Radio and Model Engineering

10 cents a Copy — 570 West 184th Street, New York City — $1.00 per year

Vol. I — OCTOBER, 1921 — No. 5

Editorial

MR. McNICOL, chairman of the Standardization Committee of the I. R. E., in summarizing the work of the Committee, said: "We can make very few decisions for all times. Our work is only contributory to that of those who will follow, but we are laying the foundation for the developments of the future."

In this way was indicated a serious responsibility, a responsibility which is also shared by each radio experimenter to those who will later carry on the work.

The experimenter's first responsibility is to himself in trying to learn well the simple fundamental theories, applying them thru correct design and good workmanship, and in limiting statements and decisions to those based on scientific knowledge. The second is to his fellow experimenters, in willing and hearty co-operation not only by thoughtful consideration in transmitting but in tests and laboratory work and the free exchange of ideas. The third is to new experimenters, securing recruits for the field, and starting beginners in such a way as to make their work successful and encourage them to broaden activities.

If you accept these responsibilities and conscientiously observe their dictates, you will do more for the advancement of radio work than the relay man who recognizes only relay operators, or the experimenter who attempts to mystify others by deep secrecy about his work.

M. B. SLEEPER,

Editor.

Radio Frequency Amplification at 200 Meters

This set, designed for reception on 150 to 250 meters, combines radio frequency amplification and regeneration in a receiver critically sharp in tuning and as easy to build as it is inexpensive

By M. B. SLEEPER

New Types of Receivers

THE urge for something new, which all radio men experience at frequent intervals, is probably responsible for the insurgent tendency to get away from the old standby—the variometer receiver. The latter is being warmly defended from many quarters, and its strong points cannot be denied. However, it is not fair to experimenters for those who are personally interested in the continued use of the variometer sets to attempt the discouragement of development work along other lines, for it is entirely possible that something better can be worked out.

In fact, many experimenters have been more successful with the familiar loosely coupled receiver and tickler coil, and they claim that no losses are apparent from the use of a small variable condenser across the secondary circuit. Any variometer set that tunes over a range of more than 150 to 350 meters has mica condensers in the secondary.

At the G. A. we have tried out many different circuits, with varying results. Different characteristics often make a circuit good for particular requirements but not broadly adaptable. One circuit, however, has stood out from the rest, a circuit

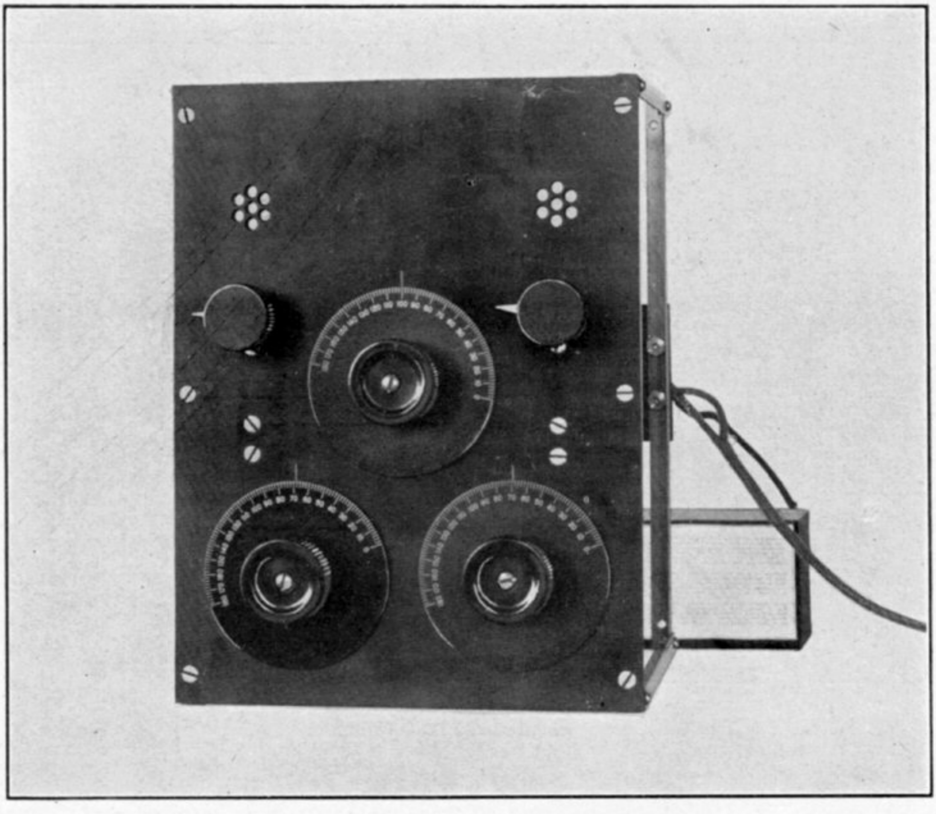


Fig. 1. A radio frequency amplifier and detector with tuning circuits for 150 to 350 meters. Addition audio frequency amplification can be used if desired.

familiar to some in Army or Navy research sections, but not generally known to experimenters. It is the tuned impedance radio frequency amplifier. While this circuit is not proposed as an open sesame to the door of optimum methods, it has several unique advantages which other circuits do not possess.

