radio is actively performing.

The Arc from Asheville, North Carolina, continues to prove a fertile and amusing source of material. W4FSE is still editing *The Arc* and doing a mighty fine job. We have reprinted below an editorial from the last issue of W4FSE's publication, which should be of interest to all amateurs.

"How do you feel when you read little items such as this: 'Still, if our 55,000 radio amateurs enable spies to operate radio safely, why not close the amateur stations for the duration?'"

This "gem" came from *Quillen's Quips* by Robert Quillen. Could it be that such homilies as, "Better not sneer at those who believe in the old platitudes. For some reason, they hold most of the big jobs," or "To argue about rights in times like these is madness, yet one must defend his rights while another threatens them," came from the same pen.

Now, don't answer the first question with a mad tongue or a hot pen . . . . I felt the same way as you feel. You will notice that, although this so called "quip" is put in the form of a question and supplies its own "if," such a thought, given circulation, bodes no good for the amateur in the eyes of the public.

Ask yourselves this question: "Have my actions or any actions of my fellows in radio-communication been the means of enabling any spy to safely operate, to the detriment of the United States?"

The willingness of the FCC to leave us *on the air* seems to answer both questions, but it does not follow that we shall be allowed to continue to operate if the answer to the first question reverses itself.

One can find an innuendo of intolerance in an utterance which bears an implication arousing doubt.

There are many amateurs. By the end of 1940 the number will probably reach 60,000; perhaps, in a decade, there will be 100,000 or more! The more amateurs there are, the stronger they are in organization, in unity, the greater their worth. On the other hand, the fewer the number, the less important they become. Don't worry about room for them on their frequencies; progress will take care of that. The FCC and the governing powers are not fools; they continue to license amateurs and they recognize the worth of the amateurs and the need they fill.

If people who give voice to such intolerances would draw themselves abreast of the facts, they would realize that the efforts of amateurs have made it possible for them to push a button and listen to music and voices from around the corner or from far away. But maybe such people do not listen "to the radio" . . . . perhaps they have retired with their indigestion . . . . so, let's put it down to dyspepsia—and let it go at that.

W2MXK is building a new receiver to accompany his 6L6. W2DUP is busy with an electronic "word counter" for his bug. W2JZH is deserting 160 for 80 CW. W2HNS is still off the air. W1KKS lost his rig in the SS—no it didn't wear out, just blew out! W2LR is doing active duty with the NCR, ditto W2PL with the Army. W2CLH is taking the fatal step shortly. W3FLA is working for the FCC in Michigan.

SS scores are probably still of interest since official results don't appear for many a month. We quote from W9BRD's letter—"SS scores are still good gabbing on the air. I can vouch for some of the Chicago gang, many representatives of which were contributing very generously to the neck deep QRM. W9's UTB and YFV each hit about 80,000. W9BRD scraped up 87,000, by the grace of God, etc. 9's MUX, DUX, and ERU are reported to have 'whoppers' for totals, but I haven't heard the bad news yet. Downstate, W9GFF stuck by his 40 meter gun and reeled off around 60,000 for a snazzy one-band score, and sez he's going to use three bands next time, so warns all to beware! As everyone probably knows by now, 3BES hit the jackpot, and I hear that a half dozen or so W3's hit in between 80 and 90 thousand. W3GKO, W3's most consistent TFC bug, rang in at 84,000 and O.O. 3EEW piled up 72,000 on 40 and 80. W2LZR, NYC Tfc reliable, made 72,000 points and promises a better wallop next year (who doesn't?). W5LW bids for Oklahoma with over 50,000 on 7-14 mc. 5AAN claims 72,000, which sounds good for a Texas high. Up in Minnesota another Traffic fiend, 9NCS, amassed 51,000.

"DX men, stripped of their branch of the hobby, were abundantly proportioned in the SS ranks. A few who will groan at the light bills are 2BHW, 8BTI, 8OQF, 4BPD, 2HHF, 8LEC, and 2ZA, and many others who were adding to their logs *quantity*, if not *quality* in QSO's."

W9GSA is on ten meter phone from the same QTH as 9SG who works 40 CW. 9KIO of Evanston took his 807 rig apart and has run into difficulties rebuilding. 9KFY has 100 watts, ECO, and a 20 meter Zepp in attic. 9ZHM in Wilmette is tinkering with an ECO and KW on 20/40 meters. 9VNW, Evanston, sports ½ KW on 40. 9VES is recuperating from SS difficulties. 9VFZ putters on all bands, both phone and CW, and worked phone division in SS. 9MFY has an 807 on all bands from 160 to 20. 9AI works both coasts with 15-35 watts on 20/10 phone and keeps in trim of 40 CW. 9BRD worked all districts on 160 meter CW in one week and has QSL's to prove it. 9VDA occasionally enhances QRM on low end of 40.

W6DUC continues to schedule all the YL's on the air who will give him a tumble. 2KEZ takes his pick of either 14, 7, or 3.5 mc. CW when not punching tape for WCX/WJS/WBN. Anytime you want a snappy ragchew and some hot code practice, just mention it to KEZ, as he can "sizzle" you with his tape! 6BPM burns up a 14 mc. beam with a KW on 40/20 meters and also has a tape. Code practice via W7YG comes through like a commercial on the low end of 40. But so do the Spanish-speaking phones. 9IBC donates CW practice of LF end of 40.

The Forty Traffic System bunch is battling against 10-meter skip and 'phones between 7200 and 7250 KC. Some of the fellows have had to resort to 80 for TFC handling. For those who wish to give 6DUC competition, there are plenty YLRL members active around 3600 KC. 9CRK in Milwaukee is heap big traffic man now, as is ex-DX'er W2AV. W9EYH sold his 100 watt final to CRK and is now taking a rest from hamming while he masters 40 w.p.m. on his mill. 9CS is battling rheumatics in Clinton, Iowa, says 9AXD who shoves out a mean signal with a 25 watt 6L6GX xtal oscillator on 40. 160 meter phones active on the North side of Chicago are numerous and include 9MCM with 80 watts and a T40, 9KYX has a Stancor 10-P, 9HDC with 65 watts into an 807, 9LPS 12 watts, 9LNE 10 watts, and 9BZJ 60 watts.

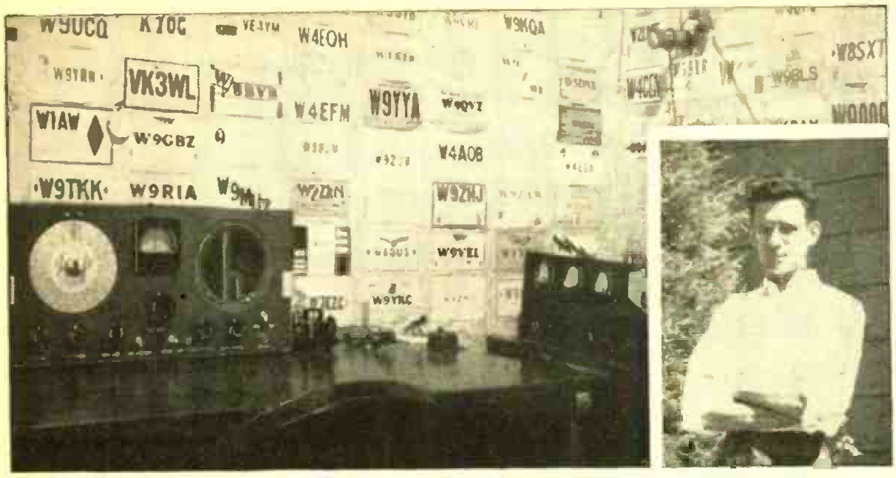
W6HGE of Lawndale, California, boosts RCC on 14 MC. He sports an 8JK beam, 100 watt RK20 final and an SX24, 3JAZ of Norfolk just got on 7 MC with 40 watts. 1AQT moves for shorter SS periods and has 200 watts on 20. 7HBB in Portland has QRP'd from a KW to 250 watts for the duration, and sulks on 20. SCM 8AQ puts his 40 watt emergency rig on 160 meter CW when there's a lull in 80 TFC. 160 CW sounds like 40 on a Saturday night. Guess the boys are tuning up for the coming 160 meter WAS party. All three KC4's can frequently be heard with whopping signals around suppertime on 14 mc phone. KD4GYM is still making the boys hop for a contact.

Back to 9BRD's fine letter. Rod put into words something that more than adequately expresses my sentiments, and probably by far the largest percentage of radio amateurs. What do you think? "Say, I wonder who the bird was who wrote in and asked how you felt about the ARRL. It could only have been a newcomer, perhaps not even a ham. Heck, the ARRL *IS* amateur radio. All we are enjoying now in this hobby is due to the League and without it the *commercials* and *broadcasters* would have had our beloved bands long ago. Some of these young squirts now getting on the air seem to think that ham radio is sponsored and put forward by the government, and that the ARRL is just another radio organization making a living off the hams. The truth of the matter is that ham radio is only tolerated by the government, and it's up to the league to sell it, and keep selling it to Uncle Sam."

What a question. *"What do you think about the ARRL?"* What can anyone mean by such a question? Does he want to abolish it? Does he want to throw it out and put up another one? Both are preposterous in view of the fact that the present organization is deeply imbedded in all the traditions of the art and enjoys the respect and cooperation of the government. Perhaps the questioner is of the opinion that with a more aggressive League we would now have been using bands twice their present size, etc. On the contrary, a too aggressive League could easily have convinced the government that our hobby was a pain-in-the-neck and a bother.

Throughout the years to come, amateur radio's perch will become more and more precarious as more and more commercials clamor for our frequencies and our removal from the air. Therefore, we must take advantage of the present circumstances. The U. S. Government recognizes the American contingent of amateurs as an unlimited source of radio operating man-power; green, perhaps, as compared with top-notch army men, but *diamonds in the rough*, so to speak, who, with a little polishing will give our country a signal corps second to none and radiomen for any capacity. Hence the League policy of code proficiency which serves notice to Uncle Sam that we hams are doing our part in the preparedness program.

NEXT MONTH!
Don't miss article describing A "Real Hi-Fi Phono Amplifier" by Milton T. Putnam, Chief Engineer, Station WDWS



Very business-like is this amateur station, operated by Donald Perazzo of Sioux City, Iowa.

"Honor" Plaque Awarded

To Donald Perazzo, W9YQY

For Best HAM Station Photo

Editor:

W9YQY has been on the air since the spring of 1937. The present set-up uses a Stancor 10-P transmitter on 160 meter phone, and a home-made 70 watt rig on 40 meter CW. The line-up of the CW rig is a 6L6 crystal oscillator, with an 807 in the "final." The receiver is a 1939 Hallicrafter Sky Champion. A bug, handkey, and "standby" switches are mounted on top of the operating table. The microphone is suspended on a hook on the right side of the operating table when not in use. A total of 47 states and 8 foreign countries have been contacted and the station is A.R.R.L. —V.A.C.—S.W.L.—R.C.C.

The operator is 19 years old and studying for a first-class commercial telephone license.

Donald Perazzo, W9YQY,
3130 Pierce St.,
Sioux City, Iowa

•

Here is the new "Award of Honor" Plaque which measures 5" x 7" in size. It is handsomely executed in colors on metal, and is framed, ready to hang on the wall. The name of the winner will be suitably inscribed.

•

Note These Important Rules

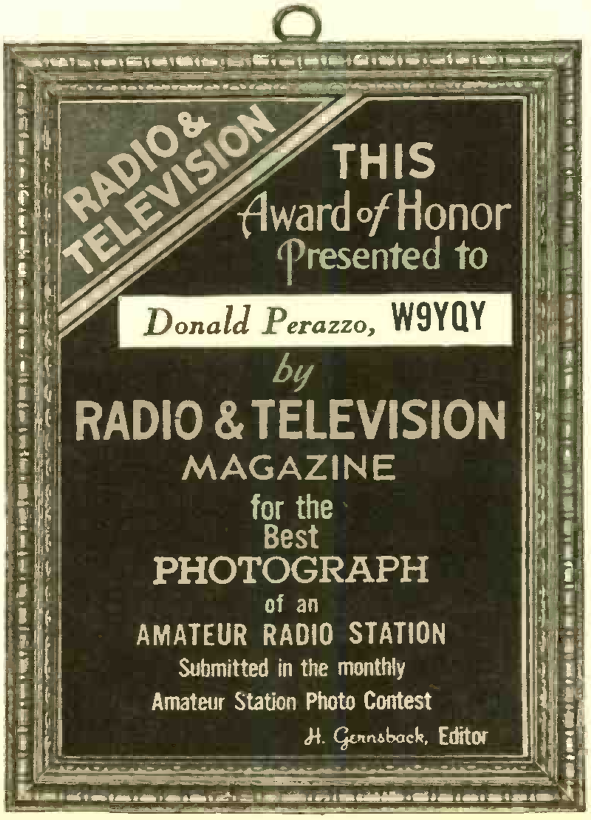
Attach a brief description not longer than 300 words, describing the general line-up of the apparatus employed, the size, type and number of tubes, the type of circuit used, name of commercial transmitter—if not home-made, watts rating of the station, whether for c.w. or phone or both, etc., also name of receiver.

State briefly the number of continents worked, the total number of stations logged or contacted, and other features of general interest. Mention the type of aerial system and what type of break-in relay system, if any.

Important — Enclose a good photograph of yourself, if your likeness does not appear in the picture!

You do not have to be a reader of RADIO & TELEVISION in order to enter the contest.

Address all photos and station descriptions to Editor, Ham Station Photo Contest, c/o RADIO & TELEVISION, 20 Vesey Street, New York, N. Y.

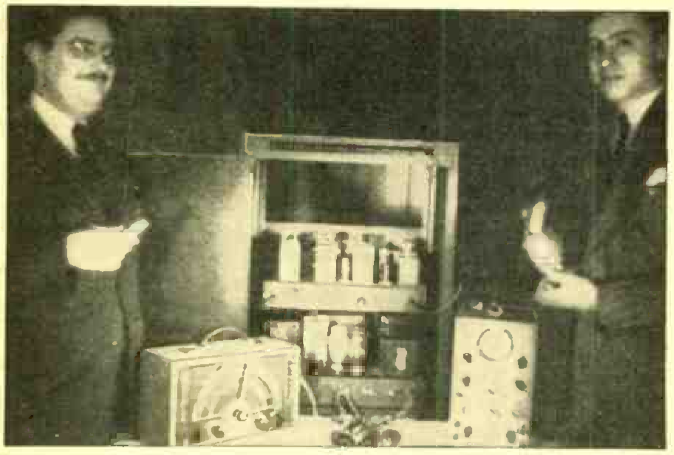


A "Pull-Swing" Frequency Modulation System for the Amateur

Part 2—Modulation Unit

Ricardo Muniz*; Donald Oestreicher**; Warren Oestreicher***

The editors are pleased to present herewith the second installment of the article on the "Pull-Swing" Frequency Modulation for the amateur. A great deal of special research work has been carried out by Mr. Muniz and his associates in the development of this simplified system of FM, which provides surprising stability.



Mr. Muniz is seen at the left of the accompanying photo, with one of his associates, together with RCA signal generator, a cathode-ray oscillograph, together with the FM apparatus thus far constructed.

THE preceding article gave some of the theory of frequency modulation and a discussion of the principles applying to the "R. & T." modulator unit. In the following article the design and construction of a complete modulator rack, including audio and R.F. stages, will be discussed. This unit is adaptable to any properly designed amplifier and is itself a low-power FM transmitter. Several innovations in amateur design will be noticed and special mention will be made of them as we discuss the transmitter.

From the first article the reader is undoubtedly aware that in "Pull-Swing" Frequency Modulation an audio amplifier modulates a pair of crystal oscillators in amplitude, 180 degrees out-of-phase. These crystal oscillators (control oscillators) then are made to pull the grid circuit frequency of an electron-coupled oscillator back and forth over the desired spectrum.

Audio System

The audio system had to have sufficient "gain" to work from a dynamic microphone (–56 db.) to a load of approximately four watts. At the same time it must have an overall amplification proportional to the audio frequency (i.e., the amplification at 5,000 cycles must be about 50 times that at 100 cycles and approximately linear between). A three-stage amplifier with a high gain pentode (6SJ7), as speech amplifier, a high-mu triode (6K5-G) as control amplifier and a 6L6-G as amplitude modulator was finally decided upon.

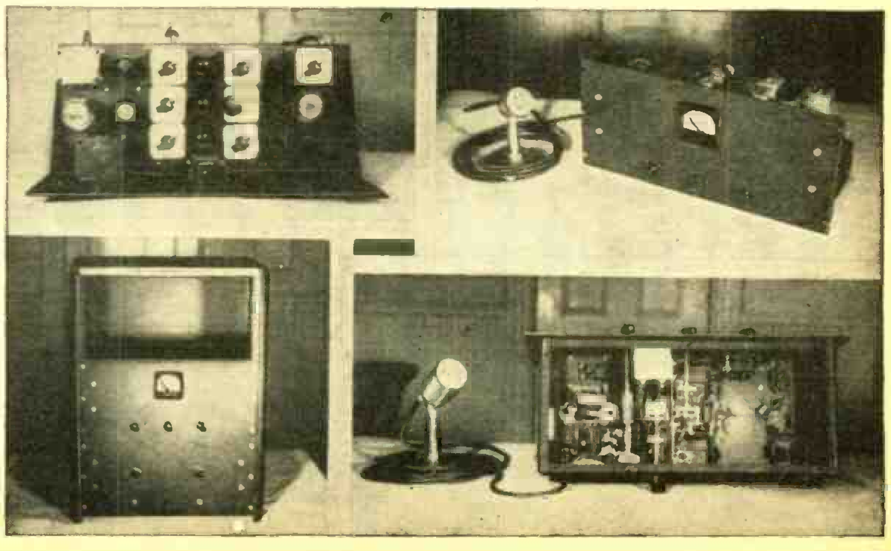
Speech Amplifier

The 6SJ7 speech amplifier is conventional in all respects. It is transformer-coupled to the 500 ohm line and the gain control is a 500,000 ohm potentiometer in the grid circuit. The potentiometer is placed near the 6SJ7 socket, in order to eliminate extra wiring in this critical part of the circuit, and it is controlled through a shaft and coupling.

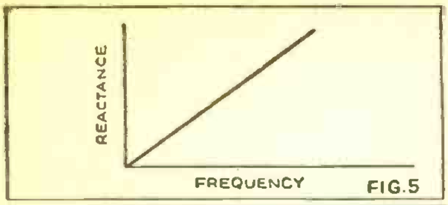
Control Amplifier

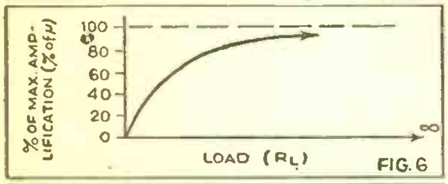
The next stage is most important. It is in this stage that the frequency-amplification ratios are established. In Fig. 5 is the curve representing the reactance (effective resistance) of an inductance with respect to increasing frequency. This curve is linear. The output of a vacuum tube (triode) is mu × E_o, where mu is the amplification factor and E_o is the input voltage. The amplification factor is proportional (in a triode) to the value of the parallel resistances R_p (plate resistance) and R_l (load resistance). The plate resistance is constant. When the load resistance is very high the amplification factor will approach its maximum value (given in the tube tables of the manufacturer). In Fig. 6 is shown how the amplification factor mu varies when the load resistance (or reactance) is varied. It will be noticed that this curve is not linear. In order to raise the curve more sharply at the top, the inductance may be made resonant at the highest frequency to be amplified. This causes a peak in the curve as in Fig. 7 and raises the response. At the same time, through proper design, the frequencies above the point of resonance may be sharply attenuated. The circuit was designed to have maximum amplification at 5,000 cycles. To resonate at this frequency a 2 henry choke shunted by 500 mmf. capacitance is required. At 100 cycles (the lowest frequency to be amplified) the choke will have a reactance of about 1200 ohms. This means that $\frac{R_pR_l}{R_p+R_l}$ will be about 1,000 ohms and the amplification factor will be about one-fiftieth of its maximum value (70 for a 6K5-G). This is about 1.6. At 5,000 cycles per second the impedance of the resonant circuit comprised of the 2 henry choke and the 500 mmf. capacitance is quite high—in the order of 60,000 ohms. This value of load will give about half the maximum mu (or 35). We thus have a ratio of about 30 to 1 over the spectrum 5,000 C. P. S. to 100 C. P. S., and this has proved satisfactory. The 2 henry reactance (X1) in the diagram is not very critical—it may be between one and three henries with .001 mf. and 300 mmf. shunt capacitances, respectively. The 150, 200 or 500 ohm winding

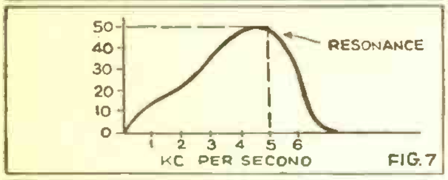
Top photos in the group herewith show top and front views of the modulator rack unit for "pull-swing" FM; bottom photos show unit assembled in rack and also "mike," together with a bottom view of the unit.

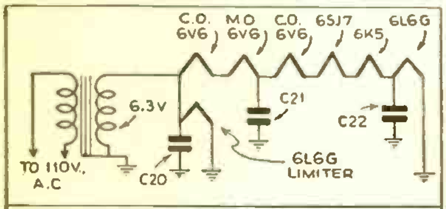


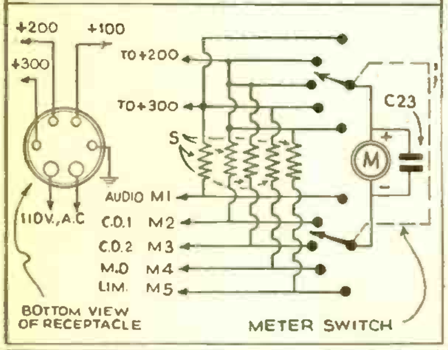
*Radio Instructor, Brooklyn Tech. H. S., Eng. WTNE.
**Student, Electrical Eng., Brooklyn Polytech., W2LOE.
***Student, Electrical Eng., Cooper Union, Night.

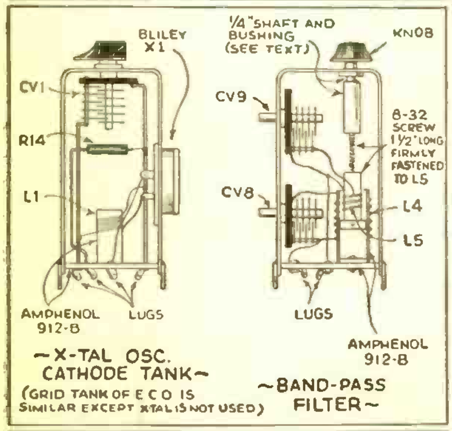


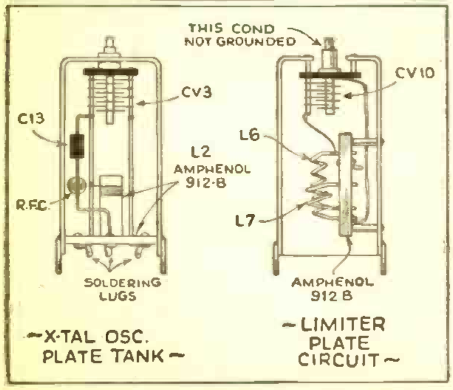












Diagrams showing FM action, as explained in the text, and also details of crystal oscillator coil units.

of a "universal" type transformer should be in the desired range of inductance. The condenser is fairly critical and should be adjusted to fit the value of the choke, so that the circuit may resonate at about 4,500-5,000 cycles. The stray capacitances in the circuit should be taken into consideration as they may run as high as 50 mmf.

Amplitude Modulator

The 6L6G amplitude modulator tube is operated in class A. It is possible that in some cases more power will be needed from this stage. If this is so, operation at 500 volts with a suitable bias is permissible since all of the low frequencies, in which most of the power of a signal is contained, are well attenuated. The output transformer available did not have a center tap. A network of two 10,000 ohm resistors and 2 mf. condensers was provided so that plate voltage could be applied to the oscillators at a neutral audio point.

