A Winder for Small Inductances

How to Build and Use a Device to Wind Efficient, Concentrated Inductances Which May be Used in Various Radio Receivers—How to Wind the Coils for the Radio Broadcast Six-Tube Second Harmonic Super-heterodyne

By ALLAN T. HANSCOM

MANY readers have been greatly interested in the second harmonic super-heterodyne described in RADIO BROADCAST for November, 1924. One of the central features of that six-tube receiver is the concentrated inductances. These are wound by a special machine which is described here. The construction of this device is not especially easy and had best be assumed by those readers who are adept at using a lathe and similar tools. In addition to the method of assembling the winder, complete information is given on the number of turns and dimensions for the intermediate frequency and oscillator coils for the six-tube, second harmonic super-heterodyne.—THE EDITOR.

SO MANY requests have come to the writer for constructional data on the small honeycomb coils which are used in the six-tube super-heterodyne discribed in this magazine for November, 1924, that a description of the method by which these coils are made should prove interesting.

In the first place, some of the more important requirements for any inductance to be used in radio work should be considered.

LOW DISTRIBUTED CAPACITY

DISTRIBUTED capacity in an inductance greatly increases the resistance of the inductance at the higher frequencies. The direct current resistance of an inductance is an inverse function of the wire size. By this we mean that the resistance of a coil of coarse wire is less than a similar coil of fine wire, but with coarse wire the distributed capacity in-

