Everyday Mechanics

RADIO AGE

July-August
1927

25¢

See Page 34

Current Science

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Everyday Mechanics

RADIO AGE

Current Science

Established March, 1922

Volume 6 *July-August, 1927* *Number 6*

CONTENTS

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Chats

One outstanding achievement is recorded this month in the lead article describing the new method of frequency modulation which is expected to be a great boon to the transmission, reception and manufacturing interests of the radio industry.

Another achievement, though secondary in importance, is the announcement of the a.c. filament tubes, one suited for the r.f. and a.f. stages, and the other only for the detector stage. Full data on these is recorded in this issue.

Amateurs will find two articles covering their activities. The first is by Armstrong Perry and shows what you are missing if you don't pound brass (telegraph). The other is a description of the short wave crystal controlled transmitter at 9BHX. In addition there is the Amateur Radio department.

Fiction lovers will revel in the Springy passages to be found in Joseph Balsamo's present instalment of "The Froth Estate."

K. B. Morcross has contributed an excellent article on the construction of the vacuum tube voltmeter for the serious-minded experimenter.

Both of our non-radio features, Current Science and Everyday Mechanics, are taking up a bit more space than usual due to the interest shown by our readers covering those two features. We shall be glad to hear from others on the subject.

Perhaps you've wondered *why* a bullet proof vest stops a veritable rain of bullets from a machine gun. Charles Lee Bryson gives an interesting account of the *modus operandi*.

We announce with regret the departure of our Associate Editor, F. A. Hill, who leaves us to join the Bremer-Tully Mfg. Co., of Chicago, as Assistant to the President.

Frederick Smith

Editor of RADIO AGE.

New Modulation is Biggest Radio Discovery in Twelve Years

By F. A. HILL
(Associate Editor)

WHAT is regarded as the most radical radio discovery since the appearance of the three element tube, is an announcement of the frequency modulation method of transmission, attributed to the fertile brain of Frank Conrad and associates.

For years the public has been kidded into believing that this and that development was revolutionary. But this discovery so far transcends in importance anything described in the last 12 years, it requires the use of superlatives which has heretofore been overworked.

This time we find a real *revolutionary* discovery. Here is what frequency modulation (as compared to power modulation means:

Return of the faithful regenerative sets.
Elimination of local station interference.
Greater signal at distant receiver.
Partial solution of the fading problem.
Extinction of the crystal set.
Sixty per cent power saving at transmitter.
More stations per channel.
Hastens crystal control of all stations.
Reduction of static-to-signal ratio.
New field for receiver design.

In the new modulation system instead of varying the amplitude of the signal component of the wave, this signal component is kept constant while the transmitting frequency is varied but not to exceed 500 cycles each side of the carrier straight line. Reference to the chart in this article will give an idea of the new scheme. The carrier frequency is shown as a beginning straight line.

The frequency of the voice or music component is determined by the distance between the humps. The closer these humps lie the higher the frequency of the voice or music. The greater the distance between the humps, the lower the frequency of sound impressed. Since the frequency variation is not more than 1,000 cycles overall, it is easy to see how sharpened this form of transmission is. With the station's emission occupying but a thousand cycle band it will permit the presence of more stations within a given band without interference.

Where in present modulation forms it is possible to receive broadcast music (although garbled) on zero beat with a regenerative receiver, under the new form of transmission music may not be received at zero beat. The only points at which music may be heard will be either side of zero beat. Zero beat will REALLY BE ZERO BEAT for nothing will be heard in that region.

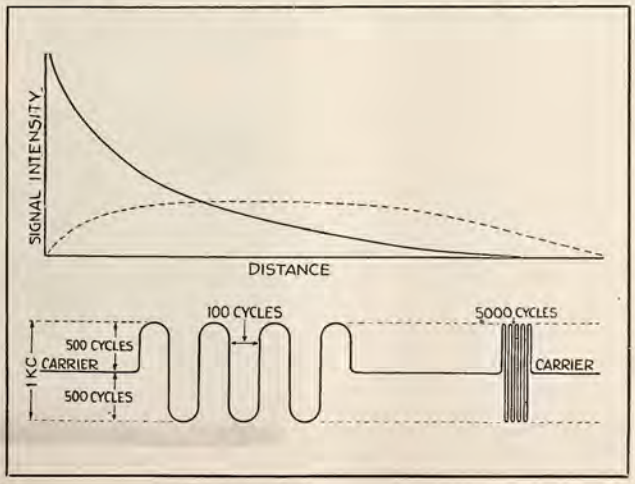
Local station interference will be abolished on account of the sharpened transmission and the necessity for a receiver with a much sharper frequency response curve.

In the sketch with this article is also shown a graph of the signal intensity against distance. In the full line is the present modulation system where maximum signal is received at the point closest to the station, this energy dwindling off as the distance increases. In the new frequency modulation (dashed line) the signal intensity is at zero at the station and increases with the distance, up to a certain point, and then drops off as the distance increases beyond the range of the station. (Receivers set up in the station at KDKA will not pick up that station. The monitor set has to be located a mile or more away and the signal brought back over a telephone line so that station operators may listen to it). Experiments have shown that the signal under the new form is greater at a distance with the same, or less, power than under the old method of modulation.

Due to an increased sharpness of transmission and a sharper receiver it has been noted that fading is considerably reduced. Likewise in this connection the static-to-signal-ratio has been cut.

Crystal sets on account of their response curve will not pick up this form of transmission.

(Continued on page 35)



Do You Know What You Are Missing?

By ARMSTRONG PERRY

YOU may think that you are getting a lot out of radio, but sit in with a bunch of radio amateurs some time and you will discover that you have been getting only about one-half of one per cent of the kick there is in it.

Attend a meeting of the American Radio Relay League, a national organization of radio amateurs organized thirteen years ago when about the only broadcasts heard were weather reports and SOS calls in Morse code. I sat near the registration desk at one of its conventions, studying the types among the arriving delegates. They were all boys, from fifteen to seventy years old. One was a gangling youth of about seventeen. He put his hand around to his hip pocket for a handkerchief or some legitimate object and revealed patches on the seat of his trousers.

Now there is a good deal of significance in patches. If a farmer has patches on the seat of his overalls it is a pretty sure sign that the mortgage on his place will be foreclosed soon. A successful farmer never finds time to sit around and wear holes in that location. But on this fellow I was sure those patches meant nights of DX work. They meant too that he had the nerve to spend his money to attend the convention, where he would find fellowship, instruction and spiritual uplift, instead of buying a new suit.

I asked him how he was getting on. He said he was not doing anything worth mentioning, just working a few ham stations in England and now and then one in South America.

After all the fuss that has been made over the opening of radio telephone service between America and England, it seemed strange that he and other boys should talk so nonchalantly of sending message across the oceans, but then the amateurs have been doing it for years. The first was a fifteen-year-old boy named Harold Robinson, who bought a radiophone transmitter guaranteed to tranmit twenty-five miles. He studied it, improved it, and increased his transmitting range until he received reports from persons who heard him 1,500 miles away.

The telephone service from America to England is a marvellous achievement. It is a far more difficult matter to establish reliable daily service than it is to make an occasional amateur record. But, when a boy who has to wear patches on his pants in order to attend a radio convention builds his own apparatus and exchanges messages across oceans, he is pointing the way for broadcast listeners to do something that is more fun than imitating a sponge and soaking up whatever happens to be in the air.

Amateurs who attend these gatherings wear tags on which their call letters are stamped. An eager youth comes hurrying through the door, glances at the letters on some other fellow's tag and they join hands. Few of the members have ever seen each other before but one glance at those call letters and they are closer than brother Masons, for they have chatted many a time with their hands on their keys and phones on their heads. Those telegraph keys of theirs unlock doors and let them into more things than any latch key ever revealed.

Nobody cares what anyone's name is. When 1BIG was in the chair at one of the sessions, every delegate who addressed the chair began just as he would if he were calling a station: "1BIG!" If anyone said "Mr. Chairman" he classified himself as a novice.

One of the delegates was a Chinaman. He looked just like any well-regular celestial in American clothes until he started in the trouble-shooting contest, then he took on the atmosphere of a busy sector in the Chinese war. The trouble-shooting contest consisted of finding out what was wrong in a lot of radio diagrams. There were even more things wrong with them than can be found in the worst set that a broadcast listener ever threw together. What Whoop La did to those diagrams made the common or garden variety of amateur gasp with amazement. He won the prize.

There was one YL (young lady) present at the last gathering that I attended. Every girl "ham" is a YL, just as every man "ham" is "OM", meaning "old man". This one led a dog, but it seemed like an unnecessary precaution. She possessed plenty of charm, but the "hams" were too crazy over radio to be susceptible to girl-itis.

Once in a while a local ham organization goes to a convention in force. The Providence Radio Association distinguished itself recently by

"Hams" registering at an ARRL gathering

OAJ3U, an Australian amateur who came over to see where his messages were received. His name is Hull, but no "ham" cares anything about names after call letters are assigned

attending one arrayed in comedy straw hats about as big as a silver dollar. This claims to be the oldest active amateur radio organization, and was started about the time some of the present members were thinking of being born.

Relaying of radio messages was the reason for the existence of the American Radio Relay League, President Maxim says. Fifteen years ago an amateur was thrilled if his signals were heard across the street. A member of the Hartford Radio Club succeeded eventually in transmitting a message to Windsor Lock, twelve miles north.

About that time it was learned that there were radio amateurs in Springfield, 25 miles north. Mr. Maxim conceived the daring idea of relaying messages through Windsor Locks to Springfield. The plan succeeded and the League was born. That was only thirteen years ago, and the other day a member of the League, sixteen years old, told me of this incident:

"I work in a radio store. I put up a sign inviting customers to give me messages to send free of charge anywhere in the world. I advertised in the papers too. A lady came in and said she had a friend who had been a missionary in China and had just escaped and gone over to the Philippines. She wanted to know if I could send a message that far and find out if her friend was all right. I sent her message to a ham in California and he relayed it to one in the Philippines. It took ten days to get the answer back, but we found out the missionary was all right."

This youth showed no signs of boastfulness. The performance was unusual for him only because of the service renderd to the missionary and her anxious friend in America. He exchanges messages with Australian amateurs without the help of a relay station, covering a distance of over station, covering a distance of over 7,000 miles, with less power than flows through the lamp that illuminates this page as you read.

Amateurs cover these enormous distances by using short waves, around 20, 40 and 80 meters. For some reason that is not yet fully understood, these waves travel further with less power behind them than those commonly used in broadcasting and commercial and government services. They work as well or better

The Providence Radio Association, which announces itself as the oldest active amateur radio organization, has a youthful appearance

1OC-1BFT of Concord, N. H. At 16 he is route manager and official observer for the APRIL and official reporter for the Army-Amateur net. He exchanges messages with many amateur stations in Europe

in daylight and are not troubled seriously by static.

They may be inaudible anywhere within 500 miles of the transmitter but loud and clear 5,000 miles away. The theory is that they are propagated upward, strike ionized strata in the upper atmosphere, and are reflected back to earth. Like shells fired at a high angle, they strike nothing between the points from which they are fired and the point where they return to the ground. Experimentation with short waves is one of the most fascinating pastimes in radio.

Twenty watts input is all the average amateur uses, so short wave work does not run up the electric bill seriously.

OAJ3U may look to you like an unintelligible jumble of letters, but read it to a "ham" and he will say right off the bat: "Melbourne, Australia." This "Aussie" is celebrated throughout hamdom because his signals come through frequently, steadily and readily. When he landed in America a few months ago the radio amateurs were so glad to see him that they forgot to argue with him about who won the war.

"I have often read your articles," he told me. So *Radio Age* is known even on the island continent.

There was a time when the radio amateur was more often an experimenter than a handler of traffic, but emphasis has been placed on traffic recently and the results are startling.

1BIG, of Augusta, Maine, won a prize offered by the League for the best traffic record for three months. He handled over 1,200 messages, including those originating at his station, those received and delivered by him and those received and relayed. 10C-1BFT of Concord, New Hampshire, a single operator with two transmitters tuned to different wavelengths, handled 1,150. He worked three stations in France, two in Belgium, one in Holland and one in England. In 1926 he took five messages from the McMillan Arctic Expedition, all of them important. This boy, who has reached the mature age of sixteen, started in radio when he was fourteen. In two years he has risen to the position of route manager and official observer of the A. R. R. L. for New Hampshire, and official operator in the Army-Amateur radio net.

1CPR, who was known as W. R. Pierce before he acquired call letters, is one of the few radio amateurs who look at broadcasting as something more than a popular amusement that gets in the way of useful radio activities. He bought a two-tube broadcast receiver and went after a logging record.

He reports that he has heard 625 stations in 38 countries, including the United States, and that he has cards or letters from all of them confirming his reception of their programs.

These amateurs are showing us how to get out of radio all there is in it. W. T. Grant, who received three cents a day as his wages on his first job and who is selling $40,000,000 worth of radio and other merchandise this year through a chain of more than one hundred stores, says that it is the law of life that anyone who renders a real service to humanity receives an adequate return.

This law operates in radio as in other affairs. Those who sit in easy chairs absorbing programs that cost someone else as much as $25,000 in an evening become so satisfied and fussy that the enjoyment of it all but vanishes. Also they develop "corporations" of a non-dividend-paying kind. The radio amateur, scrimping to buy the parts for his transmitter and receiver, putting them together with meticulous care, testing them out until they deliver satisfactory results and then using them for handling messages free of charge for anyone who needs the service, knows the joy of living.

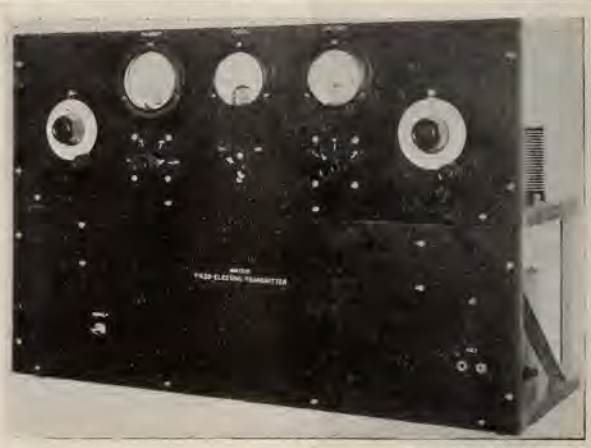


Photo courtesy General Radio Co.

This is the very latest thing in amateur apparatus, a crystal controlled transmitter. Properly installed and fed with 50 watts or less of power, it will probably be heard on all five continents, Australia and the Isles of the sea.

When the world war broke, the American Radio Relay League furnished 2,500 trained amateur operators for the fighting forces within a few weeks. If the war in China draws us into its deadly grip there are at least five times that number who will enlist at the first call. Many of them are having experience right now in handling Army and Navy traffic, for the Army-Amateur net and the Navy-Amateur chain are maintained for the purpose of training radio amateurs for emergencies. Correspondence courses and training in camps are provided, in addition to daily practice throughout the year.

Time after time the amateurs have filled the gap when storms have disrupted wire service. Gifford Grange of Jacksonville saved lives and property during the Miami disaster by keeping radio communication open. Railroads have called on the amateurs for train dispatching and other service when landslides carried away rails and telegraph poles. McMillan's messages from the Arctic have been picked up by amateurs during each expedition and he had to depend on a fifteen-year-old amateur, Arthur Collins, for twenty-two days in 1925 when his expedition was near the Arctic circle and professional radio men were unable to reach him. Dyott, on his recent trip down Roosevelt's River of Doubt in Brazil sent out reports through amateur stations.

Less than $100 will equip an amateur station with an efficient short-wave transmitter and receiver. The waves in the 20-, 40- and 80-meter bands carry half way around the world when propagated with a power input of from 20 to 100 watts. Amateur stations using 500 to 1,000 watts are exceptional and many amateurs testify that they do not reach out much if any better than those using 50 watts or less.

The short-wave receivers that amateurs use seldom have more than two tubes, which are enough to make low-

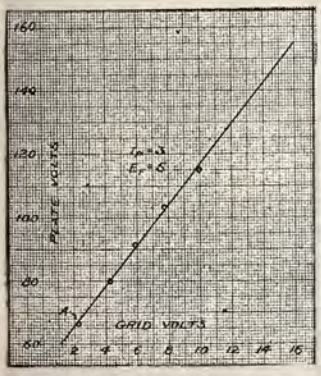
(Continued on page 39)

How to Build a Vacuum Tube Voltmeter

By KIRK B. MORCROSS

A VACUUM tube voltmeter is an apparatus consisting of a vacuum tube and associated equipment so arranged and calibrated as to permit the measurement of a wide range of alternating and direct voltages. Alternating voltages may be measured with approximately the same accuracy regardless of their frequencies. A thorough understanding of this type of voltmeter, particularly when it is used in all its various applications, requires detailed study and theoretical considerations. However, one may obtain an excellent idea of its general mode of operation without the use of elaborate equipment and with very little theoretical knowledge.

Operation of a tube voltmeter (See Fig. 1) depends upon the fact that a small increase in voltage in the grid circuit requires a correspondingly larger increase in voltage in the plate circuit to "balance" the tube, that is, to bring the plate current back to its original value. Thus one may determine the value of voltage added to the battery in the plate circuit by employing a voltmeter of small range and measurring the increase in grid voltage required to restore the balance. The value of the unknown voltage is the product of the increased grid voltage and the "mu" or amplification constant of the tube. Mu is determined for the particular tube used. This rule for voltage measurements works both ways, that is, if a very small voltage is to be measured that voltage is added to the battery in the grid circuit and the increased B battery voltage which is required to restore the balance of the tube is read with a voltmeter. The unknown voltage is then computed by dividing the increased B voltage by mu. The tube voltmeter may also be used to determine the operating condition of tubes and their characteristic curves.



Graph obtained by plotting plate voltage values along vertical axis and values of grid volts horizontally

Photograph of the completed vacuum tube voltmeter described by the author

A schematic diagram is shown in Fig. 1. Fig. 2 shows the actual arrangement of parts and Fig 3 shows the completed instrument. A 201-A type of tube is employed. The instrument MA is primarily for the purpose of indicating constancy of plate current rather than its actual value in milliamperes. A cheap voltmeter is therefore satisfactory. It should have a range of from five to ten volts. The value of R may be from 400 to 800 ohms which is sufficiently great to prevent an unduly heavy drain upon the C battery. In addition to MA, a direct current voltmeter having a range of about 100 volts is needed. (The exact range depends upon the character of the measurements.) The voltmeter should have a double scale so that small voltages may be read with fair accuracy. The instrument should be provided with connecting leads terminating in clips so that it may be readily connected to different parts of the circuit.

The parts are mounted on a board provided with binding posts assuring convenient connections and changes in B and C. The A battery may consist of dry cells (four connected in series) provided the tube is not burned for long intervals of time. Posts 7 and 8 permit easy addition of C battery as required in the measurement process; additional C battery can be added at 5 and 6 instead, but if too much voltage be applied here the drain on the battery becomes excessive.

In the usual methods of operation of the tube voltmeter the value of mu (amplification constant) for the tube is first determined by a single series of measurements. In lieu of

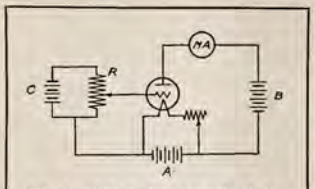


Fig. 1. Schematic circuit of the vacuum tube voltmeter

this, the writer has devised what may be termed a graphical method of finding mu which has the advantages of simplicity and better accuracy, and in addition greatly simplifies subsequent measurements with the tube voltmeter. Before describing this, however, the usual method of determining mu will be discussed as this materially assists in understanding the operation of the tube voltmeter. It is therefore suggested that the experimenter make this preliminary measurement.

Mu is not the same for all tubes and it also varies with the filament current and so it is necessary that this be kept constant. Mu is defined as the quotient obtained by dividing a change in plate voltage by the corresponding change in grid voltage required to maintain a constant plate current. This suggests the method of determining mu.

Having alloved the tube to burn for several minutes, connect 7 and 8 (Fig. 2) with a wire, clip the voltmeter across F and F and adjust the filament rheostat until five volts are indicated. Now adjust R and note that this causes a variation in the needle of MA. Connect the voltmeter across 3 and 4 and record the voltage (say 88). Next connect the voltmeter across 8 and 9, adjust R until the reading of MA is *exactly* the same as with the voltmeter across 3 and 4 and again record the voltage (say 2.5). (As a precaution, again connect the voltmeter across F and F to see that the filament terminal voltage has not changed).

Now increase the voltage across 3 and 4 by about 20 or 40 volts, connect the voltmeter at 3 and 4, readjust R until *exactly* the same reading of MA is obtained as before and record the reading of the voltmeter (say 130). If necessary, add more C battery at 7 and 8. Connect the voltmeter to 8 and 9, readjust R to give the same deflection of MA and record the voltmeter reading (say 9.2). Mu is now computed to be

$$\frac{130 - 88}{9.2 - 2.5} = 6.3.$$

It is important to obtain the voltage readings while the voltmeter is actually connected in circuit and to readjust R in each case to maintain exactly the same deflection of MA.

A somewhat simpler method of determining mu which is theoretically correct is to so adjust the plate and grid voltages that zero plate current is obtained and then divide the plate voltage by the grid voltage. In practice, it is difficult to secure good results by the use of this method.

Let us now turn our attention to the graph shown in Fig. 4. This is obtained by plotting values of plate volts along the vertical axis and values of grid volts horizontally, meantime keeping the filament terminal voltage (that is, the filament current) and the plate current constant. For the graph shown the filament voltage is 5 volts and the plate current is 3 milliamperes. As previously stated, the *value* of plate current need not be known and might in this case (for example) be a reading of 3.6 on a voltmeter inserted in the plate circuit.

To determine the graph, the voltmeter was clipped across F and F (Fig. 2) and the filament rheostat adjusted for 5 volts. The voltmeter was now connected to 8 and 9 (this caused a shift in the needle of MA) and the milliammeter brought to exactly 3. This gave a grid voltage of 2.25. The voltmeter was then clipped across 3 and 4 and the reading taken after the plate current was brought back to 3 milliamperes by adjusting R. This gave a voltage of 66.5 which together with the grid voltage of 2.25 determined point A on the graph. Other points were obtained in the same manner. A "mean" curve which is essentially a straight line, was drawn through the several points. Mu may be determined from this curve. Take any range in grid volts, say 4 to 10, and note the corresponding range in plate volts, 78.5 to 117. Mu is therefore

$$\frac{117 - 78.5}{10 - 4} = 6.4$$

In using the graph in conjunction with the tube voltmeter to measure voltages the value of Mu need not actually be known. To make such a measurement connect a source of unknown direct voltage at 3 and 4 (Fig. 2) in place of the B battery and vary the voltage across 8 and 9 by adding more battery at 7 and 8 and by adjusting R until the same plate current is obtained as was used in the calibration. Also make sure that the filament terminal voltage is the same. Suppose the grid voltage is found to be 12.6. Locate this point on the graph and read the corresponding plate volts. This shows the unknown voltage to be 133.

To measure a small direct voltage, disconnect the C battery, connect terminals 9 and 6 with a wire and connect the source of the unknown voltage to 7 and 8. Adjust B until the proper late current results, then read its voltage from the voltmeter. The unknown voltage is then determined from the curve as before.

Old dry cells are useful as "C" or "B" batteries and by connecting some in "opposition" the voltage of the B battery may be varied as accurately as desired.

The measurement of alternating voltages involves a procedure which is similar to the measurements just described. However, increase the value of the voltage obtained from the graph by one half.

(Continued on page 26)

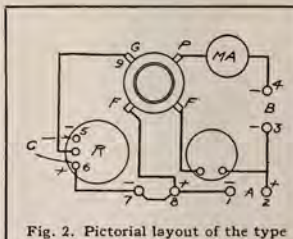


Fig. 2. Pictorial layout of the type of vacuum tube voltmeter described by Mr. Morcross

The FROTH ESTATE

by Joseph Balsamo

The story thus far

Col. Maximiliam Minimil sets $10,000,000 aside out of his personally acquired colossal fortune, for the purpose of financing the Fortunatus Gazette for his son Daly. The younger Minimil, while the great project is being organized, has some difficulty in making other people believe he intends to publish a newspaper that is to be free from the smut and hysteria of certain other dailies. He believes a clean journal will win out. Bill Rossom, publisher of the Clarion, is a former movie actor. A horse stepped on his face and, although putting him out of the picture game, so transformed his countenance that he has the appearance of a super-man. People do what Rossom wants because of the compelling power of the Rossom face. Rossom tries to prevent the sale of the first issue of the Gazette. The Minimils win their circulation battle by a ruse and the Gazette is successfully launched.

Daly, who doesn't know much about the grinding of the news mill which produces daily newspapers, visits his own local room to watch the city editor and his staff of reporters and sub-editors. The young publisher is surprised at the processes of converting facts into stories. He orders the city editor to discharge one of the girl reporters, giving the reason that she is so good-looking she might distract the attention of the young men from journalistic labors.

XII

DALY had returned to his private office and was studying a circulation chart when Miss Sims, his secretary, entered and presented a card. It was a neat little card, bearing only a name:

Amy Templeton Graves.

Daly looked at it, frowning. "Who is she and what does she want?"

"She merely says it is important and personal."