Radio Frequency Amplifier

ANY radio frequency amplifier increases the amplitude of the incoming oscillations without affecting their character. A telephone in the output circuit of a radio frequency amplifier produces no sound, as the oscillations of the input circuit are not rectified until they are put thru a detector. If the incoming signals are strong enough to operate a detector, an audio frequency amplifier will amplify them, but a radio frequency amplifier produces the same effect as moving the receiving station nearer the transmitter because it amplifies **any** impulses without regard to their weakness. In fact, signals can be received when three or more stages of radio frequency amplification are required to bring them up to a strength sufficient to act upon a detector.

Another advantage of this type of amplification is that it does not amplify static as much as the audio frequency type, as will be explained later on.

With the methods now available, transformer coupling or similar systems cannot be employed on wavelengths below 600 meters. Reasons for this have been set forth by Armstrong in his paper on "A New System of Short Wave Amplification."[1]

Tuned Impedance Coupling

TUNED impedance coupling, fortunately, offers a simple alternative method for one step. Two steps can be employed, but the tuning with more steps becomes so extremely sharp as to constitute a disadvantage. Fig. 3 shows a simplified diagram of impedance coupled radio frequency amplifier. In the plate circuit of the first tube are a coil and condenser of such dimensions that they can be tuned to the frequency of the incoming waves. The direct current from the plate battery has a low resistance path thru the coil, but the tuned parallel circuit presents an infinite impedance, theoretically, to the incoming radio frequency, serving the same purpose as a resistance in a resistance coupled ampli-

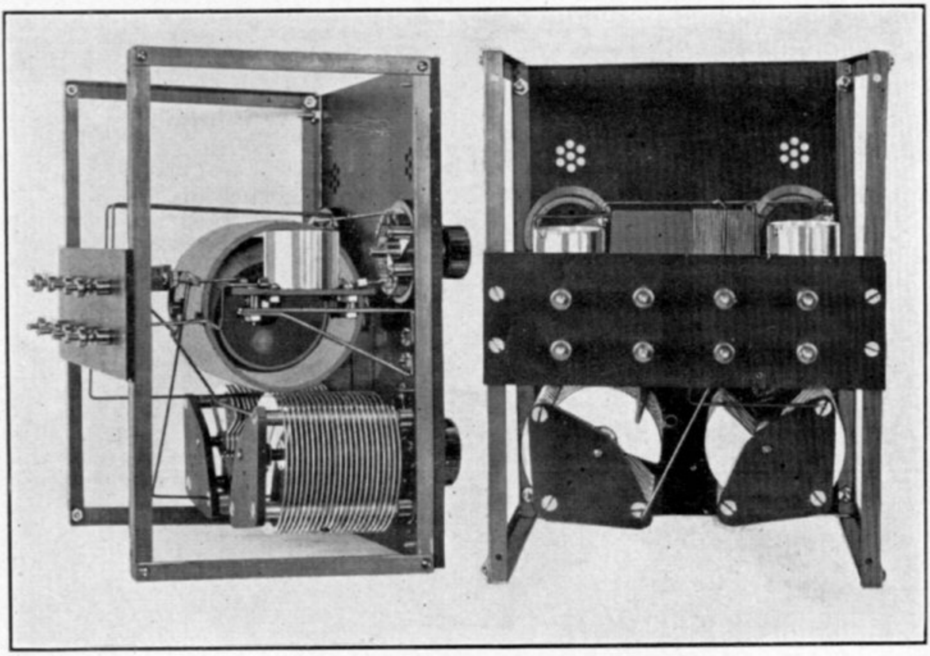


Fig. 2. Side and rear views of the receiver.

[1]Proceedings of The Institute of Radio Engineers, February, 1921. Sold by The General Apparatus Co., Inc., 570 W. 184th St., New York City. $1.50 per copy.

fier. The second tube, with its grid condenser, acts as a detector, to which audio frequency amplifiers can be added if desired. Since there is no tuning to static disturbances, they tend to pass directly thru the impedance coil, producing only a slight effect upon the detector.

General Description of Set

THE receiver shown in the accompanying illustrations is a strictly 200-meter set, as the wavelength range, with an antenna of 0.0003 mfd., is only 150 to 350 meters. Tuning in the antenna circuit is accomplished by a fixed inductance mounted at the rear of the panel and a 0.0008 mfd. condenser at the lower left hand corner of the panel. The impendance inductance, also of a fixed value, is adjustably coupled to the antenna coil, its position being controlled by the center dial. On the right is a 0.0008 mfd. impendance condenser. The radio frequency amplifier tube, on the left, and the detector, on the right, are adjusted by their respective rheostats below. Binding posts are carried on the rear connection panel mounted on an angle brass frame.