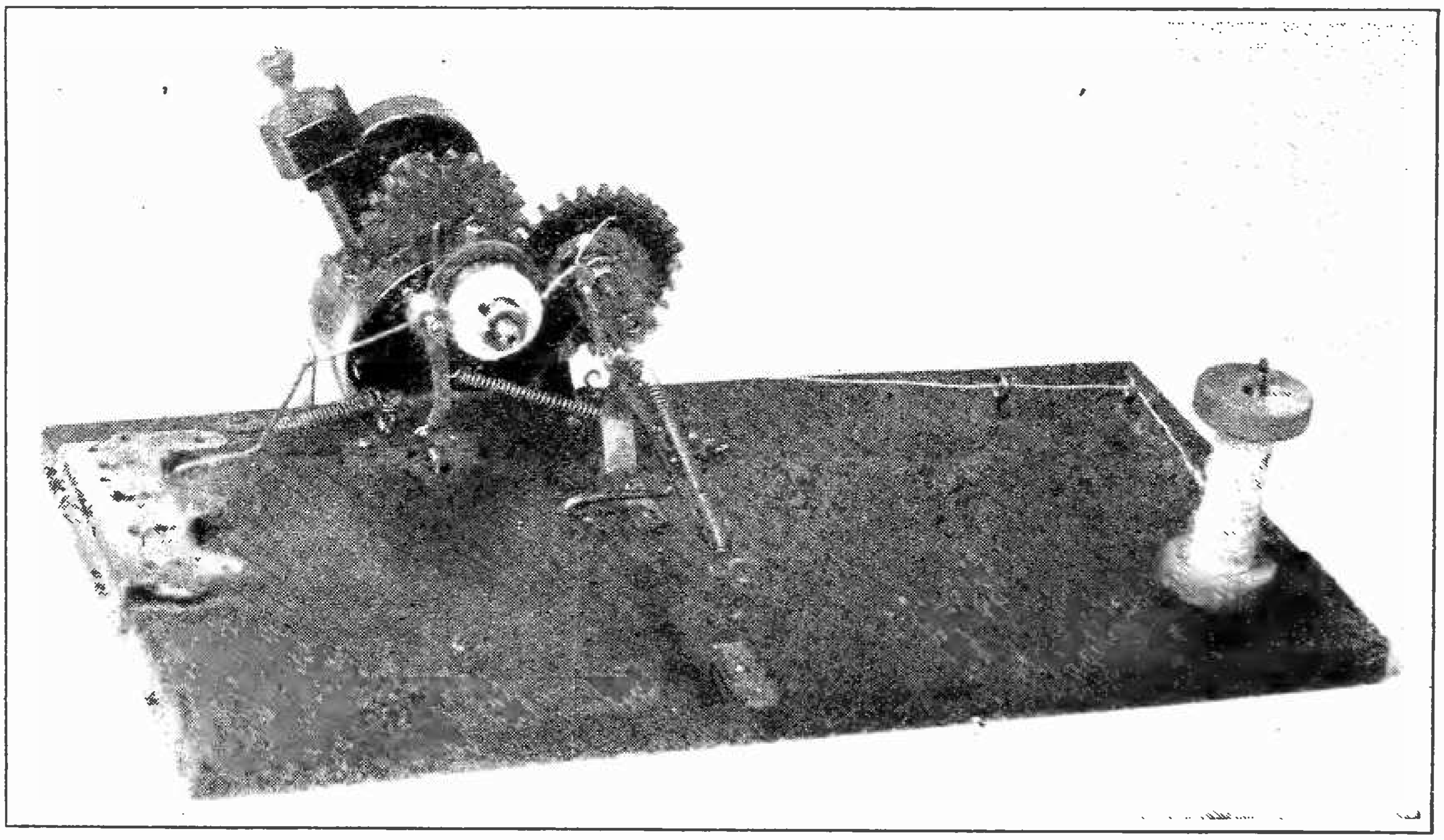


FIG. I
A photograph of the completed coil winder

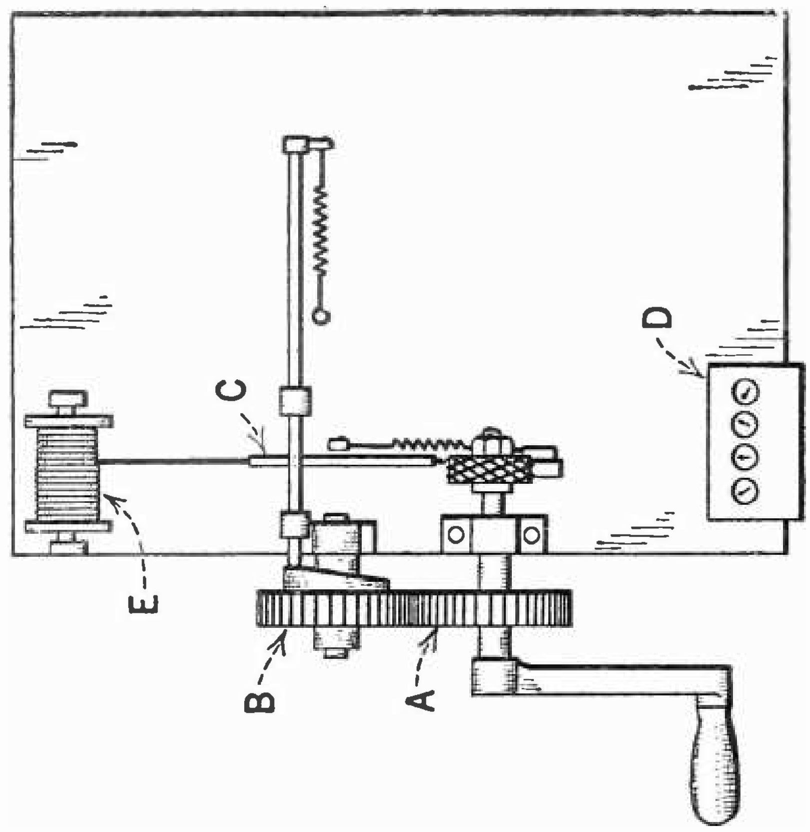


FIG. 2
The arrangement of the various parts on a baseboard. A coil gear; B nozzle feed gear; C feed nozzle; D turn counter; E spool of wire

creases so that the net gain is not as large as it would seem.