"Meaning nothing at all," said Daly. "Tell her I'm in———"

"Conference," assented the young lady secretary and withdrew.

The door between the ante room and the private office was ajar. Daly heard Miss Sims convey his threadbare little lie to the waiting visitor.

"Perfectly all right," said a well modulated voice, "I have a good book with me and I'll wait if you don't mind."

"But——"

"No trouble at all," said Amy Templeton Graves.

"It is customary to make an appointment before expecting——"

"I'm leaving for the East on a night train," said Miss Graves.

"If you would tell me the nature of your business ——"

"Sorry, but it's personal.'

Daly, listening, was becoming interested and as ne pictured the haughty shoulder that Miss Sims undoubtedly was shrugging at the moment he smiled broadly, shoving aside the circulation chart. The musical voice was heard again, in a sort of contralto chant. Daly suspected that it was raised to just the proper pitch and power to make sure of carrying through the open door.

"Remember when the Prince of Wales came to Fortunatus? I called at his hotel in the afternoon and told his major domo or valet or secretary, or whatever he was, that I wanted just a word from His Highness about what he thought of Fortunatus and American girls, *et cetera*. They must have thought I was going to try to sell the Prince some oil stock or a parcel of life insurance, the fuss they made over it. It seems they were having a bit of tea in the Wisteria Room. There was an orchestra and dancing. I was getting an eye full and thinking what a hard life that royal cake eater was having in our midst when a gentleman with flat feet and a rented cutaway stepped up and touched me on the shoulder. Usually I get along without taking advantage but when that house detective started to ease me off to the corral I used my sex. I waited until a busboy came alongside and fainted right into his tray of empty Bronx glasses. There was quite a commotion. They sat me in an occasional chair and someone started for a glass of water. I opened my eyes to tell them not to trouble about it, that a plain Bronx would do just as well, and I looked right up into the blue eyes of the eldest son of the current King of England There's a boy for you! He had asked a few questions and came right out to see what could be done. Royalty and the elite of Fortunatus stood around looking at me as if to say, 'She may, after all, be somebody's sister.' I sat up straight and reached for my turban and then I smiled at the Prince. He smiled too, and said something about me being a bit of all right."

" 'It, of course, would be impossible for us to talk to reporter for publication,' " said His Highness, " 'but after you are bucked up a bit we would regard it as a favor if you would have a one-step.' "

"Oo OO! And a few minutes before those debs and sub debs and old ladies in young clothes had been regarding Miss Amy Graves as about as important as a sparrow's birthday! I stood up and the Prince and I walked over to an open window and it wasn't long before I said I was a hundred per cent and off we glided. The Prince said I danced extremely well and I said he wasn't so bad himself and he laughed and after the dance he ordered an ice and we sat at a little table and chatted and finally I excused myself for I had got my interview, a Bronx, a parfait and I enjoyed the unanimous hatred of all the sisters in the Fortunatus blue book and I was so happy!"

Silence in the ante room and Daly wondered if Miss Sims had walked out on Miss Graves.

"No," said a sonorous voice, suggestive of Ethel Barrymore's, "No, we never met again."

Daly managed to throttle a laugh down to a gurgle, but Miss Graves had heard and she cried joyfully:

"The conference is breaking up."

Daly appeared at the door. "Come in, please," he said, and then he blushed very much like Mr. Asbury Lunt might have blushed, and exclaimed weakly, "O, it's you."

"In person," she said, and throwing a triumphant glance at the thoroughly bewildered Miss Sims, the young lady bowed gracefully as Daly stepped aside and motioned her to precede him into the private office.

XIII

Seated on opposite sides of the big flat desk they looked at one another without speaking. The girl who had been chattering so briskly a moment ago now seemed at a loss for a word. Daly, with indifferent success, tried to suppress a smile.

"You ordered me fired," she said at last. "Is that so amusing?"

"Pardon," he said, very soberly, "I was thinking of your affair with the Prince of Wales."

"I'm serious," she protested. "Stub Graham told me why you ordered me off the staff and I have gone to a lot of trouble getting in here to thank you."

"I hope you're not going to be sarcastic."

"Not a syllable," she exclaimed. "I want to thank you for paying me the finest compliment I ever had . . . too good looking to be turned loose on a helpless newspaper staff!"

Daly glanced at Miss Graves and although his appraisal of her was properly swift she was modestly aware of it and the color rose in her cheeks. Daly wondered if she knew that her oval face, framed by the chic green turban and softened by vagrant curls of auburn hair and illuminated by eyes that were pools of flickering blue light, was a face among thousands, millions. He wondered if she realized how exquisitely her tailored suit and open collared silk blouse caressed the lines of her lithe, slender body. Lips, lashes and eyebrows that gloried in freedom from rouge and pencil. A Da Vinci nose, chiselled in warm Italian marble. A throat—suddenly he looked up from the letter opener with which he had been toying. It was his turn to speak.

"Are you going to take a train East tonight?"

She looked at him in astonishment. "What has that to do with it?" she asked.

Daly pulled himself together. It occurred to him that the publisher of the Fortunatus Gazette was too rapidly becoming pop-eyed over a little girl reporter. What a laugh that situation would get in the Gazette plant, from the press room in the sub basement to radio station on the roof.

"Merely this," he said, bringing his eyes around boldly to meet hers. "I hadn't considered that my instructions to Graham might mean really serious consequences to you and I wouldn't want to be the one to drive you out of town looking for work. Perhaps we're making too much of a small matter. I'll tell Graham I've changed my mind."

A shadow deepened the blue in her eyes. She hadn't come to hear him say that. Considering the matter, she did not know that she had wished him to say it. But of course she couldn't tell him that. Couldn't permit him to guess it, even. She arose and made a move toward the outer room. He followed and stood with his hand on the edge of the door. He was a tall figure and there was nothing lacking now in poise or dignity. She looked up.

"I suppose," she said, "that I should thank you now for giving me back the job, although, if you will remember, I didn't ask you to do so. And I suppose, too, I should withdraw my thanks for the compliment you seem to have withdrawn." Daly closed the door softly and stood facing her.

"I have withdrawn nothing."

"It's a little bewildering but in that case I'm going to thank you for everything, many, many times, and I'm sure that ought to cover it."

"We haven't been honest about anything," he said. "Not since you came in. Suppose we stop fencing and begin all over again and tell the truth."

"It would be interesting," she replied. "Let's start with the conference; as a matter of fact were you in conference?"

"No, I was not. But how about the Prince of Wales? Did he tell you you were a bit of all right and buy you an ice?"

"No."

"We are two terrible, terrible liars, Miss Graves. Now the next question: Why did you come here to see me?"

"Let me get this straight. Are we both pledged to tell the truth and nothing but the truth?"

"Absolutely."

"Then, being the man, you should plunge first. As a matter of fact why did you fire me?"

She was looking up at him, her face flushed, but

determined courage in her eyes, and perhaps a [illegible].

"Because when I saw you in that local room I t[illegible]ht you were the most adorable girl I ever lool[illegible]at. Thinking that, I couldn't make it seem right [illegible]ou to be there. It didn't seem to be your backgrou[illegible]d, your atmosphere. Foolish, maybe, but the truth. But you didn't go. Why didn't you?"

"Because when Stub Graham told me what you said I concluded that you liked me an awful lot and I was very happy over it because I had been looking at you and—and I thought you seemed so *regular*, somehow, such a *man*."

Daly stood gazing at her. "Is that the whole truth; did you come to my office to thank me?"

"No," said the girl. "I really was a little worried about losing the job. I wanted to tell you that I could take care of myself and I was sure of it because I'm taking care of my mother and a kid brother. But the main thing was to come to you and see whether you would tell me—what you told Stub Graham."

Daly took her two hands within his own and held them close. Her face was lowered now.

"You are the most beautiful girl in the world."

Some time later she rescued her turban from the crazy angle it had taken and pushed back a wayward curl from her forehead. She straightened the folds of the sheer silk collar, which had been sadly disarranged.

"Ain't truth wonderful?" she said, dabbing her eyes with a tiny handkerchief.

"Devastating," he agreed. "But you must go now. Miss Sims will—. I want to meet your mother and talk this thing out. Tonight? Tomorrow? When?"

"My, what a fast worker you are I'm sure we'd better have a few hours to think about it. I'll telephone you tonight."

He opened the door and Amy Templeton Graves very bravely and successfully passed out into the ante room and nodded a bright farewell to Miss Sims who gave her the cool scrutiny that only one woman can give another—and get away with it.

At 10 o'clock that night Amy took the train East after telephoning that she was compelled to go and that she would write.

XIV

Philadelphia, Pa.
July 22, 1926.

Dear Daly Minimil,

When I left Fortunatus day before yesterday I was running away. I wanted time to think. For some years I had been sure that if and when I met the right man I would know just what to do if and when he began to make signs that he thought I was the right girl. Well, I was hardly prepared for such a ride on the speedway of romance as it eventually turned out to be. Hired, fired, kissed and proposed to, all in one afternoon and the same man playing the heavy lead in each sketch!

I am going to confess that I don't regret a minute of that afternoon. I guess I am as modern as most girls of my age, weight and class and I believe in quick decisions. But there's a speed limit to everything. You don't know a thing about me except that I am as fresh as a channel breeze and that I am the most beautiful girl in the world. You are right about the first count but all wrong on the second. You ought to see my sister. She can give me all four aces and make game in no trumps, and I don't say it hesitatingly.

On the other hand I know some things about you and yours and in that way I have an advantage. Your father, for instance. I have an idea he would take it more kindly if you give him his chance to hit the ceiling before you buy the ring instead of afterward. Tell him you are in love with the world's most adorable and then go on with the story in easy installments until you come to the part where you admit that you can't remember my first name and that I was one of your girl reporters for a few uneasy minutes and that you never saw me but once in your life. That will be a basis for further parley.

Maybe you haven't thought of it but Bill Rossom over there on the Clarion would walk a mile to read a society notice in his own newspaper and in half a dozen others to the general effect that Mr. Daly Minimil publisher of the Fortunatus Gazette, was engaged to marry Miss Amy Templeton Graves, a red-headed girl reporter who worked on his new newspaper for an hour or so.

No, Daly it would hurt you a little. And that would hurt me a lot. They would say that you were the heir to the biggest wad in the state of Coma and that I was living in the second flat back around the corner from the tannery. If you do go to the jeweler's (and I hope and pray that you will) postpone it until you have read all the latest advertisements about skid chains and brake lining. You won't need a traffic horn.

I've been a little girl reporter quite a long time now and, old dear, I know why orange blossoms wilt faster than geraniums. Do as I say about this and I'll promise to bring you the slippers and pipe ever after. I love you and I want you to love me permanently.

Yours,

A. T. G.

P. S. This is Thursday. You will receive this letter on Saturday at the latest. There's a radio in the place and I'm going to be listening in on Sunday night. If, during the half hour of old favorite songs Sunday night, I should tune in the Voice of Fortunatus, on the roof of the Gazette building, Fortunatus, Coma, and hear your baritone Soloist sing "Beautiful Garden of Roses," I would know you had arranged it. How's that for a transcontinental secret? I'll also take it as a promise that you are looking over the brake lining and the skid chains. Love. A. T. G.

(To Be Continued.)

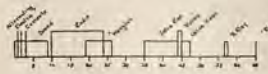
The Spectrum of Radiation

By ELMORE B. LYFORD

A LARGE part of our daily life depends upon vibration, in one medium or another. Sound, and our powers of hearing, depend upon vibration of the air around us. Light, and our powers of vision, depend upon vibrations in the ether. The radio we listen to in the evening is actuated by waves which are transmitted by this same ether. Radiant heat, X-rays, and the electric current in most of our homes—all depend upon vibrations, or waves, of one frequency or another.

What the average person does not realize, perhaps, is that all of these waves, or vibrations, are identical in their form, and differ from each other only in frequency, or wavelength. The relation of these different vibrations, one to another, and the order in which they fall when arranged according to frequency, may therefore be interesting.

When comparing vibrations of greatly differing frequencies, the most convenient measure is the octave, that is, the frequency scale of accoustics. An increase of one octave means a doubling of the frequency, regardless of the absolute frequency, or starting point. To set up such a scale, let us choose as our starting point 16 cycles, or vibrations, a second, this being about the lowest frequency that can be recognized as a sound by the human ear. One octave above this would be 32 cycles a second, two above would be 64, and so forth. The third octave above our starting point is 128 cycles per second—middle C on the piano. Sixty-five octaves will be necessary to include all the vibrations known to man.



A graphical representation of these sixty-five octaves is shown, and the position of various types of vibrations on this "scale" are marked. A little study of this chart will bring out several interesting facts. One of the most striking is that the range of visible light is less than one octave out of the entire sixty-five. The ear is much more versatile than the eye, for it can hear vibrations over a band of frequencies nine octaves wide.

At the bottom of our frequency scale—the slowest vibrations with which man deals—come the 25, 60 and 133 cycle alternating electric currents which are almost universally used for power and lighting purposes. The frequency band to which the ear is sensitive also starts around 16 cycles per second, and extends nearly nine octaves, up to frequencies in the neighborhood of 8000 cycles per second. These vibrations which affect our ear are carried by air as a medium, but all other vibrations are transmitted by waves in that intangible stuff which permeates all space, and which scientists call ether.

Next higher in our frequency scale come vibrations caused by electric waves. These are caused by lightning flashes, certain forms of arcs, and "surges" such as are sometimes encountered on electric transmission lines.

Just above and overlapping this band come the ether vibrations known to us as radio waves. Varying from 15,000 to 300 million cycles a second—from one to 20,000 meters, in wavelength—they cover a frequency band of fourteen octaves. This is the largest band of frequencies covered by any one class of vibration, and it is being gradually extended even more, particularly on the high frequency end.

On higher frequencies than the waves classed as radio, but yet closely allied, are the Herzian vibrations. These vibrations were produced and measured before those at "radio" frequencies, and in a certain sense the work of Herz was the forerunner of the great development of the radio frequencies which has occurred in the last forty years.

Between the Herzian waves and the very longest infra-red rays, next above, there is a gap in our scale which covers a range of about nine octaves. Vibrations in this range of frequencies, from about a thousand million to a million a second, have not yet been discovered, though there is no reason to suppose that they may not exist. Modern science knows no way of producing frequencies of this order, nor no way of detecting their presence if they *could* be produced. The characteristics which vibrations in this band of frequencies might have cannot even be deduced. If apparatus is ever devised which will produce and detect them, they may be found to be very valuable for the transmission of signals, or voice, or power—or they may be worthless for any practical use.

The infra-red rays or vibrations above this unexplored region cover a band of about eight octaves. They blend then into the frequencies which constitute visible light, and which, as has been said before, cover a band less than an octave wide. "Light" waves of frequencies too high to be detected by the eye are called ultra-violet, and these have been detected by other means over a band of frequencies about two octaves wide.

Vibrations in the infra-red range are sometimes called radiant heat, and are detected in the radiation from certain stars, and from the moon. Ultra-violet radiations are given off by an arc light, the brighter stars, and by other very hot bodies, including the sun. These ultra-violet rays are of importance in medicine as germ-killers, but in excess they are also more or less destructive to human life.

Above the range of frequencies covered by the ultra-violet radiations there is another band which is so far unexplored and unknown, and above this comes the range of frequencies attributed to X-rays. These cover a very narrow band at about the 57th octave. These X-rays are very important in medicine, because of their property of penetrating otherwise opaque bodies, allowing us to take photographs of things inside.

At the extreme end of our frequency scale we find the frequencies of the different radiations given off by radio-active substances such as

(Continued on page 16)

Amateur Radio

LEAVE it to an amateur (and an old time brass pounder at that) to solve the problem of properly tuning a voltage feed Hertz.

Hearing that C. W. Kern, 9KB, had done the work easily we called on him for an explanation which he advanced as follows:

"The difficulties of properly tuning a voltage feed Hertz antenna, usually encountered at amateur stations situated in crowded city locations are well known. One of the greatest obstacles is lack of communication between the man at the set and the man on the roof changing the feeder.

"At 9-KB this was overcome in a very simple manner. Two ordinary head-phone sets were connected with a piece of lamp-cord (any double conductor wire will do) long enough to reach from the set to the roof, but laid in such a way as to be entirely out of the field of the antenna itself. One side of each head-set was taken out of the holder and used as a 'transmitter,' leaving the remaining single phone on the frame to be worn over the head in the usual way. A 4½ volt 'C' battery was placed in the circuit to boost the audibility, but this was not absolutely necessary as it will work without battery.

"With such an arrangement it was easy to follow operations at both ends of the line and to tell at what point on the antenna the feeder gave the best readings.

"With a semi-vertical single wire antenna 58 feet long best results were obtained with the feeder slightly under 6 feet off center. The position of the feeder in this particular case was found to be more critical than the ordinary methods of locating it seemed to indicate. While the antenna would work at almost any point with the feeder within 3 to 7 feet off center, by the use of the telephone one point was reached where the wave was sharper and general results most satisfactory."

In a supplemental note to us Kern says:

"Since its installation I worked OA-7DX who said my signals were R-7. Also worked OA-4BD. Worked eight out of eleven stations called, in every district, at one sitting with the present antenna layout. But while we are thinking we are getting out pretty well what about our friend OA-7DX whom I have worked several times, who uses an ordinary 201-A? He said to me 'I am still using that 201-A tube' (and it was several months ago he first told me about it). Either we have good receivers here or he has much efficiency."

A PORTABLE JACK

By Charles F. Felstead (6 CU)

A PORTABLE jack can be made very easily from a single-circuit jack and a short length of Fibroc tubing. The tubing should have an inside diameter of ¾ inch, and be about 3½ inches in length. A disc of ¼-inch thick cord, wood, or bakelite, ¾ inch in diameter, is glued in one end of the bakelite tube. A hole large enough for the head of the jack is drilled in the center of

the disc. A piece of the turned up end of the jack frame that is supposed to rest against the panel may have to be cut away to permit the jack to be put inside of the bakelite tube. The other end of the bakelite tube can be plugged up by means of another disc. A small hole should be made in this second disc for the wires that connect with the jack. These wires can be a length of ordinary double phone cord, if the jack is to be used close to the receiving set; but, if it is to be used with an extension cord for connecting in a loud speaker at some distance from the receiving set, a twenty-foot long, or longer, piece of double lamp cord, or a length of any insulated, flexible double wire, may be used for the extension cord. In either case, a plug should be fastened to the other end of the connecting wires to plug into the jacks in the receiving set. If binding posts are used on the set, spade terminals soldered to the ends of the wires may be substituted for the plug. If wood or cork are used for the discs in the ends of the tube, they will look nicer if they are painted black. The bakelite tube will not have to be so long if the type of jack known as a "short" jack is used.

IN A recent card received by 9BHX from 2XAI at Newark, N. J., data is given regarding that transmitter which is engaged in amateur test work as well as photoradio work, the latter under the call of WAQ, both calls operating on 42.95 meters, crystal control, with 20 kw. input. The station is the Westinghouse test station. It uses a Conrad type antenna (probably a vertical wire with coupling coil in center as is used at KDKA). The transmitter is on daily from 8 a. m. to 4 p. m. E. S. T. with photoradio keying using the call WAQ. E. Gundrum is manager of 2XAI-WAQ. Signals from that station received at 9BHX were considerably better than our standard, WIZ.

"PROPAGATION of Short Waves Around the Earth" is the title of an article by E. Quack, reviewed in the April number of the Proceedings of the Institute of Radio Engineers by Stuart Ballantine. It is quite interesting to short wave enthusiasts in that comparison of signals from 2XT on 18,550 kc at the transAtlantic receiving station in Geltow were photographed with an oscillograph and the presence of a doubled signal found, the double occurring a short time after the principal signal. Later tests were made on the signals of AGA at Buenos Aires on 20,000 kc. Records show a time lag of .135 second. Assuming a wave velocity of 299,800 kilometers per second the corresponding path-length turns out to be 41,499 kilometers (25,750 miles). This of course exceeds the circumference of the earth. If it be assumed this path corresponds to the circumference of a circle parallel to the great circle of the earth it appears from computation that the short wave has been propagated along a super-atmospheric stratum 182 kilometers high (113 miles) above the surface. No proof that the wave actually takes this path is submitted. It is also interesting to note this double-signal effect is observed only on the very short wave lengths, from 15 to 22 meters.

Radio Stunt in "Less Than No Time"

WHILE operating an amateur receiver and transmitter one night, E. Granbacks, an operator of Station 6CTX of Richmond, Calif., got in touch with an amateur station in Belgium having the call eb4WW. The Belgian gave Granbacks a message going to Hawaii, the time in Belgium being 4:45 a. m. Very shortly after this Granbacks succeeded in hooking up with the desired amateur station in Hawaii, whose call was oh6AXW, and gave him the message. This occurred at 9:30 p. m., of the day before, in Hawaiian time. Thus a message actually traveled 7,500 miles and yet arrived at its destination seven and a half hours before it was filed in Belgium!

ASIDE from the a. c. tubes described on page 15, two new rectifier tubes have been announced by the R. C. A. which have a greater current capacity than any of the previous models and which it is believed were developed to take care of the increased current required for operation of the new a. c. tubes.

The full wave rectifier, UX 280, gives a d. c. output of 125 milliamperes. It may be employed interchangeably with any devices in which the 213 was previously used.

The half wave rectifier is called the UX 281 and takes the place of the 216-B. In circuits designed for its use the d. c. output current available is 110 milliamperes. Two of these tubes used in the full-wave scheme shown in the blueprint section of this issue will give 220 milliamperes instead of 130 as at present with the two 216-B tubes.

Both of the rectifiers are of the hot cathode type, with a new ribbon, oxide coated filament insuring great ruggedness and long life (Allah be praised!)

It is understood that greater plate current is required on the a.c. tubes, so it is imagined these two new rectifier releases are to insure ample plate current which the previous rectifiers might not have been able to afford.

JOHN E. HODGE, 4BY down in Savannah, Ga., having seen advance proofs of the blueprint article in this issue, believes we should tell those who are intending using a large tube as a power amplifier and a smaller one as a doubler, that the grid input connection of the big tube should be made variable so that it may be clipped down from the plate tap. In the drawing we have shown the grid input wire as permanently connected to the plate of the preceeding tube. In the case of a 210 feeding another 210 this practice seems to work all right. But Hodge suggests that for a 210 feeding a 203-A it would be better to make the lead variable since some instability may be found when running the grid input right off the previous plate. He also finds that amplifying the fundamental and then picking up twice its frequency seems to work better than the form we show. As most of the short wave stuff is a matter of opinion and will be for a number of years, readers should try out both methods for their own information. It is quite probable that results obtained with 210 tubes will not always match results secured with fifty watters and vice-versa. For a limited plate voltage and to ease the strain on the pocketbook the 210 proposition looks good.

Use SW Oscillator to Pick Up Programs

UNTIL recently reception of short wave broadcasting programs was confined to amateurs and experimenters who could build their own equipment for the purpose.

Now, through the invention of W. M. Bruce, Jr., consulting engineer and expert on submarine cables, the field has been widened so all radio fans who can afford the cost may enjoy the new form of entertainment. The theory of Bruce's new device, known as the Crosley Lowave, is like many other inventions, so simple that it is amazing it hasn't been thought of before.

The unit consists essentially of a small short-wave receiving set with detector and one stage of audio frequency amplification and an oscillator tube adjusted to operate within the broadcasting range.

Signals are received by the short wave set and are detected and amplified by the two tubes provided for this purpose. The amplified signals are then impressed on the oscillator tube, which is modulated by them and which rebroadcasts the signals on a longer wave length, for example, 300 meters.

It is merely necessary, then, to connect the output of this oscillator tube to a radio set, tune the set to 300 meters (or whatever wavelength the oscillator tube is adjusted to) and listen to the short-wave signals. In brief, the signals are picked up on the short wave, used to modulate an oscillator tube, and rebroadcast into the radio set at ordinary broadcasting wave-lengths.

PICK-UPS *and* HOOK-UPS *by our Readers*

ONE of our foreign Dial Twisters (in fact he is the first and original one) wishes to correspond with radio fans on general lines, and asks that we accord him a bit of space for this announcement:

"Reginald A. Garratt wishes to correspond with radio fans on general lines and also with the idea of forming an Anglo-American Radio Correspondence Club. If interested, drop him a line. His address is 70 Victoria Road, London, North Four, England."

We think the idea is a good one and wish Mr. Garratt all kinds of luck in starting such a club. Perhaps many of our Dial Twisters will be of the same opinion and will so advise our genial British member.

C. B. STAMM, D. D. S., of Lancaster, Pa., writes asking that we devote some of our energy to uncovering a super-regenerative set that will work. Remembering some of the fiascos that were perpetrated in the name of the super-regenerative class we have refrained from going into that subject. However all we need now is a good tube for r.f. amplification and when that is perfected there will be no need for the super-regenerative set. In the meantime the best bet we have found is the combination shown in the blueprint section of the May-June issue where the 9 tube World's Record super was described. By changing the plug-in oscillator coil and cutting the loop circuit the set may be adapted to short waves. It may also be enlarged without much trouble to take in long wave phone and code work. Frankly it is an all-round set.

GEORGE A. CLARK of Represa, Calif., tells us he wouldn't sell any of his RADIO AGE issues for any price. He has bound the 1925 and the 1926 (with the Annual) into a volume and finds it quite handy for his work in conducting a radio class. He thinks the magazine is getting better every month and impatiently waits for each succeeding issue.