An idea of the simplicity of the circuit may be gained from the fact that there are only 14 separate wires used to join the instruments. If an audio frequency amplifier is employed, it can be wired to posts provided at the rear. Fig. 3 shows the diagram.

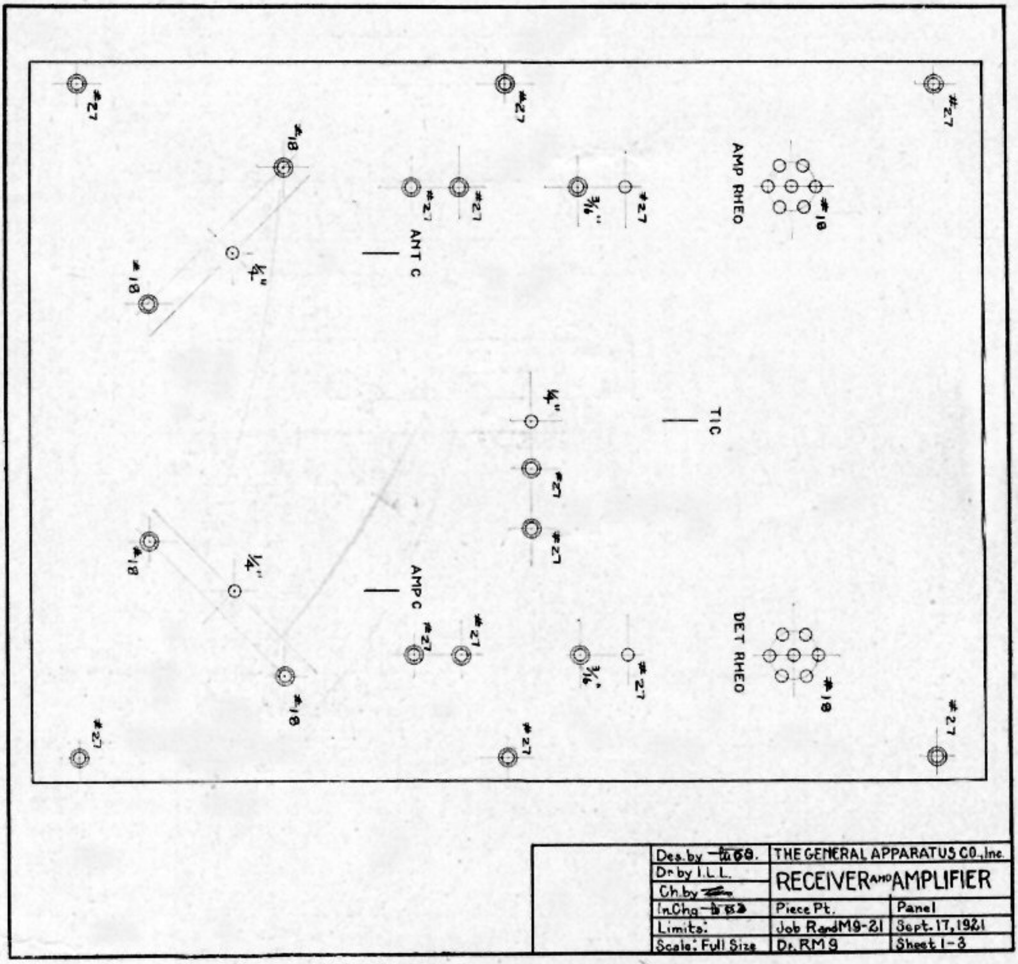


Fig. 4. One-half size. Scale drawing of the instrument panel.

The Parts Required

THIS receiver is made up of a front instrument panel, 10 by 7½ by 3-16 in., rear connection panel 7½ by 2½ by ⅛ in., cut from a standard sheet 10 by 2½ ins., angle brass frames, two 0.0008 mfd. condensers, two rheostats and sockets, fixed inductance, tickler, and grid condenser. No switches are required.

Fig. 4 shows at one-half scale the layout of the panel. To take off the dimensions it is only necessary to measure on the drawing and double the distances. Drill sizes are indicated; two circles call for countersinking. Thru standardization of the parts, a minimum variety of drill sizes are needed.

A G-A-Lite tube, 3½ ins. in diameter furnished with ¼-in. holes which give a tight fit on a ¼-in. rod.