R.F. Circuits

On this 8" x 17" chassis are three oscillators and a limiter—all working at the same time and all doubling in the output circuits. This means that there are *seven* different frequencies present in a small space! Obviously some shielding had to be done, or at least the signals had to be sharply attenuated outside their proper circuits. The method of completely shielding the tank circuits was borrowed from commercial practice and contrary to expectations, presented little difficulty in either mechanical or electrical design. In addition, shunt or parallel feed was used in the plate circuits of all but the highest frequency stages, and there is no high voltage exposed at any place. The neat, commercial appearance of the finished job is evident from the photographs. (The cans come from "bargain counter" I.F. transformers and only added a dollar to the cost of the rig. All cans are 2" x 2" x 4" high and are made of 1/32" aluminum.)

Coil Construction

In the drawings (Figs. 1-4) is shown the general construction of the tank circuits. All components associated with these circuits are inside the shield can when it is mechanically possible. The insulation of the tank circuits is all *Amphenol 912-B*. The coils are wound on this material and then painted with 912-B coil dope. The mounting base is made of 912-B sheet, ⅛" thick. (It actually pays to use this material. We wound the cathode coil of one of the control oscillators on "low-loss" bakelite, and with the oscillator running at 100 volts on the plate the coil form—not the coil—got very hot. That's one reason for *frequency drift* and *power loss*. With amphenol 912-B this trouble immediately disappeared.)

The winding data for the coils and the tank components is given in the following tables.

On Amphenol miniature forms—
- L1—15 turns No. 24 S.C.E.—closewound
- L2—12 turns No. 24 S.C.E.—closewound
- L3— 9 turns No. 24 S.C.E.—5/16" long
- L4— 9 turns No. 14 Enam.—1" long
- L5— 9 turns No. 18 Enam.—⅝" long ⅝" max. outside dia. (see text)

Airwound (supported on 912-B strip)
- L6— 9 turns No. 14 Enam.—½" dia. 1½" long
- L7— 2 turns No. 12 tinned—¾" dia. coupled to L6

L4 and L5 comprise the variable band-pass filter. The width of the pass band depends on the coupling. Coupling is varied by sliding L5 in and out of L4 by means of a screw. To the ¼" shaft, shown in the drawing, is soldered a bushing 1¼" long with an 8-32 tapped hole through it. An 8-32 machine screw is fastened to the L5 coil form and threaded into the bushing. The L5 coil form has a projection which rides in a groove cut in the L4 coil form, to keep L5 from rotating. By turning the knob the bushing draws the screw and L5 upwards and decreases the coupling between L5 and L6.

The *limiter* coil is air-wound and mounted on a strip of 912-B. The strip is supported from the can by bushings. The condenser is mounted upon two bushings fastened to the ceramic front plate and the shaft projects through a hole, which gives ⅛" clearance all around. This stage, operating at 59.2 megacycles, is the only one in which the plate circuit is series fed, as it is undesirable to depend on R.F. chokes at these frequencies.

Control Oscillators

There is little to be said about the *control oscillators*; they are the familiar tri-tet circuit. The screen grids are connected to the 100 volt tap on the power supply. They are therefore quite well stabilized. The plate circuit alone is modulated and the crystal is, therefore, always oscillating so that the critical condition (where the feed-back is low) is never reached.

Master Oscillator

The *electron-coupled oscillator* is also conventional. The plate voltage is about three hundred, in order to provide a strong signal, but if any instability results, the voltage may be lowered.

The 10 mmf. variable condenser is brought through the panel and is used for minor frequency adjustments.

Limiter

By referring to the first article of this series you will find that a *limiter* should be operated at low plate voltage, and with no grid bias and should be greatly overdriven, so that saturation and cutoff occur during each cycle. The plate voltage and screen voltage is 200 and the quarter-meg-ohm grid-leak insures that the exciting voltage will be high enough. The output of this stage is taken from a flexible amphenol concentric line attached to the chassis.

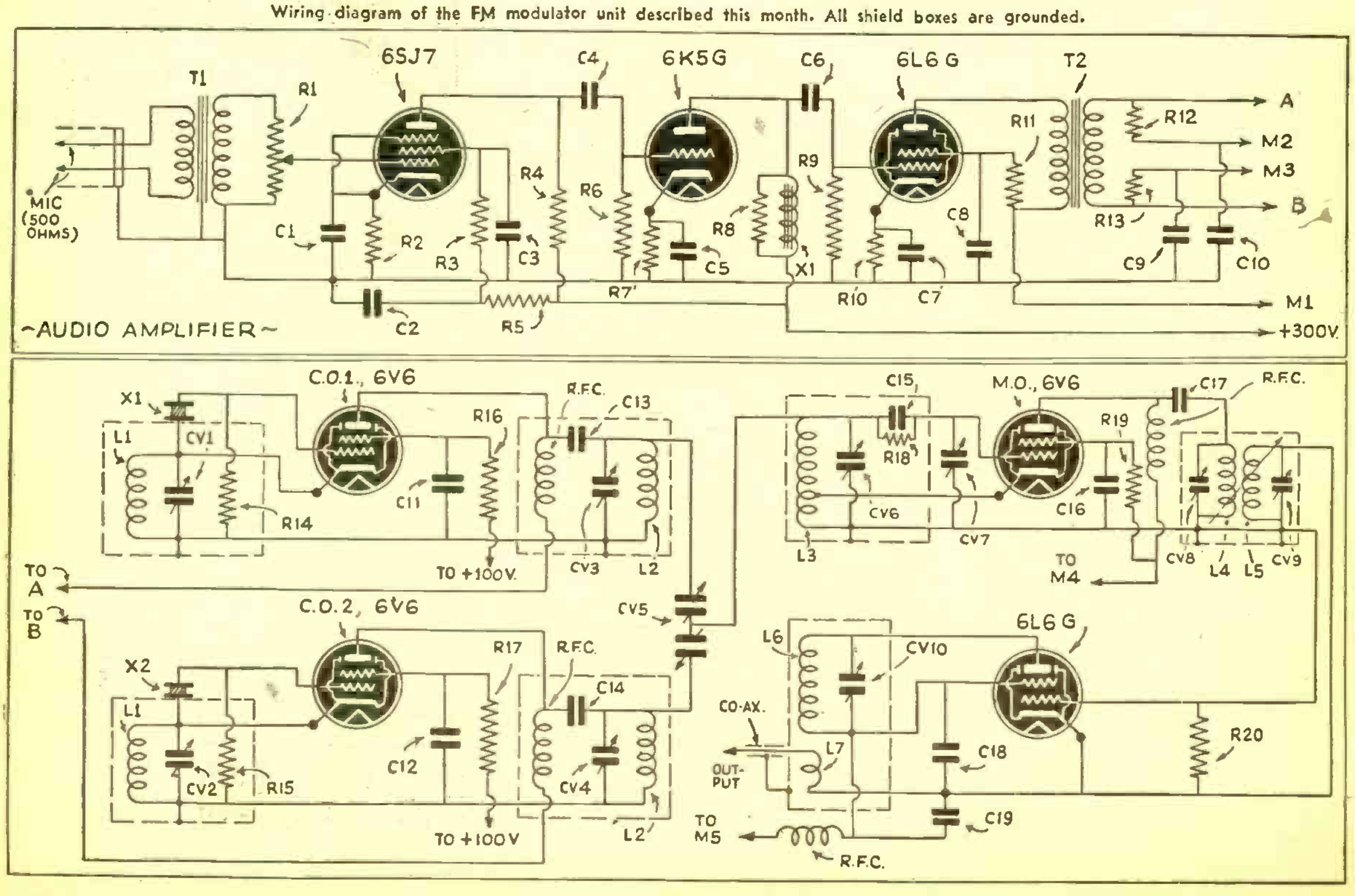
Layout

The photographs show the mechanical layout quite well. Tube sockets should be placed so that the grid and plate lugs are nearest to their respective circuit components. The wiring is very simple with the type of coil construction used. Flexible stranded wire and tinned No. 18 solid wire were used in connections.

Metering

The *meter-switching* system is quite convenient, since it allows a check to be made on all stages by just turning the knob. The shunts are easily made from resistance wire. First the shunt is carefully removed from the meter. This is quite simple as it is only soldered in. A flashlight cell and a low resistance rheostat (about 1000 ohms) are needed. The shunt just removed is soldered to the switch as in the diagram, and the meter is wired to the rotor lugs. The battery (in series with the rheostat) is connected across the shunt and the rheostat adjusted so the meter reads 100 ma. A length of wire is now soldered across two other contacts and the meter turned to that position. If the needle does not read 100 ma. when the battery is across the new shunt, then change the shunt. Make it shorter if the needle reads high, and longer if the needle reads low. The shunts are about 1.5 ohms, so that you will need at least 10 ohms of wire. (It is very cheap.) When all the shunts are made, coil them on a pencil and fasten them into the switch permanently. (There is no need for extreme accuracy—but try to make the shunts for the two control oscillator

Wiring diagram of the FM modulator unit described this month. All shield boxes are grounded.



circuits *exactly equal.*)

In the next article of this series the power-supply for the transmitter (shown in photographs) will be shown and discussed. At the same time information on testing and operating the frequency modulator unit will be given.

Parts List

KENYON (Transformers)
1—T-2, low imp. to grid
1—T-491, used to distribute audio to control osc's
1—T-351, fil. trans. 6-3 v. 3 amp.

PAR-METAL PRODUCTS CORP.
1—3604, 8¾" steel rack panel
1—15281, 8" x 17" x 3" steel chassis
1—SB-78, mounting brackets for 8" chassis

BUD RADIO, INC.
4—CH-920, 2.5 mh. 125 ma. R.F.C.

TRIPLETT ELEC. INSTRUMENT CO.
1—Model 327—TRJJW, 0-100 ma.
5—Shunts 100 ma. Shunt removed for above.

BLILEY ELECTRIC CO.
1—BC-3, 7416 kc. exact.
1—BC-3, 7396 kc. exact.

INTERNATIONAL RESISTANCE CO. (Resistors)
2—BT-1, 250 m. 1 w.
3—BT-1, 500 m. 1 w.
3—BT-1, 25,000 52 1 w.
1—BT-1, 1 meg. 1 w.
3—BT-1, 50,000 52 1 w.
1—BT-1, 850 r 1 w.
1—AB, 20,000 r 10 w.
1—BT-1, 1000 r 1 w.
1—BT-1, 10,000 r 1 w.
1—AB, 200 r 10 w.
2—AB, 10,000 r 10 w.

NATIONAL UNION (Tubes)
2—6L6G
1—6C5
1—6SJ7
3—6V6

AMERICAN MICROPHONE CO.
1—D8T, 500 ohm dynamic microphone

AMERICAN PHENOLIC CORP.
1—76-22S, 6 feet coaxial cable
7—SS8, Steatite octal sockets
6—24, 912-B miniature plain coil forms
1—65-125, sheet 912-B Polystyrene
1—PF6-7, 6 contact side cable outlet
1—PM6, 6 contact plug
1—SS6, 6 contact socket
1—PC3F, mic. connector to chassis

INSULINE CORP. OF AMERICA (I.C.A.)
4—1249, brass extension rods
2—2143, Isolantite flex. shaft coupling
1—5252, hardware assortment

P. R. MALLORY & CO.
1—SRP 252, 500 m. carbon voc. control
2—TS 102, 25 mfd. 25 v. elect. cond.
1—TS 108, 50 mfd. 50 v. elect. cond.
5—TP 418, .1 mfd. 600 v. paper cond.
12—366, bar knobs
1—151-L, "Hamswitch"

CORNELL-DUBILIER ELECTRIC CORP.
2—DY-6200, 2 mfd. 500 v. paper cond.
8—IR-5DZ, .002 500 v. mica cond.

ALLEN D. CARDWELL
3—ZU-100-AS, 100 mmfd. var. cond.
2—ZR-50-AS, 50 mmfd. var. cond.
3—ZR-25-AS, 25 mmfd. var. cond.
1—ZR-10-AS, 10 mmfd. var. cond.
1—EU-100-AB, 100 mmfd. var. cond

BOOK REVIEWS

RADIO OPERATING QUESTIONS AND ANSWERS, by Nilson and Hornung. Flexible cloth covers, 5 x 7 inches, 416 pages, illustrated. Published by McGraw-Hill Book Co., New York, N. Y.

The questions cover all the phases of radio, including diagrams, theory, FCC and International rules, etc. The opening chapters deal with basic theory and practice, and the answers when necessary, are accompanied by diagrams. The answers are given in very clear, short form so that they can be easily assimilated by the student, and should enable him to answer any of the questions which he meets with in the FCC examinations for license.

Succeeding chapters take up the radio telephone, advanced radiotelephony, radiotelegraphy—both elementary and advanced, etc. An appendix is given covering the international "Q" signals, a copy of the Morse code, rules governing commercial radio operators, extracts from the radio laws, and a very complete index of subjects.

THE METER AT WORK, by John F. Rider. Stiff cloth covers, size 5½ x 8½ inches, 162 pages, illustrated. Published by John F. Rider, Publisher, New York, N. Y.

A new and novel arrangement has been made in the mechanical make-up of this book, the pages being cut through the middle and arranged in two halves, as it were. The diagrams appear on the upper pages and are numbered progressively. Let us suppose the reader is studying the book and is interested particularly in Fig. 79 as referred to in the text. He simply takes the ribbon attached to the book and places it at the diagram page numbered Fig. 79. If he laid the book down and referred to it a little later, the text and corresponding diagram are instantly located—also the ribbon serves as a "book mark."

The various chapters describe the different types of meters, including moving iron and dynamometer types, characteristics of meters, rectifiers and thermo-couples, practical application of meters, etc. An excellent book for every radio student and service man.

THE RADIO AMATEUR'S HANDBOOK, Eighteenth (1941) Edition, by the Headquarters Staff of the A.R.R.L. 552 pages, including 8-page topical index and 96-page catalog section of amateur radio equipment. Approximately 830 illustrations and 90 charts and tables (Spanish edition available). Published by the American Radio Relay League, Inc., West Hartford, Conn.

The 32 chapters in the new Handbook constitute a very complete exposition of practical amateur operating and constructional data. First, there are two introductory chapters, intended for the newcomer first learning about amateur radio (including the code). There are four chapters on principles and design, covering the essential elements of radio theory in understandable fashion.

There are fourteen chapters in the construction and adjustment section, ranging from workshop practice through to the elimination of broadcast interference. In these chapters dozens of modern, proved units of high-performance amateur stations are described in detail. There is a section in which complete transmitters, laid out down to the last power connection, meter and switch are shown.

The remainder of the book is literally a number of separate Handbooks combined into one. The antenna section contains five chapters alone, covering the field from basic principles to the design and construction of elaborate long-wire and rotary arrays. The ultra-high frequency section, too, contains five chapters. An entirely new section on the important subject of "frequency modulation" has been added.

FESSENDEN—BUILDER OF TOMORROWS, by Helen M. Fessenden. Stiff cloth covers, size 6 x 9 inches, 362 pages with a frontispiece of Professor Fessenden. Published by Coward-McCann, New York, N. Y.

Helen M. Fessenden deserves a lot of credit for at last coming out with this complete history of the radio inventions of Professor Fessenden. Not so well known to the young radio students and engineers of today, perhaps, Professor Fessenden was one of the shining lights in the realm of American radio invention for over 30 years. In fact, he first thought of "wireless" inventions some years before the dawn of the century.

This very interesting book gives the early personal history of Professor Fessenden, covering his school and college days and the details of his first official radio researches carried out in conjunction with the U. S. Weather Bureau in 1900. No thorough student of radio should fail to read this remarkable book, as it not only sets forth the complete history of the first big American radio company—the National Electric Signaling Company—but it also discloses some of the early basic radio inventions of Mr. Fessenden.

Professor Fessenden took out some 500 patents in various fields, particularly in the transmission of light, sound and electrical waves. In 1906, using his system of transmission and reception, "two-way" trans-Atlantic radio-telegraphic service was first established between Brant Rock, Mass., and Machrihanish, Scotland.

The "first" radio broadcast in the world took place from Fessenden's Brant Rock Station on Christmas Eve and New Year's Eve of 1906, which was heard by ships along the Atlantic seaboard, as far south as Guantanamo Bay, Cuba. Among his inventions other than radio were the underwater "oscillator," the "fathometer" or Sonic Depth Finder, the "radio compass" and other submarine signaling devices. Professor Fessenden at an early date brought to the attention of the large electrical manufacturers the value of the "turbo-electric drive" for battleships. This was later adopted, without credit to him, however, as the author points out.

Setting Up

An Amateur Radio Station

Larry LeKashman, W2IOP

● PLOUGH through the myriad of material on amateur gear and you'll find so much, it becomes—if nothing else—confusing. Perhaps the trial and error method will bring satisfactory results in the end, provided you have the necessary money and time to follow this approach to a final solution. The point is, all of us have seen pictures of amateur stations that we admire and long for. All of us probably wish we could start our stations over again, with the original investment intact, but with all the knowledge we had accumulated through hours of sweat and study. What has anyone done about it? Not much—and that is the point of this series.

We are going to try and take you through the trials and tribulations that befall all amateurs who are new in the game. Suggestions, photographs, hints and kinks—all with the idea of showing you how to get the best layout first is the Herculean job cut out for us. While the famous "junk box" is an old tradition of amateur radio, it is expensive and unnecessary.

Where to start becomes a difficult problem, since to the best of our knowledge no one has set any pattern for such an all inclusive essay. What is the ideal station? How can one produce a good looking station and stay within a budget? What type tools are best for the "kitchen mechanic"? What make equipment is best looking and best performing? How much money is wasted on "beautifying" the average rig?

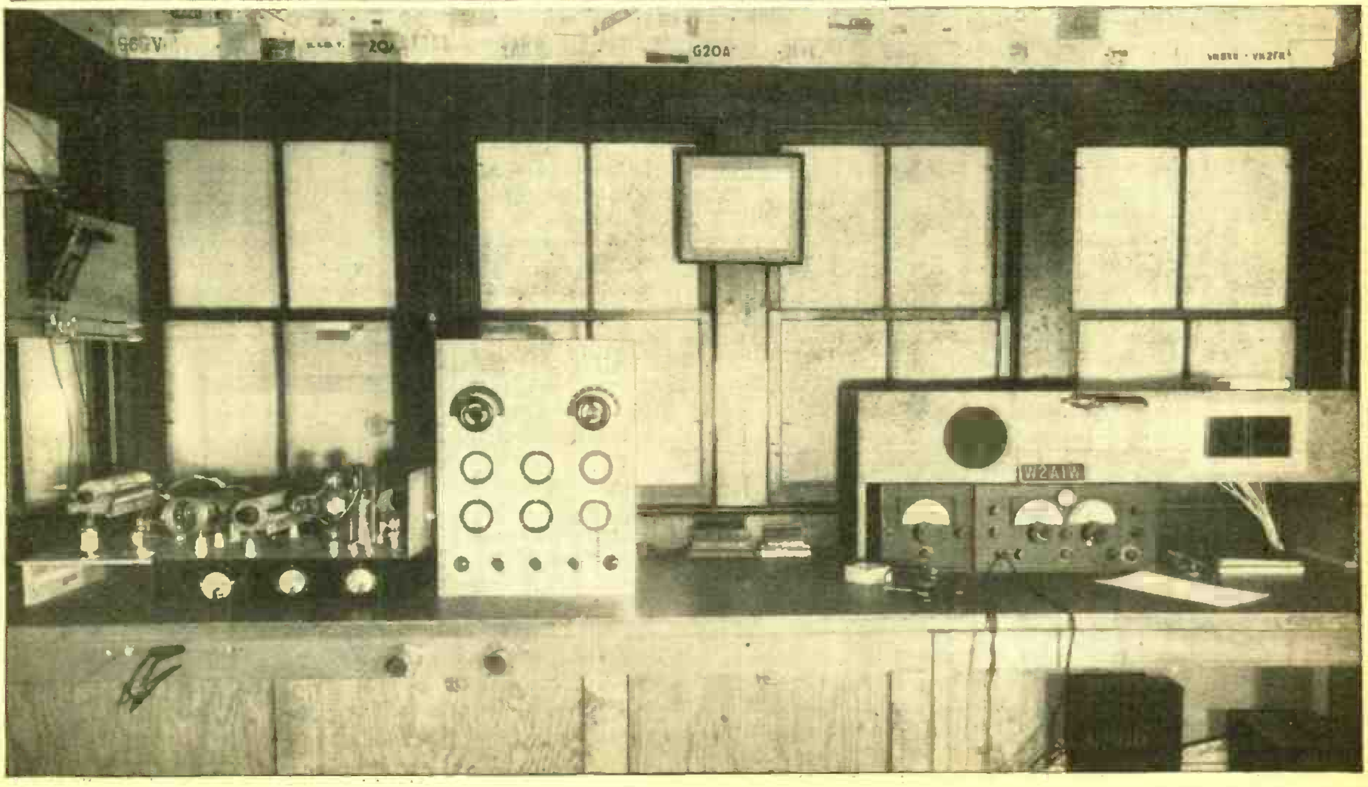
The most important questions: "Is it possible to construct a good looking station, at a minimum expense, with no sacrifice on the part of actual equipment?" can be answered with an emphatic "yes!" Take for example any of the commercial kits on the market. The Stancor or Thordarson kits are fine examples of maximum watts per dollar value. In fact such kits have greatly changed the complexion of amateur radio in recent years. But more about that later.

Before delving into the subject at any great length let us examine what we consider the essentials of a good amateur sta-

Left—A very neat Ham station layout—that used by the author at W2IOP.

●

Below—Handsome station layout at W2AIW; transmitter at left and receiver at right. Loudspeaker or phone reception provided; auxiliary apparatus in cabinet under table.



tion. No one will dispute the fact that a receiver, transmitter, and antenna system are essentials. Then what? Well, what do you consider the perfect ham station. Injecting the proverbial "needle" into my arm I'll tell you what I would like. A single dial kilowatt, which would control the frequency and all following stages. The KW would be band-switched by push buttons. There would be separate beams for all bands which would be selected by the same button that selected the frequency. On the wall a glass map would light up with the direction the beam was covering. The receiver could be any of the standard communication receivers, such as a 101X, Super Pro, etc. A good bug and straight key, real high-fidelity speech with FM available for the UHF, and a neat modernistic room make up my perfect ham shack. Of course I am a long way from that stage of the game even now, but you can't stop a man from dreaming.

Back to the question of what else after the "essentials." The CW man can't very well use an over-modulation indicator; nor can the phone man use an electronic-key. I only mention this to point out that there are such things as *useless* accessories. Invaluable aids in any amateur station would include such equipment as ECO's; monitors, wavemeters, bugs, field-strength meters, universal testers. etc. On the transmitter alone, for example, there are many so-called "extras" which can be eliminated, although for safety's sake some are almost essential. Overload and underload relays; separate meters in each stage; band-switching; separate pilot lights in each circuit—these are non-essentials when trying to squeeze the old buffalo.

Look over the photographs of amateur stations accompanying this article. Pretty nice aren't they? From this point on, remember you too can be the envy of every amateur in your town.

Let's list a few cautions for the real beginner, and some old-timers too, might well take heed. Be careful of "bargains" available at any radio stores but the most reputable houses. Don't ever be high-pressured into buying equipment you haven't got implicit faith in! And most important—don't over-build on a limited budget. More specifically, spend money on good standard parts for a low-power rig, rather than buy junk for higher power. In the end you'll be rewarded! In radio, like anything else, *you get just what you pay for.*

In order to keep our main topics of discussion intact we are going to lightly touch on several relatively unimportant hints. An excellent one is to use masonite panels wherever possible, unless you have a well-equipped machine shop. Contrary to general belief masonite is just as good looking as steel and is far easier to work with. Invest money in good tools. Every ham should have at least one good pair of cutters and long-nose pliers; at least a 75 watt soldering iron; a good chassis knock-out punch; some sort of good drill capable of handling up to 1/4" bits and some sort of ream; at least several assorted files; screw-drivers; a heavy hammer and a cold chisel. A circle-cutter, center punch, and good box of assorted hardware complete the list of equipment that makes it possible for any half-way handy ham to turn out a really finished rig.

In the next article we shall start and perhaps finish an analysis of communication receivers. Nothing startling is promised, but you might get some good ideas. It is interesting to note the fact that a large percentage of hams on the air are using commercial receivers. There is a reason and next month we shall go into it.