New A. C. Tubes Are Announced by R. C. A.

AS WE go to press announcement is made by the Radio Corporation of the UX226 a. c. filament tube useful as an r. f. amplifier and a. f. amplifier (but not as a detector) and the UY227 a. c. filament tube as a detector (but not r. f. and a. f. amplifier). The UX226 has a 1½ volt filament drawing 1.05 amperes; the UY227 takes 1.75 amperes as 2½ volts. Both are a. c. operated. Their characteristics are otherwise very similar to the conventional 201-A. While the UX226 employs the standard UX base, the UY227 however uses a special five prong base.

This seems to be the opening up of the a. c. set operated era. Tubes will be available July 1, according to the announcement.

In addition two new types of rectifier tubes have been announced. Details concerning these tubes will be found on page 14.

This announcement follows a period of announcement and denial, counter announcement and counter denial, that has had the radio industry whipped into a frenzy of expectation. Use of these new a. c. tubes (which still require plate current from batteries or eliminators) is expected to give an added impetus to the set manufacturing industry in that receivers may now be made that are truly electrically operated.

An Idyll of the Fleet

A beautiful and striking picture from the deck of the U. S. S. Pennsylvania as she sends forth one of her winged messengers from her 'plane catapult during maneuvres, as the great U. S. battle fleet proceeds from Southern waters to a resting place in New York Harbor

"Say Bill! What's a radio engineer?"
"I guess it's a fellow like you who makes his set whistle at every station."

THERE is apparently such a paradox as cold heat—at least there is the fact that in the research laboratory of the General Electrict Company there are men who nonchalantly thrust their bare hands into an electric furnace which melts metals with ease. Still another astonishing fact about this furnace is that white mice will stay in it, even though the current is on and even though it is a simple matter for the mice to run out of it if they desire to do so. Again, it is possible to heat to incandescence the interior of a

radio tube without heating the glass bulb itself, simply by inserting the tube in the furnace. Another interesting experiment can be performed with an incandescent lamp, to the base of which there has been attached a single loop of wire; by bringing the lamp near the furnace, the filament can be made to glow.

It will be noted, however, that before a person thrusts his hand into the furnace he is careful to remove any rings from his fingers. Similarly, the metal drinking cup for the mice is not placed in the furnace itself but in an extension of it, although the mice spend most of their time in the furnace proper.

The secret is that the furnace heats electrical conductors only, and the reason is that the equipment is a high frequency induction furnace.

THAT the number of persons listening at radio receivers materially affects the intensity of a radio wave at greater distances is indicated by a recent experiment carried out in London by R. H. Barfield, of the English Radio Research Board. London possesses the same forest of radio antennas which can be seen nowadays on the housetops of any American city. Unlike American cities, London has only one broadcasting station, the famous 2LO. Presumably all of the local antennas are tuned to this one station and are receiving its waves. By testing the strength of the waves received from 2LO in different directions outside the city, Mr. Barfield found that the wave energy is noticeably less after it has passed over thickly-populated residential districts, with many receiving antennas, than after it has passed outward in some other direction where residences are few and antennas sparse. This is interpreted as indicating that the energy absorbed by the antennas actually does decrease materially the energy of the radio wave, which must be used in its further progress. Radio engineers have long wished for some means of determining, inside the broadcasting station, just how many persons are tuned in at any instant. Thus they would know, by the sudden decrease of "customers," whenever an unpopular number is put on the air.

THAT the mysterious cosmic rays which reach the earth continually from somewhere in outer space, as proved recently by Professor R. A. Millikan, may have important effects on long-distance radio is the suggestion made by Professor Werner Kolhörster, of Berlin, a German physicist who studied these remarkable rays even before the investigations of Professor Millikan. The effect operates, Dr. Kolhörster believes, through the famous Heaviside layer, well known to radio fans as the stratum of air, fifty or a hundred miles up in the atmosphere, along which long-distance radio waves are believed to move. Radio waves traversing long paths around the earth are believed to follow this Heaviside layer, as otherwise they would go off into the empty space outside the earth and be lost. The passage of radio waves along the Heaviside layer varies from time to time, being more perfect at night than in the daytime and better in winter than in summer. Sometimes the Heaviside layer seems to be disturbed, so that radio waves will not pass along it at all. Some of these variations may be due, Dr. Kolhörster suggests, to the effect of the rays from space in disintegrating the atoms of the air in the Heaviside layer and thus altering the electrification of the layer. The cosmic rays which reach the earth's surface are very feeble but they are stronger, Dr. Kolhörster believes, in the upper levels of the atmosphere.

NOW that the alternating-current-operated vacuum tube is so much in the public eye, it is opportune to say a few words about the very heart of this ingenious device —the cathode or electronic emitter which takes the place of the usual filament.

The cathode or electronic emitter of virtually all present-day A. C. tubes consists of a piece of insulating tubing of about the size of ordinary lead-pencil lead, with two minute holes passing through it from end to end. About this tiny insulating tubing is placed a metal shield which in turn is coated with the electron-emitting paste. Inside the insulating tubing is a pair of resistance wires, joined together at one end to form a loop. When current is passed through this loop, the heat generated causes the electron-emitting coating to pour out its profuse flow of electrons.

Certain A. C. tubes have been made experimentally with a kind of fused quartz for the heater tube, but in several instances the material has been incapable of withstanding the severe service conditions. Of late, the A. C. tube manufacturers and experimenters have turned to Isolantite—which has proved fully capable of meeting the extraordinary requirements here involved. Isolantite tubing no thicker than lead-pencil lead is extruded in continuous lengths, together with the minute parallel holes, in perfectly round section. The insulating characteristics and very low dielectric absorption properties of this material make it ideal for the purpose. Furthermore, the heat conductivity is so exceptionally high that maximum conduction of heat is assured from heater wire to electron-emitting coating for highest efficiency.

The Spectrum of Radiation

(Continued from page 12)

radium—if, indeed, these radiations *are* wavemotions, which is open to some doubt. They are the most rapid vibrations known to man, the gamma rays of radium, for example, changing their direction at the estimated, almost unimaginable, rate of a thousand million million million (10 followed by 20 zeros) times a second. The difficulties attendant upon anything like accurate measurements at these frequencies may easily be imagined.

Much of the attention of the research workers in our laboratories today is being directed toward vibrations, at one frequency or another, and this short outline of the field gives some idea of its fertility, its interest, and of the work still remaining to be done.

Low Power Crystal Control Transmitter

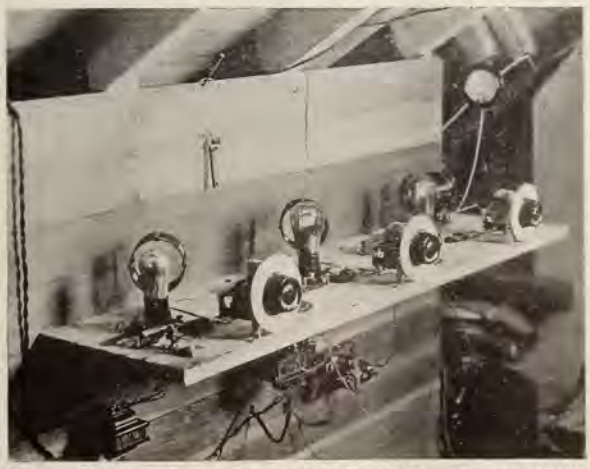
Part of Radio Age "Quad Unit"

By F. A. HILL
(Associate Editor)

BETWEEN the rugged power tubes now available, use of the 40 and 20 meter bands, and the fact power sources for a low power transmitter may be the same type as a broadcast listener uses for high quality output, the prospective amateur is no longer burdened with details that previously prevented him from getting into the transmitting game. Assuming he has learned the code, the balance of the work is relatively simple. With the advent of crystal control and the fact these bits of quartz are no longer so expensive, many an amateur with a wobbly note and a wave that skids from Calcutta to Gary, Ind., may make over his favorite set into a crystal control outfit and still give rein to all his DX propensities. The description of the crystal control outfit at 9BHX may serve as a guide for those just entering the game and who do not wish to invest very heavily in equipment. The experienced amateur will find in the story just another way of making up a transmitter without a great deal of apparatus.

The layout was named the "Quad unit" because of the four constituent parts, the transmitter, the BCL receiver, the power supply and the traffic receiver.

At the top of this page will be seen a photograph of the layout which is arranged for continuity of circuits. It could also be built on a stand with the crystal at the bottom, doubler on the middle and the power amplifier on the top shelf. However since this was to be a temporary scheme pending moving into other quarters the stunt shown was adopted. On the left is the 201-A tube and Frost socket; the crystal and its mounting, the grid biasing resistance, the bypass condenser, and the Aero 40-80 meter transmitting coil and a Bremer-Tully .0005 mfd variable condenser. Power for the quarter ampere receiving tube is derived from a Thordarson type T-2180 transformer with a 110 volt primary and a 5 volt secondary. Plate power for the crystal which oscillates at a fundamental frequency of 3800 kilocycles, is secured through the 90 volt tap on the Carter resistance strips placed across the output of the Thordarson 216-B full wave power compact. Current readings on this tube may be secured through the Jewell milliammeter shown on the test board panel on page 21. This milliammeter may be plugged into any of the various circuits in case it is not desired to use more than one meter. The connection on the test board is by means of Frost closed circuit jacks in each of the power leads, this stunt serving as well for the broadcast receiver as the transmitter. If a single meter is to be used it is suggested that one of a reading not to exceed 150 ma be used. The total output of the full wave 216-B will be 130 mills, so the meter should be large enough to take in that value. Other meters on the transmitter are shown in the schematic Figure 1, one being a O-8 ac voltmeter and the other a O-1 rf ammeter.



Photographic view of the low power crystal control transmitter at 9BHX. The crystal oscillator is at the left, the doubler in the middle and the power amplifier at the extreme right. Output leads go up through glass insulators through the roof to antenna and counterpoise. Other features of the layout are explained in the text of the article

The center tube is the doubler which takes twice the frequency of the crystal fundamental (3800) and amplifies it at 7600 kc before passing onto the power amplifier where it is again amplified at 7600 kc and passed into the antenna circuit. In both the doubler and the power amplifier the filament current is secured from a Thordarson type T-120 transformer, with an Allen-Bradley Radiostat in the primary for voltage control of the secondary. Plate supply for the doubler tube is from the 300 volt tap on the Carter resistance strip, while plate supply for the power amplifier is taken from the high voltage end which will be between 450 and 500 volts.

Instead of making up our own inductances we utilized the new Aero transmitting coils. In the crystal circuit an Aero 40-80 meter coil spanned by a .0005 mfd Bremer-Tully condenser served to tune that circuit to

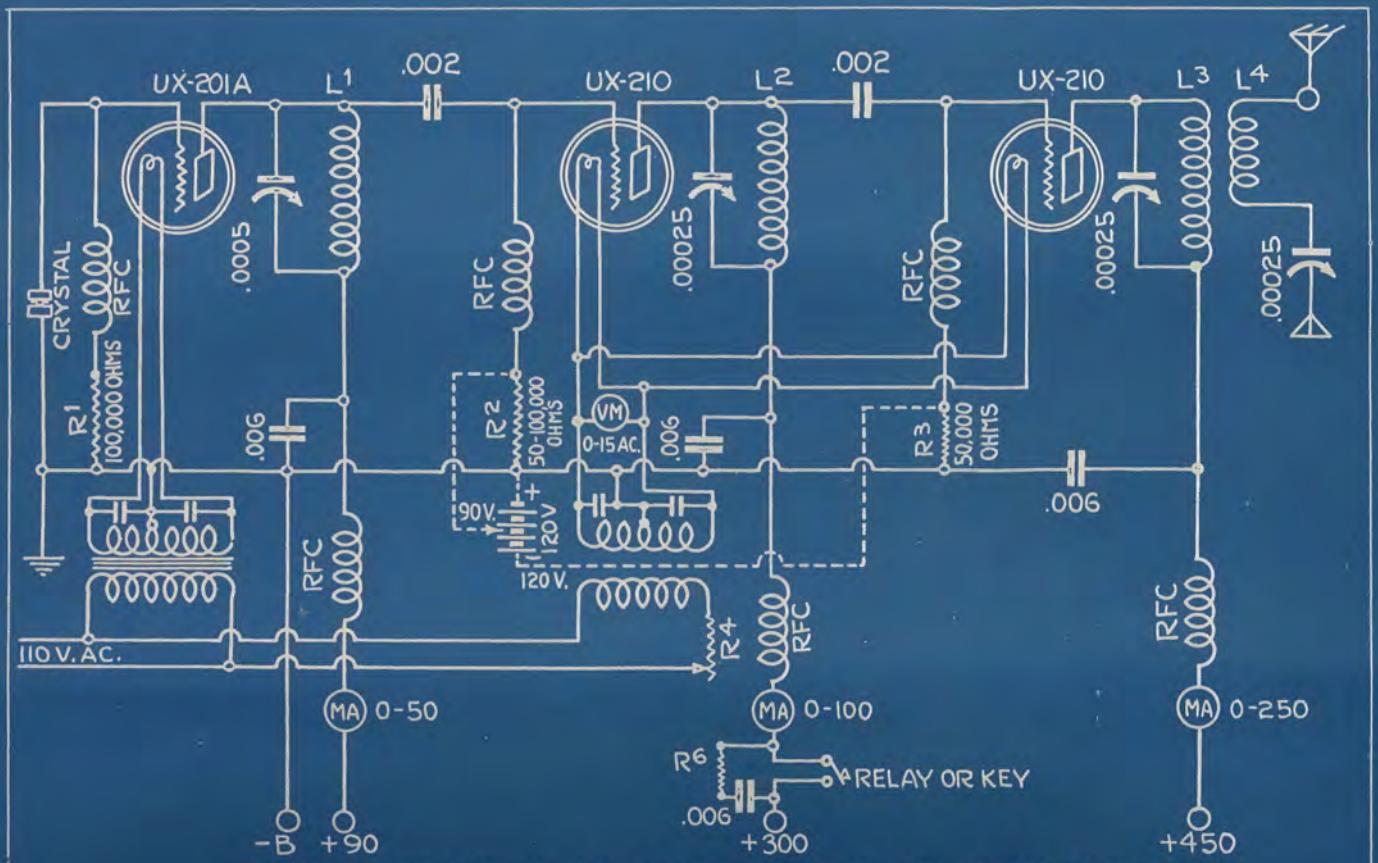


FIG.1 SCHEMATIC OF CRYSTAL CONTROL TRANSMITTER
9BHX 39.5 METERS

RADIO AGE INC.

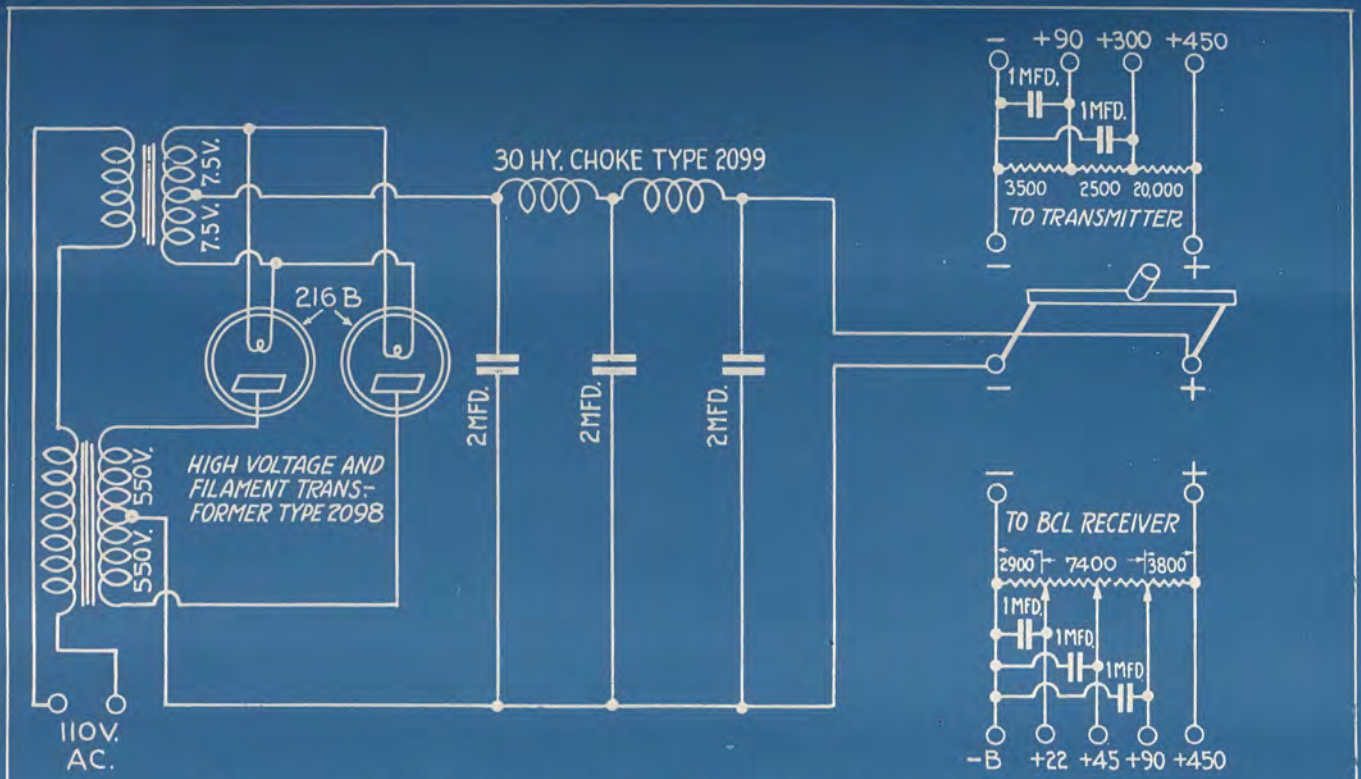


FIG. 2 SCHEMATIC OF DUAL PURPOSE RECTIFIER SYSTEM USED AT 9 BHX

RADIO AGE INC.

Top view of the short wave receiver. Grid condenser, grid leak, audio transformers and the plug mounting are placed beneath the subpanel. The set is designed for use of either a 199 or 201-A; the change being made by substitution of the proper sized Amperite in the mounting shown on the subpanel

3800 kc. The same type coil, but with a .00025 mfd condenser served to tune the doubler circuit to 7600 kc, while the same scheme was used in tuning the power amplifier circuit. The antenna coil has the rf ammeter in one lead and the .00025 mfd condenser in the other, the former going to the antenna and the latter to the counterpoise. Keying is accomplished in the plate circuit of the doubler tube.

Referring to Figure 1 in the blueprint section, bias for the grid of the crystal, oscillator tube is derived from an Allen-Bradley 100,000 ohm cartridge resistance in series with an rf choke coil (those furnished by Aero with their transmitting coils do nicely). This value may be cut to 50,000 ohms if desired for greater power in the crystal circuit. Bypassing is by means of the .006 mfd Sangamo. The rf choke shown in the plate lead is another Aero choke. In the doubler grid circuit self-biasing may be adopted with a 50,000 ohm cartridge resistance of the type mentioned previously. If you cannot use self-biasing at first, try it with C battery values of about 90 volts, and then when the set is tuned to resonance, remove the C bias and try the resistance. Probably you will succeed in getting rid of the C battery in this circuit. However in the power amplifier a little more difficulty will be encountered and here you may have to depend upon the biasing battery instead of the resistance, especially if you use the set un-neutralized as is the case at 9BHX. Other parts of the schematic are self-explanatory. (Of course if you use the C battery scheme remove the resistances otherwise the battery will be shorted). The resistance method is shown in all cases in full lines, while the battery method is shown in dashed lines.

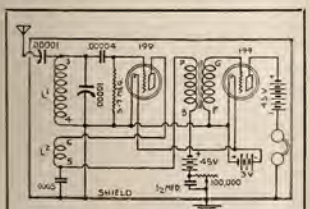
In operation of the transmitter from the same rectifier and power supply as is used for the receiver, refer to figure 2 of the blueprints for the schematic and the values of resistances. The high voltage source is a Thordrason T-2098 transformer with a T-2099 choke, connected as shown in the schematic diagram, which is the same kind of a connection as is used for a power amplifier. The only point of difference lies in the use of a double pole double throw switch which changes the power output from the receiver to the transmitter resistances. Condensers for the rectifier are made by Potter and are called their heavy duty type. Carter resistances are used on both the sending and receiving sides. In the former there are three resistances of 3500, 2500 and 20,000 ohms respectively. These will pass 25 ma at 90 volts, and 25 ma at 300 volts, while the high voltage tap (450) will give about 100 ma if crowded. These resistances draw a total of 20 ma across the line. In the receiver side the resistances are 2900, 7400 and 3800 ohms respectively, but in this case sliders are provided on the resistances so that voltages may be varied to suit individual conditions.

Having hooked up the transmitter and the power service as shown the next step would be to tune the crystal circuit. Temporarily leave the 300 volt and 450 volt connections off the doubler and power amplifier, and apply 90 volts to the plate circuit of the crystal oscillator. The crystal should be in place in its holder (See October, 1926, blueprint section). It should be cleaned with carbon tetrachloride (Carbona) before being placed in the holder. If you are using a single milliammeter for all work, plug this meter in the 90 volt line. With the variable condenser set at zero start increasing capacity, watching the meter at the time. If you are within the range of the crystal's fundamental frequency the needle will start slowly dropping as you increase capacity. Keep on increasing capacity slowly until the needle takes a pronounced dip. If further capacity is added the needle will either jump back to its original setting, or else take a second dip which will indicate the presence of another fundamental on the crystal—sometimes called the parasitic frequency. Assuming you have a crystal which shows only a single frequency and whose frequency lies within the range of the 40-80 meter coil spanned by the .0005 mfd condenser, tune the crystal plate circuit until you get the deepest portion of the crystal dip shown on the meter without instability. You are then tuned to the fundamental of your crystal. You can tune your amateur receiver in the 80 meter band and you will find the crystal's fundamental, also its second and third haromonics, or even further if you wish.

With the crystal oscillating, put back the 300 volt tap on the doubler plate circuit, put in temporarily about a 90 volt negative bias on the doubler grid, and press the key. Tune the doubler plate capacity until you find resonance in this circuit which will be indicated by lowest plate current. The simplest method we found of tuning the set was to use the resonance type indicating wavemeter described on page 23, December, 1926, issue. This meter when placed near the crystal circuit inductance will give a meter indication at the fundamental of the crystal and on several of its harmonics. Pick the second harmonic of the crystal and find the point where the resonance meter reads the highest. Then set this meter near the antenna circuit. As you tune the doubler circuit you will probably cause the resonance meter near the antenna circuit to show a reading. Tune the doubler until you get a maximum reading on

Front panel view of the short wave receiver. Regeneration dial is on the right; secondary tuning on the left. Other features are shown in the schematic

the resonance meter. Then go to the power amplifier circuit and tune it so as to get maximum reading on the resonance meter. Then tune the antenna condenser likewise, although by this time you will have enough radiation to determine your tuning by. In our work we found the resonance indicator indispensible in tuning a set easily before there would be enough radiation apparent on a O-1 rf ammeter. Of course after sufficient radiation shows it is simple, but when minute values of rf current are being measured, the resonance indicator meter showed them up before the antenna ammeter. Incidentally this same meter gives you a much better chance to tune the various circuits right on the head. After all circuits have been tuned and you no longer care for the meter, set it near your receiving antenna (if you are using a separate one) and let it indicate the fact your emitted wave is always right on the dot. We use our meter to determine the amount of contact necessary on the bug to give perfect dots at high speed. For example if the dash will run the meter to .4 we adjust the bug until it will cause a train of dots to reach .2 on the meter. At this setting the bug will be making perfect dots that match in intensity the dash signals. It is not possible to run the dots higher than about one half the value of the dashes on the meter on account of the inability of the meter to respond any quicker. This same meter is especially fine for remote control work. When you press the key the meter reads if the crystal is oscillating and the set tuned to resonance. If such is not the case you know by the failure of the meter its up to you to run back to the place where the transmitter is located and retune it. On one occasion we wore out a pair of shoes galloping back and forth between the key in one room and the transmitter in another. Finally the matter was so adjusted that the crystal stayed put for weeks and weeks at a time. (Business of knocking on wood).