The only other difficult work is in making the brackets for the sockets. They are cut from ⅜ by 1-16-in. strip, drilled and bent as in Fig. 3. To obtain a perfect adjustment of the sockets it may be necessary to file the rear holes of the lower brackets into the shape of slots. The sockets are furnished with short posts for mounting, threaded 8-32 and held by ¼-in. screws. These screws should be removed and 1-in. 8-32 screws

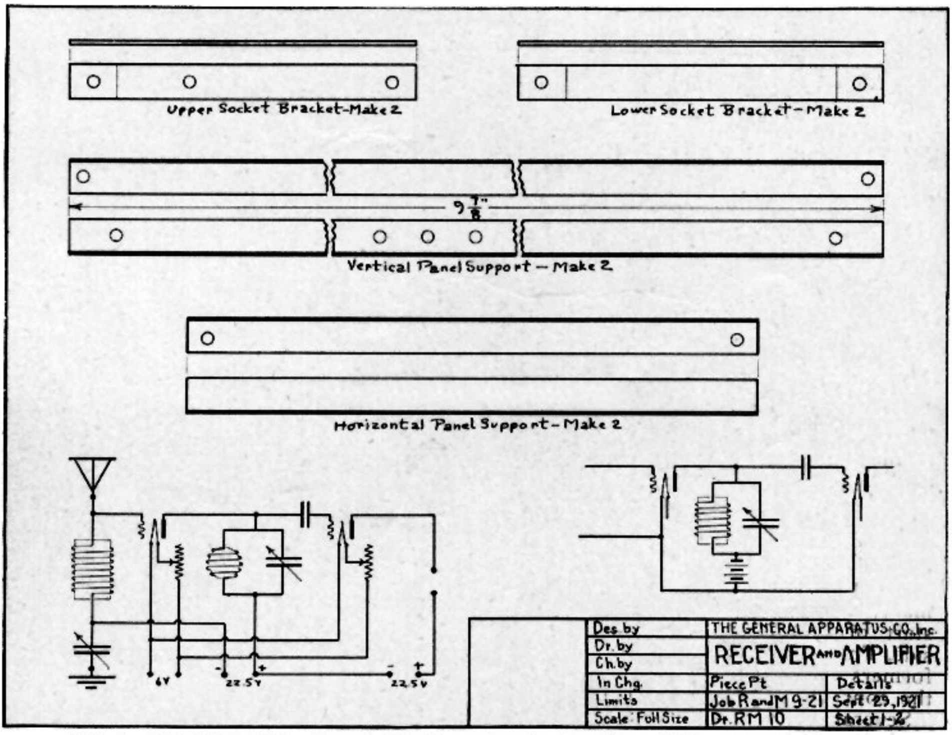


Fig. 3. One-half scale. Circuit details and scale drawings of the support frames.

by 3 ins. long, wound with 28 turns of No. 20 D.C.C. wire, is held by two supporting pillars at the right of the shaft. The screw heads are hidden by the tickler dial. A standard 3-in. tickler ball is mounted in the coil by a two section shaft. It has been found quite satisfactory to use holes drilled in the G-A-Lite tubing for shaft bearings. The tickler ball is wound with one layer of No. 20 D.C.C. wire, with the start of the coil soldered to one-half of the ¼-in. brass shaft, and the end to the other half. Pig-tail leads may be soldered to the shaft or friction bearings of spring brass fastened to the tube and pressing on the shaft are satisfactory. These balls are put in their places to extend thru the brackets.

Eight binding posts are mounted on the rear panel. The two rows are 1 in. apart and the posts separated by 1½ ins.

Assembling the Receiver

WHEN the parts are ready for assembling, the rheostats should be put on first, then the coil and tickler, after all leads have been soldered, next the condensers, and finally the angle brass frames without the rear panel. Because the rear panel is in the way during part of the soldering, all wires not running to binding posts should be fitted first. Instead of running a wire from the ground side of the left hand condenser to the ground post, both these terminals are connected to the left frame. Other details of connections are given in Fig. 3.

Suggestions on Operating

THIS receiver has a number of peculiarities which must be observed by actual operation, and the tuning is so sharp that the best results can be obtained only by the correct handling of the controls.

For best understanding, the left hand condenser may be considered as the primary control and the right hand condenser and tickler the secondary. This is because the tickler gives a wavelength control effect which makes it necessary to adjust the tickler and impendance circuit condenser simultaneously. It will be noted that a 180° dial is used on the tickler as it is sometimes put on one side or the other of zero coupling.

Spark, telephone, or undamped telegraph stations can be heard with this receiver clearly and without distortion. At the same time the receiving range is increased beyond that which can be covered with any number of audio frequency amplifiers.

Notes on Amplifying Transformers and Plate Batteries

By A. Fairlamb

Several types of amplifying transformers, including the new GA-STD-A14, have the terminals marked P1, P2 and S1, S2. This does not really indicate, however, the way in which the transformer should be connected. The numerals following the initial mean that the terminal marked 1 is connected with the beginning of the winding and 2 to the end of the winding. The inside or start of the primary winding should go to the plate and the start of the secondary winding to the grid. Then the P2 terminal will be connected to the filament side of the circuit as well as S2. If the transformer is not connected in this way it will not operate to the maximum efficiency. Other transformers, such as the Western Electric have their terminals marked, 1, 2, 3, 4. Then 1 indicates the start of the primary, 2 the end of the primary, 3 the start of the secondary, and 4 the outside. The same rule applies to these transformers as to the others in regard to the connections to the terminals.