NUMBER OF TURNS

THIS depends entirely on the inductance value which we wish the finished coil to have and because the wavelength is proportional to the square root of the inductance (other things being equal). The number of turns depends entirely on the use for which the coil is designed.

SIZE OF COILS

NATURALLY, the factor of space has to be considered and a small coil is better than a big one, provided the efficiency is not sacrificed.

As applied to the super-heterodyne, the intermediate frequency which is created within the set and is used to amplify the signal is of such a value to make necessary large inductances. Small coils wound "scramble fashion" on wooden or bakelite forms are not practical because of the difference in inductance and distributed capacity between the coils, even though they are wound with the same number of turns. In endeavoring to solve this problem the writer devised the machine which is shown in the photographs. The essential features are illustrated in Figs. 1 and 2. It is apparent upon the examination of inductances like spiderwebs, lattice windings, and commercial honeycomb coils that the biggest gain results from the fact that the wires are not close together where they run parallel. This results in a very much lower distributed capacity. Obviously, in order to wind a coil which shall be self-supporting, it is necessary that the feed for the wire should travel sideways back and forth while the coil is being wound. The relation between the speed of rotation of the coil and the speed of the side travel of the feed is what governs the angle at which the successive turns of the coil will intersect, if the nozzle which feeds the wire travels across the face of the coil and back to the original starting point in exactly one turn of the coil, then the wire will always fall in

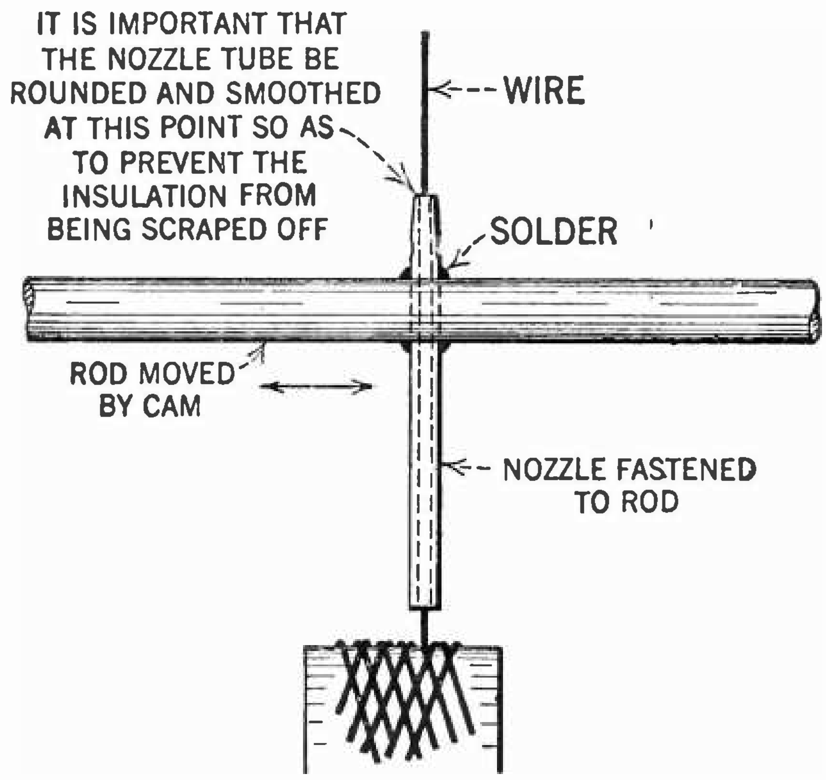


FIG. 3
Shows how the tubular nozzle is mounted and soldered to the cam shaft

the same place and a "scramble fashion" will result. But now if the feed is adjusted so that for one turn of the coil it has traveled from one side to the other, comes back again but a trifle short, crossing the first turn, then the effect shown in Fig. 4 will be created. Another way of stating this is that for one cycle of the feed, the coil has rotated through one full turn and a little more in the winder.