Schematic of the traffic receiver described in this article. The text explains reasons for some of the connections

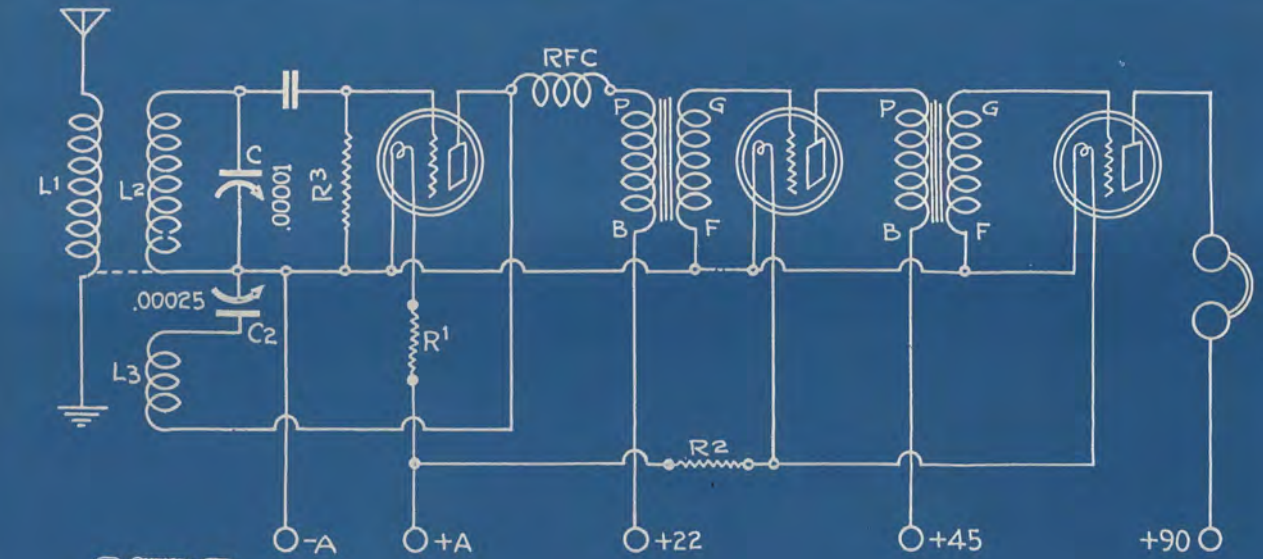
In this picture is shown the testboard (left) and the full wave 216-B combination which gives power for both the broadcast receiver and the low power crystal transmitter. The meter in the test board is a milliammeter which may be plugged into any of the voltages supplied either the broadcast receiver or the transmitter

The antenna circuit for the 40 meter transmitter was a semi-vertical single wire, 32 feet long. The counterpoise was a single wire, horizontal, the same length. The receiving antenna was a single piece of wire 20 feet long tacked to the joists under the roof. This permitted breakin communication, but was not entirely satisfactory in all respects because the energy picked up by the single wire was generally enough to ruin the disposition of a 199 used for the detector in the receiver, especially if the chap you are working is on your wave.

The schematic circuit of the receiver is shown in figure 3, which is the old Weagant now grown decrepit with age. In it were used the Aero coils for the band from 15 to 200 meters. Two of their broadcast coils were also used to cover the entire band. Condensers were Remler double rotor, which are illustrated in the pictures on page 20. The grid condenser, grid leak, transformers, etc., are placed beneath the subpanel so they will be out of the way. Tea may be served on top of the subpanel if desired since it carries nothing but the tubes and the plug-in inductances. A Jones base mounting plug is used to hook the receiver up to the A and B circuits.

While the coils referred to made the range of frequencies desired without any trouble, we wanted a traffic receiver so went over to the design shown in the schematic on page 21. Amateur gentlemen who can remember beyond 1917 will doubtless recognize an old friend. It is the receiver with two separate B batteries and it formed the basis of all schematics many years ago before radio scientists discovered that a common A and B battery might be utilized. A little concentration on the part of those who pore over circuits will develop the fact that with two B batteries (and batteries are cheap after all) it is possible to have your resistance regeneration control at ground potential, and also your headphones at ground (or shield) potential so that every time you move your head to look out of the window the signal coming in will not alter its course and land in Lima, O. So with the variable resistance at ground potential and the phones at the same potential you can crane your neck at will or scratch your head without a 20 meter signal going A. W. O. L. on you. (Derisive laughs from the gallery will be stilled if the stunt is tried.)

Next we went to a completely shielded box into which the whole kit and kaboodle was placed, batteries and all. Two dry cells furnished the filament current for the detector and one stage. Two sets of two 22½ volt B batteries were also placed inside. We used the smallest B blocks that could be found to conserve room.



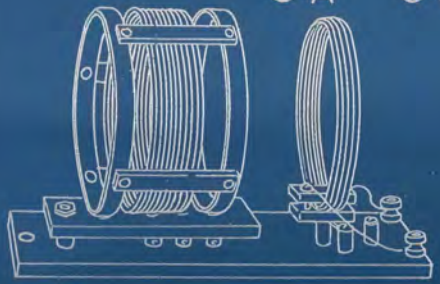


FIG. 3 SCHEMATIC OF SHORT WAVE RECEIVER

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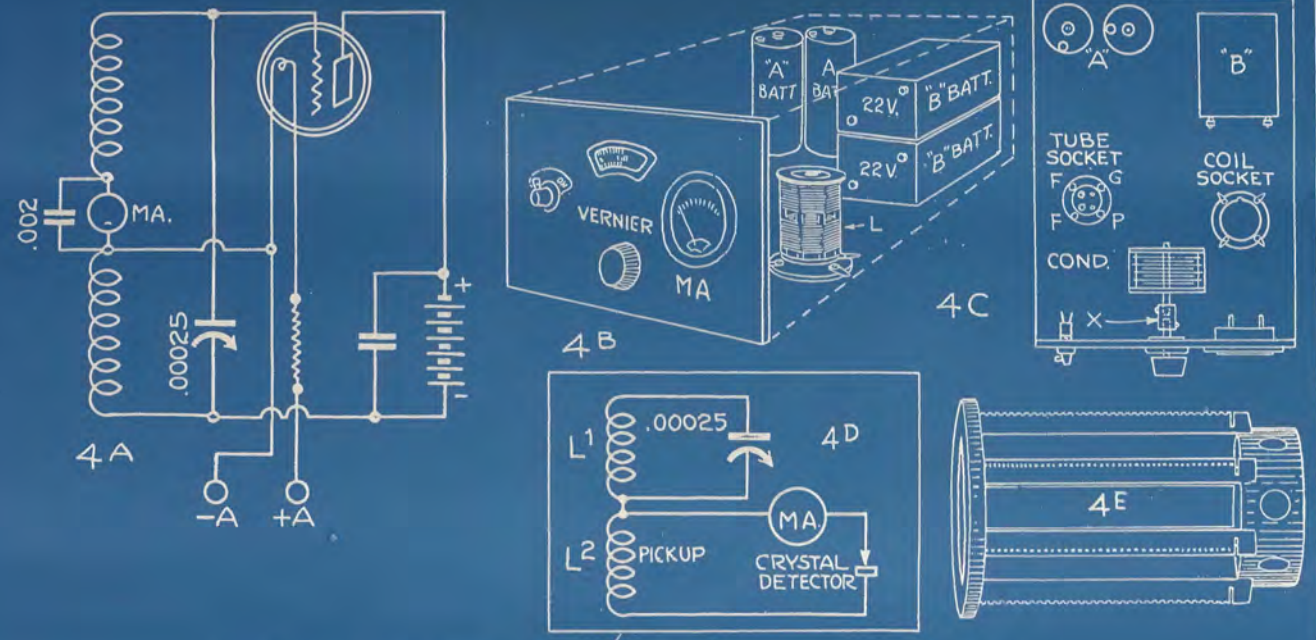


FIG. 4 GRID DIP DRIVER, SCHEMATIC AND PICTORIAL LAYOUT.

RADIO AGE INC.

The plate current is not excessive on either tube so the batteries should last a long time. The receiver is thus portable and pretty well removed from high power line interference. Signals are amply strong on one stage using 199 tubes for even the most fastidious traffic hound, unless of course it is the tin ear gentry that requires an R-17 signal to copy a message.

In this boxed receiver we used a Cardwell tapered 3 plate condenser with one of the rotor plates removed, so that as it stands now there is one rotor and one stator. Taking some Silver-Marshall blank coil forms, illustrated as 4-E in figure 4, we wound our own coils to cover the bands we wished. We used No. 18 tinned copper wire, placed one end in a vise and wound the coil under a good tension. The threaded grooves on the six ribs on the coil forms prevent slipping of the winding. The S-M people should be congratulated on the ingenious method of winding the tickler in the slot at the bottom of the coil where its position always remains the same. The size of the wire used is determined by the number of turns required, and this seems to cut no figure regarding the operation of the set. Six coils were made up in this fashion covering a band of about 2,000 kilocycles apiece. The principal one was for the band from 7000 to 8000 kc. On this coil WIZ at 6970 kc tunes in at 95 degrees and NAA on 8030 kc tunes in at 38 degrees, giving about 57 degrees tuning to cover the amateur band. The other coils take in a little larger frequency range, the smallest one going down to 20,000 kc.

The antenna condenser was a type N X-L variodenser with the capacity practically all out. Once set for our particular antenna it was left alone. In the receiver L 1 is the large winding and L 2 is the tickler. These are wound in the S-M blank coils. The resistance that governs the regeneration and oscillation is a Frost O-50,000 ohm variable resistance spanned by a one mfd condenser. It is the smoothest regeneration control we have seen for this particular work.

To aid in finding stations of a known frequency readily we built up an alleged calibrated oscillator which, considering the demands made upon it, served quite well. It is illustrated in figure 4A, 4B and 4C. A Silver-Marshall blank form carries a secondary and a tickler winding of equal number of turns, arranged for a Hartley oscillator. This stunt resolves itself into a grid dip meter as well as an oscillator. As an oscillator it covered a range from 6,000 kc to 20,000 kc, using a 199 tube. Both A and B batteries are placed inside the wooden box shown in 4B. The condenser is a Cardwell taper plate .00025 mfd. The vernier is a Marco illuminated control (with illumination eliminated) and a bakelite coupling joint between the dial and the condenser shaft to keep all oscillator parts from the panel. The meter, a O-1 ma Jewell, was placed in the front Fibroc panel although we believe it would be a bit better if placed further away from the operator. It should be bypassed with a .002 or large condenser. This oscillator was checked against a calibrated crystal and settings noted on the oscillator for all the harmonics of the crystal. Curves were then drawn for the entire range of frequencies so that a received signal could be transferred to the oscillator, the reading taken and a reference to the chart would show the approximate frequency. While this calibration held for a month we do not guarantee how much lorger it would hold. However, if one has a crystal it may be used as a frequent check against the settings of the oscillator. Use of broadcast harmonics, even the crystal control ones, we found to introduce too much error, especially when running down their harmonics into the 15,000 and 20,000 kilocycle bands.

The schematic shown in 4D is that of the resonance type indicator described in the December, 1926, issue and should be easy to build.

Before closing we might gather up a few loose ends. As to the distance which the set can cover, we do not know. Using the layout shown here the station gets R5-6 reports from this country on both coasts. It has two or three reports from Australia but no communication made. The communication angle depends mostly on the operator and how desirous he is of burning the midnight Rockefeller product.

In tuning the doubler circuit if you should happen to hit the fundamental of the crystal instead of its second harmonic you will know it by the violent oscillation of the doubler and the fact the crystal will kick off its setting. The same applies to the power amplifier circuit.

If you get the set all tuned with the use of the C batteries, try eliminating the C bias on the doubler and insert a resistance. If that is successful try the same trick on the power amplifier. Maybe you will get away with it, and maybe you will not —it all depends.

Plate current for the 201-A on the crystal in 9BHX runs 20 ma when not oscillating and about 10 ma when oscillating. Plate current for the doubler does not exceed 10 ma, and current for the power amplifier plate does not exceed 100 ma. Under these conditions all of the circuits are working at a safe value. If you are skeptical of the 201-A in the crystal, use a 112, although you do not really need a great deal of crystal energy to swing the 210 tubes.

About radiation we cannot tell you much. Our best value for the current specified has been .7 ampere. It seems enough to carry on intelligent conversation, so why worry about the elusive extra tenth of an ampere.

Description of the construction and operation of the traffic receiver has been reserved until the last so as to give as much data on it as possible.

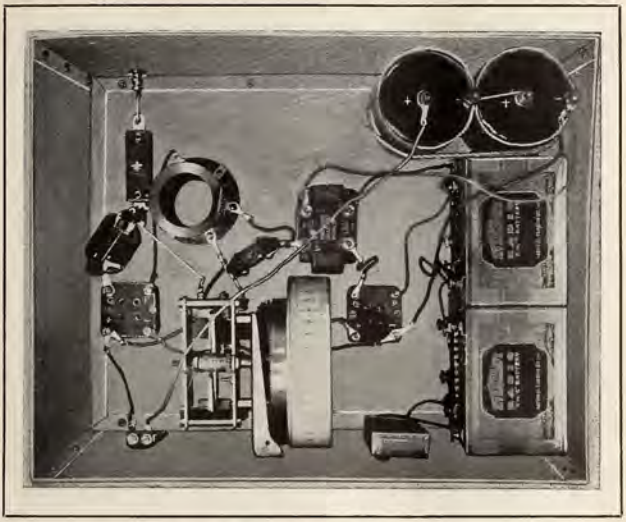
Schematically the receiver is depicted on page 21. On the opposite page will be found a photograph of the receiver itself enclosed in an aluminum box. The parts used in the set are as follows: Sockets and 50,000 ohm variable resistance by Frost; grid condenser and bypass condenser by Sangamo; audio transformer by Thorardson; I mfd bypass condenser by Potter; Electrad grid leak; coil socket and blank forms by Silver-Marshall; tuning condenser (a cut down 3 plater) by Cardwell antenna coupling

condenser (type N) by X-L, A and B batteries by Everready, and the final choice on dials is the latest Remler release which is a dandy drum dial, taking any and all kinds of condensers. The geared vernier does not make any noise either at 40, 20 or 15 meters; also does not worry the operator with backlash. Signals on any of the bands mentioned may be followed with ease, which contributes a great deal to the peace of mind of the operator.

As elsewhere stated, several items are at ground pontential. The variable condenser is grounded to shield, so is the positive A line, likewise the variable resistance which governs regeneration, and the headphones are at ground potential, being between ground and negative of the second B battery. The Frost variable resistor in the picture is hidden beneath the Potter bypass condenser, which is located midway between the drum dial and the B batteries. That is about all that is necessary to tell the traffic hound or the seasoned experimenter. The coil socket, transformer, tube sockets and the antenna coupling condenser are mounted on a flat board on the bottom of the box.

Now for the operation of the set. First of all you will want to wind your own coils to cover the different bands. The values shown in this article apply for this particular receiver used at 9BHX. However, they can be duplicated easily enough. The grid dip driver previously described is a dandy means of showing the high and low frequency limits of you rcoils. If you chart your oscillator you can set it to work on any desired frequency and tune your receiver to meet it. In winding the tickler turns which go into the slots on the Silver-Marshall blank forms, it is well to wind on an extra one or two and then if regeneration is too strong (or uncontrollable) over the entire tuning range of the coil, one turn may be lopped off at a time until you get the proper regenerative value.

Coil 1 has 20 turns of No. 18 tinned copper wire spaced about an eighth of an inch. The tickler coil is 5 turns of No. 22 DCC wound in the slot. It covers (with the cut down Cardwell) the range from 6950 kc to 8500 kc, sufficient to take in all of the 7000-8000 kc amateur band which is a thousand kilocycles wide.



Here is the traffic receiver used at 9BHX

Coil 2 has 15 turns on the secondary spaced the same as the previous coil. The tickler has 3 turns. This coil tunes from 8300 kc to 10,150 kc.

Coil 3 has an 11 turn secondary and a 3 turn tickler. It ranges from 10,000 to 12,400 kc.

Coil 4 has 9 turns for the secondary and 3 for the tickler. Its range is from 11,450 to 14,000 kc.

Coil 5 which takes in the lower amateur band, has a 7 turn secondary and a 3 turn tickler. It tunes from 14,000 to 17,000 kc. That particular amateur band is from 14,000 to 16,000 kc.

Coil 6 has a 5 turn secondary and a 3 turn tickler. Its range is from 17,000 to 20,000 kc.

It will be observed that there is quite a recurrence of a 3 turn tickler in these coils. However, this value proved to be most effective for the 199 tube with 45 volts; other tubes and voltages may change the turn number.

In the following table may be found some of the stations that will serve as a landmark for the amateurs in finding the frequency range their receiver covers. Most of the stations are crystal controlled and permanent although in the case of the Navy these frequencies may be altered from time to time:

Station	Frequency	Coil
WIZ	6970	1
2XAI	6980	1
FW	7590	1
9BHX	7600	1
9EK	7800	1
9MO	7890	1
WUAA	8010	2
NAA	8030	2
WVZ	8050	2
KDQA	8260	2
WVY	8370	2
WVO	8450	2
WVA	8510	2
WVC	8550	2
WVT	8670	2
WVA	8730	2
WVB	8850	2
WVX	8890	2
WNBT	9850	2
AQE	8965	2
WVR	9010	2
WVC	9030	2
2XAF	9150	2
KEL	10,230	3
AGB	11,270	3
GLQ	12,100	3
2XAD	11,370	4
KET	13,100	4
WIK	13,600	4
NAA	13,950	4
NAA	16,060	5
WLL	16,650	5
NPG	16,700	5
2XT	18,550	6
WSS	18,740	6
SPU	19,330	6
AGA	20,000	6
2XAW	20,000	6

It would be well not to place too great reliance on the permanence of the frequencies shown in this list, since there is a general shifting of

frequencies at the various stations as conditions demand. For the present these figures will be correct, however, as far as we could ascertain at press time.

Reception on the traffic receiver was all that could be desired. Freedom from noise and a dandy signal was the result. Inside of an hour the following foreigners were heard: OZ3AI, OZ2GA, EG5XY, OA2YI, NNINIC, NM1N, NM1J, OA2RC, OZ4AE, OA4CG, OZ1AP and OA2BP.

We cannot resist the temptation to suggest that the world is getting mighty tired of rotten ac notes and the more either pure dc or nearly so stations are, the less interference there will be on the 40 meter band. The 20 meter band may be all right for somebody with an ac note but the chap with pure dc will be passed over every time unless he has a wallop about like WIZ on the 40 meter band. Also we would like to venture the opinion that the world needs a *good* receiver and if there were more of them in existence there would be less alibis on the part of the fellow who cannot get his traffic through. With a decent tuning set it is not hard to work on the 40 meter band. With a poor receiver no wonder so many complain about punk conditions on 40 meters.

To derive kilocycles from meters divide 299,820 by meters; to secure meters divide 299,820 by kilocycles. Or better still, get a copy of the government kilocycle conversion table, Miscellaneous Publications of the Bureau of Standards No. 67, which may be secured for a nominal fee.

Beginners may find interesting data on securing licenses, etc., from a story printed on page 17, May, 1926, Radio Age.

Oscillation Control

IN MANY types of receivers, especially the home built type, the tendency of the r. f. stages to oscillate has been the greatest drawback. To counteract this condition Electrad of New York, has recently marketed a device known as the Phasatrol, which consists of a variable resistance and a fixed capacity made up into a special unit for either one hole mounting or baseboard work.

Installation of the device is very simple. The line between the plate of any r.f. stage and the P post of an r.f. coil or transformer is broken and the Phasatrol inserted. The terminal B plus goes to the B battery, while P of the Phasatrol goes to plate. PC on the unit goes to the old P connection on the transformer. In this manner the resistance is placed in series with the B battery, and r.f. current for the transformer is secured through the capacitative coupling of the condenser. Instead of the primary winding of the transformer carrying any direct current it carries only the a.c. component of the signal.

The device is shown above. It may be adapted to almost any kind of receiver, including superheterodynes in which intermediate stages have a tendency to oscillate. Well designed super intermediates will not require its use, but many of the old type supers could be improved by the insertion of a Phasatrol in each of the intermediate plate circuits.

Ghosts Prove to be Radio Mirages

The process of television recently developed by the engineers of the Bell Telephone Laboratories has supplied a new proof that the upper levels of the air are highly electrified. The process works by radio as well as by telephone wire. As the experiments continue radio images are being transmitted continually between the experimental radio station at Whippany, New Jersey, and the laboratory in New York City. It is found that many of these radio images are double, a second ghostly picture of the person whose face is seen being visible beside the main image. If the engineers in charge believed in the occult they might have been frightened by this apparent evidence of psychic influence. Much slighter appearances have led to ideas of spirits and auras and other mysteries. But the engineers have found a simpler explanation. It is that the radio waves traverse two paths between the transmitter and the receiver. One path is a direct one, like the beam of a searchlight. The other path is upward to the highly electrified layer in the air, fifty or sixty miles above the ground, and thence downward again to the receiver. The electrified layer acts like a mirror and reflects the radio waves back to the earth. The ghostly images on the television screen are really mirages, like those which travelers sometimes see in the desert or on the ocean.

Making a V. T. Voltmeter

(Continued from page 8)

The graph of Fig. 4 suggests the possibility of obtaining calibration curves with points over the entire range of the tube voltmeter by actual measurements with both alternating and direct voltmeters. Such instruments, of the high resistance type may be borrowed for the purpose and will give a calibration of good accuracy. Since the calibration described in this article depends upon the accuracy of a low priced voltmeter, the accuracy of subsequent voltage measurements outside the range of the calibrating voltmeter is limited. Nevertheless the construction of the tube voltmeter will be found to be well worth while in the interest and instruction derived from its use.

Current Science

Venomous Serpents Conquered By Science

By Dr. Raymond L. Dittmars

(Curator of Mammals and Reptiles New York Zoological Park)

POISONS of serpents have attracted the attention of many noted scientists. There is a lure and fascination in such studies. Attending their progress is the realization of contact with a high degree of specialization perfected through the ages, until the snake acquired a pair of hypodermic needles to take the place of teeth in the upper jaw, and glands secreting lethal fluids that have killed a million and more humans.

It is well to check up that latter statement. A million humans bitten and killed by poisonous snakes! "In how long a time?" asks the reader. And the answer is that in fifty years in India alone, statistics point to this appalling number of deaths from snakebite, as the annual average is slightly over twenty thousand each year. Add to this the fatalities from deadly serpents in Africa, where there is a large number of dangerous species; in Australia, where the greater number of the serpents are poisonous; and the vast tropics of Central and South America infested with poisonous snakes. There has been an estimate made (without actual statistics) that from three to five thousand deaths occur from snakebite each year in the American tropics. Statistics gathered by the writer, over a period of several years, and relating entirely to the United States, indicate an annual average of over one hundred deaths.

Hypodermic needles of the snake. These fangs of tropical vipers show how the poison is injected into the serpent's victim. Horse-hairs have been drawn through the tubular openings in the fangs through which the snake squirts his venom

The African cobra, one of the most deadly of serpents. Its cousin, the Indian cobra, kills hundreds of natives yearly

Like the history of a number of sinister human maladies, the death rate from snakebite is soon to change, with the application of scientific discoveries to practical methods of understanding and widespread use. The actual start was at the Pasteur Institute, in France, some twenty years ago. Dr. Albert Calmette immunized horses against the action of cobra venom and obtained a serum for use in India. Unfortunately, the venom of the cobra is particularly rapid in action and the population of India rather slow to appeal for help when bitten. Calmette's discoveries have, however, started research work in many countries and there are now specific serums prepared in various parts of the world.

While Calmette must be credited as being the pioneer in the production of a curative serum, following the researches of venom composition by Wier-Mitchell, Noguchi, Langmann and others, the eyes of the scientific world were turned, a little over ten years ago, to Brazil, where was founded for the first time an extensive institution for the production of serum for snakebites. The name of the chief of this novel and modern establishment in the city of Sao Paulo, was soon to become internationally known. Dr. Vital Brazil has set a world-wide pace in producing a remedy, astonishing in results, not only of vast economic importance to the American tropics, but already the means of saving many lives in the United States.

When the serum is injected into a human victim, even though grave symptoms have developed and there is great pain and swelling, an immediate immunity takes place. We cannot say that the serpent's poison is neutralized—in fact, we cannot accurately define the working of the serum. There is a change within an hour. Mental hallucinations give

Snake bite remedy. These prosaic little tubes contain the anti-venom serum with which man can save himself from death after he is bitten by the most deadly snake

way to clear thought, reflex vomiting ceases, the great swelling of arm or leg quickly subsides, and the area of discoloration fades to normal hue. At the seat of the fang wounds is an area infiltrated and broken down with the poison. Without the serum —if the victim lived—there would be a steady and dangerous necrosis, probably going to the bones and invading their surface, but this area quickly clears up, in firm and healthy tissue, leaving nothing but an indented scar to tell the story.

Serum for the United States will be ready in considerable quantities early this summer. It will be produced at the Antivenin Institute of America, at Glenolden, Pennsylvania, an establishment which came into being under the sponsorship of several scientific institutions, among them being Harvard University. The work of serum production is in charge of Dr. Afranio do Amaral, who was associated with Dr. Brazil in the work at Sao Paulo. He is a comparatively young man, of brilliant attainments, has already spent several years in the United States becoming accustomed to American methods, is a well-known authority on reptiles, and promises to produce the duplicate in this country of the Brazilian institution.

The establishment of the Institute is broader than the mere opening of the laboratory at Glenolden. Branches for the distribution of information will be located over the entire United States. The headquarters for information will be at the New York Zoological Park, in charge of the writer. An important branch in New England will be in charge of Dr. Thomas Barbour, of the Museum of Comparative Zoology, at Harvard University. The Zoological Society of St. Louis will be one of the mid-western branches, with Curator Perkins, of the Reptile Department, in charge. Another branch will be established in Texas, under the direction of Colonel M. L. Crimmins; another in California, under the direction of L. M. Klauber, Curator of Reptiles of the Zoological Society of San Diego.