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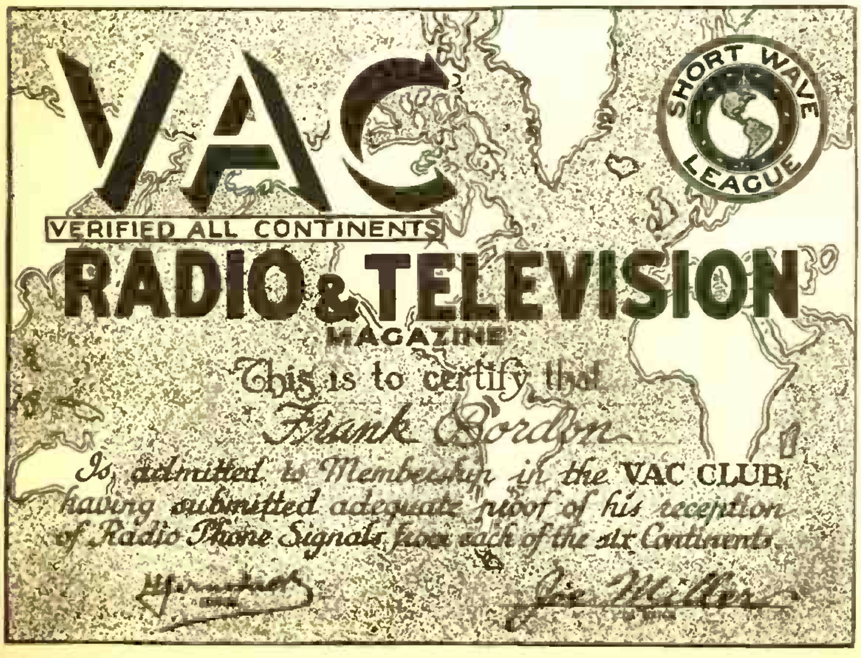
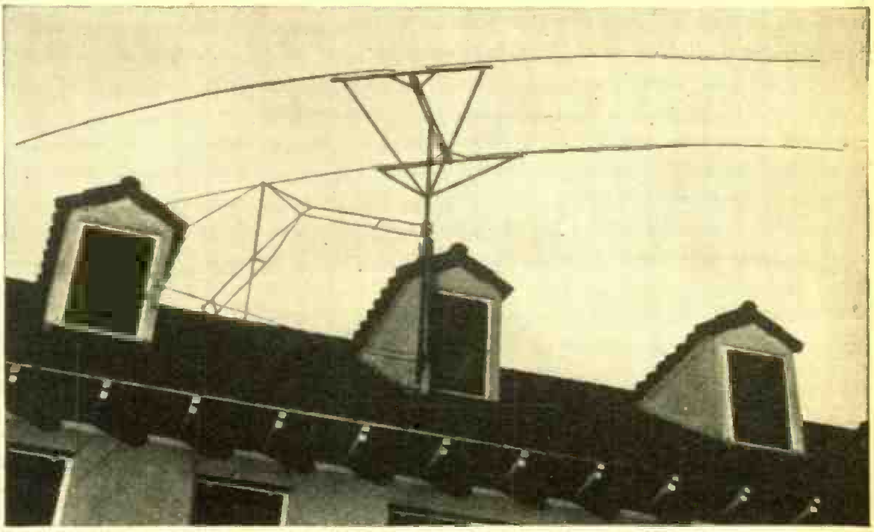




Appearance of Mr. Blanchard's bamboo beam as installed on the roof.

Bamboo Beam

By R. M. Blanchard, W4FIC

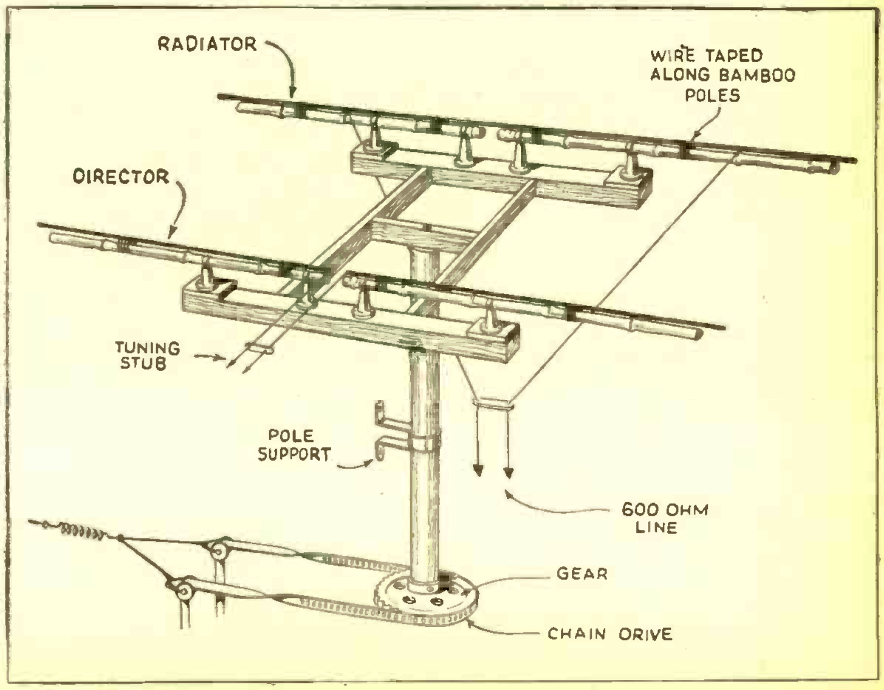
● KNOWING that I would not be satisfied until I had tried out a close spaced beam on twenty meters and not wanting to put any money into the construction of one, I began looking about for ways and means. I finally decided to build one by using bamboo poles, with wire taped along them for the *elements*.

Four straight bamboo fishing poles, each about fifteen feet long, were procured and six stand-off insulators were dug out of the scrap-box. The elements are mounted with a spacing of six feet, eleven inches for twenty meters.

Next, the four bamboo poles were mounted on the frame. This was done by fastening each pole to two stand-off insulators. The stand-off insulators on each element support of the frame were mounted to give them maximum separation (three feet will give ample support) and leave about six inches between butt ends of each adjacent pole. The poles were fastened to the insulators by small pieces of strap aluminum, bent and drilled to form an encircling strap. The outer insulators of each pole should be mounted on one-inch blocks to minimize a slight sag in the poles. Also, it is a good idea to varnish the poles before mounting them in order to keep out the weather.

At this time the element wires should be cut to their proper lengths. The approximate proper length for the radiator was found to be 34 feet 8 inches, and for the director 31 feet, plus a 12-inch tuning stub. After having done this the wire is stretched along

Constructional details of the bamboo beam.



the bamboo poles and taped in place. A delta matching section is then fastened to the radiator so that the Y is spread seven feet at the top and is seven feet from the center of the antenna to the point where the V of the delta joins the transmission line. The array is fed with a 600 ohm transmission line. The one foot tuning stub on the director can be made from heavier wire than the number 14 wire used on the antenna proper and mounted on stand-off insulators to give greater rigidity.

In tuning the array a second person's help is almost mandatory. It is also necessary to have a field-strength meter. The beam should first be mounted in place and all tuning adjustments made from there. The field-strength meter should be mounted about 50 yards away from the beam with a makeshift antenna strung to it. This antenna should be cut to approximately the correct frequency and erected parallel to the elements of the beam. The shorting stub is removed from the director and the radiator is pruned until a maximum reading is obtained in the field-strength meter. Next the shorting bar is replaced on the director tuning stub. With the transmitter *on* and very loosely coupled to the antenna, the shorting bar should be run up and down the stub, until a maximum or minimum reading is obtained on the field-strength meter, depending on whether the director or radiator is toward the meter. This is the permanent location for the shorting bar and it should be soldered in place. While this tuning adjustment is being made it is necessary to wear thick leather gloves in order not to get bitten by the R.F. present. After this has been done the beam should be rotated and the front-to-back ratio checked. This ratio should be in the neighborhood of eight to one. The delta matching, if carefully measured, need not be adjusted further as the match can be considered close enough for effective operation.

There are many effective methods of *rotating* the beam. The system used by the writer was one of ropes and pulleys. An old bicycle drive was fastened to the base of the pole, on which the beam was mounted, just above a short plug which fitted into the inner race of a ball bearing. The bearing in turn was securely mounted on a wooden base. A bicycle chain was used to rotate the beam. A rope was fastened to each end of the chain and run through pulleys to the operating room. A stout circular metal band slightly larger in diameter than the pole was mounted about six feet above the base of the pole, to act as a support and yet permit the pole to rotate. The feeders were run to slip-rings and kept tight by small springs.

So far the beam has performed admirably. It has been up about two months and withstood varied weather conditions. Its superiority over several other types of antennas tried at this location was immediately noticed. Using 150 watts input, stations have been worked in the Philippines, Guam, and Little America. One hundred percent schedules have been kept with stations in the Hawaiian Islands. It has certainly justified the small amount of effort put into it. It is believed that this type of beam would perform equally as well on ten meters and be extremely simple to construct.

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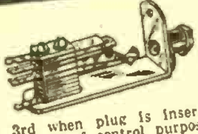

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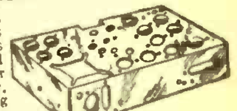

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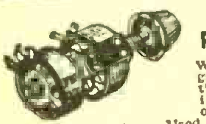

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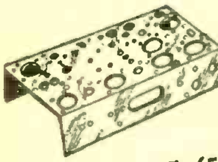

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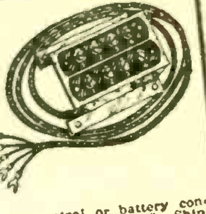

Unusually well made Philco 8 foot, 5 wire cable with spade terminals at one end and terminal block with 8 positions at other end. Wires color coded. Well insulated. May be used for remote control or battery connections, etc. Terminal block 3"x3"x¾". Ship. weight 1 lb.

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Scophony Demonstrates "Movie-Size" Television

Britain's leading proponent of optical-mechanical scanning, Scophony Limited, demonstrated movie-size television images to the press in New York after but three months in America, during which time their system was changed from the somewhat lower European standards to conform with the American standard of 60 frames per second at 441 lines. An audience of about 100 saw pictures 9 ft. x 12 ft. projected on a translux screen from the Scophony apparatus located about 12 ft. behind the screen. The system makes use of a 120 ampere arc as its light source. From here the light is passed through a "supersonic cell" about which more later. It then is projected upon a rotating mirror drum, which provides the horizontal scan, and thence to a second drum which causes the image to be scanned vertically. From this second mirror drum the light is projected onto the screen.

The pick-up was accomplished in a small studio on the same floor of the building where the demonstration was held and carried by wire to the receiver. The fact that engineers rather than studio technicians conducted the demonstration is said to have accounted for rather uneven illumination of the subjects being televised, and certain injuries which the apparatus suffered in transit from war-torn England to the United States were given as the cause of some wavering of the image.

The brilliance of the screen, while comparable to that of home-movies, does not approach that of a directly viewed cathode-ray tube. While the eye failed to differentiate very much between the cathode-ray and the projection screen, light measurements showed the decrease to be about 8 to 1.

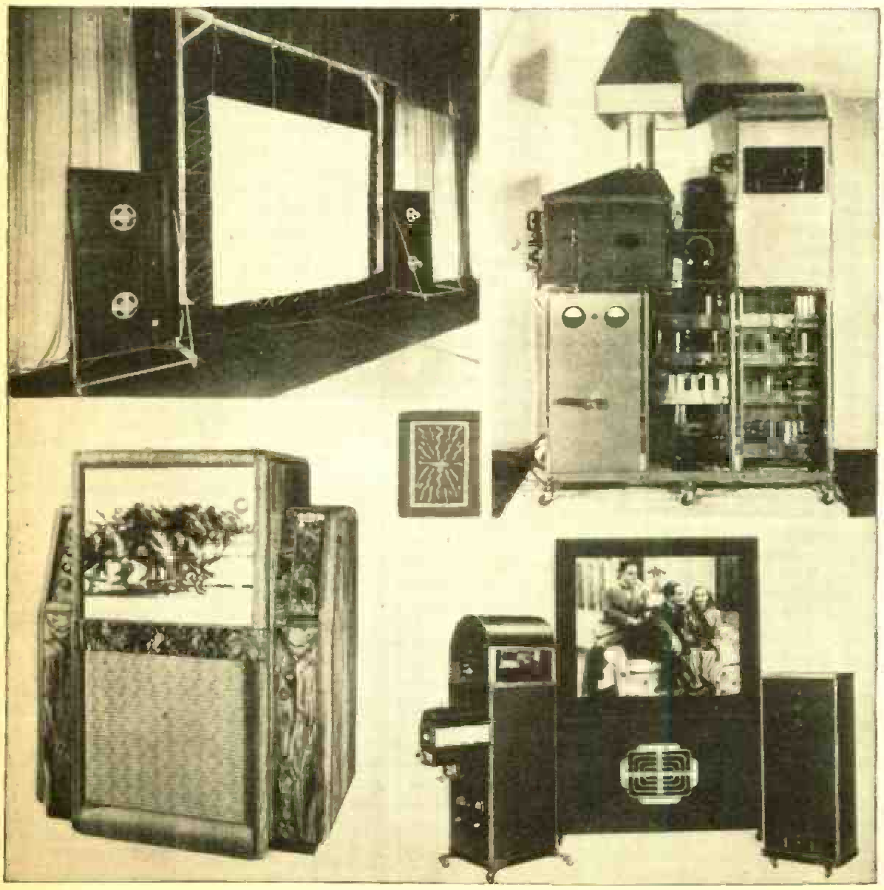
The supersonic light modulator cell, one of Scophony's major patents, uses a light storage principle, so that instead of each "dot" (or picture element) appearing on the screen at a given instant, a complete scanned line is on the picture simultaneously. This, of course, increases the brilliance to a point greatly in excess of that possible with the old Kerr cell method of light modulation.

The company also demonstrated a number of smaller receivers. Among these was apparatus using a 4 ft. screen, designed for installation in hotels, bars, restaurants, etc.; one with a 2 ft. screen, and another with an 18 inch screen, both intended for *home* use. It is interesting to know that the usual curvature of the cathode-ray tube is absent, the screen being perfectly flat. This, for a size of 18 inches and over, is a marked advantage. Spokesmen of the company also pointed out that the apparatus uses no costly replaceable elements and operates at voltages only a small fraction of those required for image projection with cathode-ray tubes.

The managing director of the company, Solomon Sagall, expressed the hope that the Federal Communications Commission would permit the advance of television in the United States, and that industrial concentration upon war-time production would not be so great that the manufacture of television apparatus would be seriously curtailed.

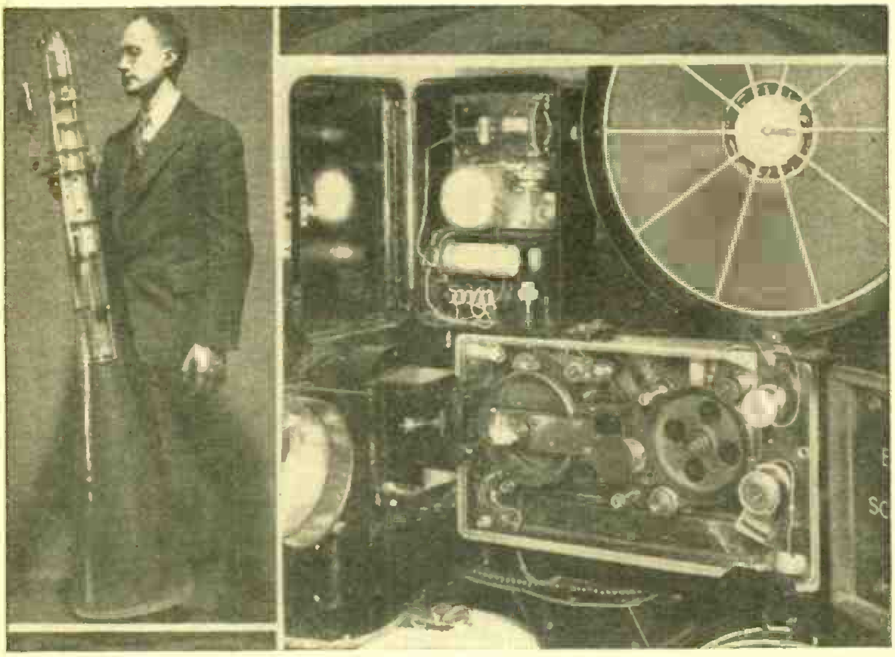
The accompanying pictures show the 2-foot screen *home* receiver, the 4-foot screen outside location receiver (flanked left and right by the scanner and the receiver—amplifier respectively), the screen used with the 9 x 12 foot receiver, and the large scanning apparatus which projects the image onto it. In both of the pictures where figures are shown on the screen, the images have been inserted; they are not image photographs.

Two top pictures (below) show Scophony large image television screen, with loudspeakers on either side, and mirror drum projection scanner used in reproducing these images. Two lower photos show Scophony "home-model" television receiver, and a larger size receiver intended for public halls, stores, etc.



Latest *Television News* as well as hints for the experimenter, will appear in the next issue. Don't miss the special article by Thornton Chew, describing in great detail how to properly locate the television receiving antenna, so as to minimize interference and prevent "ghost" images.

Television Travels 190 Miles Over Wires



Giant television receiving tube of special design, used in the latest Bell Laboratories demonstration of television over 190 mile coaxial circuit. Photo at right shows film television scanner.

● TELEVISION over an all-wire circuit had its longest-distance public demonstration when a program taken from motion-picture films was transmitted from Bell Telephone Laboratories in New York over the coaxial telephone cable to Philadelphia and back to the Hotel Pennsylvania, a 190 mile loop. Observers compared this with the same scene locally transmitted across a few miles in New York City. The scenes were reproduced on a special television receiver-tube developed in Bell Labs.; and when viewed from the usual distance of five or six feet from the tube the difference between local and long-distance cable transmission was imperceptible.

Motion pictures were scanned at the laboratories and the video signal was transmitted either directly to the Hotel Pennsylvania or to the hotel after having been sent to Philadelphia and back over the cable. Between Philadelphia and New York there are two coaxial cables inside a single lead sheath. (About 90 per cent of it is underground.) This cable system was installed in 1936 by the Bell Telephone System for use in its experiments primarily on the transmission of speech but also on the long distance transmission of television signals. One of the coaxial cables in the sheath had been used last summer for transmission of television views of the Republican Convention from Philadelphia to New York. In the present demonstration the two cables in the sheath were joined at Philadelphia to form a loop circuit back to New York. Each of the coaxial cables consists of a copper tube about the size of a lead pencil with a copper wire held centrally in it by disc insulators ¾ inch apart. About every five miles along the line there is a three-stage vacuum tube amplifier in each coaxial, making a total of 120 tubes in the loop. So large a number is required because the losses in the coaxial are enormous—2100 decibels for the round trip. That figure means that the signal is reduced in the ratio of 1:10 followed by 210 ciphers. If the energy which the earth receives from the sun were reduced in the same ratio, there would not be enough left to light a flashlight.

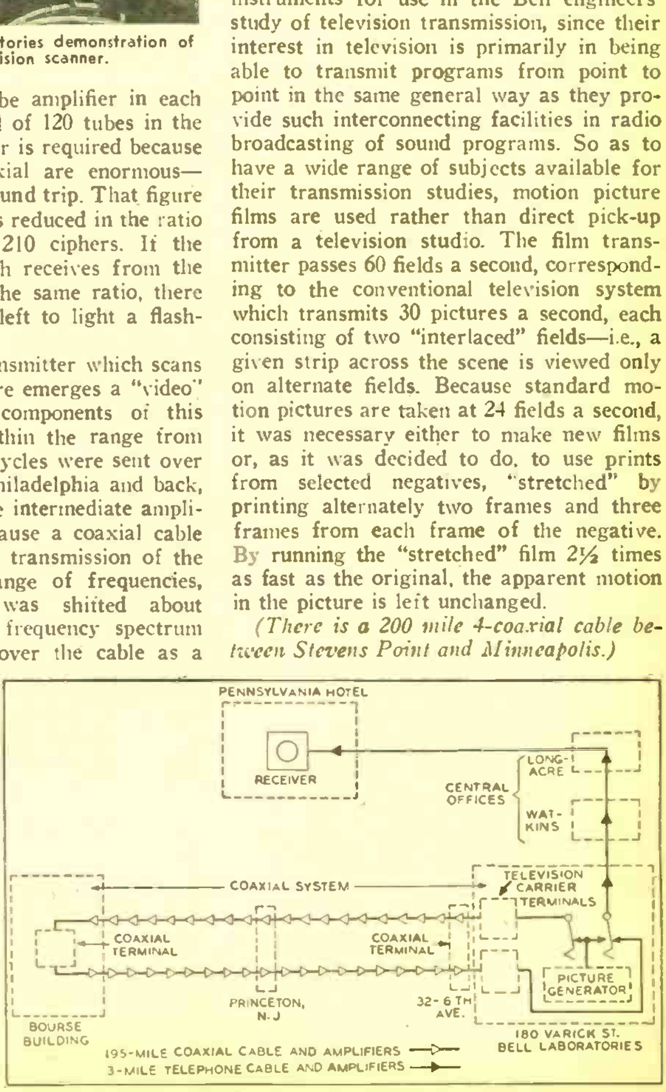
From the special transmitter which scans the motion picture there emerges a "video" signal current. The components of this signal which were within the range from 40 cycles to 2,700,000 cycles were sent over the coaxial cable to Philadelphia and back, and then through three intermediate amplifiers to the hotel. Because a coaxial cable is not suitable for the transmission of the lower part of this range of frequencies, the signal current was shifted about 300,000 cycles in the frequency spectrum and was transmitted over the cable as a band of frequencies between 300,000 and 3,000,000 cycles. When the signal current arrived at New York on its return trip it was remodulated to occupy again the range about 40 cycles to 2,700,000. A television image corresponding to this video current was then produced at the hotel by a special cathode-ray tube. This tube was developed for purposes of testing television transmission by Dr. C. J. Davisson, recent Nobel Prize winner, and his associates in the Bell Laboratories.

In the direct transmission from the film scanner to the hotel the entire frequency range of the complex "video" signal was transmitted. This extends from about 35 to 4,000,000 cycles, and occupies a wider range than was transmitted over the cable system. Despite this difference in range, motion picture scenes under the two conditions of transmission were generally agreed to be imperceptibly different.

Both the cathode-ray tube and the transmitter which were used in the demonstration were developed primarily as testing instruments for use in the Bell engineers' study of television transmission, since their interest in television is primarily in being able to transmit programs from point to point in the same general way as they provide such interconnecting facilities in radio broadcasting of sound programs. So as to have a wide range of subjects available for their transmission studies, motion picture films are used rather than direct pick-up from a television studio. The film transmitter passes 60 fields a second, corresponding to the conventional television system which transmits 30 pictures a second, each consisting of two "interlaced" fields—i.e., a given strip across the scene is viewed only on alternate fields. Because standard motion pictures are taken at 24 fields a second, it was necessary either to make new films or, as it was decided to do, to use prints from selected negatives, "stretched" by printing alternately two frames and three frames from each frame of the negative. By running the "stretched" film 2½ times as fast as the original, the apparent motion in the picture is left unchanged.

(There is a 200 mile 4-coaxial cable between Stevens Point and Minneapolis.)

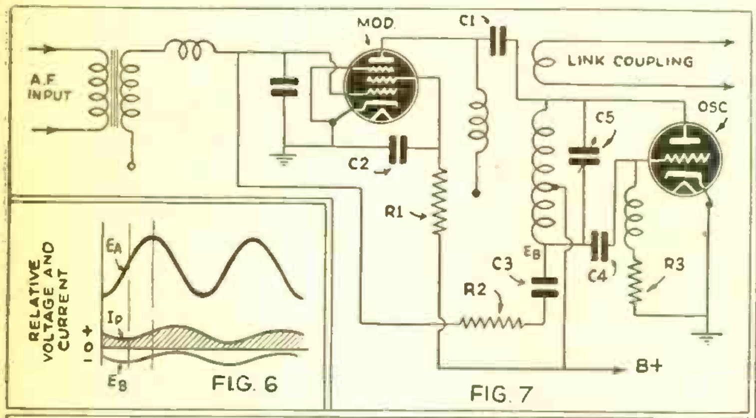
Diagram at right shows 190 mile coaxial circuit from New York to Philadelphia and return over which television images were transmitted and received in a recent demonstration in New York City. 441 line images were shown of superior quality and brilliancy, thanks to the new "square spot" cathode-ray tube illustrated above.