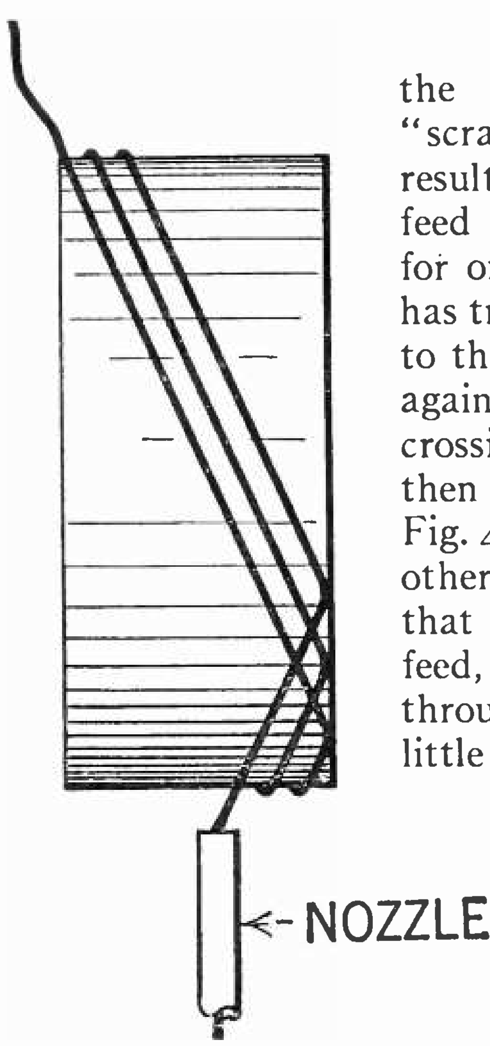


FIG. 4
The standard type of honeycomb coil winding produced by the coil winder

As illustrated this result is obtained by the ratio of the gears A and B. The gear A being on the same shaft with the coil, its rotating is the same as that of the coil, while the gear B being larger than the gear A, turns more

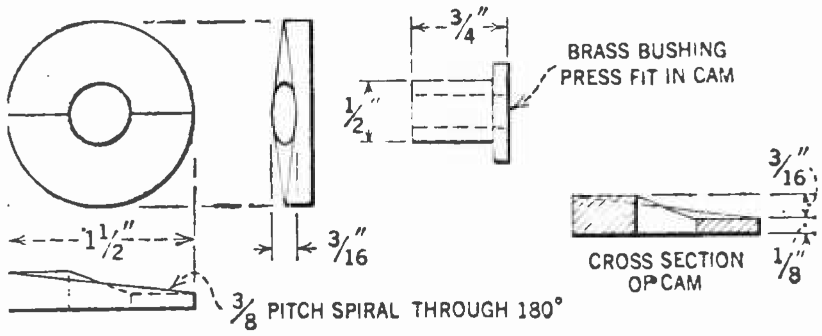


FIG. 5

A working sketch of the cam, the most important unit of the entire device

slowly. Fastened to the gear B is a cam which operates the nozzle C. The shape of this cam is very important. The rate of travel of the nozzle should be constant with practically no time-interval at the end of the travel when the direction is reversed. Therefore, the ideal shape of the cam is that of a straight spiral through 180° and the reverse spiral through the remaining 180°. There is absolutely no way that this cam can be cut except on an end milling machine with a double motion. Any up-to-date machine shop has this equipment and the actual cutting of the cam is a very short process after the milling machine is set up. Fig. 5 is a working sketch of this cam. Its lateral reciprocating action is plainly illustrated in Fig. 6.