Belated Justice for Aluminum Discoverer

THAT the wrong man has been credited for a century with the discovery of one of the most useful modern metals, aluminum, is the report made to the American Electrochemical Society by Junius D. Edwards and Martin Tosterud, research chemists of the Aluminum Company of America. In 1825 Dr. Hans Christian Oersted, Professor of Physics at the University of Copenhagen, in Denmark, and well-known all over Europe as the discoverer of electromagnetism and possibly better still as a delightful lecturer and writer on popular scientific subjects, announced that he had produced the silvery metal now called aluminum. The experiment was repeated in Germany, where chemists were unable to make it work. The German chemist, Friedrich Wöhler, quite as eminent as Oersted, then modified the reported method, made his new method work successfully and has been honored ever since as the discoverer of the metal. Oersted was already well-supplied with scientific honors and he was a busy man. Apparently he did not regard his discovery of aluminum as of any importance, for he never contested Wohler's claims or attempted to establish his own rights as the discoverer. Recently Messrs. Tosterud and Edwards extracted from the dusty annals of the Royal Danish Academy of Sciences the record of Oersted's first experiment. They have duplicated this experiment, exactly as the long-dead scientist described it. It proves to work perfectly.

Radio Map for Airship

Chief Radio Operator Asair Caradine of the dirigible Los Angeles with the new radio map for the guidance of the giant airship. The map automatically records weather conditions by radio signals

Science Investigates Athlete

Dr. A. V. Hill, eminent British physiologist now lecturing at Cornell, tests the pulse rate of a member of the University track team

This is the electrical device which Dr. A. V. Hill thinks might be used advantageously in the Olympic Games instead of the old fashioned stop-watch. The photo shows the recording apparatus, consisting of camera, galvanometer, lamp and time-marker

A mechanic adjusting the newly perfected device, a drift indicator, which measures the amount of drift of the Wright-engined Bellanca plane from its course

Bed of Pacific Believed Twisting Like Turntable

That the entire bed of the Pacific Ocean is slowly rotating, like a gigantic soup plate laid on a table and turned around in the direction opposite to the movement of the hands of a watch, is the startling idea suggested by the Japanese earthquake expert, Dr. Sakuhei Fujiwhara. Evidence supporting this remarkable conclusion has been found both in Japan and in California. Study of the earth movements associated with recent earthquakes in the Island Empire indicate a very slow drift of the sea bottom off the Japanese coast to the south, while the islands themselves are moving relatively to the north. Similarly, in California, investigation of the San Francisco earthquate as well as of subsequent earth movements, has disclosed a slow northward drift of the sea bottom and a relative southward movement of the land. Facts supporting the same conclusion are marshalled by Dr. Fujiwhara from other margins of the great Pacific basin. No reason is apparent for such a gigantic twist of the enormous depression in the earth's crust which the Pacific represents and Dr. Fujiwara suggests none. While other scientists will undoubtedly remain critical of the theory until further proof is available, it is already attracting much interest in geological circles.

Test Brick By Radio

APPLICATIONS of radio to almost every purpose have been made in the past few years so it is hardly surprising to hear of a new and novel use to which a condenser microphone and a two stage amplifier has been put.

Building bricks are now being tested for quality by means of the condenser microphone and amplifier mentioned above. One of the first uses of its kind comes to our notice in a communication appearing in the May, 1927, issue of the *Journal* of the Franklin Institute, presented by Juichi Obata, of the physics division of the Aeronautical Research Institute of the Tokyo Imperial University.

We quote from the *Journal*:

"In discriminating the quality of material the sound produced by striking it is very often utilized in practice. In the case of brick it is generally believed that one which gives a metallic sound when struck by a hammer has superior quality as the architectural material and this opinion is undoubtedly correct."

About thirty specimens were tested, the majority being overburnt. The final method of test was the use of a condenser microphone and a two stage amplifier connected to an oscillograph.

"Records of sound were obtained with about 30 specimens. A wave of 50 cycle a.c. was recorded simultaneously as the timing wave. In the beginning of the work it was noticed that there existed remarkable differences in the degree of damping of the sound in various specimens and it was hoped that by the oscillographic record of the sound produced, the pitch of as well as the degree of damping of the sound might be accurately determined, both being believed to have an intimate relation to the quality of the material. As a matter of fact it was found, however, that in some specimens the intensity of sound was greatest in the beginning and then gradually died out, while in others the sound attained its maximum after an elapse of some time. Moreover a beautiful beat note was observed with some specimens.

"To produce sound the specimen was simply supported with the left hand and then struck at the middle part with a small steel hammer held in the right hand. The force of the blow as well as the speed of separation of the hammer after striking may not be constant in each case, so that the complex nature of the sound may be partly due to the difference in the mode of striking. Anyhow, owing to such complex nature of the sound the comparison of the degree of damping was made somewhat difficult, and hence only the pitch was determined from the record."

Condenser Aids Long Lines

Frank G. Baum, noted engineer, whose device, known as the "synchronizing condenser and regulator" purchased by the Westinghouse Electric recently, solves the problem of transmitting economically large amounts of electric power over distances of thousands of miles. The advantages claimed for the new device are,—eliminates distance as a barrier in power and light transmission, increases the efficiency of the lines in that just as much power reaches the destination as starts from the generating plant. Heretofore so-called "line loss" has been a serious obstacle to long distance transmission. It also increases the amounts of power and light that may be transmitted over the wires. Baum's invention in appearance and in action is similar to a gyroscope used on ships. The "condenser" constantly revolves about an axis and is so designed that it automatically keeps the power in the lines at the highest peak

Giant Incandescent Lamp

A tremendous but practical 10,000 watt, 23,000 candlepower incandescent lamp has just been perfected by the Westinghouse Lamp Company for the lighting of airplane landing fields. Henry Ford will make use of the new lamp for his aviation field and the Army Air Service is expected to install several in their landing fields. These new lights are intended to supplement the high intensity searchlights and a single bulb enclosed in a device similar to a lighthouse lens is sufficient to illuminate an average landing runway 2,000 feet long. The heat developed inside the lamp is so tremendous that a special type of hardened glass is used

Silk Worms Are Improved by Getting Drunk

THAT silk worms do their best work when fed on alcohol is the conclusion of the Japanese silk-worm expert, Mr. Nakai, as reported to the Journal of the American Medical Association by that periodical's Japanese correspondent. Working at the silk-culture laboratory of the Prefecture of Okayama, Mr. Nakai has developed a food for silk worms consisting in part of *sake*, the Japanese national drink which is an alcoholic wine made by the fermentation of rice. Silk worms are fed usually on the leaves of the mulberry tree, which grows in profusion in Japan. By the use of the *sake*, mixed with wheat flour, the worms can be kept alive and active, Mr. Nakai finds, on much smaller amounts of the mulberry leaves. Even more important practically than this saving of the quantity of the leaves necessary for the worms is the fact, which Mr. Nakai also reports, that the dose of alcohol in the *sake* improves the physical condition of the worms.

Sky Salts England

THAT the whole island of Great Britain is being sprinkled with salt, as if from a gigantic salt-shaker, is the conclusion recently announced to the Literary and Philosophical Society of the city of Manchester, England, by Wilfred Irwin. The salt comes from the sea and most of it falls on the land surface, not as dry salt, but as salt dissolved in the British rain-water. Mr. Irwin has analyzed rain-water collected at twelve different points in England and Wales, both at times of calm weather and during violent storms blowing from the sea. Averaging the data, with proper calculations of the amount of rainfall and so on, he finds that about one million tons of salt falls each year on England and Wales alone. This enormous amount of salt would soon render the land a barren desert, like the salt flats of the Sahara, were it not for the fact that the salt is carried back to the sea again in the water of the brooks and rivers. The amount of salt sprinkled on the land is much greater, as was expected, during or just after violent storms from the sea than at times of calm. The source of the salt is believed to be almost entirely sea spray blown up from the surface of the ocean during storms and dried in the air to tiny particles of salt dust. These then blow inland and are dissolved and carried down by the rain.

Daily Tide Discovered in Blood Corpuscles

THAT there is a daily tide in the human blood, not unlike the ebb and flow of the tides in the sea, is the remarkable conclusion recently announced by Dr. A. F. Bernard Shaw, of Newcastle, England, as the result of a long series of researches on the white corpuscles of the blood. These white corpuscles exist in the blood in much smaller numbers than the familiar red corpuscles but they are equally necessary to life. They are believed to have the duty, among other things, of dealing with disease germs that enter the blood. Physicians have long known that the number of these white corpuscles in the blood varies fom time to time, as well as in different conditions of health. Dr. Shaw has discovered that these variations in the number of the white corpuscles correspond to two daily waves of rise and fall, like the changes of the tide. One of these white-corpuscle tides reaches its maximum in the afternoon; the other in the early morning, after midnight. The causes of this curious fact are quite unknown. Dr. Shaw has not been able to detect any relation to the hours of eating or sleeping or of other periodic bodily actions. It is not inconceivable that some real tidal effect may be at work; either an inherited habit from the days when our remote animal ancestors were really tidal creatures living along the seashores, or some effect of the changing positions of the sun and the earth.

Test Tube Traps Drinkers

For Tipplers' wives—no more sniffing; this simple device, will tell whether friend husband has been drinking and how much. One breath through the tube and chemicals betray the secret

Scientist Travels Around Earth In Submarine

A YOUNG Dutch scientist has completed a voyage around the world under water in order to measure the gravitational attraction of different parts of the earth's crust. His name is Dr. Vening Meinesz and his voyage was made in a submarine loaned by the Government of Holland. By measurements of the force of gravity on land scientsis have learned this force is not quite the same everywhere. At some points on the earth's surface a pound weight weighs a trifle more than a pound; at other points it weighs a trifle less. The differences are too small to be detected by ordinary scales but are important to science because they are believed to indicate differences in the density of the rocks of the earth's crust. This idea, known scientifically as the theory of isostasy, is important to theories of the structure of the earth, of earthquakes and of many other matters. The intensity of gravity cannot be measured on shipboard because the motion of the ship disturbs the apparatus. Dr. Meinesz devised a method of using apparatus carried by a submarine, submerged in the ocean. The motion due to the waves is thus avoided. When detailed measurements made on the recent under-water voyage have been computed they are expected to prove of great value to science.

Everyday Mechanics

Automatic Photo Device

During the past few months over 280,000 people have stopped in at a Broadway store and had eight tiny photographs of themselves made for 25 cents, the entire operation being performed in eight minutes by a remarkable device. The machine has now been sold for $9,000,000 by its inventor, Anatol Josepho, a young Russian photographer. The syndicate buying the patent's rights is headed by Henry Morgenthau, New York financier and former United States Ambassador to Turkey. Photo shows Josepho demonstrating how his machine is operated

One-Man Orchestra

S. L. Norris, of Dalton, Ga., had cravings to be an orchestra leader but the prospect seemed far distant. However, he has invented a machine which satisfies that craving somewhat. He can be his own orchestra and orchestra leader at one and the same time. The device by which he can play six different instruments was exhibited at the Fiddlers' convention in Atlanta, Ga., recently. The instruments which the contrivance operates includes one fiddle, three banjos, a whistle and a set of bells

Picks Lottery Winners

A view of the apparatus used in deciding the winning numbers in the States Highway Lottery of Lower California, Mexico, which was recently inaugurated. The proceeds of the lottery go towards the developing of new roads throughout Mexico. The machine used to decide the winning numbers cost $10,000 to build. Three poor road laborers drew the winning numbers in the first lottery and won $10,000

Distress Pistols for Aviators

Lloyd Bertaud (left), navigator, and Clarence Chamberlain, pilot, examining a Coston aerial distress pistol which the latter carried on his flight across the Atlantic to fire cartridge flares in the event he was forced to land on the sea

When Rail Monsters Crash

This photograph shows the tangled mass of steel and iron that resulted when two locomotives of the Colorado & Southern Railway met in a head-on collision at Wheatland, Wyo., recently

Left-Handed Girl Wins

Mary Weiser, of Newark, N. J., who is left-handed, has found that her peculiarity is an advantage for it enables her to do easily a job that right-handed girls cannot succeed at. The engineers of the Westinghouse Lamp Company recently built a machine for testing radio tubes at the rate of 30,000 a day and designed it to be fed by girls seated on either side. It was soon found that one of the girls did her part well enough but her partner could not keep pace with her. It was soon discovered that the second girl was forced to work left-handed and, therefore, was handicapped. A hurried search for a left-handed operator was instituted and Mary Weiser was selected for the job

Builds Tin Can Locomotives

Henry Comstock, 18-year-old high school student at Leonia, N. J., with his miniature Mikado type of locomotive which he constructed out of tin cans in eight days. The boiler of the engine is made of syrup cans, the wheels of can tops (the spokes punched out), and the cylinder is a tea can. The coupler on the front is the top of a shaving cream tube, the compressor is an adhesive tape box. The roof of the locomotive is made from part of a ginger snap can. The tank of the tender is made from a coffee can. The marker lights are binding posts from a radio battery and the headlight is made out of the top of a ketchup bottle

How Bullet-Proof Vests Stop Steel

Mayor Kendrick and other Philadelphia city officials visited Model Farms recently where they watched the testing of a new bullet-proof vest for the Philadelphia police. Photo shows John J. De Boves firing a pistol at Alvar Jacobson, wearing the vest

BY CHARLES LEE BRYSON

FROM that day when the caveman first made for himself a clumsy contrivance of dinosaur hide stretched over a flat piece of wood with which to ward off the blows of his adversary's stone axe, the imagination of man has been stirred by every advance in the art of protecting himself from the missiles of his foes. These advances have come slowly down to us through the prehistoric shield, the wool-wadded skin armor of the wild Afghans, the bronze helmets of the Assyrians and Babylonians, the cuirass and greaves of the Middle Ages and the light shirts of steel chain of later days, until the twentieth century has brought us to the bullet-proof vest. It looks like the ordinary woolen garment, but it stops bullets from the heavy U. S. .45 calibre automatic service pistol, the powerful German Mauser, and even the deadly Thompson machine gun.

Of what is this vest made? One might expect to find it fabricated of steel, tempered more finely than the old masters of Damascus could do it. Not so. It is made of a metal which is an improvement over steel in its resistant aspect—a metal lighter, more tough, more elastic. It has been named bovite, after its inventor, Mr. John J. de Boves.

Is the principle on which it operates, then, mere toughness? Mere resisting power? Not at all. Its lightness, its toughness, its elasticity all are made use of; but the great principle which holds safe the life of the man behind the vest is the *distribution of*, rather than the *resistance to*, the force of the bullet. In making this distribution of the energy of the bullet, Mr. de Boves says he merely supplies the necessary "vibratory leak" which gradually absorbs the force of the bullet's blow instead of meeting and forcibly resisting its power.

For the bullet-proof vest is not merely a cloth-covered metal plate which by its strength and thickness is impenetrable. The metal part consists of three layers of bovite, each more thin and more light than the blade of a safety razor. And instead of each layer being one broad sheet, it is made up of many strips running perpendicularly, each about an inch and a half wide, held in place by the cloth and the stitching, much after the manner of the corsets which, within the memory of men still living, women used to wear. These strips overlap, after the style of the weatherboarding on a house, so that there is no crevice through which a bullet may slip. The whole is covered with handsome black cloth, so that no one suspects that the wearer is encased in armor more resistant than ever Ivanhoe or Richard Coeur de Leon wore.

The vest fits snugly under the arms, reaches well up to the neck, and of course covers the back as well as the front of the body. There is also a little flap, or apron, which hangs down to protect the groin. Thus all the vulnerable parts of the torso are held safe. Alexander H. Dunlap, publisher of *The Detective*, the official journal of the police and sheriffs' forces all over the country, estimates that of all the men killed by gunshot wounds, ninety-eight per cent are shot in the body, and ninety per cent in the front part of the body. That leaves only two per cent of all fatalities for those portions of the body not covered by the vest, and of course all but a negligible percentage of these are head wounds.

What, then, happens when a man wearing one of these bullet-proof vests is shot? If the vest is put on a tailor's dummy, presenting a hard, unyielding resistance, the bullet goes through it as if it were a piece of tin nailed on a board. The principle of the "vibratory leak" has no opportunity to work. But on the soft, yielding human body, this principle saves the victim. The outer of the three plates of bovite receives the shock of the bullet, and instantly it springs, stretches, yields, and permits part of the force to be transmitted. One such thin plate alone would be perforated. But instantly the second plate takes up such of the strain as has passed the first, and it in turn springs, stretches, yields. It sustains perhaps one-tenth of the force of the blow which was delivered to the outer plate, yet if there were but two plates they might, conceivably, be penetrated by a high-powered bullet. But inside the second lies the third plate, waiting its turn to take up and distribute the blow. It receives perhaps one per cent of the force of the blow, and it springs, yields slightly, and the bullet is stopped there dead in its course, deformed, flattened, utterly harmless.

Mr. de Boves says that he hit upon this principle by observing a large bell set in vibration by the blows of a heavy hammer. He considered that if he interposed his hand between the hammer and the bell he might, by suffering a crushed hand, diminish though he could not wholly prevent, the ringing of the bell; but after the blow had fallen he could easily, and without harm to himself, grasp the rim of the bell and by providing the "vibratory leak" instantly stop the vibration and the sound. Then he set about providing a "vibratory leak" to take up the force of a bullet's blow before it had penetrated the human body. The tough, elastic, yielding metal bovite, arranged in three very thin overlaying plates, furnished him the medium.

Jim Letts, the "human target" who has been shot 5,000 times and never wounded. He has ripped away the cloth covering and is showing the marks of 17 machine gun bullets just fired at his body. Some of the bullets may be seen still adhering to the bullet proof vest. One man holds some of the deformed bullets in his hand

Interesting exhibits showing effect of gun bullets on Bovite sheets. Above is shown the Thompson machine gun used in all tests. Lower left, bullet proof glass which stopped 6 bullets in one spot. Center, sheet of Bovite (less than 1-16 inch thick) which stopped every bullet. Right, another 1-16 inch sheet of Bovite showing reverse side and two bullet marks. Bottom, cartridges and used steel bullets, showing how they are deformed. Two at left, all that could be found of the 6 bullets fired into the glass. Five others were fired against the sheet of Bovite. Ranged at the rear, for comparison, are unused cartidges

What happens to the bullet fired against this impenetrable barrier? It is unbelievably deformed and flattened. The heavy steel missles are mushroomed out like lead bullets fired against seasoned oak with a steel backing. Here again the value of the "vibratory leak" is seen. If a steel bullet were instantly stopped by a thick, unyielding steel plate, the bullet might be shattered, and each fragment would become a dangerous miniature bit of shrapnel. But, merely held back by the yielding but impenetrable series of bovite plates, the bullet is flattened and distorted, but not splintered.

One of the most interesting features of the development of this vest is the series of demonstrations on human beings. James Letts, of Mr. Dunlap's office, known by his fellows as the "human target," has been shot more than 5,000 times, and has yet to feel a wound. He has de-

(Continued on page 45)

Broadcasting Under Water and In the Air

ABROAD where radio is still in the novelty class, a good deal of interest has been attached to the recent experiments of broadcasting from a ship to a plane, broadcasting from the ocean depths to a plane and broadcasting from a plane to the under sea diver.

This stunt was performed off the coast of Sylt, Germany. In the large photograph shown above is the makeshift studio in one of the German vessels from where the program was sent. It was picked up by Otto Kemmerick, a German long distance swimmer who wore a specially built rubber suit which carried headphones so the swimmer could listen in. An especially constructed antenna was used inside the suit for reception.

In the lower photograph are shown: Otto Kemmerick, right, the famous German long distance swimmer, bidding good-bye to Alnwik Harmstorf, a diver, just before the broadcasting tests were tried off the coast of Germany. The diver broadcast to an airplane pilot who in turn replied. The swimmer passing through the water picked up both sides of the conversation through an especially constructed suit and headphones.

Buys Station WENR

STATION WENR formerly owned by the All-American Radio Co., has been purchased by the Commonwealth Edison Co., of Chicago, effective June 1.

Studios are located on the 23rd floor of the Straus building in Chicago. According to the new schedule of broadcasting the programs will be divided into noon hour, matinee, dinner music, classical hour and the popular hour.

Plays For Hour At Time

A new phonograph, has been perfected which will play for an hour at a time. The machine automatically feeds twelve records to the revolving disk from a magazine, with stops between records of less than half a minute. It makes it possible to put into the magazine the records of an entire symphony, or an assorted program of dance music, or the more important selections of an opera, and listen to them all without the necessity of changing records. The several operations which take a record from the turntable, deposit in it the magazine and replace it with a new record are performed by a system of cams, which are so simple that there is said to be no more chance of anything getting out of order than there was in the old-fashioned machine

Auto Happy Hunting Ground

Thousands of new automobiles are manufactured yearly in America, but have you ever wondered where all the old autos go to? There is a firm in Los Angeles which buys any make or model auto in existence, including wrecks. These cars are stripped of all the parts which are still in good working order, and sold to the public. All other parts which are not useful are cut up with a torch and sold to steel and junk companies

New Modulation Biggest Discovery

(Continued from page 3)

While it is not indicated that this modulation system may be applied to other than crystal control outfits, it appears at the time to hasten the universal adoption of crystal control for all stations.

This recent discovery will open up a new field for receiver design in which the manufacturers will find the greatest necessity for sharp-tuning receivers. This will be greatly welcomed by the listening public.

So much for the achievements that must follow the lead of Conrad's research. Those who have been following closely crystal control work will see the basis for the new frequency modulation system. For some time past the Westinghouse interests, of which Conrad is assistant chief engineer, have been using crystal control not only on their broadcast transmitters but on their private telegraphic stations. Normally it takes sixty percent of a station's power to modulate its carrier. Under the stunt originated by Conrad, there is an immediate saving of 60 per cent in power costs.

Like other important basic discoveries there appears to be no limit to their applications and the frequency modulation seems to be no exception to the rule. The longer the matter is considered the more its importance grows on one.

How Strong Are the Signals?

How strong are the signals from your favorite broadcasting station? How many miles do the average broadcasting station cover day and night, winter and summer? These and many other questions may be answered by the portable radio receiving outfit shown in this photograph and designed by the radio laboratory of the Bureau of Standards for use by radio supervisors of the Department of Commerce. S. S. Kirby of the Bureau's radio laboratory is shown in the picture

Glider Establishes New Mark

Ferdinand Schulz, a teacher in East Prussia and one of the foremost German gliding flyers, recently established a new world's record for remaining in the air in a motorless plane at Rossitten, Germany. Schulz kept his glider in the air for fourteen hours and seven minutes during which time he covered a distance of at least 450 kilometers and at times rising to a height of 380 meters

England Hears Rome Storm

HOW a thunderstorm in Rome ruined radio reception for listeners in Spain, in England, in France and even in Norway was described recently to the Royal Meterological Society, in London, by the well-known physicist and radio investigator, R. A. Watson Watt.