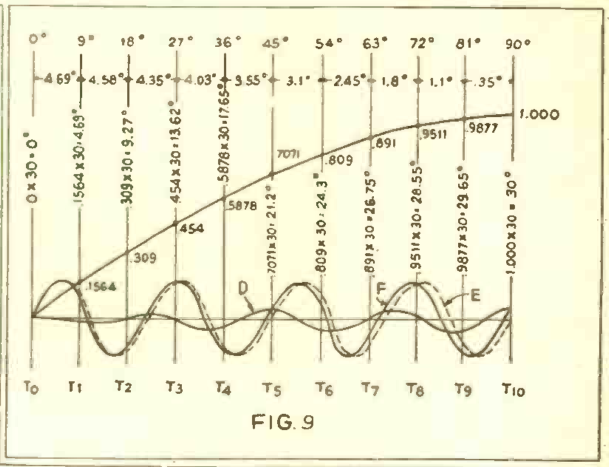


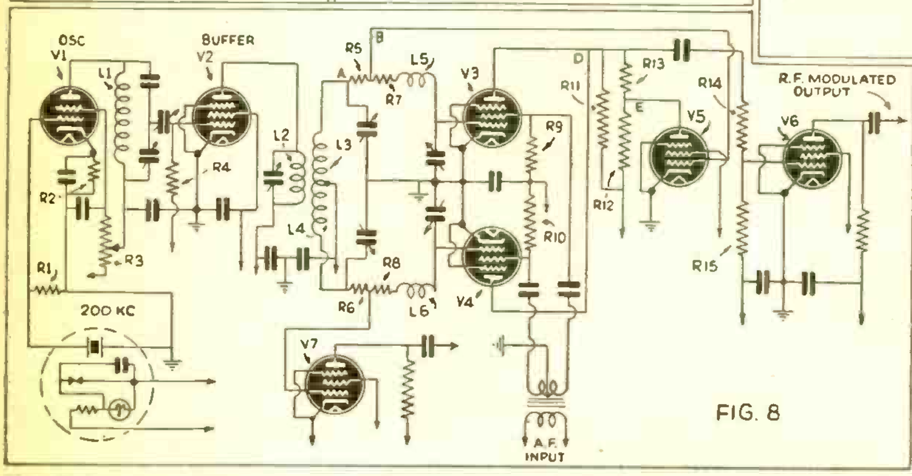
Principles of Frequency Modulation

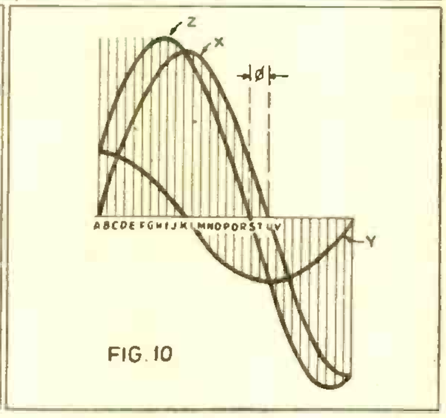
Part 2

F. L. Sprayberry*









The diagrams above, in connection with the accompanying text, will serve to give the student an intelligent idea of what Frequency Modulation is all about.

● COMING now to Fig. 6, we find that as we apply a plate voltage Ea to the 6L7 tube in Fig. 3 and a grid voltage Eb lagging it by 83°22′ we have a plate current essentially lagging Ea by 83°22′. This condition corresponds exactly to an inductance with a resistance in series with it.

The A.C. current drawn by the plate circuit is, of course, limited by the A.C. plate resistance of the tube which we have assumed as 1 megohm. The impedance (L and R in series) which these figures indicate may be specified as usual as—

1,000,000 /83°22′ — Note: The phase angle is positive in this case, indicating inductive reactance

and is, therefore, equivalent to components of—

resistance = 1,000,000 cos 83°22′
(cos 83°22′ = .1161)
= 1.000.000 × .1161
= 116,100 ohms and a
reactance = 1,000,000 sin 83°22′
(sin 83°22′ = .9932)
= 1,000,000 × .9932
= 993,200 ohms

Inductive reactance $X_L = 2\pi fL$ and hence

$$L = \frac{X_L}{2\pi f}$$

Thus solving for an inductance value here we have—

$$L = \frac{993{,}200}{2\pi \times 2{,}000{,}000} = .0788 \text{ h or}$$

78.800 microhenries

Now let us assume that L2 of Fig. 3 has a value of 60 microhenries which would be appropriate for the oscillator shown. Being in parallel with the inductance represented by the tube, the total inductance Lt would be found as follows:

$$L_t = \frac{L_1 L_2}{L_1 + L_2}$$

and substituting values we have—

$$L_t = \frac{78{,}800 \times 60}{78{,}800 + 60} = 59.95 \text{ microhen. approx.}$$

Naturally, there is no mutual inductance because the tube has no appreciable magnetic field and does not store energy as for a regular inductance. The formula as above for uncoupled inductances is, therefore, an accurate expression for the sum of the two.

The inductance value of 78.8 mlh. which the tube forms artificially is true only for one value of control grid voltage. As the control grid (No. 3 from the cathode) becomes more negative, less plate current can flow and the A.C. plate resistance is increased. Likewise, as it becomes positive, the A.C. plate resistance is reduced and the artificial reactance is reduced.

Let us assume that the inductance represented by this tube (6L7, Fig. 3) can be varied from 7880 microhenries to 788,000 mh. These two values separately considered in parallel with 60 mh. will give totals of—

59.5 mh. for 7880 mh.
60 mh. for 788,000 mh.

Note: These values are considerably greater than we would find in practice and are given only as examples.

Now, if a coil of 60 mlh. will tune to 2000 kc. with any condenser combination and it

*President, Sprayberry Academy of Radio.

is changed to 59.5 mh., the frequency will rise. This is made true because the frequency varies as the square root of the factor of inductance change. The latter is: 60/59.5 or 1.0084 the square root of which is 1.0042. At 2000 kc., therefore, the frequency change would be $1.0042 \times 2000 = 2008.4$ kc. or a change of 8400 cycles. Half of this would be 4200 cycles and if the oscillator is set at 2000 kc. after the reactance tube is added, and the latter is adjusted at its correct bias (signal control grid) the frequency may be made to swing from $2000 + 4.2$ kc. to $2000 - 4.2$ kc., or from 2004.2 kc. to 1995.8 kc.

This frequency shift may take place at any audio frequency because A.F. is fed into the No. 3 grid of the 6L7 tube and the A.C. plate resistance of the tube is changed at A.F. and in accordance with the voice or music wave form.

While this FM wave as described might be transmitted without further equipment, we shall see later that, for satisfactory reception, the actual numerical frequency swing of an FM wave must be at least as great as the highest A.F. used in modulation, and preferably, as much higher as practicable. For example, if we desired to use modulation components as high as 10,000 cycles, we must have a frequency deviation of at least 10,000 cycles and preferably 50 to 60 kc.

With the apparatus described as a start, we can achieve this by frequency multiplication of the carrier. Let us assume that we use two frequency tripler stages and one frequency doubler which will multiply every frequency by $3 \times 3 \times 2$ or 18. Considering now, the carrier and maximum deviation both above and below it, we will have at the transmitting antenna—

$2004.2 \times 18 = 36{,}075.6$ kc. carrier + positive deviation
$2000 \times 18 = 36{,}000$ kc. carrier
$1995.8 \times 18 = 35{,}924.4$ kc. carrier + negative deviation

The carrier frequency is raised to the ultra-high frequencies at 36 mc. while the frequency deviation is 75.6 kc. each side of the carrier on audio peaks.

Postponing the study of frequency multipliers we now refer to the disadvantages of this type of frequency modulator. Shunting the inductance of the oscillator is a rather low D.C. resistance in the form of the resistance component of the modulator tube. This has been shown in our example to be about 116,100 ohms. This value changes with modulation, thus varying the load on the tank circuit. This action causes amplitude modulation of the oscillator as well as frequency modulation. The lower the plate resistance of the modulator the more pronounced becomes this undesirable effect.

It should be obvious also that crystal control of the oscillator is not possible with this type of modulation. This means that any instantaneous frequency change of the oscillator not controlled by the modulator will produce additional modulation, which is undesirable.

To avoid a more involved discussion than the preceding, we have not considered certain other factors in this problem such as, for example, the effect of the amplified grid signal on the H.F. voltage applied to the plate, the input grid admittance, factors other than capacitance, etc.

More recent work on the reactance tube modulator indicates that it is possible to adjust the phases of the grid and plate voltages in such a way as to do away with the resistance component.

If instead of attaching the grid feeder connection at Ea as in Fig. 3, we attach it to point Eb as in Fig. 7, the phase difference between the applied H.F. plate voltage to the modulator and the grid voltage will be between 90 and 180 degrees. If we disregard any phase change due to C3 in Fig. 7, the phase will approach 180° as R2 is reduced. As we know, in this type of oscillator circuit voltages Ea and Eb are substantially 180° out of phase, and of course, the presence of R2 allows a reduction of phase difference with adjustment of R2. This resistance corresponds exactly with resistance R4 in Fig. 3.

Now, if the modulator behaves as an inductance with a phase angle of 83°22′, all we need to do is to adjust R2, Fig. 7, until we establish a plate to grid phase of 96°38′ which will *average* exactly 90° as $83°22' + 96°38' = 180°/2 = 90°$. The modulator will then act as a pure reactance and will not "resistance load" the tank circuit at all but will be electrically a part of it. Such a reactance tube modulator produces no measurable amplitude modulation, allows the use of a power tube as an artificial reactance, permitting much greater frequency swing and is more efficient in operation. The circuit represents a very considerable advance in FM development. (Credit—C. F. Sheaffer, Proc. I.R.E., February, 1940.)

So far this type of modulator has reached practical application only in amateur and laboratory communication but it has much future possibility in low powered and particularly portable or mobile transmitting equipment.

The Armstrong Modulating System

In this system of FM, we start our study with a crystal controlled (constant frequency) master oscillator. Usually it operates at 200 kc., chosen simply as a convenient and practical value. Any stable oscillator circuit of the crystal controlled type may be used.

The oscillator in combination with the frequency modulation circuit is shown in Fig. 8. The 200 kc. carrier generated by the crystal controlled oscillator, excites a buffer stage V2 to insure a constant load on the oscillator and this buffer stage in turn excites the grids of a circuit which we call a balanced modulator. It consists of two tubes V3 and V4, having their grids operated in push-pull fashion (phase opposition) and their plates connected directly together.

At point A at one side of the grid input circuit a 200 kc. signal is fed to the grid of V3 and V5. With V5 a resistance only is involved while with V3 an inductance is involved. Both signals are reduced by R5 but more important than this, the voltage at C leads that at B by about 90° because of the inductance L5. We may, therefore, expect any signal at the plate V5 to be 90° out of phase with that at the plate of V3.

As long as tubes V3 and V4 have identical characteristics there will be no output at V3, because it will be neutralized or completely compensated by an equal and opposite signal at the plate of V4. The screens of these tubes, however, are fed A.F. in reverse phase so that the balanced modulator is unbalanced first in one direction, then the other; as one screen voltage is increased and the other correspondingly reduced, the output of the tube having the greater screen voltage overcomes the other and there is a net output at both the V3 and V4 plates which is transferred to the grid of amplifier V6 by the coupling means shown. The output of V5, however, is continuously fed into the same grid by means of the delta resistance network connecting plates V3, V4 and V5 with the plate supply voltage.

At point D in the circuit tubes V3 and V4 simply produce a type of amplitude modulated 200 kc. signal. It is a wave which is proportional at every instant to the A.F. voltage fed to it, being zero for no modulation *but having no carrier frequency changes whatever.* Tube V5 supplies an unmodulated 200 kc. carrier 90° out of phase with the one just described to the same point (D) in the circuit. Being supplied from the same oscillator buffer stage the two waves are exactly in synchronism always remaining 90° out of phase, and they are added or combined and applied to the V6 grid. Tube V7 is simply a carrier frequency monitor and may be omitted from this study.

A careful analysis of the two waves at D in Fig. 8 and how they combine is the story of how frequency modulation is acquired. We will, therefore, turn our attention to this matter. Refer to Fig. 9.

The sine wave voltage E of Fig. 9 is the same as that created at point E in Fig. 8, and is due to the amplified signal at the plate of V5. Wave D in Fig. 9, due to V3 and V4 produced at D in Fig. 8, is a wave of *constant frequency* (200 kc.) and *constant phase* with *respect to E; namely, 90° leading. It never changes either phase or frequency at any time of transmission, but does change amplitude.* Its amplitude is proportional to the A.F. or modulating wave.

Wave D in Fig. 9, starting from zero amplitude at the left and rising to about 1/3 the amplitude of wave E is what results from the first quarter cycle of A.F. introduced into the screens of V3 and V4, Fig. 8. Just as the A.F. rises from zero to maximum in the first quarter cycle, so wave D does the same. D is simply an amplitude modulated wave but starting from zero instead of from an average carrier value.

When these two voltages (waves E and D of Fig. 9) are joined in a single circuit, they add and form a third wave F (corresponding to point F in Fig. 8) or, in fact, at D also. Wave D has had the effect of merely shifting the phase of E without materially affecting its amplitude. Note in Fig. 9 that there is a successive phase "slip" or "shift" from right to left of F with respect to E. At the left (time T_0) where D is zero, E and F are in phase but at the right where D is maximum, F has slipped to the left about 30° in phase. This slip in phase grows larger from left to right, or as time progresses from T_0 to T_{10}.

Many more carrier cycles are involved than appear in Fig. 9 for this "phase slipping" action but this graph is only symbolic of what actually happens.

In order to clarify this principle of superposition, refer to Fig. 10. Here we have shown a sine-wave carrier X and a phase changing wave Y of lower amplitude. For this study, Y has a constant amplitude of about 1/3 that of X (39% in this case). Waves X and Y are divided horizontally by vertical lines into 9° intervals starting at A. Thus, point B is 9°, C is 18°, D is 27°, etc. The numerical values of amplitude or height of waves X and Y are added at each interval and points are placed at the sum of these two at each interval. These sum values when connected form wave Z.

For example, at A the value of the amplitude of X is zero, while that of Y is 1.17 inch. At B, X is .4695 inch high, while Y is 1.155 inch high. At C, wave X is .9275 inch high, while wave Y is 1.112 inch high and so on.

The sum of the X and Y values at A are 0 + 1.17 inch = 1.17 inch and at B their sum is .4695 + 1.155 or 1.6245 inch. These sum values such as 1.17 and 1.6245 are the heights of the wave Z at the corresponding points A, B, etc. A complete table showing all values for every 9° interval for more than ½ cycle follows. It is in no sense essential to learn this, as we have enough information in Fig. 10 for our purpose. It is included for those who desire to pursue the study further.

It must be noted that the measurements 3" and 1.17" are purely arbitrary and may be changed to other values without altering the idea intended.

TABLE 1

	θ°	Peak X = 3" Sin θ	3 Sin θ	θ1	Sin θ1	Peak Y = 1.17" 1.17 Sin θ1	3 Sin θ + 1.117 Sin θ1
A	0°	0	0	90	1.0000	1.1700	1.1700
B	9	.1564	+ .4695	99	+ .9877	+1.1550	+1.6245
C	18	.3090	+ .9275	108	+ .9511	+1.1120	+2.0395
D	27	.4540	1.3620	117	+ .8910	+1.0420	+2.4040
E	36	.5878	1.7620	126	+ .8090	+ .9460	+2.7080
F	45	.7071	2.1200	135	+ .7071	+ .8275	+2.9475
G	54	.8090	2.4250	144	+ .5878	+ .6875	+3.1125
H	63	.8910	2.6700	153	+ .4540	+ .5320	+3.2020
I	72	.9511	2.8500	162	+ .3090	+ .3600	+3.2110
J	81	.9877	2.9600	171	+ .1564	+ .1830	+3.1430
K	90	1.0000	3.0000	180	0	0	+3
L	99	.9877	2.9600	189	— .1564	— .1830	+1.7770
M	108	.9511	2.8500	198	— .3090	— .3610	+2.4890
N	117	.8910	2.6700	207	— .4540	— .5320	+2.1380
O	126	.8090	2.4250	216	— .5878	— .6875	+1.7375
P	135	.7071	2.1200	225	— .7171	— .8275	+1.2925
Q	144	.5878	1.7620	234	— .8090	— .9469	+ .8160
R	153	.4540	1.3620	243	— .8910	—1.0420	+ .3200
S	162	.3090	.9275	252	— .9511	—1.1120	— .1854
T	171	.1564	.4695	261	— .9877	—1.1550	— .6855
U	180	0	0	270	—1.	—1.1700	—1.1700
V	189	—.1564	.4695	279	— .9877	—1.1550	—1.6245
W	198	—.3090	.9275	288	— .9511	—1.1120	—2.0395

NOTE: θ is used for X measurements while θ1 is used for Y measurements.

Your attention in Fig. 10 is called to the fact that wave Z leads wave X by about 20° and has a peak just a trifle higher than wave X. Its peak is a little to the left of point I while the peak of X is at K. Since wave X crosses the base line at U while wave Z crosses it a little to the left of S, the two waves are displaced a little more than two of the 9° intervals, in other words, more than 18°, which we estimate at about 20°. This phase difference is indicated as φ in Fig. 10.

With another graph, we could show that as the amplitude of wave Y is reduced, the phase between X and Z would be reduced correspondingly. In fact, there is a substantially linear relationship between the amplitude of Y and the phase between X and Z for small angles—that is, up to approximately 30°.

It should be obvious that if Y were 180° from the phase shown, that Z would lag X in phase instead of leading it as in Fig. 10, all other conditions being equivalent.

Now we must determine what connection this phase shift has with frequency modulation. For this purpose, let us return to Fig 9 and note a part of the graph which we have not as yet discussed.

Curve G is the first quarter cycle of a sine wave and simply represents the manner in which the average amplitude of wave D increases. On the necessarily small amplitude scale on which D is actually drawn, it is not at all obvious that *D is actually an R.F. wave having a ¼ cycle A.F. envelope*. This quarter of an audio wave is also divided into 9° intervals, T_0-T_1, T_1-T_2, T_2-T_3, etc. At T_0 wave D does not exist or is at zero, at T_1 it is 15.64% of its maximum amplitude, at T_2 it is 30.9%, etc. These percentages are shown on wave G as factors of 1, that is 15.65/100 or .1564 for T_1, etc.

The R.F. (200 kc.) and audio (100 cycle) waves shown in Fig. 9 are not shown in proportion. Actually the time T_0 to T_{10} which is ¼ cycle of a 100 cycle audio wave is only 1/400th second. During this time the 200 kc. wave actually produces 200,000/400 or 500 cycles instead of the 4 cycles of it shown by the wave E.

Phase shift between E and F *must correspond to the average amplitude of D.* E and D in Fig. 9 of course correspond respectively to X and Y in Fig. 10 while F in Fig. 9 corresponds to Z in Fig. 10. In Fig. 9, we are going to limit the maximum shift in phase between E and F to 30°. This helps insure that the phase change between E and F will be automatically proportional to the amplitude of D.

Then if wave D increases from zero to .1564 in the first 9° of the audio cycle the *phase shift* between E and F will be .1564 x 30° or 4.69°, which is the average phase shift between E and F approximately for the *first* 9° of the audio cycle. From T_1 to T_2, wave D increases from .1564 to .309 and the corresponding phase angle changes to .309 x 30 or 9.27°. During this interval the phase shift will be an additional 4.58° (9.27 —4.69°).

From these figures it is obvious that from T_0 to T_1, *the phase between waves E and F (Fig. 9) changes the greatest amount per unit time or most rapidly,* while from T_9 to T_{10} the phase change is minimum. *The frequency deviation from the carrier is proportional to this rate of change of phase* between E and F and hence *is maximum in the interval T_0 to T_1.*

Tabulating all intervals to T_{10} we have in Table 2 at left:

TABLE 2

Time	Degrees Audio Cycle	Average Amplitude of D or Audio Amplitude		Degrees Max. Phase	Total Phase Shift of E and F	Increase in Phase Angle Per. 9° Time Interval
T_0-T_1	9°	.1564	x	30°	4.69°	4.69°
T_1-T_2	18°	.309	x	30°	9.27°	4.58°
T_2-T_3	27°	.454	x	30°	13.62°	4.35°
T_3-T_4	36°	.5878	x	30°	17.65°	4.03°
T_4-T_5	45°	.7071	x	30°	21.2°	3.55°
T_5-T_6	54°	.809	x	30°	24.3°	3.1°
T_6-T_7	63°	.891	x	30°	26.75°	2.45°
T_7-T_8	72°	.9511	x	30°	28.55°	1.8°
T_8-T_9	81°	.9877	x	30°	29.65°	1.1°
T_9-T_{10}	90°	1.0000	x	30°	30°	.35°

If wave G, for example, should represent an audio wave of 100 cycles this quarter cycle shown would require only 1/400th second for transmission and a 9° interval of this quarter cycle being only 1/10th of the quarter cycle (90°) would take place in 1/4,000th second.

Furthermore, if as indicated, the phase between E and F changes 4.69° in this time, namely 1/4000th second, in one second, *at the same rate* it would change 4000 × 4.69 degrees or 18,750 degrees. Dividing this by 360 to get the total number of cycles represented in 18,750 degrees as there are 360 degrees in one cycle, we have 18,750/360 or 52.2 cycles increase in carrier frequency whatever the primary carrier frequency may be. If it is 200 kc., then the carrier, during the time interval T_0-T_1 is 200,052.2 cycles and, as we have seen, this is the maximum frequency deviation of the carrier for a modulating frequency of 100 cycles under the conditions assumed above.

Let us now trace the carrier deviation for the other time intervals as we have done for this one to determine the carrier deviation during each 9° audio interval at 100 cycles modulation. Arranging the above calculations in one equation, we have—

$$F = \frac{\frac{1}{\frac{1}{4} \times 1/10 \times 1/100} \times \varphi}{360}$$

F = frequency deviation of carrier

$$F = \frac{\frac{1}{1/4000} \times \varphi}{360}$$

φ = *rate of change* of phase (E and F) in degrees per unit of time

$$F = \frac{4000\ \varphi}{360} \qquad F = 11.11\varphi$$

and tabulating all 9° values of φ° we have the results recorded in Table 3, next page.

The values of deviation frequency shown here as well as the carrier values might be considered averages for the time units given and are quite accurate enough for all practical work. In the interest of exactness, however, it must be stated that the rate of

TABLE 3

Time Interval	*Rate of Change of Phase (ϑ°)*	*Deviation - Cycles (ϑ° Times 11.11)*	*Actual Carrier Cycles*
T_0-T_1	4.69	52.2	200,052.2 cycles
T_1-T_2	4.58	51.0	200,051.0
T_2-T_3	4.35	48.3	200,048.3
T_3-T_4	4.03	44.8	200,044.8
T_4-T_5	3.55	39.4	200,039.4
T_5-T_6	3.1	34.4	200,034.4
T_6-T_7	2.45	27.2	200,027.2
T_7-T_8	1.8	20.0	200,020.0
T_8-T_9	1.1	12.2	200,012.2
T_9-T_{10}	.35	3.88	200,003.88

phase shift in every interval varies throughout the entire interval. Thus, while it averages 4.69° in the interval T_0-T_1, it is slightly greater than this at T_0 and slightly less at T_1. We have taken a small enough interval here to obtain good accuracy but there are other means of obtaining exact values at any single time interval.

One means of doing this makes use of mathematics which is beyond the scope of this course and is in no way essential to the practical study as given above. It is included here, however, for those students who may possibly make use of it and for those who desire to pursue this study in advanced technical literature. The work includes calculus which is not essential to the above understanding of this subject.

We first convert the above formula for frequency deviation into an expression with which we may solve for any particular value—that is, a formula of what we may call "continuous functions." This formula is as follows:

$$F = \frac{\vartheta \text{ Sin } 2\pi \text{ fmt}}{2\pi t}$$

in which ϑ is the maximum carrier phase shift, fm is the audio frequency and t the time under consideration.

The similarity of this to the former equation will be shown by making the same substitution in it as in the other expression. We first convert the "angle" 2π into degrees as we know this to represent 360 degrees or an entire "circle" or "cycle." This gives us—

$$F = \frac{\vartheta \text{ Sin } (360 \text{ fmt})}{360t}$$

Now if, as above, t is to be 1/4000 second, we may express this decimally for convenience as .00025 second. Also, we have seen that we desire a maximum carrier phase shift of 30 degrees so ϑ would be 30°.