Several unusual features are incorporated in the GA-STD-A14 transformer. In the first place it is absolutely water tight. This eliminates the corosion caused by the effect of moisture upon the extremely fine wire with which transformers are wound. The coil itself is not made with a string winding which increases the size of the coil and takes the winding farther away from the core but is wound with a sheet of insulating material between each individual layer.

A very novel feature is the design of the transformer itself, details of which have not yet been made public although they can be discovered by breaking the transformer. The effect of perfect shielding is accomplished without the use of any iron laminations. As a result, distortion and the familiar transformer noises frequently attributed to the tube eliminated. These effects are frequently very marked when three steps of amplification are employed on transformers where corrective measures have not been taken. Experimenters are not advised to employ more than three steps of audio frequency amplification using the-A14 transformers because the power amplification is so great that the windings are liable to be burned out. After the third step a stepdown transformer and power tube such as a radiotron UV202 should be used with 135 to 300 volts on the plate.

Aside from the increase in operating life obtained by the new design of the GA-STD-A11 and -A12 plate batteries they have a particular appeal to those purchasing batteries by mail because of their greatly reduced weight over the size formerly required for equally operating life, and to those who are using portable receiving or vacuum tube transmitting apparatus. It is possible, for example, to use three of the -A12 batteries to get 135 volts with a weight of only 12 lbs. There is nothing that can be used to give this voltage that will compare at all in lightness with this source of plate supply. Very simply portable transmitting equipment has been made up using two UV-202 bulbs on three -A12 batteries and distances as high as 40 miles have been covered.

The larger type has a center tap to give 22 1-2 volts for detectors and 45 volts for amplifiers. No variation of plate voltage is found necessary in ordinary practice although a filament battery potentiometer can be employed if this is required. The absence of taps also does away with accidental short circuiting which may, if left over night, ruin the battery.

Ideas For the Radio Shop and Laboratory

Here are a few handy instruments, neatly made, which every experimenter needs but not so many have

By W. H. Bullock

Short Wave Laboratory Oscillator

HAVE you ever worked and worked to get a resonance point in making measurements with a wavemeter, giving up in the end or taking a chance that the readings you made were somewhere near correct? You won't have to do that with an oscillating wavemeter. The circuit is simple, and contains only the elements of an oscillating circuit, an inductance connected at one end to the grid of a tube, a center tap to the filament, and the other end running to the negative side of a plate battery, the positive battery lead to the telephones, and the phones to the tube plate. A variable condenser is connected across the ends of the coil. This is a laboratory oscillator which, when calibrated, becomes a wavemeter.

There are many uses to which the instrument can be put described in detail at the end of this article.

Construction of the Wavemeter

FIG. 1 shows the completed meter connected and ready for use on wavelengths from 180 to 600 meters. A GA-STD-A15 variable condenser, 0.0002 mfd. capacity, is mounted on a 5 by 5 by 3-16-in. panel fitted on a box 2½ ins. deep inside and 5 ins. square outside. Three special clamping posts are needed for connections, made to hold the coil connection lugs in the center and wires to the audion at the top. They are located ⅝ in. from the edge, the left hand post being 1 5-16 in. from the side of the panel, the next ½ in. to the right and the third 1 15-16 in. from the second.

The coil is 1 7-16 in. long, of 65 turns of No. 24 S.S.C. wire on G-A-Lite tube 3½ ins. in diameter and 2¾ ins. long. Winding is started 1 in. from the left hand end, and a tap is taken off at the thirtieth turn. Next, 1-in. round head 8-32 screws are put thru the tube, spaced to line up with the binding posts and clamped with nuts. End and center leads from the coils are soldered to their respective screws. Finally large size soldering lugs are put in position on the binding posts and the screws on the coil soldered to them. Thus the screws provide support for the coil as well as connections. The outside binding posts are wired to the condenser terminals.

Connections to the audion have been described already. When a Laboratory Type Control is employed, as in Fig. 1, the right hand wavemeter post is joined to the upper left hand control post, the center post to the lower control post, negative plate battery lead to the left wavemeter post, and the positive lead to the regular positive plate battery connector at the rear of the control. The right control panel posts take the telephones.

Calibrating the Meter

TO calibrate this meter, connect it as directed and light the tube filament. If a UV200 is used, put 22.5 volts on the plate, or for more power a UV201 with 45 volts. Couple the coil to the inductance of the calirated meter, and swing the condenser back and forth until clicks are heard in the phones. There will be a click on each side of the resonance point. Decrease the coupling until the clicks are very close together. The center point between the clicks gives the true reading. This method, tho it may seem rather uncertain from the description, works out very nicely in practice.