DeForest and Crosley

This is the first picture of Dr. Lee DeForest, left, and Powel Crosley, Jr., right, taken together. Mr. Crosley became president of the DeForest Radio Corporation a few weeks ago and he will retain complete control of the company for five years under an agreement

Plane Tows Glider

Experiments are being conducted by the Raab-Katzenstein Airplane Works, near Berlin, to prove that airplanes may do what railroad trains are doing nowadays, that is to have a "Locomotive" pull a number of motorless airships, releasing each one of them over various cities. A glider was fastened to an airplane by means of a wire and an automatic release enables the pilot of the glider to disconnect his ship at will

Correct List of Broadcast Stations

KDKA	Westinghouse Electric & Mfg. Co.	E. Pittsburgh, Pa.	309
KDLR	Radio Electric Co.	Devils Lake, N. D.	231
KDYL	Intermountain Bdcstg Corp.	Salt Lake City, Utah	246
KELW	Earl L. White	Burbank, Calif.	535
KEX	Western Broadcasting Company	Portland, Ore.	447
KFAB	Nebraska Buick Auto Co.	Lincoln, Neb.	341
KFAD	Electrical Equipment Co.	Phoenix, Ariz.	273
KFAF	A. E. Fowler	San Jose, Calif.	217
KFAU	Independent School Dist.	Boise, Idaho	280
KFBB	F. A. Buttrey & Co.	Havre, Mont.	275
KFBC	W. Z. Azbill	San Diego, Cal.	278
KFBK	Kimball-Upson Co.	Sacramento, Calif.	535
KFBL	Leese Bros.	Everett, Wash.	224
KFBS	School District No. One	Trinidad, Colo.	238
KFBU	Bishop N. S. Thomas	Laramie, Wyo.	375
KFCB	Nielson Radio Supply Co.	Phoenix, Ariz.	238
KFCR	Santa Barbara Broadcasting Co.	Santa Barbara, Calif.	416
KFDD	St. Michael Cathedral	Boise, Idaho	275
KFDM	Magnolia Petroleum Co.	Beaumont, Texas	316
KFDX	First Baptist Church	Shreveport, La.	236
KFDY	South Dakota State College	Brookings, S. D.	300
KFDZ	Harry O. Iverson	Minneapolis, Minn.	231
KFEC	Meier & Frank	Portland, Ore.	252
KFEL	Eugene P. O'Fallon, Inc.	Denver, Colo.	254
KFEQ	Scroggin & Co.	St. Joseph, Neb.	268
KFEY	Bunker Hill & Sullivan	Kellogg, Idaho	233
KFFP	First Baptist Church	Moberly, Mo.	242
KFGL	N. L. Cotter	Trinidad, Col.	222
KFGQ	Boone Biblical College	Boone, Iowa	300
KFH	Hotel Lassen	Wichita, Kans.	268
KFHA	Western State College of Colo.	Gunnison, Colo.	252
KFHL	Penn College	Oskaloosa, Iowa	240
KFI	E. C. Anthony, Inc.	Los Angeles, Calif.	468
KFIF	Benson Polytechnic Institute	Portland, Ore.	248
KFIO	North Central High School	Spokane, Wash.	273
KFIQ	First Methodist Church	Yakima, Wash.	256
KFIU	Alaska Electric Light & Power Co.	Juneau, Alaska	226
KFIZ	Commonwealth Reporter	Fond du Lac, Wis.	273
KFJB	Marshall Electric Co.	Marshalltown, Iowa	248
KFJF	National Radio Mfg. Co.	Oklahoma City, Okla.	261
KFJI	E. E. Marsh	Astoria, Ore.	246
KFJM	University of North Dakota	Grand Forks, N. D.	278
KFJR	Ashley C. Dixon & Son	Portland, Ore.	263
KFJY	Tunwall Radio Co.	Fort Dodge, Iowa	246
KFJZ	W. E. Branch	Ft. Worth, Tex.	254
KFKA	Colo. State Teachers College	Greeley, Colo.	273
KFKB	J. R. Brinkley	Milford, Kan.	219
KFKU	The University of Kansas	Lawrence, Kans.	275
KFKX	Westinghouse Elec. & Mfg. Co.	Hastings, Neb.	288
KFKZ	State Teachers College	Kirksville, Mo.	225
KFLR	University of New Mexico	Albuquerque, N. M.	254
KFLU	San Benito Radio Club	San Benito, Texas	236
KFLV	Swedish Evangelist Church	Rockford, Ill.	229
KFLX	George Roy Clough	Galveston, Texas	240
KFMR	Morningside College	Sioux City, Iowa	261
KFMX	Carlton College	Northfield, Minn.	337
KFNF	Henry Field Seed Co.	Shenandoah, Ia.	461
KFOA	Rhodes Department Store	Seattle, Wash.	454
KFOB	KFOB, Inc.	Burlingame, Calif.	225
KFON	Nichols & Warriner, Inc.	Long Beach, Calif.	232
KFOR	Tire & Electric Co.	David City, Neb.	225
KFOT	College Hill Radio Club	Wichita, Kans.	231
KFOX	Tech. High School	Omaha, Nebr.	248
KFOY	Beacon Radio Service	St. Paul, Minn.	252
KFPL	C. C. Baxter	Dublin, Texas	252
KFPM	The New Furniture Co.	Greenville, Texas	236
KFPR	Los Angeles County Forestry Dept.	Los Angeles, Cal.	231
KFPW	St. Johns M. E. Church	Carterville, Mo.	258
KFPY	Symons Investment Co.	Spokane, Wash.	273
KFQA	The Principia	St. Louis, Mo.	261
KFQB	Lone Star Bdcast Co.	Fort Worth, Texas	508
KFQD	Anchorage Radio Club	Anchorage, Alaska	300
KFQU	W. E. Riker	Holy City, Calif.	231
KFQW	C. F. Knierim	Seattle, Wash.	216
KFQX	Alfred M. Hubbard	Seattle, Wash.	210
KFQZ	Taft Products Co.	Hollywood, Calif.	226
KFRB	Hall Bros.	Beeville, Texas	248
KFRC	Don Lee, Inc.	San Francisco, Calif.	268
KFRU	Stephens College	Columbia, Mo.	500
KFSD	Airfan Radio Corp.	San Diego, Calif.	246
KFSG	Echo Park Evan. Assn.	Los Angeles, Calif.	275
KFTL	C. C. Baxter	Dublin, Tex.	252
KFUL	Thomas Groggan & Bros.	Galveston, Texas	258
KFUM	W. D. Corley	Colorado Springs, Colo.	240
KFUO	Concordia Seminary	St. Louis, Mo.	545
KFUP	Fitzsimmons General Hospital	Denver, Colo.	234
KFUR	Peery Bldg. Co., Inc.	Ogden, Utah	224
KFUS	Louis L. Sherman	Oakland, Calif.	256
KFUT	University of Utah	Salt Lake City, Utah	263
KFVD	Chas. & W. J. McWhinnie	Venice, Calif.	208
KFVE	Benson Broadcasting Corp.	St. Louis, Mo.	240
KFVG	First M. E. Church	Independence, Kans.	236
KFVI	Headquarters Troop, 50th Cavalry	Houston, Texas	240
KFVN	Carl E. Bagley	Fairmont, Minn.	227
KFVR	Olinger Corporation	Denver, Colo.	244
KFVS	Cape Girardeau Battery Sta.,	Cape Girardeau, Mo.	224
KFVY	Radio Supply Co.	Albuquerque, N. M.	250
KFWB	Warner Bros. Pictures	Hollywood, Calif.	252
KFWC	L. E. Wall	San Bernardino, Calif.	278
KFWF	St. Louis Truth Center	St. Louis, Mo.	214
KFWH	F. Wellington Morse, Jr.	Eureka, Calif.	254
KFWI	Radio Entertainments, Inc.	San Francisco, Calif.	250
KFWM	Oakland Educational Society	Oakland, Calif.	214
KFWO	Lawrence Mott	Avalon, Calif.	211
KFWU	Louisiana College	Pineville, La.	238
KFWV	KFWV Studios	Portland, Ore.	213
KFXB	Bertram C. Heller	Los Angeles, Calif.	353
KFXD	Service Radio Co.	Logan, Utah	222
KFXF	Pike's Peak Broadcasting Co.	Denver, Colo.	430
KFXH	Bledsoe Radio Company	El Paso, Texas	242
KFXJ	R. G. Howell	near Edgewater, Colo.	216
KFXR	Classen Film Finishing Co.	Oklahoma City, Okla.	214
KFXY	Harry M. Costigan	Flagstaff, Ariz.	205
KFYF	Carl's Radio Den	Oxnard, Calif.	214
KFYJ	Chronicle Pub. Co. (Portable)	Houston, Tex.	238
KFYR	Hoskins-Meyer, Inc.	Bismarck, N. Dak.	248
KGA	Northwest Radio Service Co.	Spokane, Wash.	341
KGAR	Tucson Citizen	Tucson, Ariz.	244
KGBS	A. C. Dailey	Seattle, Wash.	227
KGBU	Alaska Radio Co.	Ketchikan, Alaska	229
KGBX	Foster Hall Tire Co.	St. Joseph, Mo.	349
KGBY	Dunning & Taddikon	Shelby, Nebr.	203
KGBZ	George R. Miller	York, Nebr.	333
KGCA	C. W. Greenley	Decorah, Iowa	280
KGCB	Wallace Radio Institute	Oklahoma, Okla.	319
KGCG	Moore Motor Co.	Newark, Ark.	234
KGCH	Wayne Hospital	Wayne, Nebr.	434
KGCI	Liberty Radio Sales	San Antonio, Texas	240
KGCL	Louis Wasmer	Seattle, Washington	238
KGGN	Concordia Bdcstg. Co.	Concordia, Kansas	210
KGCR	Cutler's Broadcasting Service	Brookings, S. D.	252
KGCU	Mandan Radio Ass'n.	Mandan, N. D.	285
KGCX	First State Bank	Vida, Mont.	240
KGDA	Home Auto Co.	Dell Rapids, S. D.	254
KGDE	Jaren Drug Co.	Barrett, Minn.	232
KGDJ	R. Rathert	Cresco, Iowa	203
KGDM	V. G. Koping	Stockton, Calif.	217
KGDO	C. H. & Henry Garrett	Dallas, Tex.	285
KGDP	Boy Scouts of America	Pueblo, Colo.	261
KGDR	Radio Engineers	San Antonio, Tex.	240
KGDX	William Erwin Antony	Shreveport, La.	291
KGDY	J. Albert Loesch	Oldham, S. Dak.	210
KGDW	Frank J. Rist,	Humboldt, Nebr.	242
KGEF	Trinity Methodist Church	Los Angeles, Calif.	526
KGEH	Eugene Broadcast Station	Eugene, Oregon	236
KGEK	Beehler Elect. Equipment Co.	Yuma, Colo.	252
KGEL	Ernest W. Ellison	Jamestown, N. D.	225
KGEN	E. R. Irey & F. M. Bowles	El Centro, Calif.	278
KGEO	Raymond D. Chamberlain	Grand Island, Nebr.	270
KGEQ	Fred W. Herrmann	Minneapolis, Minn.	331
KGER	C. Merwin Dobyns	Long Beach, Calif.	326
KGES	Central Radio Electric Co.	Central City, Nebr.	205
KGEU	L. W. Clement	Lower Lake, Calif.	222
KGEW	City of Fort Morgan	Fort Morgan, Colo.	256

Know What You're Missing

(Continued from page 6)

power Australian amateur stations plainly audible in any part of the United States.

The short waves interfere with no one. It is not unusual to find a short-wave station operating in a section filled with broadcast receivers without causing complaints. Often the neighbors do not know that the station is there.

There are many purposes that amateur radio might serve which are now overlooked; opportunities that challenge men of vision.

Men who have common commercial interests might easily maintain communication over long distance with low-power, short-wave sets installed in their homes. They could exchange confidential messages with small chance of their being intercepted and could code them if greater safety were required.

Radio amateurs could serve philanthropies such as the Young Men's Christian Association by sending their messages across the continent in less time than it takes the mail to go from New York to Chicago.

The Boy Scouts of America requires its members to learn the International Morse code in order to reach the rank of first-class Scout, and a merit badge in radio is offered, but for lack of technical leadership it seldom gives the Scouts an opportunity to put their knowledge of radio to practical use. Here and there are radio patrols that do interesting stunts in the field and at home stations. A very little effort would be required to increase interest in radio and build up a communication system that would handle much of the organization's correspondence and be of invaluable service in emergencies.

Which idea appeals most strongly to a red-blooded man: to sit in the old arm chair night after night merely listening to programs, or to be communicating with folks all over the country and exerting an influence felt around the world You can start something today, by securing the parts for an amateur transmitter. Directions come with them and amateur short-wave apparatus is far simpler to assemble than any other kind. (See the blueprint section in this issue.—Editor).

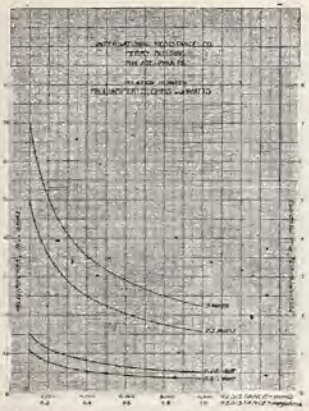
There is one thing that never yet has been accomplished and any man who achieved it would become famous. There never has been a complete tie-up between local radio amateurs and the chamber of commerce, the police and fire departments, the Red Cross, the Y. M. C. A., the Boy Scouts and other civic organizations.

KGEY	J. W. Dietz	Denver, Colo.	204
KGEZ	Flathead Broadcasting Assn.	Kalispell, Mont.	353
KGFB	A. G. Dunkel	Iowa City, Ia.	224
KGFF	Earl E. Hampshire	Alva, Okla.	205
KGFG	Full Gospel Church	Oklahoma City, Okla.	384
KGFH	Frederick Robinson	La Crescenta, Calif.	219
KGFI	M. L. Eaves	Fort Stockton, Texas	220
KGFJ	Ben S. McGlashan	Los Angeles, Calif.	216
KGFK	Kittson County Enterprise	Hallock, Minn.	224
KGFL	Trinidad Broadcasting Co.	Trinidad, Colo.	222
KGFM	Geo. W. Johnson	Yuba City, Calif.	450
KGFN	Haraldson & Thingstad	Aneta, North Dakota	222
KGFP	Mitchell Broadcast Co.	Mitchell, South Dakota	263
KGO	General Electric Co.	Oakland, Calif.	361
KGRC	Gene Roth & Co.	San Antonio, Texas	315
KGRS	Gish Radio Service	Amarillo, Tex.	234
KGTT	Glad Tidings Tabernacle, Inc.	San Francisco, Cal.	207
KGU	Marion A. Mulrony	Honolulu, Hawaii	270
KGW	Oregonian Publishing Co.	Portland, Ore.	491
KGY	St. Martins College	Lacey, Wash.	278
KHJ	Times-Mirror Co.	Los Angeles, Calif.	405
KHQ	Louis Wasmer	Spokane, Wash.	394
KICK	Atlantic Automobile Co.	Anita, Ia.	273
KJBS	J. Brunton & Sons Co.	San Francisc, Coalif.	220
KJR	Northwest Radio Service Co.	Seattle, Wash.	384
KKP	City of Seattle, Harbor Dept.	Seattle, Wash.	261
KLDS	Reorganized Church of Jesus Christ,	Independence, Mo.	441
KLIT	Lewis Irvine Thompson	Portland, Ore.	380
KLS	Warner Brothers	Oakland, Calif.	250
KLX	Tribune Publishing Co.	Oakland, Calif.	508
KLZ	Reynolds Radio Co.	Denver, Colo.	384
KMA	May Seed & Nursery	Shenandoah, Iowa	461
KMED	W. J. Virgin	Medford, Ore.	250
KMIC	J. R. Fouch	Inglewood, Calif.	261
KMJ	Fresno Bee	Fresno, Calif.	234
KMMJ	M. M. Johnson Co.	Clay Center, Nebr.	229
KMO	Love Electric Co.	Tacoma, Wash.	250
KMOX	Voice of St. Louis	St. Louis, Mo.	280
KMTR	Radio Corp.	Hollywood, Calif.	379
KNRC	C. B. Juneau	Santa Monica, Calif.	238
KNX	Los Angeles Express	Los Angeles, Calif.	337
KOA	General Electric Co.	Denver, Colo.	322
KOAC	Oregon Agriculture College	Corvallis, Oreg.	280
KOB	N. Mex. College of Agric.	State College, N. Mex.	349
KOCH	Omaha Central High School	Omaha, Neb.	258
KOCW	Oklahoma College for Women	Chickasha, Okla.	270
KOIL	Mona Motor Oil Co.	Council Bluffs, Iowa	304
KOIN	KOIN, Inc.	Portland, Ore.	319
KOLO	Gerald K. Hunter	Durango, Colo.	355
KOMO	Fisher's Blend Station, Inc.	Seattle, Wash.	307
KOWW	Frank A. Moore	Walla Walla, Wash.	285
KPCB	Pacific Coast Biscuit Co.	Seattle, Wash.	521
KPJM	Wilburn Radio Service	Prescott, Ariz.	214
KPNP	Central Radio Co.	Muscatine, Iowa	256
KPO	Hale Bros., Inc.	San Francisco, Calif.	428
KPPC	Pasadena Presbyterian Church	Pasadena, Calif.	229
KPRC	Houston Printing Co.	Houston, Texas	297
KPSN	Star-News	Pasadena, Calif.	316
KQW	First Baptist Church	San Jose, Calif.	333
KQV	Doubleday-Hill Electric Co.	Pittsburgh, Pa.	353
KRAC	Caddo Radio Club	Shreveport, La.	220
KRE	Berkeley Daily Gazette	Berkeley, Calif.	256
KRLD	Dallas Radio Laboratories	Dallas, Tex.	337
KRLO	Freeman Lang & A. B. Scott	Los Angeles, Calif.	440
KROW	Oregon Broadcast Co.	Portland, Ore.	231
KROX	N. D. Brown	Seattle, Wash.	265
KRSC	Radio Sales Corp.	Seattle, Wash.	500
KSAC	Kansas State Agricultural College	Manhattan, Kans.	341
KSBA	W. G. Patterson	Shreveport, La.	261
KSD	Pulitzer Publishing Co.	St. Louis, Mo.	545
KSCJ	The Journal	Sioux City, Iowa	261
KSEI	Broadcasting Association	Pocatello, Idaho	261
KSL	Radio Service Corp.	Salt Lake City, Utah	300
KSMR	Santa Maria Valley Railroad	Santa Maria, Calif.	283
KSO	Berry Seed Co.	Clarinda, Iowa	405
KSOO	Sioux Falls Bdcst. Ass'n.	Sioux Falls, S. D.	219
KTAB	Associated Broadcasters	Oakland, Calif.	303
KTAP	Robert B. Bridge	San Antonio, Texas	263
KTBI	Bible Institute	Los Angeles, Calif.	294
KTBR	M. E. Brown	Portland, Ore.	263
KTCL	Amer. Radio Tel. Co.	Seattle, Wash.	306
KTHS	New Arlington Hotel	Hot Springs, Ark.	375
KTNT	N. Baker	Muscatine, Iowa.	333
KTRL	Technical Radio Lab.	Midland Park, N. J.	280
KTUE	Uhalt Electric	Houston, Texas	263
KTW	First Presbyterian Church	Seattle, Wash.	454
KUJ	Puget Sound Broadcasting Co.	Seattle, Wash.	352
KUOA	University of Arkansas	Fayetteville, Ark.	300
KUOM	University of Montana	Missoula, Mont.	375
KUSD	University of South Dakota	Vermillion, S. D.	278
KUT	University of Texas	Austin, Texas	273
KVI	Puget Sound Broadcasting Co.	Tacoma, Wash.	345
KVOO	Southwestern Sales Corp.	Bristow, Okla.	375
KVOS	L. Kessler	Seattle, Wash.	333
KWBS	Schaeffer Mfg. Co.	Portland, Ore.	201
KWCR	H. F. Parr	Cedar Rapids, Iowa	296
KWG	Portable Wireless Telegraph Co.	Stockton, Calif.	248
KWKC	Wilson Duncan Studios	Kansas City, Mo.	236
KWLC	Luther College	Decorah, Iowa	428
KWSC	State College of Washington	Pullman, Wash.	349
KWTC	J. W. Hancock	Santa Ana, Calif.	263
KWUC	Western Union College	Le Mars, Iowa	252
KWWG	Chamber of Commerce	Brownsville, Texas	278
KXL	KXL Broadcasters	Portland, Ore.	400
KYA	Pacific Broadcasting Corp.	San Francisco, Calif.	400
KYW	Westinghouse Electric & Mfg. Co.	Chicago, Ill.	535
KZM	Preston D. Allen	Oakland, Claif.	240
WAAD	Ohio Mechanical Institute	Cincinnati, Ohio	258
WAAF	Chicago Daily Drovers Journal	Chicago, Ill.	278
WAAM	Isaiah R. Nelson	Newark, N. J.	263
WAAT	F. V. Bremer	Jersey City, N. J.	234
WAAW	Omaha Grain Exchange	Omaha, Nebr.	384
WABB	Harrisburg Radio Co.	Harrisburg, Pa.	204
WABC	Atlantic Broadcasting Corp.	New York, N. Y.	316
WABF	Markle Broadcasting Corp.	Pringleboro, Pa.	280
WABI	1st Universalist Church	Bangor, Me.	270
WABO	Hickson Electric Co., Inc.	Rochester, N. Y.	278
WABP	Keystone Broadcast Co.	Philadelphia, Pa.	278
WABQ	Keystone Broadcasting Co.	Philadelphia, Pa.	261
WABR	Scott High School	Toledo, Ohio	341
WABW	College of Wooster	Wooster, Ohio	207
WABX	Henry B. Joy	Mt. Clemens, Mich.	246
WABY	John Magaldi, Jr.	Philadelphia, Pa.	242
WABZ	Colis Place Baptist Church	New Orleans, La.	275
WADC	Allen T. Simmons	Akron, Ohio	258
WAFD	Albert P. Parfet	Detroit, Mich.	240
WAGM	R. L. Miller	Royal Oak, Mich.	225
WAGS	Willow Garage, Inc.	Sommerville, Mass.	250
WAIT	A. H. Waite & Co.	Taunton, Mass.	229
WAIU	American Insurance Union	Columbus, Ohio	294
WALK	Albert A. Walker	Bethayres, Pa.	204
WAMD	Raddison Radio Corp.	Minneapolis, Minn.	244
WAOK	A. H. Andreasen	Ozone Park, N. Y.	248
WAPI	Alabama Polytechnic Institute	Auburn, Ala.	461
WARC	American Radio & Research	Medford, Mass.	261
WARS	Amateur Radio Specialty Co.	Brooklyn, N. Y.	252
WASH	Baxter Laundry Co.	Grand Rapids, Mich.	256
WATT	Edison Elec. Illum.	Boston, Mass.	204
WBAA	Purdue University	W. Lafayette, Ind.	273
WBAK	Pennsylvania State Police	Harrisburg, Pa.	275
WBAL	Consolidated Gas & Power Co.	Baltimore, Md.	246
WBAO	James Milliken University	Decatur, Ill.	270
WBAP	Carter Publication, Inc.	Ft. Worth, Tex.	476
WBAW	Waldrum Drug Co.	Nashville, Tenn.	236
WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.	256
WBBC	Brooklyn Bdcstg. Corp.	Brooklyn, N. Y.	268
WBBL	Grace Covenant Presbyterian Church	Richmond, Va.	229
WBBM	Atlass Investment	Chicago, Ill.	225
WBBP	Petoskey High School	Petoskey, Mich.	238
WBBR	People's Pulpit Assoc.	Rossville, N. Y.	416
WBBW	Ruffner Junior High School	Norfolk, Va.	222
WBBY	Washington Light Inf.	Charleston, S. C.	500
WBBZ	C. L. Carrell	Chicago, Ill.	204
WBCN	Foster & MacDonnell	Chicago, Ill.	266
WBES	Bliss Electrical School	Takoma Park, Md.	222
WBET	Boston Transcript Co.	Boston, Mass.	394
WBKN	Arthur Faske	Brooklyn, New York	248
WBMC	Malbrook Co.	Woodside, N. Y.	294
WBMH	Braun's Music House	Detroit, Mich.	353
WBMS	G. J. Schowerer	North Bergen, N. J.	224

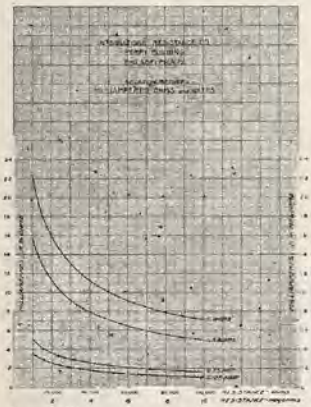
Graphs Show Resistor Resistance Values

FEW radio enthusiasts recognize or even realize the relationship between milliamperes, ohms and watts. Consequently, resistors are often incorrectly applied, resulting in serious overload and early breakdown, with the cause remaining an unsolved mystery to the layman although it may be perfectly plain to the electrical and radio engineers with their knowledge of the mathematics of the thing and the ability to figure it out for themselves with the hard-working slide-rule.

It will be noted that the first curve



sheet or graph covers a resistance range of from 0. to 10,000 ohms, and also from 0. to 100,000 ohms, while the second covers a range of from 0. to 100,000 ohms, and also from 0 to 10 megohms. Otherwise, both graphs cover the same ground. Furthermore, it will be noted that if the resistance be considered in ohms, instead of megohms, then the reading



for milliamperes is taken from the left-hand margin, while if the resistance is considered in megohms, then the reading for milliamperes is taken from the right-hand margin.

It is interesting to note the correspondence between current, resistance and wattage. Thus the 5-watt curve starts off with a current of 70 milliamperes at 1,000 ohms resistance, and drops down in a broad swing to 22½ milliamperes at 10,000 ohms.