For the same audio frequency of 100 cycles, fm would equal 100 cycles. Our substitution would therefore be—

$$F = \frac{30 \text{ Sin } (360 \times 100 \times .00025)}{360 \times .00025}$$

Solving for this we have—$360 \times 100 \times .00025 = 9°$ and $360 \times .00025 = .09$. The sine of 9° as given in Fig. 9 is equal to .1564 and hence we have—

$$F = \frac{30 \times .1564}{.09}$$

$$F = \frac{4.69}{.09}$$

$F = 52.2$ cycles

It is obvious that this formula expresses the same ideas. In this form, however, it may be used to further advantage. Expressed in this way we no longer have a fixed time interval such as T_0-T_1 but a variable time element t. We may decrease the time factor t indefinitely until it is zero and in this way find the rate of change of phase for any particular time instead of for a time interval or continuously for the entire time.

So as to make the denominator the same as the sme function in the numerator in the formula we multiply both numerator and denominator by fm obtaining—

$$F = \frac{\text{fm}\vartheta \text{ Sin } 2\pi \text{fmt}}{2\pi \text{fmt}}$$

these must be alike to compare them in the expression given—and factoring for convenience we may write—

$$F = \text{fm}\vartheta \frac{\text{Sin } 2\pi \text{fmt}}{2\pi \text{fmt}}$$

In this expression as the value t is made indefinitely small, the entire value of the expression approaches—

$$F = \text{fm}\vartheta \frac{\pi}{180} \cos 2\pi \text{fmt}$$

(We do not undertake to show the process by which this formula is derived.)

The smallest possible value t can have is zero, and assuming it to be zero here; $\cos 0° = 1$ and—

$$F = \text{fm}\vartheta \frac{\pi}{180} \times 1$$

and substituting our values as before we have—

$$F = \frac{100 \times 30 \times \pi}{180} \times 1$$

$$F = \frac{100\pi}{6}$$

$F = 52.3$ cycles approx.

The accuracy of this figure at time T_0 in Fig. 9, where the time is zero, depends only on how far we desire to carry out the decimal places in— $\frac{100\pi}{6}$

Any and all other values of t from T_0 to T_{10} may be used here to find exact frequency deviations. A table such as that above may be arranged to show these values if desired.

It will be noted from the above work as well as from the preceding that in the interval T_0-T_1 the deviation of the carrier is maximum or more exactly at time T_0 in the latter calculation.

Simplifying our original equation—

$$F = \frac{4000\vartheta}{360}$$

and converting it to enable other substitutions, we may write—

$$F = \frac{\text{Nfm}\vartheta}{360}$$

in which—

N = number of parts per cycle for each time interval

fm = modulation frequency

ϑ = rate of phase change in the interval $\left(\frac{1}{N}\right)$

or, more exactly at time T_0, we observe that $t = 0$ and $\cos 2\pi \text{fmt} = 1$. Hence by the more exact formula—

$$F = \frac{\text{fm}\vartheta\pi}{180}$$

Here we find the factor $\pi/180$ to be constant and to have a value of .01745 permitting us to write—

$F = .01745 \text{ fm}\vartheta$

It is this formula that has very great importance, for it shows what factors determine the maximum amount or degree of modulation. We shall return to it shortly.

In the meantime, take notice that wave F in Fig. 9 is actually changing frequency in accordance with this figure in the last column in Table 3. Just because waves E and F are "in phase" at T_0 this does not mean that they have the same frequency at this or any other point. We know from previous studies that the phenomenon of beats or heterodynes is caused by two waves changing phase continuously, *and at every cycle of the beat, the two beating waves are exactly in phase at one instant although they are never of the same frequency.* In this type of frequency modulation, we have the effect of two waves changing phase not continuously but in accordance with a sine wave or, as we say, "sinusoidally." There is, of course, only one wave but its changes are considered with respect to the reference wave of constant 200 kc.

At T_{10} in Fig. 9 actually waves E and F are of exactly the same frequency although of different phase by 30°, while at T_0 they are of the same phase but differ in frequency by 52.3 cycles.

Referring back to Fig. 8, we must realize that the wave at D is first applied from V3 and then from V4 as the A.F. changes from plus to minus. The carrier that is impressed at D from V4 is in reverse phase of that at V3 and its phase is made to advance beyond the 200 kc. carrier as a reference and as a phase slip occurs, this produces a lower carrier by as many cycles as it was above it before.

Repeating again this very important formula—

$F = .01745 \text{ fm}\vartheta$

We find that the deviation frequency depends entirely on the modulation frequency and the total phase change ϑ which is chosen in the design. We have seen, however, that the total phase shift ϑ is controlled by the modulating voltage and moreover we have determined to not let this exceed 30° for reasons mentioned. However, we desire that the audio voltage be sufficient to produce a phase shift of ϑ or 30 degrees maximum for every frequency. For example, let us assume that 10 volts is required at the screens of the balanced modulators to produce a phase shift of 30 degrees of the modulated carrier as referred to the original carrier. Then regardless of its frequency, every audio signal must reach a maximum of 10 volts to produce this phase displacement.

But we have the term, fm, in this formula which represents the modulation frequency.

(To be continued)

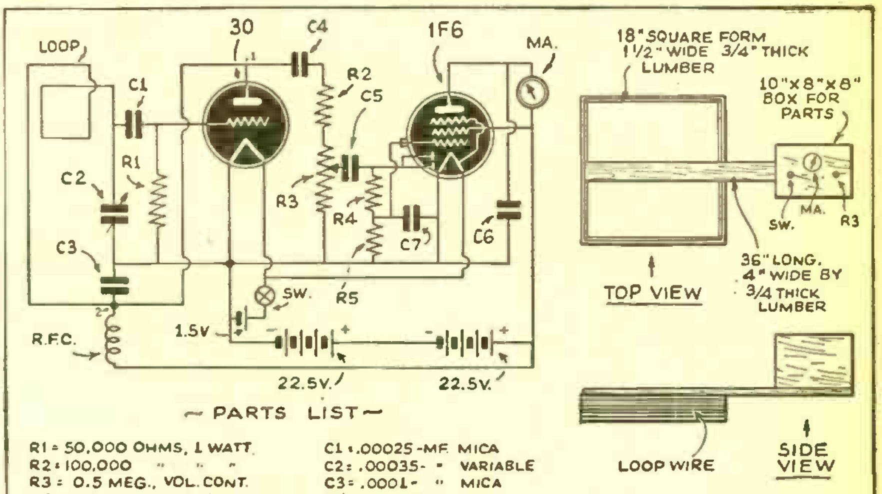
Diagrams of Interest

This is a new department. If you have a new Hook-Up, send it along; a pencil diagram will do. Be sure to include a brief description.

All diagrams and descriptions accepted and published will be paid for at regular space rates. Diagrams may be for receivers, adapters, amplifiers, etc. Send them to Hook-Up Editor, RADIO & TELEVISION, 20 Vesey St., New York City.

LOOP ABSORPTION TREASURE FINDER

COVER DIAGRAM



— PARTS LIST —

R1 = 50,000 OHMS, 1 WATT
R2 = 100,000 " " "
R3 = 0.5 MEG., VOL. CONT.
R4 = 100,000 OHMS, 1 WATT.
R5 = 1,000,000 " " "
R.F.C. = 85 MH.,
MA. = 1.5 MA., D.C. METER
SW. = ON-OFF SWITCH

C1 = .00025-MF. MICA
C2 = .00035- " VARIABLE
C3 = .0001- " MICA
C4 = .00025- " "
C5 = . " " "
C6 = .01- " PAPER
C7 = " " "

LOOP = 18" SQUARE FORM
40 TURNS, No. 24 D.C.C. WIR

● THIS type of "treasure finder" operates on the principle that there will be absorption of energy by metal objects (due to eddy currents) in the field of a coil which is carrying radio frequency current.

When using a treasure-finder the operator should first have an idea of about where to look, otherwise it would be like searching for a needle in a haystack. Also the operator should realize that even the best of treasure-finders have definite limitations and should be considered as an experimental project. A treasure-finder will only cover a certain amount of ground, and works best on a dry day over dry sandy soil, as moist soil tends to conceal the effects of the metal.

Only the highest grade parts should be used in the construction of a treasure-finder, and these parts should be arranged and wired carefully to secure the best results.

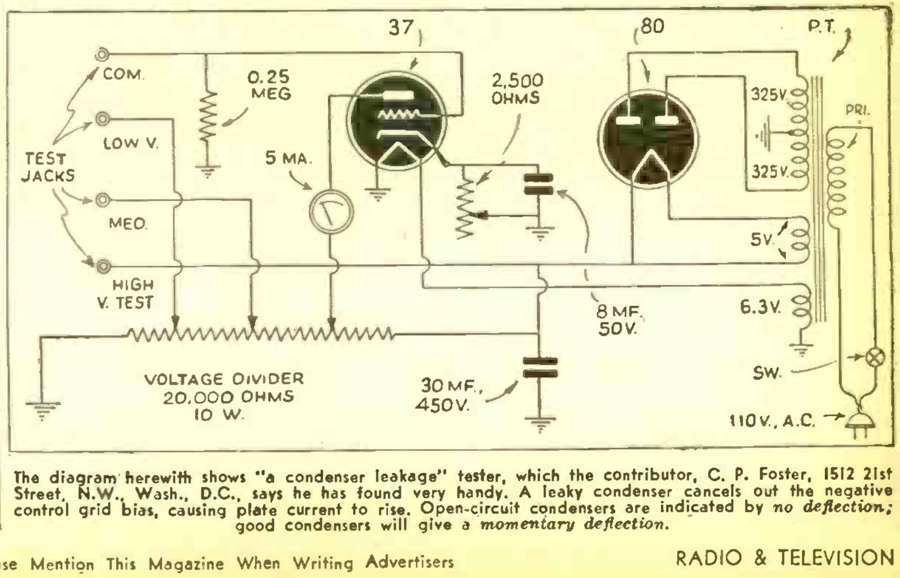
This instrument employs a Colpitt type of oscillator. The greater the intensity of oscillation the larger the R.F. voltage between points 1 and 2. The presence of metal in the field of the coil will cause the voltage to decrease, as indicated by a decreased reading of the milliammeter.

When using the "finder," first turn on switch SW and allow the tubes to heat up. When you have no metal in the field of the coil, adjust R3 and C2 until the meter reads about mid-scale. Then place a large metal object under the loop and adjust C2 until the *greatest change* in meter reading is obtained.

It is the amount of change in meter reading which indicates the presence of metal; therefore it is essential that C2 be adjusted for maximum change in reading. Considerable experience must be had to interpret the readings correctly. To gain experience the constructor should experiment with various types and sizes of metal, buried at different depths in the earth.

This treasure finder is ideal to use at a beach party to locate treasure buried by the host.—*H. R. Wilkening, Loomis, Sask., Can.*

CONDENSER LEAKAGE TESTER

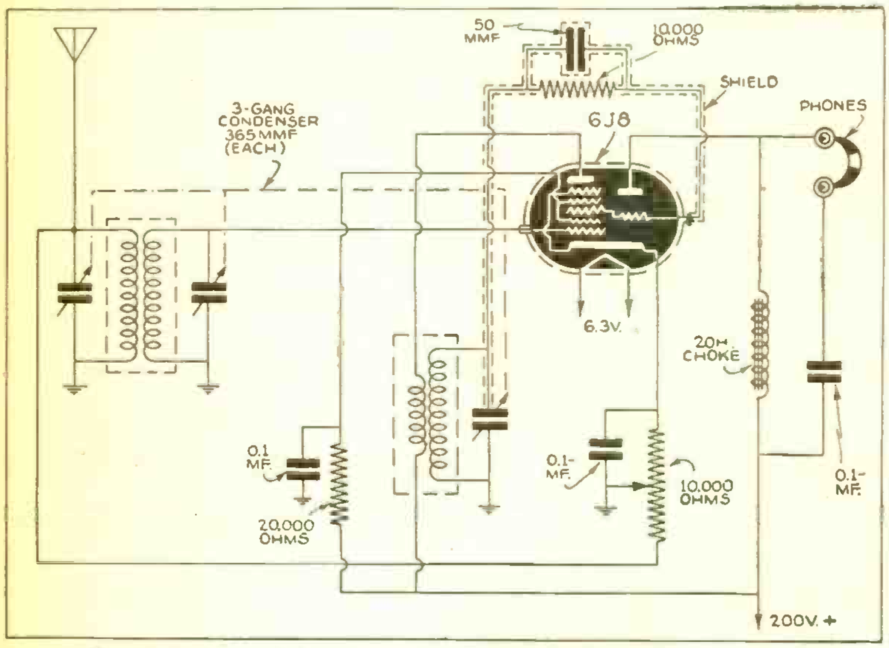


The diagram herewith shows "a condenser leakage" tester, which the contributor, C. P. Foster, 1512 21st Street, N.W., Wash., D.C., says he has found very handy. A leaky condenser cancels out the negative control grid bias, causing plate current to rise. Open-circuit condensers are indicated by *no deflection; good condensers will give a momentary deflection.*

See Pages 691 and 701 for other valuable premiums offered **FREE** to subscribers.

to the Radio Experimenter

One-Tube Super-TRF Receiver



"Puzzle" Diagram—Is this 1-Tuber working as a super-het? Let's hear your opinion!

● THE single tube used in this circuit is a 6J8 (Sylvania) Triode-Heptode-Converter, designed for service as an autodyne tube in a super-het circuit. Its function, however, in the present circuit is widely different from what the tube was originally intended. This will become apparent as we go along.

Starting at the antenna: The incoming signal is first taken care of by a band-pass tuner. This tuner is of the same general design as the kind used on an I.F. transformer, except that it is actually constructed like a R.F. coil. The coupling between the two coils is made adjustable by having one coil slide back and forth over the other. The coupling must be made quite loose in order to avoid *double-spot* tuning.

This type of hook-up at the antenna delivers a strong signal to the control grid of the heptode-half of the tube 6J8.

Consider the oscillator circuit: The tuning condenser of the oscillator grid circuit tunes in-step with the first two tuning condensers, so that the oscillator current always has the same frequency as that of the incoming signal.

The amplifying action in the heptode-half of the tube is two-fold. First, the signal delivered by the control grid is amplified in the usual manner. Second, the oscillator current, being in the same electron stream, and having the same frequency as the incoming signal, and also being in phase, now becomes added arithmetically to the signal, so that the final amplification is two-fold.

The oscillator serves two purposes: Additional amplification and higher selectivity. This may look like the old bottle called *regeneration*, only with a new label—but is it?

This brings us to the triode-half of the tube. Though originally designed to serve as an oscillator, the triode is now used as a combined detector and output tube. Direct coupling is secured by the connection of the two grids within the tube—the output from the heptode is detected, further amplified, and then delivered to the head-phones—sweet music!

The reception at the phones has good fidelity, and every station on the broadcast band comes in with good volume. Some of the stronger locals are often too loud and have to be turned down to lower volume.

The selectivity is about the same as obtained by an equal number of tuned stages in a regular TRF circuit.

All this circuit needs to make it "bugless" is to have the super-control feature added to the tube, so as to prevent *cross-modulation.*—*Ralph W. Martin.*

Edited by Herman Yellin, W2AJL

Modernizing Old Pilot Set

? *Can you advise me if I can change over my battery operated Pilot Super-Wasp receiver to use more modern tubes?—C. Small, Ruxton, Md.*

A. We show a diagram of this old and popular Pilot all-wave receiver, with the modern metal tubes. All the original parts have been incorporated, including the coils and condensers. The only additions necessary will be the sockets, tubes and a few resistors and condensers. Note that the old audio transformers have been used, but that a new output transformer will be needed. Although not shown on the diagram, on the broadcast band, a primary or antenna coil is used, while on all the *short-wave* bands, capacity coupling is employed from the antenna to grid coil.

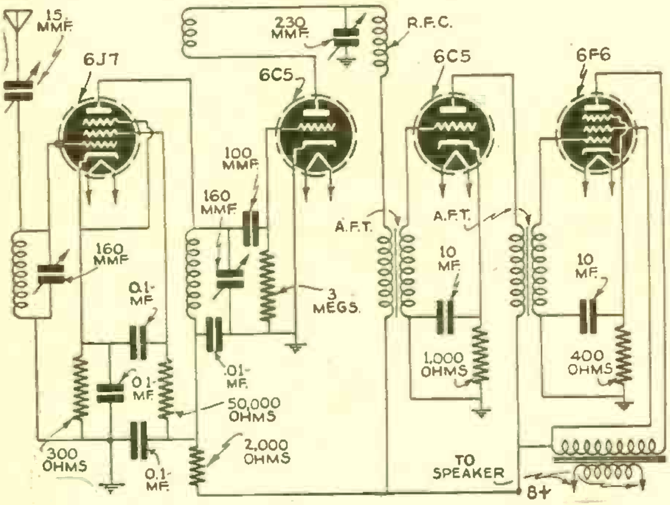


Diagram above shows how to re-vamp one of the old Pilot all-wave receivers for use with modern tubes. (No. 1248)

Economy Transmitter

? *How many crystals are needed to operate on all bands with the Economy transmitter described in the July issue? What is meant by the switch contact marked "Pent."?—P. Bowen, Llanerch, Pa.*

A. Two crystals can be used for all-band operation, since there is sufficient output, even when quadrupling in the oscillator, to adequately drive the buffer amplifier. When the switch is on the "Pent." or Pentode tap, the cathode coil and condenser is *shorted out,* enabling the oscillator to act as a pentode oscillator and delivering output on the crystal's fundamental frequency.

Signal Tracer

? *I wish to use an A.C.-D.C. TRF set as a signal tracer. How can I also trace the various I.F. stages? Can I use* untuned *stages?—B. Axelrod.*

A. Probably the simplest way would be to arrange the coils to be plug-in and use a coil with sufficient inductance to tune to the I.F. frequencies. However, for ease in operation, it is desirable to incorporate some method of switching from one band to the other. Untuned stages are not at all desirable for any kind of effective work. Use tuned R.F. stages by all means. Incidentally, coils suitable for this type of work and small enough to be mounted on a switch can be procured commercially.

Output of Amplifier

? *What is the output wattage of the one tube amplifier shown on page 496 of the December issue? What kind of speaker is used?—E. Meyer, Union Hill, N. J.*

A. This little amplifier will deliver 55 milliwatts and should use a small speaker of the 3 inch or 6 inch type. Its output transformer should have an impedance of 4000 ohms. A magnetic speaker can also be used. Remember that this amplifier has quite low gain and is therefore suitable as a phono amplifier and not for use with low-level microphones.

"Call Letter" Identity

? *The other night I copied code station JFMD but could not make out what he was saying as many of the letters were unfamiliar, and it seemed as though he was using a special code. —Rev. R. W. L. Mark, Hawley, Penna.*

A. JFMD are the call letters of a Japanese ship and he evidently was using the Japanese code. Since the Japanese alphabet contains 40 letters, some of their letters will have different dot-dash combinations than are used in the English alphabet. These extra combinations will contain more symbols than the letters we are used to, thereby making their code slower to send. Incidentally Japanese operators all learn both the Japanese code and the regular International Morse code, which makes his training much more difficult than ours, and puts to shame those students who protest against learning our code.

Antenna Problem

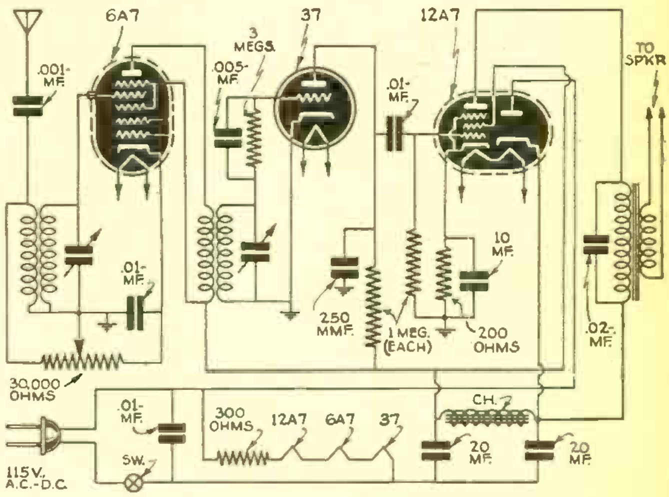
? *I wish to construct an antenna for the 80 meter band, but have only 70 feet of roof space available, with a lead-in distance of about 30 feet. Can you recommend an antenna for use on this band, as well as on the 40 meter band?—W. Deans, Brooklyn, N. Y.*

A. You can use an end-fed antenna, half-wave for 80 meters, which will be about 130 feet, including lead-in; make the flat-top portion as long as possible. If you cannot get in the entire 130 feet of antenna and lead-in, use an inductance in series with the lead-in at the transmitter end, and vary the amount of inductance until the antenna loads up the final to the maximum. Thereafter, loading of the final can be adjusted by varying the point at which the series coil is tapped onto the final coil. Remember that there is high R.F. voltage at the end of the lead-in, so use adequate insulation to prevent leakage.

Small A.C.-D.C. Receiver

? *Can you show a small A.C.-D.C. set using 6A7, 37 and 12A7 tubes?—G. Sarmiento, New York.*

A. A simple T.R.F. receiver is shown. It has adequate volume to operate a small loudspeaker and is simple to build. Either one of the small A.C.-D.C. filter chokes can be used or a 5000 ohm, 5 watt resistor can be used, with the choke preferred. A regular resistance type line cord can be used, or a 300 ohm, 25 watt resistor incorporated in the set itself; whichever is available to you.



Hook-up for small A.C.-D.C. receiving set of the T.R.F. type. (No. 1249)

Queries to be answered by mail (not on this page) should be accompanied by fee of 25c (stamps, coin or money order). Where schematic diagram is necessary, our fee is 50c up to 5 tubes; for 5 to 8 tubes fee is 75c; over 8 tubes, fee is $1.00. *No picture diagrams can be supplied.*

"Time Signals" Where Heard

? *Can you furnish me with information on how to build a simple receiver to tune in the NAA time signals on 113 kc., or information on how to tune the signals in on a short-wave receiver?—B. Stratton, Ridley Park, Pa.*

A. There is no need to build a special receiver in order to pick up NAA. Time signals are sent out almost every hour on the *short-waves,* and can be picked up with any *short-wave* (or all-wave) receiver. Their 9425 and 9250 kc. transmissions are perhaps the most easily heard in all sections of the country.

Untuned R.F. Stage

? *I have a 6-tube short wave super-het, with a 2-stage preselector. I would like to know if an untuned R.F. stage would further increase the sensitivity and selectivity. —J. T. Smisek, New Prague, Minn.*

A. Untuned R.F. stages give practically no gain whatever on the *short waves.* Their only value lies in their ability to isolate the antenna from the tuned circuits. They are sometimes used ahead of the detector to eliminate "dead-spots" in tuning, caused by the natural frequency or harmonics of the antenna falling in the particular portion of the frequency spectrum one wishes to listen to. Untuned R.F. stages are particularly valuable with regenerative receivers, since they prevent radiation from the detector. This can be particularly bothersome to other listeners.

24 Vt. Lighting Plant & Radio Problem

? *I am operating a boat that is powered with a 100 H.P. Diesel engine. The electric system on this motor consists of a 24 volt starter and generator. The lighting system on the boat consists of six screw-base 12 volt lights (I don't know the wattage on these lights), three 32 C.P., and three 3 C.P. automobile pin-base lamps, 12 volts. I have been cutting in these lights over half of my 24 volt battery but this causes an uneven drain over half of the battery.*

Also I have a 15 watt Transceiver hooked up to ¼ of this 24 volt battery.

I would like to know how to change this hook-up, by inserting the proper resistors in the positive leads, so that I could hook both the lights and the vibrapack across all of my 24 volt battery, getting an even drain across all of my battery.

The power-supply for the radio is a vibrapack that came with the set. It is marked: TYPE 6 V.P. VOLTS 6. I don't know the current drain of this vibrapack.—John Smithson, New York, N. Y.

A. Your lighting problem can be solved quite readily. First, let us assume that 24 volt bulbs for lightning are unavailable; if they are, we would strongly recommend their use. However, lacking 24 volt bulbs, the six screw-base bulbs should be connected in series-parallel.