Measuring Other Circuits

BEFORE measuring the wavelength of a circuit disconnect any other circuit coupled to it or set the coupling at zero. Whether the circuit is for transmitting or receiving it is not necessary to excite it. Merely couple the wavemeter to it and listen for the clicks which indicate resonance.

If the wavemeter is set up near a telephone or undamped wave transmitter, beat notes will be heard on both sides of the resonance point.

Other Uses for the Wavemeter

THERE are many interesting uses for this instrument. It may be coupled to a non-oscillating audion or crystal circuit and used for heterodyning undamped wave signals. For experiments on impedance coupled radio frequency amplifiers the meter itself can be used as the impendance circuit. Again, it may be connected in the plate circuit of a non-oscillating detector, and it will cause the circuit to oscillate and regenerate.

Comparison Testing Switch

THE only way to compare tubes, amplifying transformers, receiving sets, and other devices is to connect one and then the other, keeping the conditions the same. A handy switch for this purpose is shown in Fig. 2, at the left.

It is a Federal anti-capacity switch mounted on an L.P.F. panel 5 by 5 by 3-16 in. The panel is supported on a wooden base. Fahnestock clips for the center contacts are mounted across the top of the panel, and the clips on the sides for the side contacts. It might have been better to have the handle thrown to the side instead of up and down. For simplicity, small wire was used for connections, insulated with Empire tubing.

The top and side clips should be given corresponding numbers to facilitate the wiring of instruments to be compared. Whatever devices are to be compared should be connected to the side clips, while the top clips go to the auxiliary apparatus.

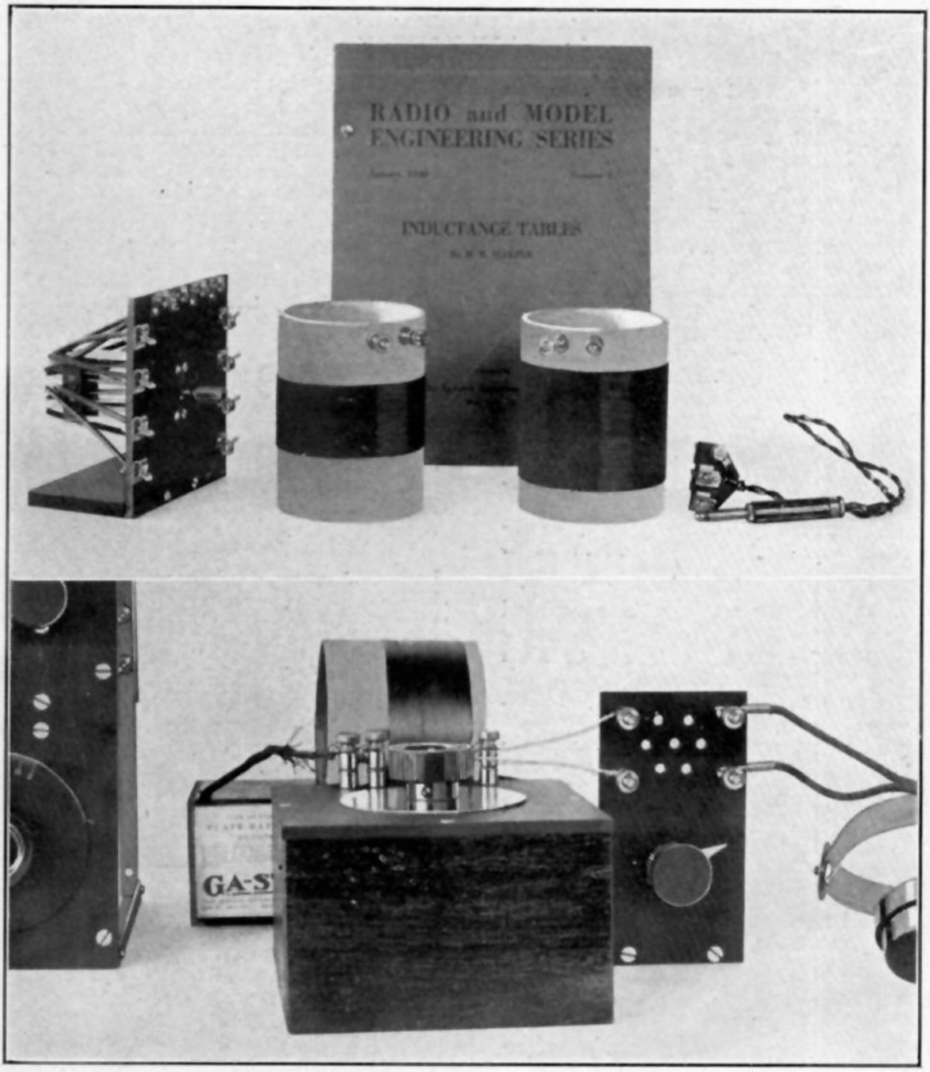


Fig. 1, below. The complete wavemeter set-up, coupled to a receiving set.
Fig. 2, above. Testing switch, inductance standards, phone bob, and Inductance Tables, all useful things for the radio man.