WBNY	Baruschrome Corp.	New York, N. Y.	297
WBOQ	Atlantic Bdcst. Corp.	Richmond Hill, N. Y.	236
WBRC	Birmingham Broadcasting Co.	Birmingham, Ala.	248
WBRE	Baltimore Radio Exchange	Wilkes-Barre, Pa.	231
WBRL	Booth Radio Laboratories	Tilton, N. H.	420
WBRS	Universal Radio Mfg. Co.	Brooklyn, N. Y.	248
WBSO	Babson's Statistical Org.	Wellesley Hills, Mass.	242
WBT	Charlotte Chamber of Commerce	Charlotte, N. C.	275
WBZ	Westinghouse Elect. & Mfg. Co.	Springfield, Mass.	333
WBZA	Westinghouse Elect. & Mfg. Co.	Boston, Mass.	333
WCAC	Connecticut Agricultural College	Mansfield, Conn.	331
WCAD	St. Lawrence University	Canton, N. Y.	263
WCAE	Kaufman & Baer Co.	Pittsburgh, Pa.	461
WCAH	C. A. Entrekin	Columbus, Ohio	265
WCAJ	Nebraska Wesleyan University	University Pl., Nebr.	254
WCAL	St. Olaf College	Northfield, Minn.	337
WCAM	City of Camden	Camden, N. J	337
WCAO	Monumental Radio Inc.	Baltimore, Md.	275
WCAR	Southern Radio Corp.	San Antonio, Texas	263
WCAT	School of Mines	Rapid City, S. Dak.	240
WCAU	Universal Broadcasting Co.	Philadelphia, Pa.	278
WCAX	University of Vermont	Burlington, Vt.	250
WCAZ	Carthage College	Carthage, Ill.	246
WCBA	Charles W. Heimbach	Allentown, Pa.	254
WCBD	Wilbur Glenn Voliva	Zion, Ill.	345
WCBE	Uhalt Radio Co.	New Orleans, La.	263
WCBH	University of Mississippi	Oxford, Miss.	242
WCBM	Hotel Chateau	Baltimore, Md.	229
WCBR	C. H. Messter	Providence, R. I.	201
WCBS	H. L. Lewing	Springfield, Ill.	244
WCCO	Washburn-Crosby Co.	Anoka, Minn.	416
WCFL	Chicago Fed. of Labor	Chicago, Ill.	492
WCFT	Knights of Pythias Home	Tullahoma, Tenn.	252
WCGU	C. G. Under	Lakewood, N. J.	351
WCLO	C. E. Whitmore	Camp Lake, Wis.	231
WCLS	WCLS Inc.	Joliet, Ill.	214
WCMA	Culver Military Academy	Culver, Ind	285
WCOA	City of Pensacola	Pensacola, Fla.	252
WCOC	Crystal Oil Co.	Columbus, Miss.	265
WCOM	172nd Field Artillery	Manchester, N. H.	252
WCOT	Jacob Conn	Olneyville, R. I.	265
WCRW	Clinton R. White	Chicago, Ill.	394
WCSH	Congress Square Hotel Co.	Portland, Maine	509
WCSO	Wittenberg College	Springfield, Ohio	248
WCWK	Chester W. Keen	Fort Wayne, Ind.	234
WCWS	Bridgeport Bdcst. Sta.	Bridgeport, Conn.	204
WCX	Detroit Free Press	Pontiac, Mich.	517
WDAD	Dad's Auto Accessories, Inc.	Nashville, Tenn.	225
WDAE	Tampa Daily Times	Tampa, Fla.	273
WDAF	Kansas City Star	Kansas City, Mo.	366
WDAG	J. Laurence Martin	Amarillo, Texas	263
WDAH	Trinity Methodist Church	El Paso, Texas	268
WDAY	Radio Equipment Corp.	Fargo, N. Dak.	261
WDBE	Gilham Electric Co., Inc.	Atlanta, Ga.	270
WDBJ	Richardson Wayland Elec. Corp.	Roanoke, Va.	229
WDBK	Bdcst Co.	Cleveland, Ohio	227
WDBO	Rollins College	Winter Park, Fla.	239
WDBZ	Kingston Radio Club	Kingston, N. Y.	232
WDEL	Wilmington Elec. Specialty Co.	Wilmington, Del.	265
WDGY	Dr. George W. Young	Minneapolis, Minn.	263
WDOD	Chattanooga Radio Co., Inc.	Chattanooga, Tenn.	256
WDRC	Doolittle Radio Corp.	New Haven, Conn.	268
WDWF	Dutee Wilcox Flint, Inc.	Cranston, R. I.	441
WDWM	Radio Industries Broadcast Co.	Newark, N. J.	280
WDXL	WDXL Radio Corp.	Detroit, Mich.	297
WDZ	J. L. Bush	Tuscola, Ill.	278
WEAF	National Broadcasting Co.	New York, N. Y.	491
WEAI	Cornell University	Ithaca, N. Y.	254
WEAM	Bor. of N. Plainfield	North Plainfield, N. J.	261
WEAN	The Shepard Co.	Providence, R. I.	366
WEAO	Ohio State University	Columbus, Ohio	294
WEAR	Willard Storage Battery Co.	Cleveland, Ohio	389
WEAU	Davidson Bros. Co.	Sioux City, Iowa	275
WEBC	Walter Cecil Bridges	Superior, Wis.	242
WEBE	Roy W. Waller	Cambridge, Ohio	234
WEBH	Edgewater Beach Hotel	Chicago, Ill.	370
WEBJ	Third Avenue Railway Co.	New York, N. Y.	273
WEBL	R. C. A. Show (Portable)	New York, N. Y.	226
WEBQ	Tate Radio Corp.	Harrisburg, Ill.	225
WEBR	H. H. Howell	Buffalo, N. Y.	244
WEBW	Beloit College	Beloit, Wis.	268
WEDC	E. Denemark Station	Chicago, Ill.	250
WEEI	The Edison Elec. Illuminating Co.	Boston, Mass.	349
WEHS	A. T. Becker	Evanston, Ill.	242
WEKD	Foulkrod Radio Engineering Co.	Philadelphia, Pa.	250
WEMC	Emanuel Missionary College	Berrien Springs, Mich.	316
WENR	All-American Radio Corp.	Chicago, Ill.	266
WEPS	Matheson Radio Co., Inc.	Gloucester, Mass.	294
WEW	St. Louis University	St. Louis, Mo.	360
WFAA	Dallas News & Dallas Journal	Dallas, Tex.	476
WFAM	Times Publishing Co.	St. Cloud, Minn.	273
WFAV	University of Nebraska	Lincoln, Neb.	270
WFBC	First Baptist Church	Knoxville, Tenn.	255
WFBE	Garfield Place Hotel Co.	Cincinnati, Ohio	232
WFBG	The Wm. F. Gable Co.	Altoona, Pa.	278
WFBJ	St. John's University	Collegeville, Minn.	236
WFBL	The Onondaga Co.	Syracuse, N. Y.	252
WFBM	Merchants Heat & Light Co.	Indianapolis, Ind.	268
WFBR	Fifth Infantry National Guard	Baltimore, Md.	254
WFBZ	Knox College	Galesburg, Ill.	254
WFCI	Frank Crook, Inc.	Pawtucket, R. I.	258
WFDF	F. D. Fallain	Flint, Mich.	234
WFHH	Fort Harrison Hotel	Clearwater, Fla.	353
WFI	Strawbridge and Clothier	Philadelphia, Pa.	394
WFIW	The Acme Mills, Inc.	Hopkinsville, Ky.	357
WFKB	Vesta Battery Corp.	Chicago, Ill.	217
WFLA	Boca Raton Radio Corp.	Boca Raton, Fla.	440
WFRL	Flatbush Radio Labs.	Brooklyn, N. Y.	205
WGAL	Lancaster Elec. Supply & Const. Co.	Lancaster, Pa.	248
WGBB	H. H. Carman	Freeport, N. Y.	244
WGBC	First Baptist Church	Memphis, Tenn.	278
WGBF	Fink Furniture Co.	Evansville, Ind.	236
WGBI	Scranton Broadcasters, Inc.	Scranton, Pa.	240
WGBS	Gimbel Brothers	Astoria, L. I., N. Y.	316
WGBU	Florida Cities Finance Co.	Fulford By-The-Sea, Fla.	384
WGBX	University of Maine	Orono, Me.	234
WGCP	May Radio Broadcast Corp.	Newark, N. J.	252
WGES	Oak Leaves Broadcasting Corp.	Chicago, Ill.	319
WGHP	G. H. Phelps	Detroit, Mich.	270
WGL	International Broadcasting Corp.	New York, N. Y.	416
WGM	Verne and Elton Spencer	Jeanette, Pa.	270
WGMU	Atlantic Bdcst. Co.	New York, N. Y.	204
WGN	The Tribune	Chicago, Ill.	303
WGR	Federal T. and T. Co.	Buffalo, N. Y.	319
WGST	Georgia School of Technology	Atlanta, Ga.	270
WGWB	Radiocast Corporation	Milwaukee, Wis.	384
WGY	General Elec. Co.	Schenectady, N. Y.	379
WHA	University of Wisconsin	Madison, Wis.	535
WHAD	Marquette University	Milwaukee, Wis.	275
WHAM	Stromberg-Carlson Tel. Mfg. Co.	Rochester, N. Y.	278
WHAP	W. H. Taylor Finance Corp.	New York, N. Y.	431
WHAR	F. D. Cooks Sons	Atlantic City, N. J.	275
WHAS	Courier-Journal & Louisville Times	Louisville, Ky.	400
WHAZ	Rensselaer Polytechnic Institute	Troy, N. Y.	379
WHB	Sweeney School Co.	Kansas City, Mo.	366
WHBA	C. C. Shaffer	Oil City, Pa.	250
WHBC	Rev. E. P. Graham	Canton, Ohio	254
WHBD	Chamber of Commerce	Bellefontaine, Ohio	222
WHBF	Beardsley Specialty Company	Rock Island, Ill.	222
WHBL	C. L. Carrell	Chicago, Ill.	204
WHBM	C. L. Carrell	Chicago, Ill.	204
WHBN	First Ave. Methodist Church	St. Petersburg, Fla.	238
WHBP	Johnstown Automobile Co.	Johnstown, Pa.	256
WHBQ	WHBQ, Inc.	Memphis, Tenn.	232
WHBR	Popular Radio Shop	Memphis, Tenn.	316
WHBU	Citizens Bank	Anderson, Ind.	219
WHBW	D. R. Kienzle	Philadelphia, Pa.	216
WHBY	St. Norbert's College	West de Pere, Wis.	250
WHDI	W. H. Dunwoody Institute	Minneapolis, Minn.	278
WHEC	Hickson Electric Co., Inc.	Rochester, N. Y.	258
WHFC	Triangle Broadcasters	Chicago, Ill.	258
WHK	The Radio Air Service Corp.	Cleveland, Ohio	273
WHN	George Schubel	New York, N. Y.	361
WHO	Banker's Life Co.	Des Moines, Ia.	526
WHOG	Huntington Bdcstrs. Assn.	Huntington, Ind.	242
WHT	Radiophone Broadcasting Corp.	Deerfield, Ill.	238
WIAD	Howard R. Miller	Philadelphia, Pa.	234
WIAS	Home Electric Co.	Burlington, Iowa	254
WIBA	Capital Times-Strand Theatre	Madison, Wis.	236
WIBG	St. Paul's Protestant E. Church	Elkins Park, Pa.	222

WIBI	Frederick B. Zittell, Jr.	Flushing, L. I., N. Y.	219
WIBJ	C. L. Carrell	Chicago, Ill.	204
WIBM	C. L. Carrell	Chicago, Ill.	204
WIBO	WIBO Broadcasters, Inc.	Chicago, Ill.	225
WIBR	Thurman A. Owings	Weirton, W. Va.	246
WIBS	T. F. Hunter	Elizabeth, N. J.	203
WIBU	The Electric Farm	Poynette, Wis.	222
WIBW	C. L. Carrell	Chicago, Ill.	204
WIBX	WIBX, Inc.	Utica, N. Y.	234
WIBZ	A. D. Trum	Montgomery, Ala.	231
WICC	Bridgeport Bdcst. Station	Bridgeport, Conn.	285
WIL	Benson Radio Co.	St. Louis, Mo.	258
WIOD	Earl G. Fisher Co.	Miami, Fla.	248
WIP	Gimbel Bros.	Philadelphia, Pa.	508
WJAD	Jackson's Radio Eng. Laboratories	Waco, Texas.	353
WJAG	Norfolk Daily News	Norfolk, Neb.	270
WJAK	Kokomo Tribune	Kokomo, Ind.	254
WJAM	D. M. Perham	Cedar Rapids, Iowa	268
WJAR	The Outlet Co.	Providence, R. I.	484
WJAS	Pittsburgh Radio Supply House	Pittsburgh, Pa.	275
WJAX	City of Jacksonville	Jacksonville, Fla.	337
WJAY	Cleveland Broadcasting Corp.	Cleveland, O.	436
WJAZ	American Bdcast Corp.	Mt. Prospect, Ill.	394
WJBA	D. H. Lentz, Jr.	Joliet, Ill.	207
WJBB	Financial Journal	St. Petersburg, Fla.	254
WJBC	Hummer Furniture Co.	LaSalle, Ill.	234
WJBI	Robert S. Johnson	Red Bank, N. J.	219
WJBK	E. F. Goodwin	Ypsilanti, Mich.	232
WJBL	Wm. Gushard Dry Goods Co.	Decatur, Ill.	270
WJBO	Valdemar Jensen	New Orleans, La.	268
WJBR	Omro Drug Stores	Omro, Wis.	227
WJBT	John S. Boyd	Chicago, Ill.	468
WJBU	Bucknell University	Lewisburg, Pa.	211
WJBW	C. Carlson, Jr.	New Orleans, La.	270
WJBY	Electric Construction Co.	Gadsden, Ala.	270
WJBZ	Roland G. Palmer	Chicago Heights, Ill.	210
WJJD	Supreme Lodge, L. O. of Moose	Mooseheart, Ill.	370
WJPW	J. P. Wilson	Ashtabula, Ohio	240
WJR	Station WJR, Inc.	Pontiac, Mich.	517
WJUG	U. B. Ross	New York, N. Y.	517
WJY	Radio Corp. of America	New York, N. Y.	405
WJZ	Radio Corp. of America	Bound Brook, N. J.	454
WKAF	WKAF Broadcasting Co.	Milwaukee, Wis.	261
WKAQ	Radio Corp. of Porto Rico	San Jaun, P. R.	341
WKAR	Michigan State College	East Lansing, Mich.	285
WKAV	Laconia Radio Club	Laconia, N. H.	224
WKBA	Arrow Battery Co.	Chicago, Ill.	210
WKBB	Sanders Bros.	Joliet, Ill.	214
WKBC	H. L. Ansley	Birmingham, Ala.	222
WKBE	K. & D. Electric Co.	Webster, Mass.	270
WKBF	N. D. Watson	Indianapolis, Ind.	244
WKBG	C. L. Carrell	Chicago, Ill.	204
WKBH	Callaway Music Co.	LaCrosse, Wis.	250
WKBI	F. L. Schoenwolf	Chicago, Ill.	220
WKBJ	Gospel Tabernacle Inc.	St. Petersburg, Fla.	282
WKBL	Monrona Radio Mfg. Co.	Monroe, Mich.	252
WKBM	J. W. Jones	Newburgh, N. Y.	285
WKBN	W. P. Williamson, Jr.	Youngstown, Ohio	361
WKBO	Camith Corporation	Jersey City, N. J.	213
WKBP	Enquirer and News	Battle Creek, Mich.	265
WKBQ	Starlight Amusement Park	New York, N. Y.	285
WKBS	P. M. Nelson	Galesburg, Ill.	361
WKBT	First Baptist Church	New Orleans, La.	252
WKBU	H. K. Armstrong	Newcastle, Pa.	204
WKBV	Knox Battery and Electric Co.	Brookville, Ind.	236
WKBW	Churchill Evang. Ass'n.	Buffalo, N. Y.	362
WKBY	Fernwood Wuick	Danville, Pa.	220
WKBZ	K. L. Ashbacker	Ludington, Mich.	256
WKDR	Edward A. Dato	Kenosha, Wis.	491
WKJC	Kirk Johnson & Co.	Lancaster, Pa.	258
WKRC	Kodel Radio Corp.	Cincinnati, Ohio	326
WKY	Hull and Richards	Oklahoma City, Okla.	349
WLAC	Life & Casualty Ins. Co.	Nashville, Tenn.	226
WLAL	First Christian Church	Tulsa, Okla.	250
WLAP	Wm. V. Jordan	Louisville, Ky.	275
WLB	University of Minnesota	Minneapolis, Minn.	278
WLBC	D. A. Burton	Muncie, Ind.	224
WLBE	J. H. Fruitman	Brooklyn, N. Y.	231
WLBF	E. L. Dillard	Kansas City, Mo.	211
WLBG	R. A. Gamble	Petersburg, Va.	220
WLBH	Joseph J. Lombardi	Farmingdale, N. Y.	227
WLBI	Legion Broadcasters, Inc.	East Wenona, Ill.	297
WLBJ	Henry Grossman	Cleveland, Ohio	300
WLBL	Wisconsin Dept. of Markets	Stevens Point, Wis.	278
WLBM	Browning Drake Corp.	Boston, Mass.	405
WLBN	William Evert Hiler	Chicago, Ill.	204
WLBO	Frederick A. Tribbe, Jr.	Galesburg, Ill.	244
WLBP	R. A. Fox	Ashland, Ohio	220
WLBQ	E. Dale Trout	Atwood, Ill.	231
WLBR	Alford Radio Company	Belvidere, Ill.	214
WLBT	Harold Wendell	Crown Point, Ind.	229
WLBU	Matthew B. Greiner	Canastota, N. Y.	220
WLBV	John F. Weimer & D. A. Snick	Mansfield, Ohio	231
WLBW	Petroleum Telephone Co.	Oil City, Pa.	322
WLBX	John N. Brahy	Long Island City, N. Y.	231
WLBY	Aimone Elec.	Iron Mountain, Mich.	250
WLBZ	Thompson L. Guernsey	Dover-Foxcroft, Maine	306
WLCI	Lutheran Association	Ithaca, N. Y.	626
WLIB	Liberty Weekly, Inc.	Elgin, Ill.	303
WLIT	Lit Bros.	Philadelphia, Pa.	394
WLPP	Robert A. Fox	Ashland, Ohio	220
WLS	Sears Roebuck & Co.	Crete, Ill.	345
WLSI	Lincoln Studios	Cranston, R. I.	441
WLTS	Lane Technical High School	Chicago, Ill.	258
WLW	Crosley Radio Corp.	Harrison, Ohio	422
WLWL	Paulist Fathers	New York, N. Y.	384
WMAC	C. B. Meredith	Casenovia, N. Y.	275
WMAF	Round Hills Radio Corp.	Dartmouth, Mass.	441
WMAK	Norton Laboratories	Lockport, N. Y.	400
WMAL	M. A. Leese	Washington, D. C.	294
WMAN	Haskett Radio Station	Columbus, Ohio	278
WMAQ	Chicago Daily News	Chicago, Ill.	447
WMAY	Kingshighway Presbyterian Church	St. Louis, Mo.	248
WMAZ	Mercer University	Macon, Ga.	261
WMBA	LeRoy Joseph Beebe	Newport, R. I.	250
WMBB	American Bond & Mortgage Co.	Chicago, Ill.	250
WMBC	Michigan Broadcasting Co., Inc.	Detroit, Mich.	256
WMBD	Peoria Heights Radio Lab.	Peoria Heights, Ill.	278
WMBE	Dr. C. S. Stevens	St. Paul, Minn.	220
WMBF	Fleetwood Hotel Corp.	Miami Beach, Fla.	384
WMBG	Havens & Martin	Richmond, Va.	220
WMBH	Edwin Dudley Aber,	Chicago, Ill.	204
WMBI	Moody Bible Institute	Chicago, Ill.	288
WMBJ	Wm. Roy McShaffrey	Monessen, Pa.	278
WMBK	John C. Slade	Hamilton, Ohio	360
WMBL	Bonford Radio Studios	Lakeland, Fla.	410
WMBM	Seventh Day Adventist Church	Memphis, Tenn.	214
WMBO	Radio Service Laboratories	Auburn, N. Y.	238
WMBQ	Paul J. Gollhofer	Brooklyn, N. Y.	210
WMBR	Premier Electric Co.	Tampa, Fla.	250
WMBS	Mack's Battery Co.	Harrisburg, Pa.	366
WMBU	Paul J. Miller	Pittsburgh, Pa.	405
WMBW	Youngstown Bdcstg. Co., Inc.	Youngstown, O.	278
WMBY	Robert A. Isaacs	Bloomington, Ill.	291
WMC	Commercial Pub. Co.	Memphis, Tenn.	500
WMCA	Greely Sq. Hotel Co.	Hoboken, N. J.	341
WMHA	Young Men's Hebrew Ass'n	New York, N. Y.	230
WMPC	First Methodist Church	Lapeer, Mich.	203
WMRJ	Peter J. Prinz	Jamaica, N. Y.	227
WMSG	Madison Sq. Gard. Bdcast. Corp.	New York, N. Y.	302
WMVN	Edward J. Malone, Jr.	Newark, N. J.	476
WNAB	Shepard Stores	Boston, Mass.	280
WNAC	Shepard Stores	Boston, Mass.	447
WNAD	University of Oklahoma	Norman, Okla.	254
WNAL	Omaha Central High School	Omaha, Nebr.	258
WNAT	Lenning Brothers Co.	Philadelphia, Pa.	250
WNAX	Dakota Radio Apparatus Co.	Yankton, S. Dak.	244
WNBA	M. T. Rafferty	Forest Park, Ill.	238
WNBF	Howitt-Wood Radio Co.	Endicott, N. Y.	205
WNBH	New Bedford Hotel	New Bedford, Mass.	242
WNBI	Wm. J. Romanouski	Peru, Ill.	357
WNBJ	Lonsdale Baptist Church	Knoxville, Tenn.	337
WNBK	Barton Electric Co.	LeRoy, N. Y.	354
WNBL	Harvey R. Storm	Bloomington, Ill.	495
WNBO	John Brownlee Spriggs	Washington, Pa.	215
WNBR	Popular Radio Shop	Memphis, Tenn.	250
WNBQ	Gordon P. Brown	Rochester, N. Y.	408
WNJ	Herman Lubinsky	Newark, N. J.	353
WNOX	Peoples Tel. & Tel. Co.	Knoxville, Tenn.	268

Bullet Proof Vest Stops Steel

(Continued from page 32)

fied death from Colt automatics, Thompson machine guns and German Mausers. And it is a fact that recently he was shot by accident, fairly over the heart, and if he had not happened to be wearing his bullet-proof vest at the moment he would have been killed instantly.

What is the effect on the man shot when he wears a bullet-proof vest? There is none. Mr. Letts says that he feels a very slight impact, as if one tapped him with a finger tip. There is not the slightest inconvenience, and the ashes are not even jarred off his cigaret. And this by a blow which, but for the vest, would mean instant death.

Policemen, sheriffs and their deputies, state and highway police, are rapidly being equipped with this safety device, and already the lives of many officers have been saved. It is of record that a motorcycle policeman of East St. Louis, Ill., pursued and, single-handed, captured an auto load of gunmen though they fired at him repeatedly. When they were safely in custody he examined his vest and found that it had stopped four bullets, any one of which would have killed him.

Another instance is cited from Martin's Junction, Ky., where the town marshall, John Hall, arrested two desperadoes as they stepped off a train, and his vest stopped ten bullets, any one of which would have given him a fatal wound.

More recently, in a Chicago suburb, several policemen arrested a number of escaped convicts from the state penitentiary. There was a hot revolver battle, and a number of the officers were saved by their bullet-proof vests. The only policeman killed had been furnished with the vest, but had scorned to wear it.

Such is the use to which the principle of the "vibratory leak" is being put—an idea so novel that Hiram Maxim said that Mr. de Boves "seemed to have discovered a new law of physics."

Radio Principles Help Make Rubber Tires

EVERY DAY a new use of radio is announced to the world. The latest is the practical application of radio principles to the manufacture of rubber for tires, bathing caps and many other products.

This inventor, Albert Allen, of Boston, happened to put a piece of tissue paper in a condenser of his radio receiving set one night, thinking that the station he was listening to would come in better. Much to his surprise, he heard an entirely different station. This interested him and he put in a thicker piece of paper and strangely enough, got a third broadcasting station.

Inventor Allen had not discovered a new radio principle. But there came to his mind's eye a practical use of this fact. If, he thought, changing the size of the paper, changes the wave length of the radio set, why cannot we measure the size of paper placed in a condenser by noting the actual change in wavelength.