If you cannot rewire your lighting system to this series-parallel arrangement, the next best thing would be for you to connect your string of six screw-base bulbs across one-half of your 24 volt battery, and the string of six auto pin-base lamps across the other half of the 24 volt battery. This system will not give you an even drain across the entire battery.

Hooking up your Transceiver is somewhat of a problem. Connecting a resistor in series with your vibrapack and placing the two across the 24 volt battery is very uneconomical, since the power drawn by the resistor is wasted and will be three times as great as the power taken by the vibrapack. Why not try changing the 6 volt vibrapack for a 24 volt unit or a 12 volt unit. If you must use a series resistor with the 6 volt vibrapack, you will have to know the amount of current drawn by the vibrapack. The value of the resistor in ohms will be equal to 18 divided by the current in amperes. If a 12 volt vibrapack is used, the value of the series resistor will be 12 divided by the current in amperes. In either case the resistance will be in the order of a couple of ohms and should be capable of dissipating quite a bit of heat, about 50 to 100 watts.

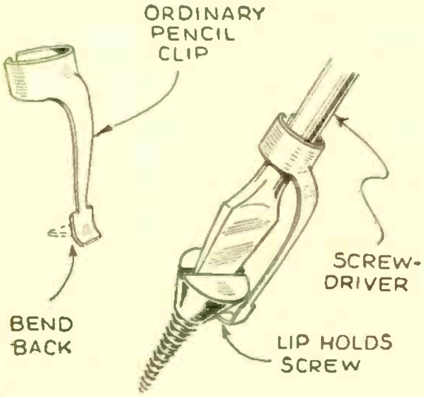
Converting Set for Short Waves

? *How can I change a 5-tube car radio into a short-wave receiver to pick up the 160 meter amateur band?—B. J. Moore, Eastland, Texas.*

A. If the receiver is of the T.R.F. type, it should be very simple to remove about one-third of the turns from each R.F. coil. This will enable the receiver to tune to the higher frequency. A superhet can have the same operation performed, but will necessitate some careful pruning of the coils, in order to get the detector and oscillator to "track" at the new frequencies. In removing turns, remember that the oscillator is much more critical than the detector, so prune the oscillator coil carefully.

The Cover Kink
First Prize Winner
Screw Holder

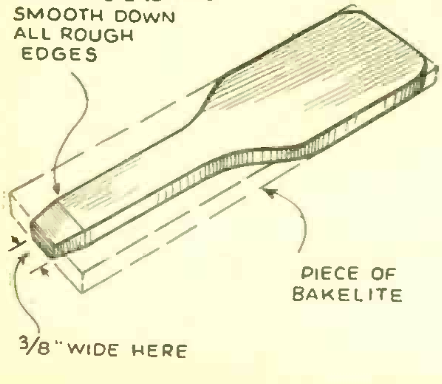
It is often very convenient to use one of those gadgets for holding a screw on the screw-driver. The attachment may be made out of a pencil clip of the commonest variety. All that is necessary is to bend down the tip as shown in the diagrams. There is less danger of breaking the tip off if it is first heated in a blowtorch or even a candle flame. Of course, if it is heated, it should be re-tempered after the bending operation.—*Melvin Levine.*

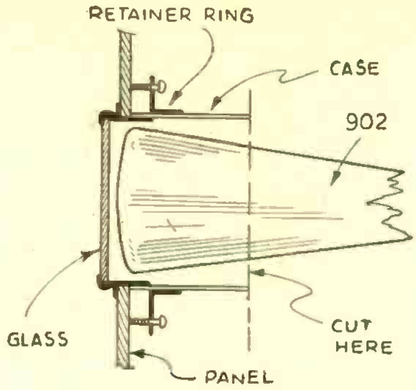


Neutralizing Tool

Frequently there comes to the Ham the problem of tuning the neutralizing condensers in the "final," without the error of the capacity of a metal shank screw-driver. Not only is this kink a good neutralizing tool, but it can be used wherever high voltage might be encountered.

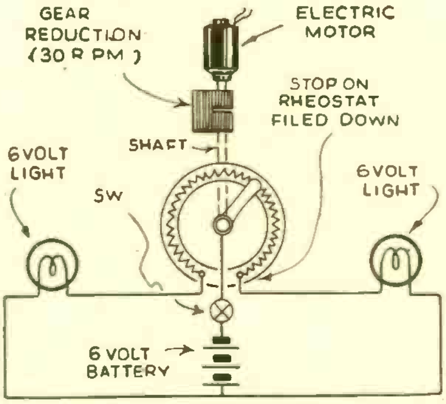
First find a piece of bakelite about one by ten inches in size. Take an old coping saw and cut it to the shape shown in the diagram, making the shaft about three-eighths inch wide. This should prove strong enough for the average job. Now, file the end of the shank down to a flat point, just like a point on a screw-driver. Thus you have a high voltage capacity-less screw-driver at no cost at all. If you want to spend more time and do a better job, you can build out the handle to suit yourself, but this is not necessary.—*George C. Michaelis,* W9DUI.





Oscilloscope Screen

Recently I built an oscilloscope using a 902 two inch cathode-ray tube. The problem of making a neat hole in the panel of the oscilloscope for viewing the screen presented itself. The solution to the problem was found in the case of a two inch panel meter. The inside diameter of the case was just a trifle over two inches and was, therefore, just right to accommodate the viewing screen of the 902. The back of the case was sawed off as shown, and the retaining ring used to keep the case in the hole, thus making a very neat looking viewing screen.—*Carl Helber.*



Rotary Lamp Dimmer

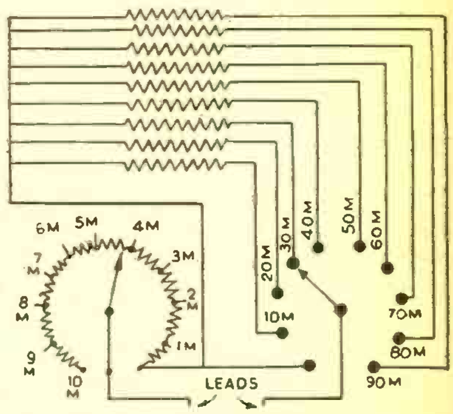
The accompanying diagram shows how to make an interesting "dual-circuit" lamp dimmer, to be rotated with a motor, so that when one lamp is dimming, the other lamp is becoming brighter, etc. I took an old rheostat and filed down the stop so that the arm could rotate continuously over the resistance wire; the rheostat was then mounted so as to be driven by a motor, geared down to rotate the arm at about 30 r.p.m. For larger lamps a rheostat with heavier wire will have to be used. For a more elaborate lamp display, several coils of German silver or other resistance wire may be wound and provided with rotary arms, a gang of such units being employed if necessary and driven by a motor.—*Roy Loughary.*

Resistance Indicator

As I have accidentally burned out several factory indicators, I devised a plan shown which makes the instrument easy and economical to repair, as only one resistor and potentiometer are in use at any one time. With a selection of good resistors and a good ohmmeter, the instrument can be calibrated accurately. A fuse may be placed in one of the lead wires to guard against accidental overload. The parts required are:

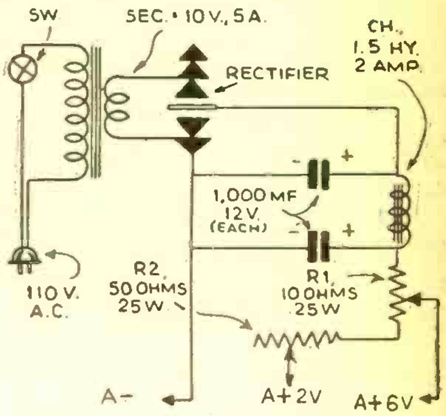
1—10 point selector switch
1—10M ohm resistor
1—20M ohm resistor
1—30M ohm resistor
1—40M ohm resistor
1—50M ohm resistor
1—60M ohm resistor
1—70M ohm resistor
1—80M ohm resistor
1—90M ohm resistor
1—10M ohm potentiometer

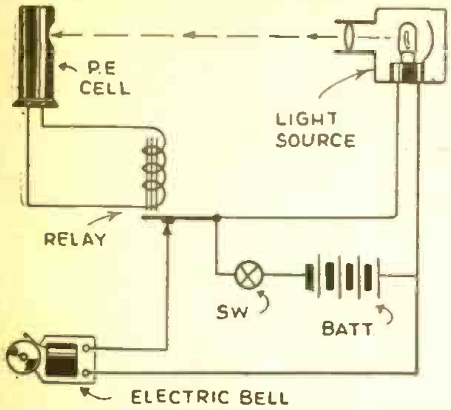
—*John Ralph Amos.*



Low Voltage Power Supply

The diagram shows a low voltage power-supply which many experimenters frequently have need of. The rectifier employs dry-disc copper-oxide units, obtained from an old battery charger. This rectifier I obtained was a 2 ampere, 6 volt type, which rectifies the low voltage A.C. obtained from a step-down transformer. Rheostat R1 regulates the 6 volt output, and R2 the 2 volt output, using a load of at least 4 ohms resistance.—*Alban F. Hatzell.*





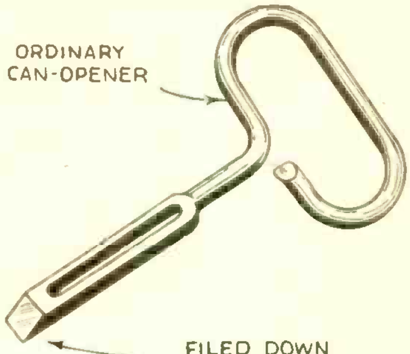
A Simple Burglar Alarm

A simple yet efficient burglar alarm can be made as illustrated. A photo-electric cell is wired to a sensitive electro-magnet fitted with a soft iron core, wound full with No. 36 enamelled wire. A very light armature is pivoted directly beneath the core, and is just held up by the magnetism generated by the current from the photo-electric cell.

When the pencil-light beam is interrupted, the armature falls, completing the bell-circuit. The light is operated from the bell batteries; to reset, the armature is lifted. A master switch is incorporated, by which the apparatus is controlled.—*Colin Hojem.*

Emergency Screw-Driver

At some time or other, I know every Ham and experimenter has been at a loss for a small screw-driver. One can be very easily made from an ordinary can-opener key. Just file down the end and there you are—with a very efficient emergency screw-driver.—*Tex Powers,* W5JED.

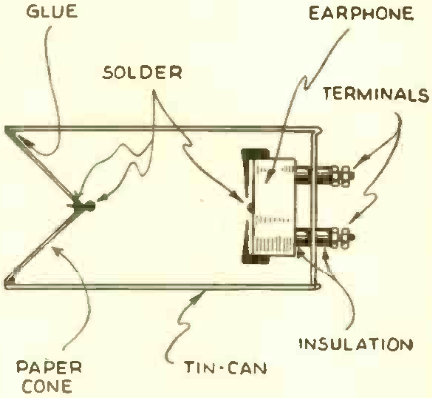


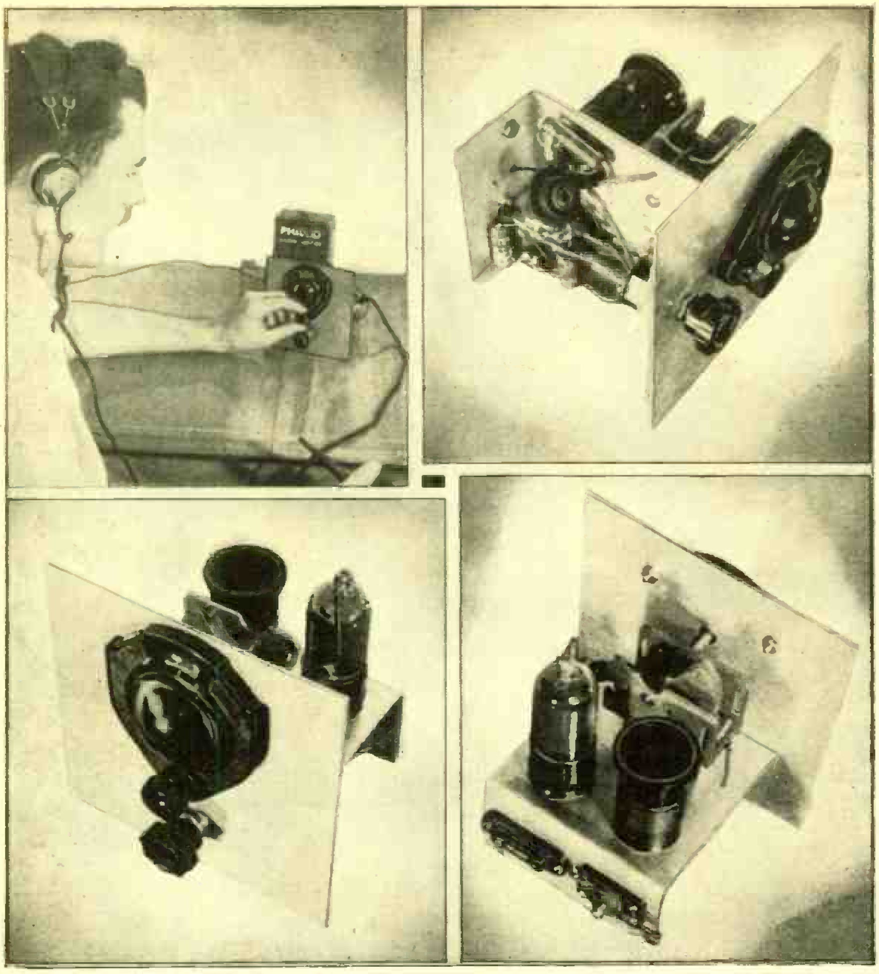
Code Practice Idea

Instead of building a separate code practice oscillator, I found that my receiver (SW5) would do just as well. First I inserted a key in series with one of the output leads of the receiver. Closing the switch on the key, I tuned to some station that was on the air. Then by tuning slightly off the station, I got the whistle which is characteristic of most sets, and "keyed" that. With the regeneration and by tuning, you can change the "pitch" of the tone to suit yourself. This gives more realism to the tone, static, fading, etc. An automatic sender can be used to just as good advantage.—*Walter Gabsa.*

Improved Mike

Usually the quality of an earphone mike is quite poor. The quality can be greatly improved by providing a paper cone to receive the sound to be transmitted. The case for the improvised mike is a tin-can, slightly greater in diameter than the earphone. The cone is made of heavy paper and is connected to the earphone diaphragm by means of a stiff piece of copper wire. The wire is soldered to the diaphragm and connected to the cone by means of a drop of solder on each side of the vertex. The edge of the cone can be fastened to the edge of the can by means of glue.—*Carl Helber.*





The four photos at the left show:—the Duette one-tube battery-operated receiver in operation—a bottom view of the receiver—a close-up front view and finally a rear view, showing the plug-in coil and tube.

The "DUETTE"—1-Tube Battery-Operated Receiver

William J. Vette

This single tube receiver will appeal to the "short-wave" beginner and it may also be built as a "broadcast" receiver, using suitable plug-in coils to cover the band. The circuit provides a sensitive regenerative detector and one stage of audio amplification. A smooth-working regeneration control is provided; while intended for head-phone reception, strong stations may be received on a sensitive PM type loudspeaker.

● HERE is a little job that is the very ultimate in one-tube receivers. Making use of one of the most recent tube types, the 3A8-GT, in a very simple circuit, performance is all that could be expected from any two-tube set.

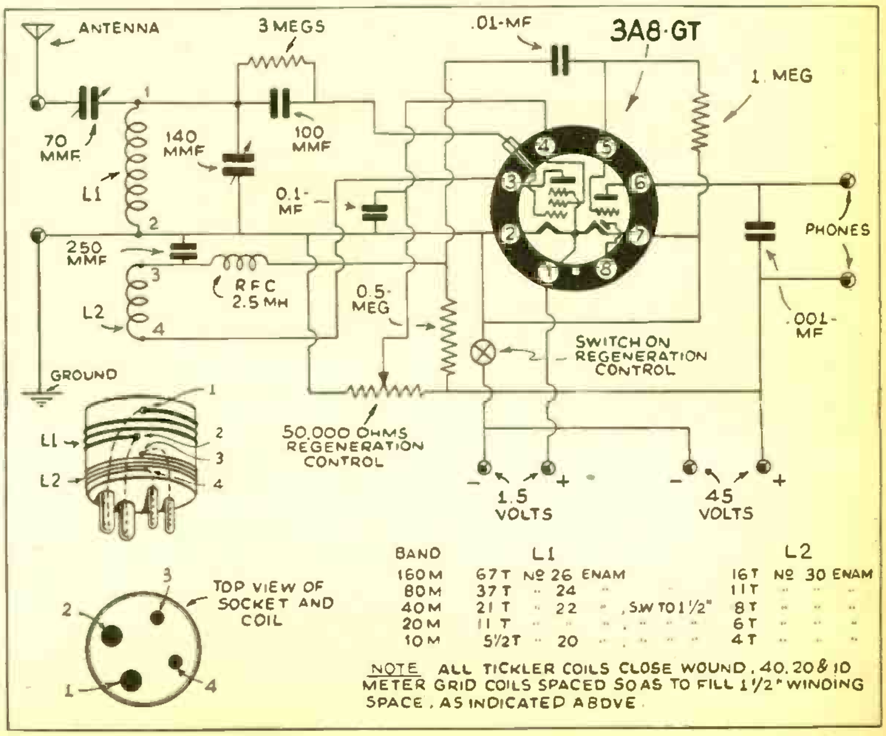
Requiring an absolute minimum of parts, this little receiver can be quite easily built in a very short time—and at surprisingly low cost.

The necessary power supply is quite simple, as the tube is designed to operate with only 1.5 volts on the filament, and a single 45 volt "B" battery supplies the plate current for both sections of the tube. Thus, the set can be made very compact and it makes an ideal portable set.

The tube consists of two separate sets of elements, a pentode and a triode. In this circuit, the pentode section is used as the detector, making a very sensitive arrangement, while the triode is used as a single stage of audio amplification. Regeneration is controlled by varying the screen voltage applied to the detector section, making for very smooth control, with a minimum effect upon the tuning when the regeneration is varied.

Standard two-winding plug-in coils may be used, or the constructor may build his own from the data with the drawing.

No special precautions need be observed in the building of this set other than to make certain that all leads are as short as possible, and check carefully all wiring before



BAND	L1	L2
160 M	67 T Nº 26 ENAM	16 T Nº 30 ENAM
80 M	37 T " 24 "	11 T " " "
40 M	21 T " 22 " , S.W TO 1 1/2"	8 T " " "
20 M	11 T " " " , " " "	6 T " " "
10 M	5 1/2 T " 20 " , " " "	4 T " " "

NOTE ALL TICKLER COILS CLOSE WOUND. 40, 20 & 10 METER GRID COILS SPACED SO AS TO FILL 1 1/2" WINDING SPACE, AS INDICATED ABOVE.

Wiring diagram for the one-tube receiver which performs two functions, is shown at the right. The single tube serves as a regenerative detector and one stage of audio. The "broadcast" band may be tuned in, by using a plug-in coil with more wire on it; 126 turns of No. 28 for L1 and 28 turns of No. 34 for L2.

trying the set out, to be sure that no errors have been made in connections, which might cause the tube to burn out.

The tube is designed with a double filament, to permit of operation on 1.5 volts, as shown in the diagram, or, by a series arrangement, on 3 volts. In the latter arrangement, prongs 2 and 7 are used for the filament connection, with no connection to prong No. 1. For 1.5 volt operation, hook up as shown in the diagram, prongs 2 and 7 connected together as the negative terminal, and No. 1 as the positive. In the series arrangement, prong No. 7 is the negative terminal, No. 2 the positive.

The tube also includes a diode section, at the negative end of the filament. In this set, we make no use of this diode, so prong No. 8, to which it is connected, is left blank, with no connection to any part of our circuit.

The antenna for use with this set may be very short, only about 20 or 30 feet being needed; too long an antenna may block the detector and not permit smooth control of the regeneration; in fact, if the antenna is much too long, the detector may refuse to oscillate.

Although shown in the diagram, an *external* ground connection is not absolutely necessary. In some cases you may find stronger reception *without* the ground connection, so it is better to try it both with and without the ground, and use it whichever way works out best in your case.

Be sure to connect the switch as shown in the diagram, between the negative terminal of the set and the common negative connection of both "A" and "B" batteries, for if the "B" battery is not thus disconnected when the set is not in use, the regeneration control will soon run the battery down.

Connections to the socket as shown in the drawing are looking at the *bottom* of the socket.

If you use standard coils other than those shown, be sure that your tickler is properly connected, otherwise the set will refuse to oscillate, and no reception can be had. In such a case, try reversing the leads to the tickler.

With reasonable care in wiring, this little set will provide you with most excellent reception, and will undoubtedly surprise you with its ability to pull in stations from far and near with ease.

Parts List

1—Set tuning coils (see diagrams)
1—Socket to fit coils
1—Tuning condenser, .00014 mf.
1—Antenna coupling condenser, .00007 mf. max.
1—Grid condenser, mica, .0001 mf.
1—Feedback condenser, mica, .00025 mf.
1—Bypass condenser, .1 mf., 100 volt
1—Coupling condenser, .01 mf., 100 volt
1—Bypass condenser, .001 mf., 100 volt
1—500,000 ohm resistor, ¼ watt
1—1 megohm resistor, ¼ watt
1—3 megohm grid-leak, ¼ watt
1—Variable regeneration control, 50,000 ohm
1—Octal socket for tube, bakelite
1—Slow tuning vernier dial
1—Knob for regen. control
1—Small grid clip
2—Binding posts, "Ant" and "Gnd"
1—Pair of tip-jacks for phones
4—Binding posts for battery connections
1—Panel and sub-base to fit layout
Solder, hook-up wire, etc.

Accessories

1—3A8-GT tube
1—1.5 volt dry cell
1—45 volt "B" battery
Headphones, aerial, etc.

Experiment with RADIOACTIVITY!

Ivan H. Walker

● PLEASE don't allow the title to frighten you with visions of X-ray tubes and other high priced apparatus. All that is needed is only a few things that, if you do not have them, may be obtained at the local hardware store.

Of course radium is one of the few elements which have the natural property of releasing part of their mass by radiation of energy. However, it is possible to cause other, less costly materials, to emit radiations. The gas in the ordinary electric lamp bulb lends itself admirably to this purpose.

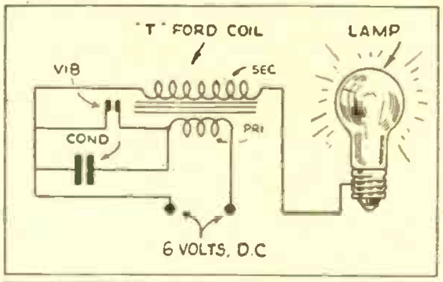
The diagram is self-explanatory. The parts used are: an electric bulb containing Argon gas, and a power-supply, consisting of a six volt storage battery, which operates an ignition coil from a Model T Ford (or similar high voltage induction coil).

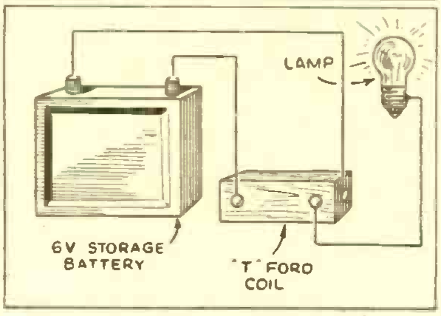
When the voltage is fed to the Argon you will notice a blue fluorescence, which, as you can easily guess, is caused by ionization of the gas, similar to the operation of neon signs. This is readily noticeable in daylight, but complete darkness is necessary to observe the radioactivity. After the gas has "percolated" for a minute or two, turn off the current and hold the bulb close to the eye. You will notice a dim radiance coming from the bulb, which lasts as long as ten to fifteen minutes, depending upon the degree of excitation of the gas.

The explanation of this artificially induced radioactivity is:

In 1933 it was discovered that by bombarding certain nuclei with atomic particles, a sort of hybrid nucleus could be built up which was unstable and soon broke down, in much the same way as do the nuclei of the naturally radioactive elements such as radium. Atomic physics is in its infancy as yet. Who knows what part it will play in the world of tomorrow?