Standard Inductance Coils

ALL kinds of experiments call for inductance standards. Every laboratory should have an assortment, running from 0.1 to 10.0 milihenries. While these are expensive in the forms in which they are usually manufactured, the coils in Fig. 2 can be wound up quickly, and to an accuracy of well within 5%.

Two Phones on One Plug

So many times we have needed two pairs of phones on a set provided with only one jack that we now use a phone bob. It is just a little piece of L.P.F. cut from a 2½ by 5 by ⅛ in. panel, carrying four Fahnestock clips, with a cord running to the phone plug. A phone bob, as we call it, is shown at the left of Fig. 2. Its convenience has more than compensated for the time it took to make it.

The easiest way to determine the size of a coil to produce a given inductance is by means of "Inductance Tables." By means of these Tables the size of wire, diameter, length, or turns per inch required for a certain inductance can be found to an accuracy of 2% merely by a multiplication or division. Actually the Table consists of 2,900 separate calculations from Nagoaka's formula applied to coils from 0.1 to 10.0 ins. long and 3 to 10 ins. in diameter but without the turns per inch squared value. This is supplied in making the calculation. A glance at the directions which accompany the Tables show how easily the required contents can be determined.

STANDARDIZED PARTS FOR 200-METER RECEIVER WITH RADIO FREQUENCY AMPLIFIER

1—L.P.F. panel 10x7½x3-16 in.	(20 oz.)	$1.97
1—L.P.F. rear panel 10x2½x⅛ in.	(4 oz.)	.45
6—Lengths ⅜ in. angle brass	(12 oz.)	1.20
4—Lengths tinned square copper wire	(3 oz.)	.24
2—Fada rheostats	(8 oz.)	2.50
2—GA-STD-A1 sockets	(8 oz.)	1.60
8—GA-STD-A10 binding posts	(4 oz.)	.80
1—Pkg. small soldering lugs	(1 oz.)	.25
2—GA-STD-A18 variable condensers	(2 lb.)	8.60
1—GA-STD A2 grid condenser	(1 oz.)	.35
3—Knobs and dials, 180°	(6 oz.)	1.95
1—GA-STD-11 mahogany tickler ball	(3 oz.)	.90
1—G-A-Lite tube 3½ ins. diam.	(5 oz.)	.32
1—½ lb. spool No. 20 D.C.C. wire	(10 oz.)	.80
1—Length ¼ in. brass rod	(7 oz.)	.15
2—Lengths ⅛x1-16 in. brass strip	(12 oz.)	.26
2—Pkg. ½ in. 6-32 F.H. polished nickled screws	(2 oz.)	.24
1—Pkg. ½ in. 8-32 F.H. polished nickeled screws	(1 oz.)	.14
1—Pkg. 1 in. 8-32 R.H. polished nickeled screws	(1 oz.)	.16
1—Pkg. ¼ in. 4-36 R.H. polished nickeled screws	(2 oz.)	.11
1—Pkg. ½ in. 6-32 R.H. polished nickeled screws	(1 oz.)	.12
2—Nickeled coil mounting pillars	(2 oz.)	.16
4—Brass washers, ¼ in. hole	(2 oz.)	.04
1—Pkg. No. 6 nickeled washers	(1 oz.)	.04
1—Pkg. 4-36 nickeled nuts	(1 oz.)	.08
1—Pkg. 6-32 nickeled nuts	(1 oz.)	.08
1—Pkg. 8-32 nickeled nuts	(1 oz.)	.09

COMPLETE SET OF PARTS

As listed above, ready to assemble in your own shop. The cost of the complete set is less than that of two variometers and a vario-coupler	(8 lbs.)	$22.78

SEMI-FINISHED PARTS

Front panel drilled, extra		$ .90
Rear panel drilled, extra		.40
Complete supporting frames, nickeled, per pair	(12 oz.)	1.70
Coil and tickler assembled with leads soldered ready to mount	(1 lb.)	3.89
Front panel drilled, with coil and tickler, rheostats, sockets and condensers mounted, ready to wire	(8 lb.)	29.75

AUXILIARY PARTS

GA-STD-A11 plate battery	(2 lb.)	$1.75
Radiotron UV200	(8 oz.)	5.00
Witherbee 6-volt, 40 ampere-hour storage battery	(15 lb.)	15.00
GA-STD-A6 amplifier control	(2 lb.)	13.95
Radiotron UV201	(8 oz.)	6.50