WNRC	W. B. Nelson	Greensboro, N. C.	224
WNYC	Dept. of Plants & Structures	New York, N. Y.	526
WOAI	Southern Equipment Co.	San Antonio, Texas	394
WOAN	J. D. Vaughn	Lawrenceburg, Tenn.	356
WOAX	Franklyn J. Wolff	Trenton, N. J.	240
WOBB	Longacre Eng. & Const. Co.	Chicago, Ill.	555
WOCB	Orlando Broadcasting Co.	Orlando, Fla.	294
WOC	Palmer School of Chiropractic	Davenport, Iowa	484
WOCL	A. D. Newton	Jamestown, N. Y.	275
WODA	O'Dea Temple of Music	Paterson, N. J.	322
WOI	Iowa State College	Ames, Iowa	270
WOK	Neutrowound Radio Mfg. Co.	Homewood, Ill.	410
WOKO	Harold E. Smith	Peekskill, N. Y.	232
WOKT	Titus-Ets Corporation	Rochester, N. Y.	500
WOMT	Mikado Theater	Manitowoc, Wis.	254
WOO	John Wanamaker	Philadelphia, Pa.	508
WOOD	Grand Rapids Radio Co.	Fernwood, Mich.	242
WOQ	Unity School	Kansas City, Mo.	278
WOR	L. Bamberger and Co.	Newark, N. J.	405
WORD	People's Pulpit Assn.	Batavia, Ill.	275
WOS	State Market Bureau	Jefferson City, Mo.	441
WOW	Woodman of the World	Omaha, Nebr.	526
WOWO	Main Auto Supply Co.	Fort Wayne, Ind.	227
WPAB	Radio Corp. of Virginia	Norfolk, Va.	319
WPAK	N. D. Ag. College	Agricultural College, N. D.	275
WPAP	(See WQAO)	Cliffside, N. J.	361
WPCC	North Shore Cong. Church	Chicago, Ill.	258
WPCH	Concourse Radio Corp.	New York, N. Y.	273
WPDQ	H. L. Turner	Buffalo, N. Y.	205
WPEP	Maurice Mayer	Waukegan, Ill.	213
WPG	The Municipality of Atlantic City	Atlantic City, N. J.	300
WPRC	Wilson Printing & Radio Co.	Harrisburg, Pa.	216
WPSC	Pennsylvania State College	State College, Pa.	261
WPSW	Philadelphia School of Wireless Tel.	Philadelphia, Pa.	236
WQAA	Horace A. Beale, Jr.	Parkersburg, Pa.	220
WQAE	Moore Radio News Station	Springfield, Vt.	246
WQAM	Electrical Equipment Co.	Miami, Fla.	285
WQAN	Scranton Times	Scranton, Pa.	250
WQAO	Calvary Baptist Church	Cliffside, N. J.	361
WQJ	Calument Rainbo Broadcasting Co.	Chicago, Ill.	444
WRAF	The Radio Club (Inc.)	LaPorte, Ind.	447
WRAH	S. N. Read	Providence, R. I.	235
WRAK	Economy Light Co.	Escanaba, Mich.	267
WRAM	Lombard College	Galesburg, Ill.	244
WRAV	Antioch College	Yellow Springs, Ohio	263
WRAW	Avenue Radio & Electric Shop	Reading, Pa.	238
WRAX	Beracah Church, Inc.	Philadelphia, Pa.	268
WRBC	Immanuel Lutheran Church	Valparaiso, Ind.	278
WRC	Radio Corp. of America	Washington, D. C.	468
WRCO	Wayne Radio Co.	Raleigh, N. C.	252
WREC	Wooten's Radio Shop	Whitehaven, Tenn.	254
WREO	Reo Motor Car Co.	Lansing, Mich.	285
WRES	H. L. Sawyer	Woloaston, Mass.	300
WRHF	Wash. Radio Hospital Fund	Washington, D. C.	256
WRHM	Rosedale Hospital, Inc.	Minneapolis, Minn.	252
WRK	Doron Bros.	Hamilton, Ohio	270
WRM	University of Illinois	Urbana, Ill.	273
WRMU	Atlantic Bdcst Co.	New York, N. Y.	204
WRNY	Experimenter Publishing Co.	Coyetsville, N. Y.	375
WRR	City of Dallas	Dallas, Tex.	246
WRRS	Racine Radio Corp.	Racine, Wis.	361
WRSC	The Radio Shop	Chelsea, Mass.	270
WRST	Radiotel Mfg. Co., Inc.	Bay Shore, N. Y.	203
WRVA	Larus & Brother Co., Inc.	Richmond, Va.	256
WSAI	United States Playing Card Co.	Cincinnati, Ohio	326
WSAJ	Grove City College	Grove City, Pa.	229
WSAN	Allentown Call Publishing Co. Inc.	Allentown, Pa.	229
WSAR	Daughy & Welch Electrical Co.	Fall River, Mass.	217
WSAV	Clifford W. Vick	Houston, Tex.	248
WSAX	Zenith Radio Corp.	Chicago, Ill.	319
WSAZ	Chase Electric Shop	Pomeroy, Ohio	244
WSB	Atlanta Journal	Atlanta, Ga.	428
WSBC	World Battery Co.	Chicago, Ill.	288
WSBF	Stix Baer & Fuller	St. Louis, Mo.	273
WSBT	South Bend Tribune	South Bend, Ind.	316
WSDA	Seventh Day Adventist Church	New York, N. Y.	261
WSEA	Virginia Beach Broadcasting Co.	Virginia Beach, Va.	517
WSIX	638 Tire & Vulc. Co.	Springfield, Tenn.	250
WSKC	World's Star Knitting Co.	Bay City, Mich.	261
WSM	Nashville Life & Accident Ins. Co.	Nashville, Tenn.	283
WSMB	Saenger Amuse. Co.	New Orleans, La.	319
WSMH	Shattuck Music House	Owosso, Mich.	240
WSMK	S. M. K. Radio Corp.	Dayton, Ohio	275
WSOE	School of Engineering	Milwaukee, Wis.	246
WSOM	Union Course Laboratories	Woodhaven, N. Y.	288
WSRO	Harry W. Fahrlander	Hamilton, Ohio	252
WSSH	Tremont Temple Bap. Church	Boston, Mass.	261
WSUI	State University of Iowa	Iowa City, Iowa	484
WSVS	Seneca Vocational School	Buffalo, N. Y.	219
WSYR	Clive B. Meredith,	Syracuse, N. Y.	353
WTAD	Ill. Stock Medicine Corp.	Quincy, Ill.	236
WTAG	Worcester Telegram	Worcester, Mass.	545
WTAL	Toledo Broadcasting Co.	Toledo, Ohio	254
WTAM	Willard Storage Battery Co.	Cleveland, Ohio	389
WTAQ	C. S. Van Gordon	Eau Claire, Wis.	254
WTAR	Reliance Electric Co.	Norfolk, Va.	261
WTAS	Richmond Harris & Co.	Batavia, Ill.	275
WTAW	A. & M. Coll. of Texas	College Sta., Texas	270
WTAX	Williams Hardware Co.	Streator, Ill.	231
WTAZ	Thomas J. McGuire	Lambertville, N. J.	261
WTHO	W. J. Thomas Radio Co.	Ferndale, Mich.	219
WTIC	Travelers Insurance Co.	Hartford, Conn.	476
WTRC	20th Dist. Republican Club	New York, N. Y.	240
WTRL	Technical Radio Laboratory	Midland Park, N. J.	280
WWAE	L. J. Crowley	Chicago, Ill.	242
WWJ	Evening News Assn.	Detroit, Mich.	353
WWL	Loyola University	New Orleans, La.	275
WWNC	Chamber of Commerce	Asheville, N. C.	254
WWRL	W. H. Rouman	Woodside, N. Y.	258
WWVA	John C. Stroebel, Jr.	Wheeling, W. Va.	349

Dominion of Canada

CFAC	Calgary Herald	Calgary, Alta.	434
CFCA	Toronto Star Pub. & Prtg. Co.	Toronto, Ont.	356
CFCF	Marconi Wireless Teleg. Co., (Ltd.) Ca. Mont., Que.		411
CFCH	Abitibi Power & Paper Co. (Ltd.) Iroquois Falls, Ont.		500
CFCK	Radio Supply Co.	Edmonton, Alta.	517
CFCN	W. W. Grant (Ltd.)	Calgary, Alta.	434
CFCR	Laurentide Air Service	Sudbury, Ont.	410
CFCT	Victoria City Temple	Victoria, B. C.	329
CFCU	The Jack Elliott (Ltd.)	Hamilton, Ont.	341
CFHC	Henry Birks & Sons	Calgary, Alta.	434
CFKC	Thorold Radio Supply	Thorold, Ont.	248
CFQC	The Electric Shop (Ltd.)	Saskatoon, Sask.	329
CFRC	Queens University	Kingston, Ont.	450
CFXC	Westminster Trust Co.	Westminster, B. C.	291
CFYC	Commercial Radio (Ltd.)	Vancouver, B. C.	411
CHBC	The Calgary Albertan	Calgary, Alta.	434
CHCM	Riley & McCormack (Ltd.)	Calgary, Alta.	434
CHCS	The Hamilton Spectator	Hamilton, Ont.	341
CHIC	Northern Electric Co.	Toronto, Ont.	357
CHNC	Toronto Radio Research Society	Toronto, Ont.	357
CHUC	International Bible Ass'n.	Saskatoon, Sask.	329
CHXC	R. Booth, Jr.	Ottawa, Ont.	434
CHYC	Northern Electric Co.	Montreal, Que.	411
CJCA	Edmonton Journal	Edmonton, Alta.	511
CJCL	A. Couture	Montreal, Que.	279
CJGC	London Free Press	London, Ont.	329
CKAC	La Presse	Montreal, Que.	411
CKCD	Vancouver Daily Province	Vancouver, B. C.	397
CKCK	Leader Pub. Co.	Regina, Sask.	476
CKCL	Dominion Battery Co.	Toronto	357
CKCO	Ottawa Radio Association	Ottawa, Ont.	434
CKCX	Int'l Bible Students Ass'n.	Toronto	291
CKFC	First Congregational Church	Vancouver, B. C.	411
CKLC	Wilkinson Electric Co. (Ltd.)	Calgary, Alta.	434
CKNC	Canadian National Carbon Co.	Toronto, Ont.	357
CKOC	Wentworth Radio Supply Co.	Hamilton, Ont.	341
CKY	Manitoba Tel. System	Winnipeg, Man.	384
CNRA	Canadian National Railways	Moncton, N. B.	322
CNRC	Canadian National Railways	Calgary, Alta.	435
CNRE	Canadian National Railways	Edmonton, Alta.	517
CNRM	Canadian National Railways	Montreal, Que.	411
CNRO	Canadian National Railways	Ottawa, Ont.	434
CNRQ	Canadian National Railways	Quebec, Que.	341
CNRR	Canadian National Railways	Regina, Sask.	312
CNRS	Canadian National Railways	Saskatoon, Sask.	329
CNRT	Canadian National Railways	Toronto, Ont.	357
CNRV	Canadian National Railways	Vancouver, B. C.	291
CNRW	Canadian National Railways	Winnipeg, Man.	405

Sun Spots Responsible

RENEWED evidence that the sunspot maximum which is due this year will be one of the most severe for many years is supplied by the summary of sunspots visible during 1926 contained in the annual review of astronomy just issued by the Royal Astronomical Society of England. The number of spots on the sun varies according to a regular cycle, with maxima every eleven years. It is known, however, that not all of the sunspot maxima are of equal intensity. At some of the eleven-year peaks of the sunspot curve the sun is much more active than at others. The average spottedness of the sun during 1926 was already high, although the real peak of the curve is not expected until this year. This fact, together with certain characters of the spots and of their locations on the sun, suggest to the experts of the Society the maximum of sunspots in 1927 will be a high one, perhaps one of the highest since careful scientific observations of the sun were begun. The activity of the sun, as indicated by the spots, is believed to be responsible for many terrestrial disturbances, including stormy weather, bad radio and sunburn. We may expect that 1927 will be an altogether exceptional year in these respects.

Radium Kills Hair

THAT in addition to its other uses in medicine radium may be employed to remove superfluous hair, is reported by Hayward Pinch, Director of the Radium Institute, in London. The rays shot out from radium when its atoms explode are powerfully destructive to living matter. That is why radium can be used to kill germs. It is used similarly to kill cancer cells. Its rays can be used equally well, Mr. Pinch reports, to destroy the living hair cells from which superfluous hair grows. Merely to shave such hair or to remove it with chemicals is not permanent. These cells can be killed by electrolysis, by introducing a tiny electric needle into each cell.

CLASSIFIED ADVERTISEMENTS

If you have anything to buy or sell, don't overlook RADIO AGE'S classified advertisements.

The classified advertising rates are but four cents per word for a single insertion. Liberal discounts are allowed on six and twelve-time insertions, making rate of 3 and 2 cents a word per insertion respectively. Unless placed through an accredited advertising agency, cash should accompany all orders. Name and address must be included at foregoing rates. Minimum contract charge $1.00.

All classified ads for the September issue must be sent in by July 25.

AGENTS

Sell Radio Sets on time $10.00 down buys 3 tube set. Agents get my special prices. Bargain Speakers; order now. T. King, 699 Oneida St., Syracuse, N. Y.

AIRPLANES

SEND FOR free illustrations and plans of our wonderful two-place, companion type, small, high lift wing monoplane, and information on how to build this ship, and be sure it will fly; also propeller literature. Crawford Airplane Manufactory, 2223 American Avenue, Long Beach, California.

BOOKS AND MAGAZINES

Judge Lindsey's "companionate marriage" hoax exposed! Rich debate! Flays other "doctrines". Exponent 15c, Orlando, Fla. Consigned: Newsdealers, Agents.

FREE—Two big New Magazines and information worth hundreds of dollars to you. Enclose 2c stamp. Salesmanager, Box 74-R, Beaver Dam, Wisconsin.

What could be better than magazine subscriptions for gifts. Send stamp for our special list of subscription bargains. Midland Products, Dept. R. A., 524 Courtland Ave., Park Ridge, Illinois.

Twentieth Century Book of Receipts, Formulas and processes, an 807 cloth bound book containing 10,000 proven formulas for the manufacturer, workshop, laboratory, office and home. Sent prepaid upon receipt of $4.00. Send dime for our 48 page catalog of latest and best practical, scientific mechanical and industrial books. Midland Products Co., Dept. RA, 524 Courtland Ave., Park Ridge, Ill.

BOYS

Boys get a three foot model aeroplane free. No selling. Write for particulars. Aero Shop, 3050 Hurlbut Ave., Detroit, Michigan.

RADIO SET FREE. Farm magazine clubs among friends. Club list free. Sponsorlan Agencies, Los Angeles, Brentwood Heights, California.

BUSINESS OPPORTUNITIES

PECAN-Orange-Fig Groves "On the Gulf". Monthly payments. Guaranteed care. Big, quick returns. Suburban Orchards, Dept. R, Biloxi, Mississippi.

MAKE RADIO PANEL LAMPS. Inventor can supply necessary parts. Easily assembled. Rests on top of radio cabinet. Lights dials. Information free. Sample Lamp $1.25. Postpaid. Robert Stevenson, Lancaster, Ohio.

LAND FREE If planted to bananas. Bananas bear a full crop the second year. $5.00 monthly will plant five acres, which should pay $1,500 profit annually. Reliable Companies will cultivate and market your bananas for 1/3. Bananas ripen every day and you get your check every 30 days. For particulars address Jantha Plantation Co., Empire Building, Block 766, Pittsburgh, Pa.

DOGS

BEAUTIFUL REGISTERED BULL PUPS $15. Bulldogs, 501 Rockwood, Dallas, Texas.

ELECTRICAL

ELECTRIC FUN! Seventy stunts, 110 volts, $1. Cecil Ting, Campbell, Calif.

FORMULAS

20c—Any Formula, 20c. "Hawkins," 215R Lasanimas, Colorado Springs, Colorado.

HELP WANTED

Firemen, Brakemen, Baggagemen, (White or colored) sleeping car, train porters (colored), $150-$250 monthly. Experience unnecessary. 278 Railway Bureau, East St. Louis, Illinois.

MEN, get Forest Ranger job; $125-$200 mo. and home furnished; permanent; hunt, fish, trap. For details, write Norton, 209 McMann Bldg., Denver, Colorado.

MISCELLANEOUS

"MUSIC Composed" to words. Bauer Bros., (formerly of Sousa's Band). Oshkosh, Wis.

GILLETTE STYLE Razor with 10 Blades 69c Prepaid. Loud Speaker $3.89, Speaker Unit $1.10 prepaid. Transformer 25c, Mele Station A, New Haven, Conn.

PANEL ENGRAVING

WE SPECIALIZE in high grade single panel engraving. Also quantity panel work and special machine engraving on small parts. The only panel engraver in Chicago devoted exclusively to engraving. A. L. Woody, 19 South Wells St., Chicago, Ill.

PERSONAL

LONELY HEARTS: Exchange letters; make interesting new friends in our jolly club. Particulars free. Eva Moore, Box 908, Jacksonville, Florida.

RADIO

EXTRA HEAVY Antenna wire 7 No. 18 $1.50 100 feet. 12 No. 22 braided 3/8" wide $2.00 100 feet all prepaid. George Schulz, Calumet, Michigan.

MR. H. SADZECK, 1855 Addison St., Chicago, Ill., writes us as follows: "I bought one of your Radio Trouble-Shooters. Just the thing I have been looking for, Dandy. Please send me catalog or literature of other parts you carry. Thanking you for this favor, I am (Signed) H. Sadzeck." It will pay you to investigate at Universal Test Equipment Co., 2939 N. Oakley Ave., Chicago, Ill.

Radio Books—Construction of a modern Super Heterodyne Type Receiver including Testing and Operation $1.00; Henley's 222 Radio Circuit Designs, 207 pages, $1.00; The ABC of Vacuum Tubes used in Radio Reception 182 pages, 75 cents; Henley's Workable Radio Receivers 196 pages $1.00; Experimental Wireless Stations 392 pages $2.00; Wireless Telegraphy and Telephony Simply Explained 154 pages $1.00. Sent prepaid on receipt of price. Send dime for our 48 page catalog of latest and best practical, scientific, mechanical and industrial books. Midland Products Co., Dept. RA, 524 Courtland Ave., Park Ridge, Illinois.

SILICON Transformer Steel cut to order .014". 10 lbs. 25 cents, 5 lbs. 30 cents, less than 5 lbs. 35 cents per lb., 4 cubic inches to the lb. postage extra. At least ½ cash with order—balance C. O. D. Geo. Schulz, Calumet, Michigan.

PURE ALUMINUM and lead rectifier elements, holes drilled, with brass screws and nuts per pair 1-10", 1"x4", 13c, 1x6, 15c, 1½x6, 17c, 1½x8, 19c, single elements half price. Sheet aluminum 1-10", $1.00, 1-8" $1.50. Lead $1.00 square foot all prepaid. Geo. Schulz, Calumet, Michigan.

CONDENSERS. 800 VOLT FILTER, .1 mfd 45c, .25 5le, .5 60c, 1. 75c, 2. $1.20, 3. $1.80, 4. $2.40, 1500 VOLT FILTER, .1 5le, .25 80c, .5 75c, 1. $1.05, 2. $1.55, 3. $2.70, 4. $3.80. ELIMINATOR BLOCKS, 2, 2, and 8 $5.70, 2, 2, 8 and 1 $6.15, 2, 2, 8, 1 and 1 $6.60, .1 and .1 in series 90c. Many other exposities. Acme transformers and chokes. THE RADIO CLUB, INC., La Porte, Ind.

IVORY RADIO PANEL beats them all. Write for FREE Sample. Ivorylite Radio Panel Co., 3330 Ave. G, Fort Worth, Texas.

Complete kit for S-M 7 tube Super including every part —Panel, dials, etc. Guarantee new and perfect. First $41.50. P. E. Chapman, 841 Preston, Philadelphia, Pa.

AMAZING RADIO OFFER. 3 new S-M 7 tube Super Hets engraved panels—Sub-base completely wired. Beautiful folding loop FREE. The choice of experts—Coast to Coast on loop. Without cabinet $52.50 each. The Radio Hospital, 841 N. Preston, Philadelphia, Pa.

Iron core chokes 20H-25 MA $1.00, 30H-60MA $2.25, 30H-85 MA $2.75, 30H-125 MA $3.75, 50H-85 MA $2.75, 50H-125 MA $3.75. Write for list or let us quote on your requirements. Radio Parts Sales Co., Orange, N. J.

10% off all standard radio apparatus laboratory tested radiotron UV 201A's at only $1.70. Postage prepaid. Petsto Radio Laboratories, Wauwatosa, Wisconsin.

GUARANTEED RADIO PARTS—TUBES 38c and $1.23; 3½ or 5 to one Transformers $1.41; 16, 17, or 23 plate Variable Condensers $1.43, Tandems $2.47, Midgets 88c; 3 Circuit Tuning Coils $1.31; Rheostats and Potentiometers 34c to $1.09; CORNELL Bronze Verniers $1.37, (Worth $2.00); 7"x18" Black or Matted Rubber Panels $1.32; Unpainted Knocked Down 18" or 21" Cabinets with subpanel and hardware $2.75 —POSTPAID—Cash With Order. GORDON G. ATWELL, Shreveport, La.

110-199-8 volt transformer for making a Trickle Charger for "B" Battery using 201A tube $2.08. 30H 85 MA. 28.0 Ohm. Choke $2.75. 110-420-6 volt transformer $4.00. All postpaid. Write for list of specials. We estimate on kits to your specifications. Radio Parts Sales Co., Orange, N. J.

WESTERN Electric power amplifier $18.00. Magnavox Three-stage power amplifier $14.09. Signal 1-plate condensers at 50 cents each. Get my bargain list for the ham. 9MV Story City, Iowa.

RUBBER STAMPS

RUBBER STAMPS and supplies. 20c per line. Cushion Mounted. Catalog for stamp. Newman & Son, Auburn, Nebraska.

SALESMEN WANTED

I AUTO GAS SAVER FREE
To Introduce. Amazing car performance. Doubles mileage. CRITCHLOW, Inventor, C-90, Wheaton, Illinois

STAMMERING

STAMMERING quickly and cheaply cured in your own home. Free book of facts with proof of cures. Write, Mohr, 34 Fernhill Avenue, Buffalo, New York.

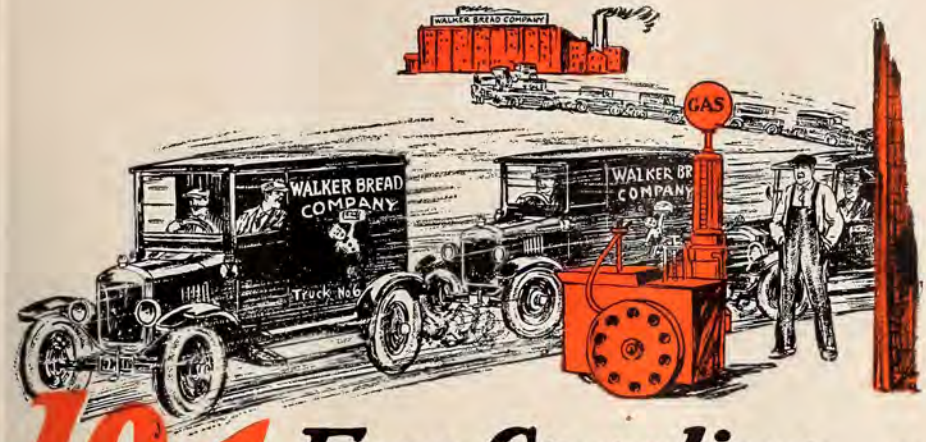
TYPEWRITERS

TYPEWRITERS, all standard makes, $10 up. Fully Guaranteed. Free Trial. Write for COMPLETE Illustrated lists. Northwestern Typewriter Exchange, 121 N. Francisco Ave., Chicago.

WANTED TO BUY

Full value paid for old GOLD jewelry, silver or platinum. Packages returned if our offer not satisfactory. Blaine Specialty Company, 3330 Ave. G, Fort Worth, Texas.

Radio Age Classified Ads Bring Results



104 Free Gasoline Days a Year!

The Walker Bread Co., of Fort Worth—one of the best known baking concerns in Texas—run their Blancke Control Equipped Ford Delivery Trucks and Salesman's Cars TWO EXTRA DAYS EVERY WEEK without gas—giving them 104 days of FREE gasoline per year.

Agents—150%

Walker Bread Co. Delivery Truck No. 6 used 28 gallons of gas in four days (7 gals. a day). This same truck equipped with the Blancke Control ran SIX days on an equal amount of gas—gaining two days a week over its former record—or 104 Free Gasoline days a year.

Original Letter from the Walker Bread Co., on file in our office, lists other similar average results on their numerous cars and says further: "These cars cover the same territory daily; gas is put into the cars each day, so that we have an accurate account of the amount of gas used by each car. The saving of gas by the use of your Automatic Carburetor Control will pay for its installation every thirty days." Backed by scores of endorsements from well known Companies such as this,—by a big National Advertising campaign and by guaranteed results—the Blancke Control is bringing undreamed of success to our representatives. R. K. Waite ordered 2000 controls in 2 months, making a profit of $6,000! Every mail brings additional astounding reports.

Cadillac, the new La Salle and Delco Light Now Use As Standard Equipment Thermostatic Carburetor Control Under Blancke License.

Profit Guaranteed

Strongest Guarantee in automotive history backs sale of Blancke Control. Guaranteed to give **150 miles on 5 gals. of gas** on Fords—to practically eliminate carbon—save half oil—relieve battery strain—make motor run smoother—give better acceleration—allow slower speeds in high gear. Saves half repair bills. No holes to drill; no bolts to remove—Anyone can attach it in 3 minutes. Ford owners everywhere are delighted with the Blancke Control and their boosting promotes sales. You don't need experience. Guaranteed results speak for themselves and sensational "Sure-Fire" Demonstration sells for you.

Get One Free to introducer, also Blancke plan that guarantees 150% profit, starts you without capital in a real business that pays you from $300.00 to $2,500.00 and up each month and gives user agent new Ford Car free by time his present one is worn out. Get started NOW. Use the coupon!

BLANCKE AUTO DEVICES CO.
154 E. Erie St., Dept. 820 K Chicago, Ill.

BLANCKE THERMOSTATIC CARBURETOR CONTROL

$15 a Day Guaranteed to Distributors

RUSH THIS IMPORTANT COUPON

BLANCKE AUTO DEVICES CO., Dept. 820K,
154 E. Erie Street, Chicago, Illinois.

Gentlemen: I should like to get a Blancke Control FREE. Also send details of amazing new Guarantee Plan by which I can make from $300.00 to $2,500.00 a month profit—no obligation for me.

Name.....

Address.....

City..... State.....

SALES Guaranteed

Drum notes not only heard — but identified

Thousands of radio listeners will now realize for the first time that radio orchestras have drums when they hook up this new, improved Crosley Musicone.

As originally produced the Musicone startled the radio world, eclipsing the old type horn and squeaky speaker.

Today, the new Musicone with its latest refinements and improvements correspondingly leads its host of imitators.

Prepare for a real surprise when you hear this amazing device with its beauty and fidelity of treble reproduction—clarity and breathless reality in middle tones—richness and resonance of bass. Today—infinitely bettered and superlatively developed, the Musicone is the world's finest loud speaker—and, at such extremely low prices, it's the world's greatest radio value.

The Crosley patented actuating unit (and not the cone) is the secret. There's nothing else like it.

Write Dept. 63 for descriptive literature

The improved

CROSLEY MUSICONE

SUPER-MUSICONE
16 *inch Cone*
$14.75

THE CROSLEY RADIO CORPORATION

Powel Crosley, Jr., Pres.

Cincinnati, Ohio

Prices slightly higher west of the Rocky Mts.

ULTRA-MUSICONE
12 *inch Cone*
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