The editors will be very glad to hear from other readers of RADIO & TELEVISION *who may have made simple yet very interesting experiments, like that here described. Photos are desirable but sketch will do.*





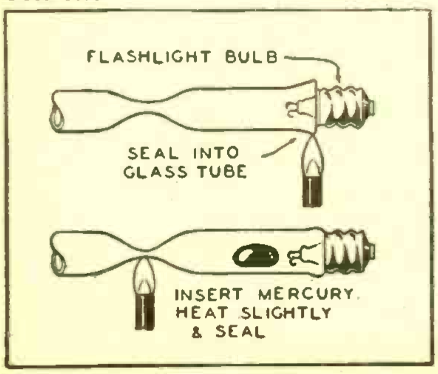
How spark coil is connected to lamp bulb.

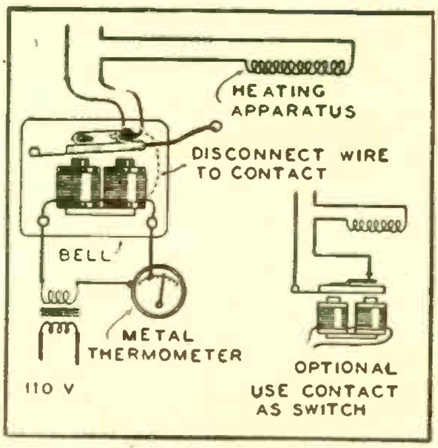
More Useful Electrical Ideas

HEAVY DUTY SWITCHES

● OFTEN it becomes necessary to close an electrical circuit in the laboratory carrying current amounting to several amperes. However, delicacy of the controlling instrument may not permit such heavy load. When this occurs it is advisable to use a second relay. The diagrams illustrate two methods. The first shows the construction of a mercury switch from an old flashlight bulb, glass tubing and mercury. The second illustrates how the unit is connected into the circuit and gives an optional circuit. In this illustration a 5- and 10-cent store thermometer is used as a thermostat. This has a small contact fitted in the proper position to close the circuit at a predetermined temperature and is connected in series with an electric bell in which the circuit has been changed to eliminate the interrupter. If the mercury switch is mounted on the armature of this bell, this switch can be used to interrupt heavy currents.

In the optional arrangement the circuit breaker of the bell is used to make and break the heavy current.—*Courtesy Science Observer.*





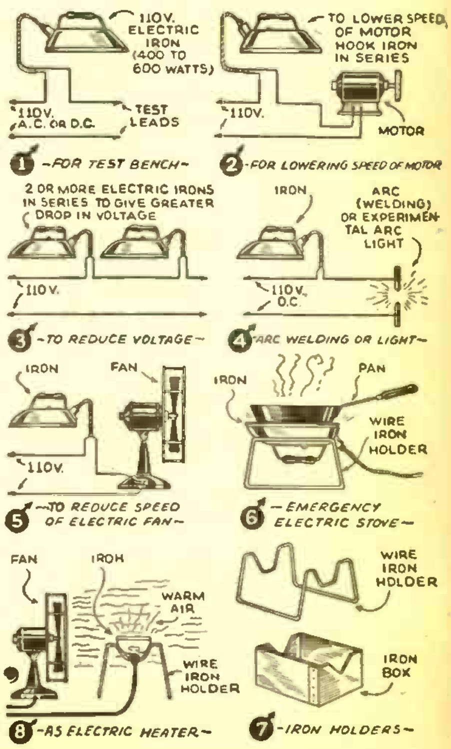
Simple remote control switch—also see below at left.

ODD USES FOR ELECTRIC IRON

● THE electrical experimenter often needs a resistance unit to connect in series with 110 volt test leads and the family electric iron comes in handy for the purpose. The average electric iron consumes about 400 watts and will therefore pass about 4 amperes at 110 volts A.C. or D.C. The picture No. 2 shows how an electric iron may be used to reduce the voltage fed to a motor where it is desired to have the motor rotate at a lower speed. Diagram 3 shows how two or more electric irons may be connected in series to give a still further reduction in voltage for test or other purposes. A simple electric welder made up with a couple of arc carbons and an electric iron connected in series as shown at Fig. 4. *(Don't forget to wear heavy black glasses to protect your eyes.)* An electric iron (or part of the resistance from an old burned out iron) can be used to reduce the speed of a fan motor as indicated in Fig. 5.

Fig. 6 shows how to use an electric iron as an emergency stove by turning it upside-down and Fig. 7 illustrates the construction of two simple supports to hold the iron in an inverted position. An emergency warm air supply may be made by placing an electric iron in front of a fan.

Eight uses for electric iron.

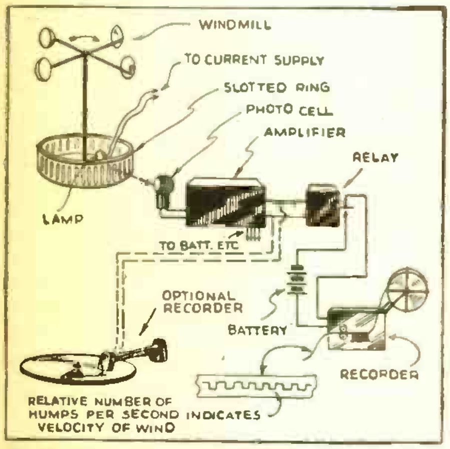


WIND VELOCITY INDICATOR

● THE photo-cell has found a new use as shown in the accompanying sketch where it is put to work by C. E. Delbos of *Ciencia Popular* for the purpose of graphically indicating the velocity of the wind. As the set of four cups arranged in the usual fashion rotate at a speed depending upon the relative velocity of the wind, they also cause a slotted disk to rotate. Each time the slot passes through the beam of light projected upward from the battery lamp towards the photo-cell, a pulse of current is produced and sent through the amplifier. This causes the relay to be energized and its local circuit actuates a tape recorder, similar to those used for radio and telegraph signals.

The experimenter may devise some other type of recorder, and if desired an old phonograph might be used, the magnets operating a pen or pencil recorder on a circular paper chart placed on the turn-table. By noting how many pulses occur in the record in a given time, the relative velocity of the wind can be calculated. If a large number of humps appear on the record in a period of one second for example, then the wind velocity is high; if only a small number of humps appear in the same time period, then the wind velocity is low.

Many other variations of this apparatus will suggest themselves, such as sunlight recorders (using photo cells). Rain recorders can easily be devised, etc.



The simple arrangement illustrated will prove interesting as a home-made "wind velocity" indicator and recorder.

ELECTRICAL ARTICLES WANTED!

● IF you enjoy this department be sure to send us a description of your favorite piece of electrical apparatus. We want articles on simple electric motors and methods of using them, electric meter test set-ups, high frequency furnaces, home-made battery chargers, home-made measuring instruments and bridges, etc. All articles accepted and published will be paid for at regular space rates. Be sure the photos are sharp and clear.—*The Editors*

Interesting Radio Patents Issued Recently

Cover Patent

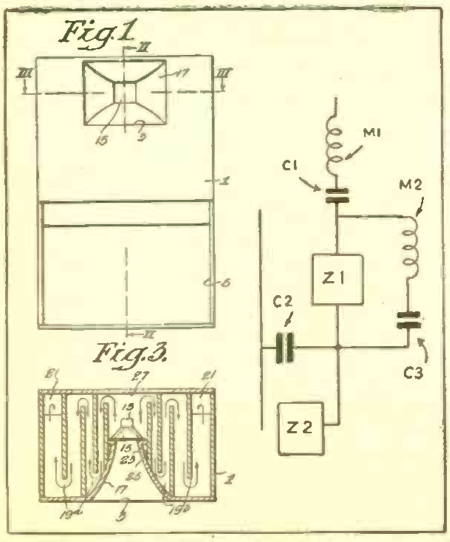
Loud-Speaker Design

2,224,919—Issued to Harry F. Olson, Audubon, N. J.

● ONE of the objects of this invention is to provide an improved loud-speaker of the compound horn type, which will reproduce the high frequencies in a satisfactory manner, and not permit them to suffer serious attenuation or reflection. Another point is to provide improved acoustic filters for discriminating between the length of frequencies supplied by the respective high and low frequency systems of the loud-speaker. Furthermore the design permits of a reasonably simple construction and has proved highly efficient in use.

In accordance with my present invention, I provide a cabinet having upper and lower openings in one of its walls and divide the cabinet into two chambers or compartments. A small, straight axis horn adapted to particularly transmit high frequencies is placed in the upper compartment and fits into the upper openings, while a long, folded, low frequency horn is disposed partly in the upper and partly in the lower compartment and terminates at the lower opening, a single driver feeding both horns. The small horn is arranged at substantially the level of the listeners' ears, whereby very little loss of high frequencies is obtained as a result of absorption and reflection. If desired, the small horn may be omitted and the cone or diaphragm of the single driver arranged to feed directly into the atmosphere as a direct radiator. In either case, the low frequency horn is preferably provided with an acoustic filter which efficiently passes only the low frequencies, and the high frequency horn, in the first modification referred to above, may be provided with an acoustic filter which efficiently permits transmission of only the high frequencies.

Figure 3 is a sectional view taken on the line III—III of Fig. 1.



New loud-speaker design combining the use of a horn and a "folded" low-frequency sound expansion chamber.

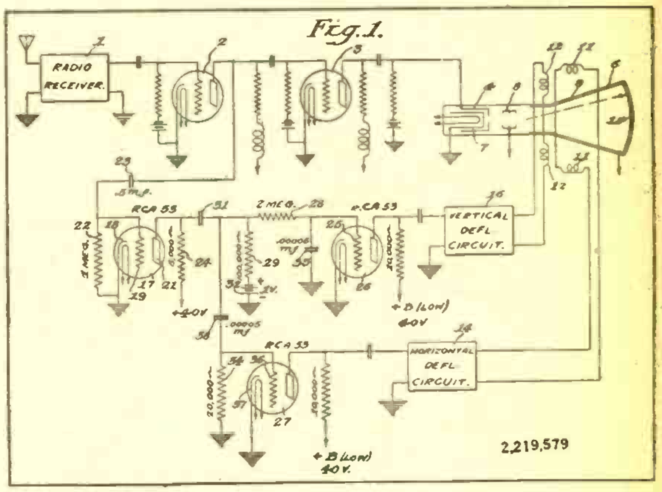
Television Synchronization

● WALDEMAR J. POCH of Collingswood, N. J., recently devised a new system of television synchronization and patent No. 2,219,579 has been issued to him covering this subject. This patent covers an improved means for applying synchronizing impulses of substantially uniform amplitude to the deflecting circuits in a television receiver. Another object is to impress upon a vertical deflecting circuit vertical synchronizing impulses which are free from irregularities. In one of the phases covered by this patent, after the transmitted carrier wave has been received and demodulated, the composite signal comprising picture signals and synchronizing impulses is impressed upon a grid-leak biased separating tube, with the synchronizing impulses having a positive polarity. The synchronizing impulses are then impressed upon two frequency separating networks, one of which permits the passage of vertical synchronizing impulses to a vacuum tube in the vertical deflecting channel, substantially to the exclusion of the horizontal synchronizing impulses. The other network permits the passage of the horizontal synchronizing impulses to a vacuum tube in the horizontal deflecting channel, to the exclusion of the vertical synchronizing impulses.

Preferably, the above-mentioned vacuum tubes are so adjusted that the negative synchronizing impulses which are impressed upon their control grids, drive them beyond cut-off. This adjustment may be accomplished by applying a voltage to the plates of the tubes which is much less than the rated voltage for the tubes.

In the above-described circuit the separating tube is so negatively biased that it clips the synchronizing impulses at a level near their base, while the succeeding amplifier tubes clip them at a level spaced away from the first clipping level, whereby all synchronizing impulses are given the same amplitude.

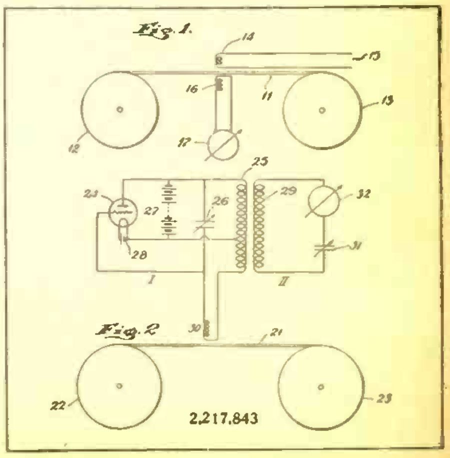
Diagram at right is taken from patent covering an improved means for applying television synchronizing impulses, of substantially uniform amplitude, to the deflecting circuits in a television receiver.



Film Density Measurement

● NICHOLAS LANGER of New York recently received this patent No. 2,217,843 for an improved method for measuring or indicating the relative density of a film, such as photo film, whether developed or undeveloped; his system works as follows:

Broadly stated, according to the principles of the invention. an electro-magnetic field of alternating character is provided and the film to be integrated is passed in proximity to or through said field. All photographic films, both in finished and unfinished condition, embody finely distributed metallic particles in the form of emulsions. These metallic particles, constituted in most cases of silver in finely distributed form, will absorb a portion of the electro-magnetic energy present in the electro-magnetic field which is employed. Thus, the field will be varied or distorted by the presence of the metallic particles, and the variations caused in the intensity or distribution of the field may be employed as an indication of the amount of silver particles on the surface of the film under measurement. Since the amount of silver present or remaining on the surface of the film determines the transparency thereof, the measurement of light permeability or translucency is reduced or converted into a measurement of electro-magnetic character.



ELECTRON MICROSCOPE

● MARTIN PLOKE of Dresden, Germany, recently received this patent, No. 2,219,113, on an improved system of electron-microscopy. One of the principal improvements made by Mr. Ploke is that he avoids the production of heat which accompanies the bombardment of an article with electrons. Therefore, this invention has as its object a method of producing primarily an image of the subject on a photo cathode, and then enlarging this image by electron optics. The further object is to produce this enlargement of the cathode image by means of electrical or magnetic lenses. Also in Mr. Ploke's invention the subjects can be changed rapidly and without difficulties, as contrasted with present methods in which the subject or object has to be positioned within a vacuum chamber. Another idea incorporated in the patent is the production of the image of the subject on the photo cathode by rays of short wavelength, X-rays for instance, thus avoiding eventually any projection by long wave light rays, which are visible. When employing X-rays, one method advocated is to use thin metal foils (Lenard windows) as a photo cathode.

Electron microscope improvement by which the production of heat is eliminated.

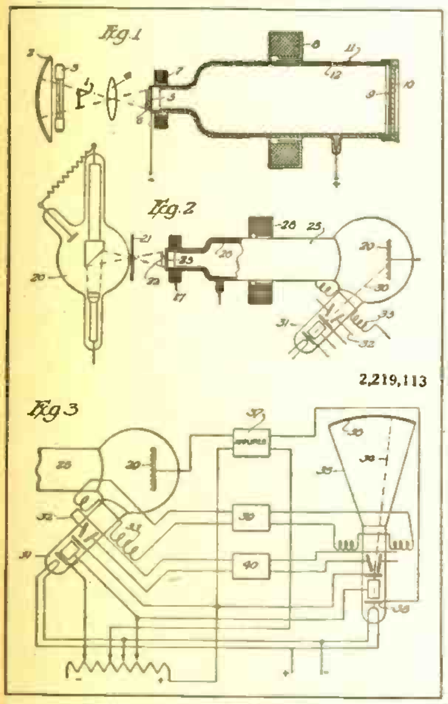
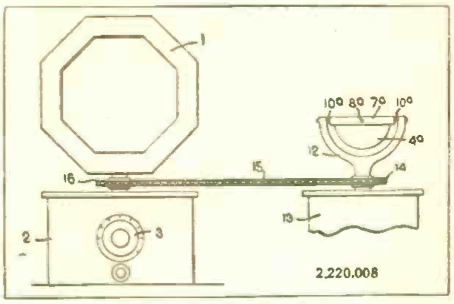


Fig. 1 shows one arrangement where the subject is illuminated by ultra-violet rays. Fig. 2 shows the arrangement for use of X-rays, and Fig. 3, the transmission of the scanning impulses to a cathode-ray tube.

RADIO DIRECTION FINDER

● WILLIAM L. WOODWARD of South Yarmouth and Marcus G. Limb of West Yarmouth, Mass., were recently awarded this patent No. 2,220,008. This radio direction finder comprises a directional loop antenna, adapted to be manually rotated about a vertical axis, a radio receiver to receive the signal picked up by the antenna and give an audible indication thereof, and a compass element associated with the loop antenna and by which the direction of the latter—and consequently the direction of the radio beam—can be determined when the antenna is set for minimum signal reception.

One object of the invention is to provide means which facilitate the reading of the compass when the loop is thus adjusted for minimum reception. A further object is to provide a novel device constructed so that the person who is manually adjusting the loop antenna can easily read the compass when the antenna has been brought into the position of minimum signal.



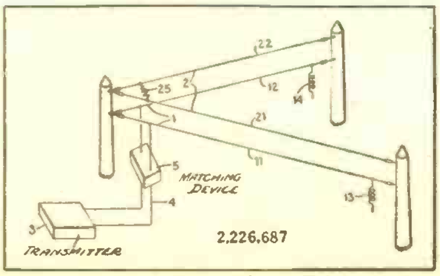
Novel radio direction finder.

One way of accomplishing this object is by mounting the compass element direction on the loop antenna so that the compass bowl, with its lubber line, will rotate with the antenna when the latter is adjusted. The position of the compass bowl about its vertical axis is thus fixed, with respect to the antenna, and the compass card will thus indicate at all times the direction of the antenna, and consequently the direction of the radio beam.

V-TYPE ANTENNA

2,226,687—Issued to Andrew Alford, San Mateo, Calif.

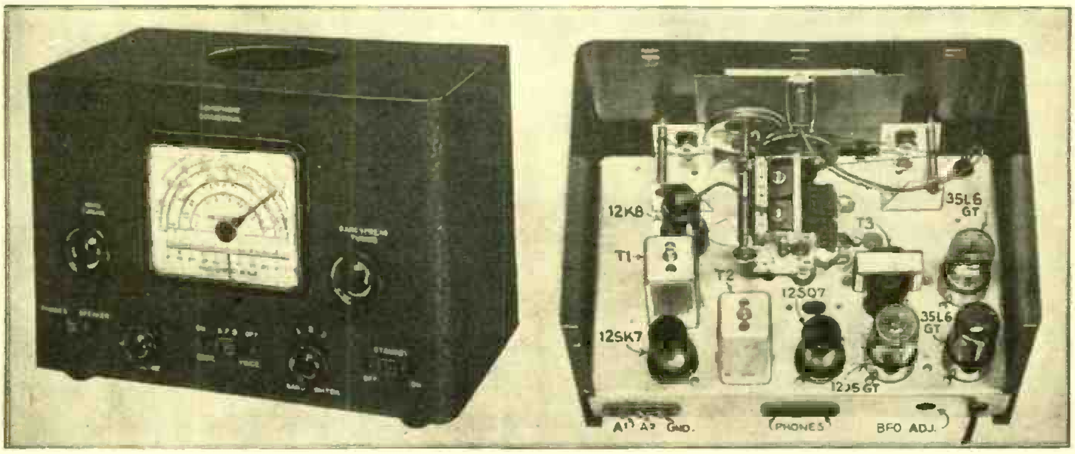
● THIS patent covers an improved type of V-antenna which will radiate a substantial unidirectional wave pattern and which moreover is simple and inexpensive to erect. A further object is to provide a V-type antenna system, in which the combined action of an exciter antenna and a reflecting antenna serve to eliminate radiant action in the backward direction; further the system is claimed to be substantially aperiodic. The free ends of the exciter antenna are terminated through coils as shown. The reflector antenna adjacent to the exciter section neutralizes the backward radiant action introduced by such reflection by creating a second backward wave out of phase with, but of substantially the same amplitude as, and traveling in the same direction and along the same path as the backward wave of the exciter antenna. A resistor connects the limbs of the reflector antenna.



New directional antenna.

A New "Semi-Communications" Receiver

Holmes Webster



A new receiver intended for the short-wave fan who wants the BC band included, along with a beat oscillator and other "trimmings" found on the professional communications type receivers.

Front and rear views of the Echophone "Commercial" receiver for S-W fans and junior Hams.

● THERE are many radio enthusiasts who find the ordinary BCL receiver lacking in some of the features which they desire, yet the various refinements found in many receivers of the "communications" type are more than they require. Moreover, if they are out to purchase a receiver these refinements may cost more than their pocket-books will stand; or if they plan to build a receiver, unnecessary complications are introduced.

The circuit presented here is one which will prove suggestive to many home constructors who can readily "lift" some of its circuit ideas to apply to their own pet designs. or even to their existing receiving equipment. Then. too, the fact that this Echophone "Commercial" receiver is available in built-up form, ready for use, will undoubtedly be of interest to many short-wave listeners, budding hams, and the like, because it provides the special features needed for these types of service and at the same time is highly inexpensive.

Actually this design might be said to combine the merits of a good little all-wave BCL receiver with a number of the features usually found only in communications receivers. While it is small in size (10⅞" wide, 7½" high and 7⅝" deep) the layout of parts is "open," avoiding the constructional and electrical disadvantages of undue crowding.

Communications Features: Briefly, its features, not usually found in other small models, include: a beat-frequency oscillator for use in locating weak signals, bringing in C.W. code signals and code practice; electrical band-spread with a separate band-spread knob and slide-rule tuning scale; speaker-headphone switch which permits instant switching from the built-in speaker to headphones, the latter being left connected to phone-tip jacks at the rear of the chassis; stand-by switch; main tuning dial fully calibrated and with large scales; 7 to 1 step-down ratio between main tuning knob and dial pointer; A.V.C. off-on switch for improved C.W. reception (combined with B.F.O. switch); trimmer adjustment to vary B.F.O. pitch, etc., etc.

Continuous coverage of the range from 550 kilocycles to 30.5 megacycles is provided in three switch-selected bands of 550-2100 kc., 2.1-8.15 mc., and 7.9-30.5 mc. This means that every type of service is available: amateur, police, broadcast, commercial, etc., right down to below 10 meters. Operation is from any A.C. or D.C. line within the voltage range of 115 to 125 volts.

Referring to the circuit, it will be seen that provision is made for the use of a doublet antenna with the A1 and A2 terminals isolated from ground. The connection shown between A2 and Gnd terminals is an external jumper used when an "L" type antenna is connected to A1. Primaries as well as secondaries. are switched by the 4-gang, three-position band-switch. The tuning capacity consists of the two-gang main tuning unit. while *band-spreading* is accomplished by single rotor plates which mesh into the stators of the main condensers.

No attempt will be made to discuss the entire circuit in detail. as it is basically sufficiently conventional to make fundamental treatment unnecessary. Among the special features is the *standby* switch, located in the common cathode return of the first two tubes. By opening up this lead. the tubes are disconnected from B–, making the receiver inoperative but returning to operation instantly when this switch is again closed. Such provision is an essential where the receiver is used in a "ham" station, and it is also useful to momentarily silence the receiver when the telephone rings, etc.

The beat-frequency oscillator, tuned to the 455 kc. I.F., is a separate tube which is cut in and out as needed by the switch located in its B-plus lead. Another section of this same switch cuts out the A.V.C. system when the B.F.O. is turned on. This is done to avoid the time-delay action of the A.V.C. system which tends to put "tails" on the dots and dashes and to create additional interference in crowded C.W. bands. The B.F.O. tube is grid-connected to the diode detector through a 10 mmf. capacity.

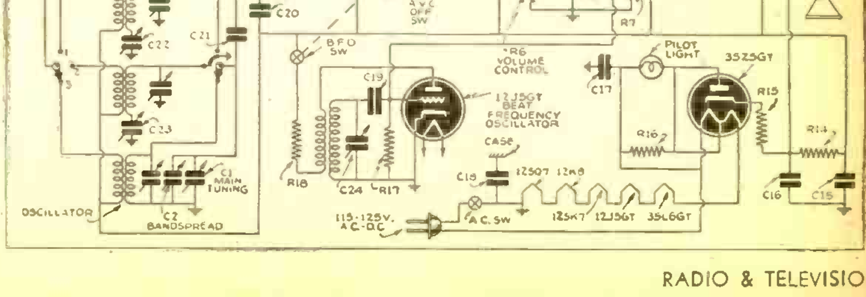
The headphone circuit is completely isolated from the high voltage and from the line voltage by connecting it to the secondary of the output transformer. The shunting resistor insures proper loading of the output tube circuit, even when crystal phones are employed. The simple switching arrangement silences the headphones when the speaker is cut in and vice versa. It is of interest, incidentally, that in this receiver the PM speaker is mounted in the top of the metal cabinet, rather than in the conventional front-panel position. This allows room for a large tuning dial with easily read calibrations.