STANDARDIZED PARTS FOR THE OSCILLATING WAVEMETER

1—L.P.F. panel 5x5x3-16 ins.	(6 oz.)	$ .67
1—Knob and dial	(2 oz.)	.65
3—GA-STD-A18 double base binding posts	(3 oz.)	.42
1—Length G-A-Lite tube, 3½ in. diam.	(7 oz.)	.38
1—¼ lb. spool No. 24 S.S.C. wire	(6 oz.)	.70
1—Pkg. large soldering lugs	(3 oz.)	.31
1—GA-STD-A15 0.0002 mfd. condenser	(10 oz.)	3.25
1—Pkg. 8-32 1 in. R.H. nickeled screws	(2 oz.)	.16
1—Flemish oak cabinet	(1 lb.)	2.00
1—Pkg. 8-32 ½ in. F.H. nickeled screws	(1 oz.)	.14

COMPLETE SET OF PARTS

As listed above, to build the 150 to 600-meter oscillating wavemeter	(5 lb.)	$8.39

COMPLETE WAVEMETER

As illustrated, without calibration	(5 lb.)	$12.00

CALIBRATION CURVE

Individual calibration curve, guaranteed accurate to 2 per cent		$2.00

(Note: We accept no responsibility for damage to wavemeters shipped to us for calibration.)

STANDARDIZED PARTS FOR INDUCTANCE STANDARDS

Inductance tables, post paid		$ .25
G-A-Lite tubing, 3 ins. diam., 9 in. length	(5 oz.)	.32
G-A-Lite tubing 3½ ins. diam., 9 in. length	(7 oz.)	.38
G-A-Lite tubing 4½ ins. diam., 9 in. length	(9 oz.)	.48
No. 24 S.S.C. wire, per ¼ lb. spool	(6 oz.)	.70
No. 24 S.S.C. wire, per 1 lb. spool	(18 oz.)	2.25
GA-STD-A10 binding post	(1 oz.)	.10
Small size soldering lugs, per 20	(1 oz.)	.25

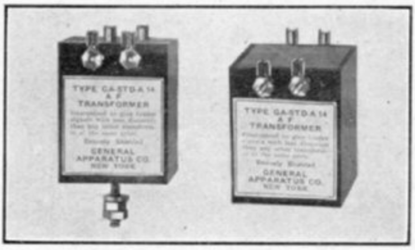
COMPLETE INDUCTANCE STANDARDS, 5 PER CENT ACCURATE

Inductance standard 0.1 mh., or 100,000 cms., 3 in. tube, 4½ in. long	(8 oz.	$ .75
Above, 0.2 mh., or 200,000 cms.	(8 oz.)	1.00
Above, 0.5 mh., or 500,000 cms.	(9 oz.)	1.50
Above, 1.0 mh., or 1,000,000 cms., 3½ in. tube, 4½ ins. long	(1 oz.)	2.00
Above, 2.0 mh., or 2,000,000 cms., 3½ in. tube, 4½ ins. long, 2 banks	(12 oz.)	2.75
Above, 5.0 mh., or 5,000,000 cms., 3½ in. tube, 4½ ins. long, 3 banks	(15 oz.)	3.25
Above, 10.0 mh., or 10,000,000 cms., 3½ in. tube, 4½ ins. long, 3 banks	(20 oz.)	4.50

STANDARDIZED PARTS FOR PHONE BOB

Federal phone plug	(5 oz.)	$2.00
Nickeled Fahenstock clip	(1 oz.)	.05
L.P.F. panel 2½x5x3-16 in.	(3 oz.)	.36

AMPLIFYING TRANSFORMER



THE A-14 audio frequency amplifying transformer, tho completely shielded, has no iron laminations. This is not the only distinctive feature, however, about this new addition to the GA-STD line which accounts for its superiority over all other types, regardless of price. It is sealed in a grain finished, unbreakable bakelite case 1⅜ ins. square by 1⅞ ins. high. It can be immersed in water indefinitely without injury. Corrosion of the wires, commonly known as burn-outs, is impossible. The windings, correct for Radiotrons, Audiotrons, and A-P tubes, are layer-wound of No. 44 wire. Design of core prevents distortion. Transformer noises and howling eliminated.

PRICE: GA-STD-A14 audio frequency amplifying transformer, the smallest, handsomest, most efficient type produced. (5 oz.)........$5.00

CLASS 20-D

PLATE BATTERY

BY co-operation with the Ace Battery Mfg. Corp. The G. A. Company has brought out two new plate batteries which give an operating life equal to other batteries of twice the size and weight. This last feature means a great saving in postage, as well as space in portable equipment. The A-11 type is for detectors, while the A-12, of 45 volts with its 22.5-volt tap, is very convenient for detector and amplifiers. You will quickly recognize the superiority of these types once you get them on your set.

PRICES: GA-STD-A11 Plate Battery, 22.5 volts, 5½x3¼x2 3-8 ins. high, 2 lb........................$1.75

GA-STD-A12 Plate Battery, 45 volts, 22.5-volt tap, 5x5x¾x2 3⅜ ins. high, 4 lb......................$3.20

CLASS 10-C

GA-STD

G.A. STANDARDIZED EXPERIMENTAL SUPPLIES

THE GENERAL APPARATUS COMPANY, Inc.

570 West 184th Street New York City