All tube filaments draw .15 amp. and can therefore all be connected in series. The tubes are so selected that their total rated voltages add up to 118. For this reason no additional series resistance is required. The pilot lamp and shunt resistor across one leg of the 35Z5GT rectifier is a conventional arrangement recommended by the tube manufacturers, and has the advantage that a burned out pilot lamp does not prevent operation of the set, as would be the case were its filament connected in series with the tube filaments.

This model is housed in a metal cabinet, a rather unusual proceeding for an A.C./D.C. receiver. To make this practical and avoid all chance of a shock, the chassis is completely isolated from the cabinet by rubber mountings at its ends. The chassis has no front apron, but instead the various controls are mounted directly on the cabinet, avoiding the possibility of accidental shorting of the chassis to the cabinet through the control shafts. The top and bottom plates of the cabinet are removable to permit inspection and alignment. To facilitate removal of the top (to which the speaker is attached) the speaker is connected into the circuit by a plug.

This little Model EC-1 "Commercial," while relatively new on the market, is enjoying tremendous popularity among short-wave listeners who appreciate the advantages of its special features; among new hams because it not only provides the features important to their station operation, but doesn't crimp the budget too much; among those who desire to learn the code as part of their preparation for service in the country's armed forces, and among students taking the various radio vocational courses. It is interesting to note that a telegraph key connected in series with the headphones, with the B.F.O. "on" and the receiver tuned to a broadcast carrier, permits practice with the key. When this is done the "sending" is heard in the headphones precisely like a C.W. signal coming in over the air.

Diagram of the Echophone receiver.



List of Parts

Resistors

No.	Ohms	Wattage
R1	50,000	¼
2	300	¼
3	2,000,000	¼
4	400	¼
5	50,000	¼
6	500,000	Volume
7	10,000,000	¼
8	250,000	¼
9	100,000	¼
10	500,000	¼
11	150	¼
12	7,500	1½
13	15	¼
14	750	1½
15	25	¼
16	300	½
17	50,000	¼
18	500	¼

Condensers

No.	Capacity	Voltage	Type
C1	530 mmf	Main tuning	
2		Band Spread	
3	.01 mfd	400	Paper
4	.05 mfd	200	Paper
5	.02 mfd	400	Paper
6	.05 mfd	200	Paper
7	100 mmf		Mica
8	100 mmf		Mica
9	.005 mfd	200	Paper
10	10 mmf		Twisted Pair
11	.01 mfd	400	Paper
12	.05 mfd	200	Paper
13	20. mfd	25	Elect. Filter
14	.01 mfd	400	Paper
15	30. mfd	150	Elect. Filter
16	40. mfd	150	Elect. Filter
17	.02 mfd	400	Paper
18	.25 mfd	200	Paper
19	150 mmf	Section of C24	
20	.05 mfd	200	Paper
21	50 mmf		Mica
22	600 mmf	Pad	No. 1 Band
23	1,900 mmf	Pad	No. 2 Band
24	450 mmf	BFO Trimmer	

Junior VoltOhmyst Radio Test Meter

● THE Rider VoltOhmyst circuit, providing a convenient push-pull electronic D.C. Voltmeter-Ohmmeter with a resistance range ratio wide enough for engineering and servicing requirements

New test instrument of value to set-builders, servicemen and radio engineers.

for years to come, has been applied to a compact, low-cost instrument known as the RCA Junior VoltOhmyst.

The instrument incorporates every feature required for the ideal testing unit of its type. It is extremely useful for servicing radio and television receivers, transmitters, aircraft radio, sound amplification and reinforcement systems, facsimile and other types of equipment. Its features are similar to the laboratory type RCA 163 VoltOhmyst.

The new instrument offers many of the features of the 163 VoltOhmyst, with the addition of an isolated A.C. voltmeter circuit. Its most appreciated feature is the complete meter overload protection on the D.C. voltage and Ohm scales. No damage can be done if the probe slips to a high voltage point when a low D.C. voltage is being measured.

The input resistance for measuring D.C. voltages is constant at 11,000,000 ohms, allowing voltages to be read in high resistance circuits. On the 3 volt scale this gives a meter with a sensitivity of 3,666,666 ohms per volt! This feature permits the serviceman to read AVC, FM Discriminator, and many other voltages which are impossible with the ordinary meter. A Signal Tracing type probe lead is provided.

The D.C. voltmeter circuit has six ranges—0 to 3, 10, 30, 100, 300, and 1000 volts. It is not necessary to guess what scale is required before the leads are connected. The leads can be put in place, and then the range switch may be turned until the meter reads "on scale." Considerable saving in time results.

Aside from the electronic D.C. voltage and ohms measuring circuits, the Junior VoltOhmyst is equipped to make isolated A.C. voltage measurements as well. These are read on five scales: 0 to 10, 30, 100, 300 and 1000 with a sensitivity of 1000 ohms per volt.

Noise Elimination

● FOR years exhaustive investigation of radio noise elimination has been going on in the Cornell-Dubilier labs. and in outside field tests conducted by its engineers. It will interest many servicemen and others to know that these investigations have been summarized in a series of articles written by the C-D engineering staff, beginning in the September issue of the "C-D Capacitor," monthly bulletin of this company.

These articles are of particular interest in that they suggest simple and common-sense methods for analyzing noise, for locating sources without complicated equipment, and for determining the practical effectiveness of different remedies, both at the radio set and at the source of noise. Detailed circuits are shown for various types of noise filters, including the capacitive, capacitive-inductive and capacitive-resistive type, with information as to how to determine which of these types will best meet the requirements of any given installation.

For those who are interested, a request will bring, without charge, the past and future issues of the "C-D Capacitor" in which these articles are appearing. Write to Service Dept., RADIO & TELEVISION, and ask for bulletins series CD-100.

Picture at left shows special test room with wire screen shield, in which various circuits and apparatus for radio noise elimination are checked in the Cornell-Dubilier Laboratories.

Two New RCA Tubes

● THE 1629 is a high-vacuum, heater-cathode type of tube designed to indicate visually, by means of a fluorescent target, the effects of a change in the controlling voltage. The tube, therefore, is essentially a voltage indicator and as such is particularly useful as a convenient and non-mechanical means of indicating accurate adjustment of a circuit to the desired conditions. Because of its 12.6-volt heater and its 7-pin base, the 1629 is particularly suitable for service in aircraft radio equipment. In this equipment and other equipment subject to vibration and shock, the 7-pin base provides ample friction to hold the base in its socket.

The 8000 is a transmitting triode having a maximum plate dissipation of 150 watts under ICAS conditions. In self-rectifying oscillator circuits, such as are often used in therapeutic applications, two 8000's are capable of delivering a useful power output (at 85% circuit efficiency) of 550 watts. The 8000 is rated for operation with full input at frequencies up to 30 megacycles, but it may be used with reduced plate voltage and input at higher frequencies up to 100 megacycles.

Tentative Characteristics and Ratings

Filament voltage (A.C. or D.C.)	10	volts
Filament current	4.5	amps.
Amplification factor	16.5	
Direct interelectrode capacitances:		
Grid-plate	6.4	mmf.
Grid-filament	5.0	mmf.
Plate-filament	3.3	mmf.
Bulb	T-20	
Plate cap	Medium Metal, Skirted	
Grid cap	Medium Metal	
Base	Jumbo 4-Large Pin	

As R.F. Power Amplifier and Oscillator
Class C Telegraphy
Key-down conditions per tube without modulation

	CCS	ICAS	
D.C. plate voltage	2000 max.	2250 max.	volts
D.C. Grid voltage	–500 max.	–500 max.	volts
D.C. plate current	250 max.	275 max.	ma.
D.C. grid current	40 max.	40 max.	ma.
Plate input	500 max.	620 max.	watts
Plate dissipation	125 max.	150 max.	watts
Typical operation:			
D.C. plate voltage	2000	2250	volts
D.C. grid voltage:			
From a fixed supply of	–195	–210	volts
From a grid resistor of	8100	8400	ohms
From a cathode resistor of	710	700	ohms
Peak R.F. grid voltage	370	400	volts
D.C. plate current	250	275	ma.
D.C. grid current (approx.)*	24	25	ma.
Driving power (approx.)*	8	9	watts
Power output (approx.)	375	475	watts

As Self-Rectifying Oscillator
CCS

A.C. plate voltage (RMS)	2500 max.	volts
D.C. grid voltage	–500 max.	volts
Peak R.F. grid voltage	750 max.	volts
D.C. plate current	160 max.	ma.
D.C. grid current	25 max.	ma.
Plate input	450 max.	watts
Plate dissipation	125 max.	watts
Typical operation in push-pull circuit at 30 mc.:		
Unless otherwise specified, values are for 2 tubes		
A.C. plate voltage (RMS)	2500	volts
Grid resistor	5000	ohms
D.C. plate current	320	ma.
D.C. grid current (approx.)	40	ma.
Power output (approx.)	650	watts
Circuit power output (85% circuit efficiency)	550	watts

*Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should be capable of delivering considerably more than the required driving power.

New Rectifier Replaces GL-866 and GL-866A

● A NEW mercury-vapor rectifier, bearing the type number GL-866A/866, has been added to the General Electric Company tube line for amateur and commercial service. Completely interchangeable with present-type GL-866 and GL-866A rectifiers, the new tube makes possible the higher rating of the GL-866A at the price of the GL-866.

The GL-866A/866 has a spiral edgewise-wound cathode with its axis vertical and surrounded by a heat-conserving shield which is at cathode potential. The glass envelope is of the dome type with the anode placed at the lower end of the small portion of the dome. Thus there is a very small space between the edge of the anode and the glass, minimizing ionization at the back of the anode and near the anode lead. The anode lead is also enclosed in a glass "pantleg." The tube has a standard medium four-pin base, and is of unusually sturdy construction.

The rating of the new tube is: filament voltage, 2.5 volts; filament current, 5 amperes; maximum inverse peak plate voltage, 10,000 volts; average plate current, 0.25 ampere; maximum instantaneous plate current, 1.0 ampere.

New mercury vapor rectifier.

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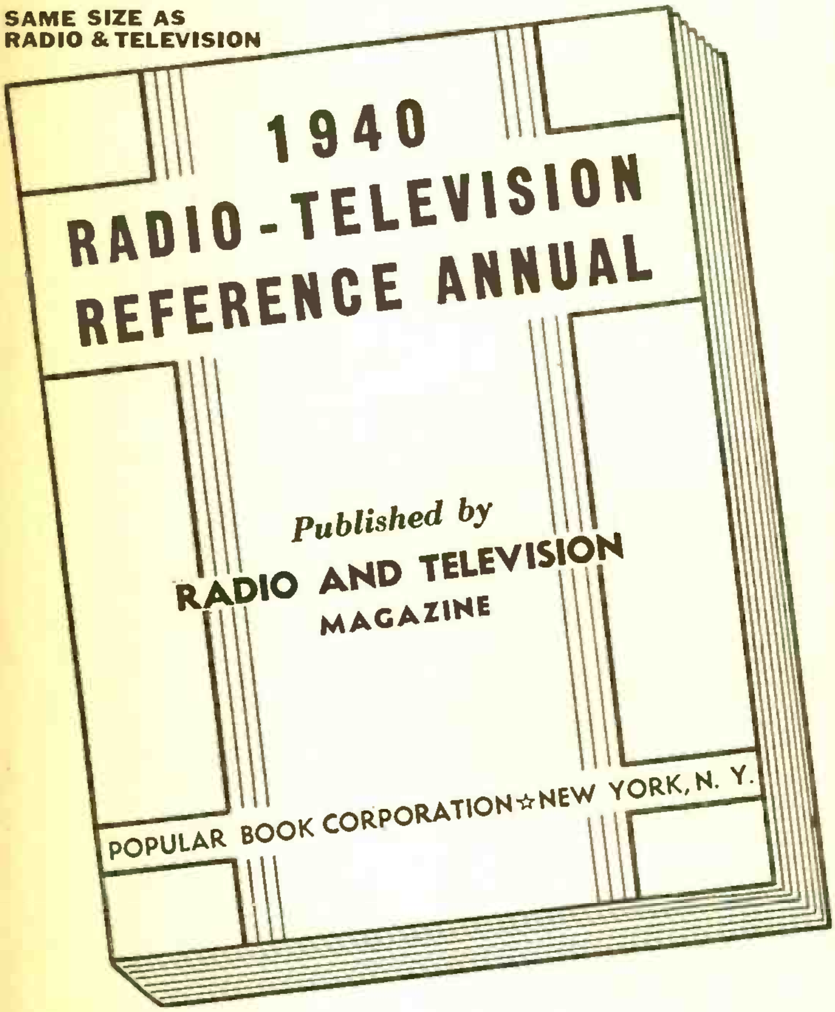

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How to Build a 441 Line T.R.F. Television Receiver—Useful Notes on Television Antennas.

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Simple Photo-Cell Relay Set Up—Making a Burglar Alarm—How to Build A.C.-D.C. Capacity Relay—How to Make a Modern Radio Treasure Locator.

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Complete Your Short-Wave Library!
Six Outstanding Books on All Phases of Short Waves. See Page 664.

New Emergency Searchlight

● JACKSON BURGESS of the Burgess Laboratories has developed one of the brightest portable battery lights in the world. Even though it is so powerful that it is possible to read a newspaper by its light half a mile away, it is smaller than a man's head.

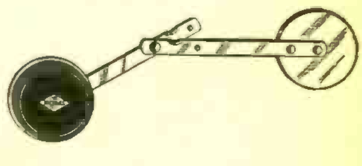
This new lantern produces 180,000 maximum beam candlepower and is 180 times as powerful as the best two-cell flashlight in common use today.

The spot of light cast by the lantern is 45,000 foot-candles at arm's length which is 4½ times as bright as sunlight on a spot of the same size. It has 180 foot-candles at 100 feet, which is equal

to the average office light. The fire and police departments may use this light as emergency "standby" lights. They may also be carried in planes to be used in "emergency." The light is not intended for everyday use but for special standby or emergency purposes only. The battery will maintain the light at peak brilliance for about six minutes, after which time the light output diminishes over a period of twenty minutes or more.

Loop Checker

● THE "Check-A-Loop," an efficient service instrument for checking loop antenna alignment, is announced by the F. W. Sickles Company. By its ability to raise or lower the inductance of a loop, it quickly shows whether trimming capacity should be increased or decreased. A handy tool for the design engineer, for radio production set alignment, and for the radio service man.



Unique Police Radio System on Bridge

● ONE of the most unusual police radio systems ever installed has been placed in service on the Philadelphia-Camden Delaware River Bridge, one of the most heavily traveled spans in the country. The two-way mobile communication system is called upon to meet the unusual conditions imposed by the steel construction of the bridge, which absorbs radio signal energy, and the necessity for providing dependable coverage over its entire 1.7-mile length.

The problem was solved by the RCA engineers who designed the equipment by installing the fixed transmitter and antenna atop one of the two 385-foot high towers which support the huge bridge. The elevation permits complete coverage of the bridge, its approaches and surrounding area. To insure maximum flexibility, dual control facilities are provided in the headquarters building of the Delaware River Joint Commission, and in one of the toll houses.

Tied in with a police teletype system which blankets eight surrounding states, the new police radio system provides a ready emergency "blockade" against criminal suspects.

Mobile transmitting and receiving apparatus is installed in the bridge police patrol cars; motorcycles are equipped with receivers. Another unusual feature is the provision made for keeping a foot traffic patrolman stationed on the Philadelphia approach posted on all radio calls. A highly directional RCA loudspeaker has been mounted on the bridge structure in such a way that it directs sound down on the spot where the patrolman is on duty. He hears the calls, but the loudspeaker's construction keeps the sound out of the surrounding neighborhood.

What Do YOU Think?

FROM ARMY AMATEUR RADIO STATION W7FSH

Editor:

Back in the year 1933 I became interested in short-wave by reading your magazine SHORT-WAVE CRAFT. I usually bought it from the newsstands and also subscribed for it at times.

ALBERT RYAN

It was the means of getting me started on *transmitting;* I finally got an amateur license on March 14, 1936, and have been operating on C.W. ever since. It has given me much pleasure in my old age.

We later exchanged pictures and I have yours (the editor's) hanging up in my operating room, and many of the Hams have inquired who it was. I have told them that you were the inspiration of my getting on the air.

I am now 64 years old and hope to live long enough to see the end of this war, as I am confident it will last ten years, and be plenty tough for a long time afterwards.

I first built the "one lung" 45 TNT that you showed in the September issue of SHORT-WAVE CRAFT, 1933, and have it yet. Then I built the push-pull 45 TNT shown in the October issue. August 1937 I sold the P.P. 45 TNT to Ralph L. Price, W7EIC, in Polson, Montana. Recently I had a QSO with him for the first time in nearly three years. He is still using that old P.P. 45 TNT and has been "getting out" all over the world. He told me he is using both an end-fed Hertz 80 and 40 meter voltage-fed antennas and putting 60 watts on the plate.

I have always had a yearning to try out high-power on a push-pull TNT, so I am going to build one for an experiment. I have a very fine 2000 volt D.C. 500 mill power-supply, well filtered and choked, also all the parts for the experiment as I was getting ready to put a kilowatt amplifier on my rig.

At present I am using a 6L6G xtal osc. into a T-55, with 1050 volts on the final plate. My receiver is an RME-69.

I have kept the bills of all the stuff I have bought for radio, and when I counted them up recently I found I have spent about $700 on my hobby.

ALBERT H. RYAN,
4445 51st Avenue Southwest,
Seattle, Washington.

A BRITISH SWL SPEAKS

Editor:

I am writing to you to congratulate you on your very fine magazine which I have read for several years, and it sure is the best radio mag. in the world. I have just received the September issue, and enjoyed the article on F.M. Principles, by Ricardo Muniz.

I have been a SWL for about two years, and during that time I've heard all States on 20 meter phone, and verified 26 of them. I've also heard and verified all continents on 20 and 31 meters. The RX used here is an 8 tube "Radio-gram," and is used with a 20 meter center-fed doublet, which runs N.E.-S.W. I've tried several other antennas but find this is most reliable for 20 meter DX reception.

My SWL card may be of interest to your readers, and if any SWL cares to exchange cards I'll be pleased to do so 100%, with anyone in the world (that goes for Hams, too).

During my SW listening I've found that U. S. Hams are the best for QSLing, and they really do appreciate a good report from SWL's. Conditions on 20 meters at present are very poor here, only one or two W 1's and 2's coming through on 20 meter Ham phone, but the International short-wave stations WGEA, WRUL, and WCBX still put through a good signal. Australia is coming through at R8-9 on 25 meters at 0830 B.S.T.

I'll close, wishing your magazine continued success, and hoping to hear from some of the Hams and SWL's who read your swell paper. 73.

E. J. ROBERTS,
B.L.D.L.C. Member 6679
179, Whittington Road,
Bowes Park, London, N.22.
England.

AN EMBRYO HAM

Editor:

I want to commend you on your fine magazine. I get quite a kick from the letters sent in by readers. Your articles on combination phone and CW. xmitters interest me the most at the present time, as I am planning to make a small 40 and 20 meter rig. Say, let's see some diagrams like these.

At present I'm an SWL. I have a Hallicrafter Skybuddy S19. I am going to use a doublet antenna; I am now using a short aerial in the attic and this contraption picks up too much hash to be practicable. Well, anyway I have logged 25 states in amateur phone bands; this was on 20 meters, mostly. I'll QSL 100%.

Well, 73 and keep the "Kink" department going.

FRANK GUYER,
Calverton, L. I., N. Y.

Index to Advertisers

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

FROM A CANADIAN S.W.L.

Editor:

Just a line to let you know how much I enjoy reading RADIO & TELEVISION. From among your swell articles and diagrams, I have built a 3-tube all-wave receiver using a 57, 56 and 2A5, and have logged numerous stations, thanks to your S-W listening tips.

I have been a SWL about 2 years and have high hopes of becoming an amateur in the near future.

I would like to hear from any "Hams," "Hams-to-be," SWL's, and YL's between the ages of 17 to 19 who are interested in stamps, coins and any other hobbies as well as radio.

I sincerely promise to QSL 100% to anybody, anywhere, so let's hear from you.

LOUIS GOLD,
257 Beatrice St.,
Toronto, Ont., Canada.

HERE'S YOUR CHANCE, HAMS

Editor:

I recently purchased your December, 1940 RADIO & TELEVISION issue and read your editorial *"Amateur Intolerance."* Yes, I am one of those would-be prospects. I wonder if you could help me. I've been an SWL for quite some time and believe me, I think I'd cherish those call letters if a Ham helped me along, as you suggest. I am appealing to you, my good friend, or probably you know of a licensed amateur who would work with me, until success is accomplished. I've always wanted to talk into a mike for enjoyment, or as a hobby, or actual service. Yes, I would like to become one of those 200,000 radio amateurs, too, if there is a Ham to do so.

JOSEPH ZUKAUSKAS,
513 W. Susquehanna Ave.,
Philadelphia, Pa.

Single Television Image Tube Held Simplest

That the present single cathode-ray tube television technique is simplest and probably cheapest, is the opinion held by Allen B. DuMont, television manufacturer.

"Of course I am interested in the multiple cathode-ray tube television technique proposed by Dr. Alfred N. Goldsmith, whereby the image is assembled by an array of (small) tubes instead of the single large tube used today," states Mr. DuMont. "I fully appreciate that the motivating urge is economy, and that the belief behind the suggestion is that small cathode-ray tubes might be mass-produced on much the same basis as radio tubes and at correspondingly low prices.

"It is interesting to note that the late Dr. C. Francis Jenkins, with whom I was associated in some of the earliest television work, also had the idea of a *multiple* screen. He was likewise influenced by the *moving-letter* electric sign boards. At that time, when mechanical scanning was in use, Dr. Jenkins demonstrated a large checker-board of tiny electric incandescent bulbs which, as they were turned on or off, could weave the image pattern of lights and shadows. The present suggestion of Dr. Goldsmith is, of course, quite different in details, in that it utilizes small cathode-ray tubes instead of lamps, with each tube scanning a portion of the total image rather than supplying just a single picture element.

"Still, I am afraid that the contemplated economies can hardly be realized with a multiple cathode-ray tube receiver. Our own practical experience, in producing cathode-ray tubes in all sizes and types, indicates that there is not the proportional difference in cost, based on size, that might be expected. A smaller tube does not necessarily effect considerable economies. We abandoned the 2-inch tube because we found it to cost as much or even more than our 3-inch tube.

"If Dr. Goldsmith purposes to use a battery of tiny tubes, it is my personal belief that the cost of such an array will be equal to or even greater than that of a corresponding *single* tube, providing the same image size. I cannot see any marked advantages in the economic sense. There may be a saving in the other components, due to lower operating voltages for the smaller tubes, but this may well be wiped out by the addition of the required switching or transferring means, whereby to cut in the multiple tubes in proper sequence.

"Our own long experience is that a *single* large tube provides the best economic and technical solution thus far. We pioneered the first *large-screen* television receiver with a 14-inch tube, and more recently the 20-inch tube. Aside from the cost of the glass blanks, the production costs run pretty nearly alike between these two sizes, since the internal details are virtually the same for both.

"To my way of thinking, marked economy in television reception must come through a more widespread demand for receivers based on good and adequate program sources, followed by the justification of mass-produced equipment, which alone can bring down the cost to popular levels. *Once we feel justified in putting large cathode-ray tubes on continuous exhaust and other automatic machines, our costs and prices will fall rapidly.* Likewise the remainder of the receiver. The problem today is mainly economic. It's for the businessmen to make the next move, since we engineers have done all the playing thus far."

* * *

Asked to comment on Mr. DuMont's opinions of the multiple projector tube system, Dr. Alfred N. Goldsmith said: "I think Mr. DuMont's comments express a viewpoint to which he is fully entitled. I have good reason to believe, from the past history of vacuum tubes and cathode-ray tubes that the system I have proposed for large-screen television will find increasing favor and economic justification. When the normal pictures of the future in the home, from 20 inches to 50 inches in width, become the vogue, I am satisfied that either methods of the type which I have proposed or projection-tube methods will best meet the public needs and commercial requirements."

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