THE WINDING MACHINE

OF COURSE, it is absolutely necessary that there is no end play in the mechanism. The shaft on which the coil is wound must run absolutely true in order to prevent

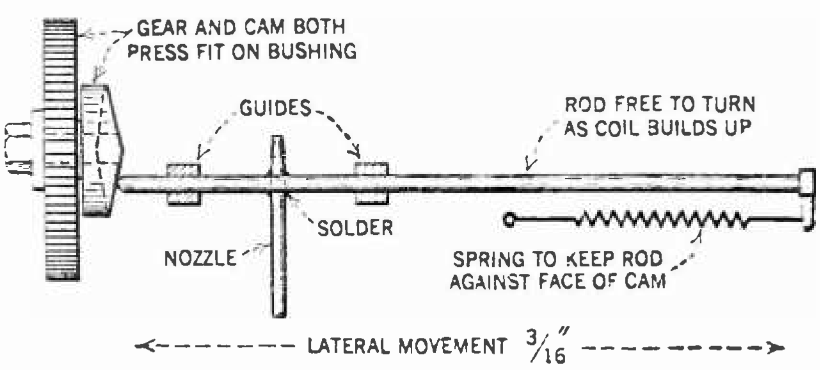


FIG. 6

Illustrates the function of the cam and nozzle

the wire from slipping on the edges of the coil while it is being wound. D in Fig. 2 represents a counter which counts the number of turns being wound. This is likewise almost a necessity because it is very easy to make an error in attempting to count and wind by hand. The writer used a motor with a worm drive with a gear on the main shaft, but any form of drive would serve the purpose.

In using the machine, the wire is first fastened on the end of the shaft and allowed to wind twenty or thirty turns on the bushing D which is clamped on the end of the shaft with a nut. At this point the machine is stopped and a piece of adhesive tape $\frac{1}{8}$ of an inch wide is laid across the bushing with the sticky side up as in Fig. 7. Then the counter is set at zero and the desired number

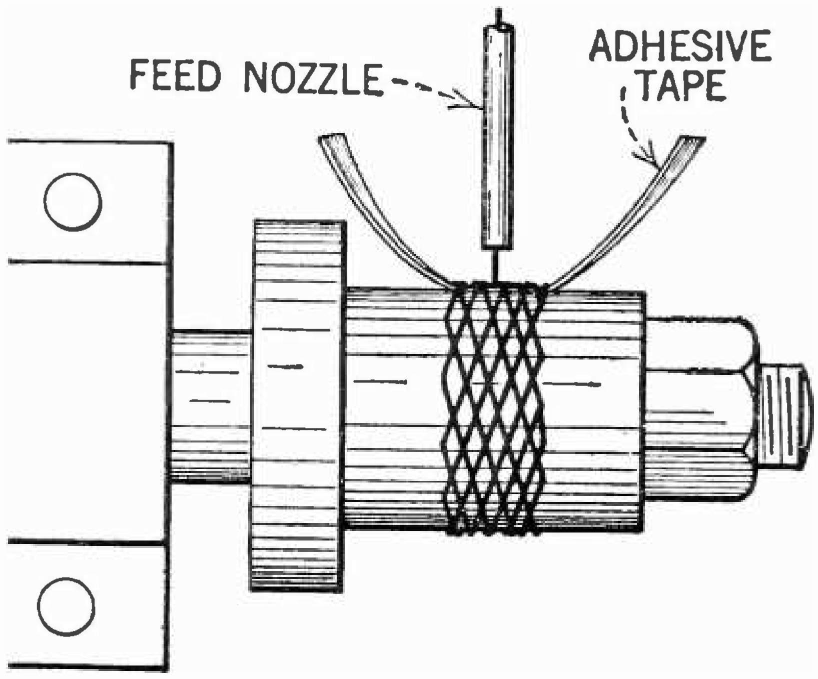


FIG. 7

Preparing the coil for binding with adhesive tape

of turns are wound on. After this, the adhesive tape is brought up over the outer edge of the coil to hold the last turn and the bushing with the coil on it is removed from the shaft. After driving the bushing out of the coil the first twenty or thirty turns are removed from the inside and the finished coil is dipped in a mixture of acetone and celluloid.

By varying the shape of the cam which con-

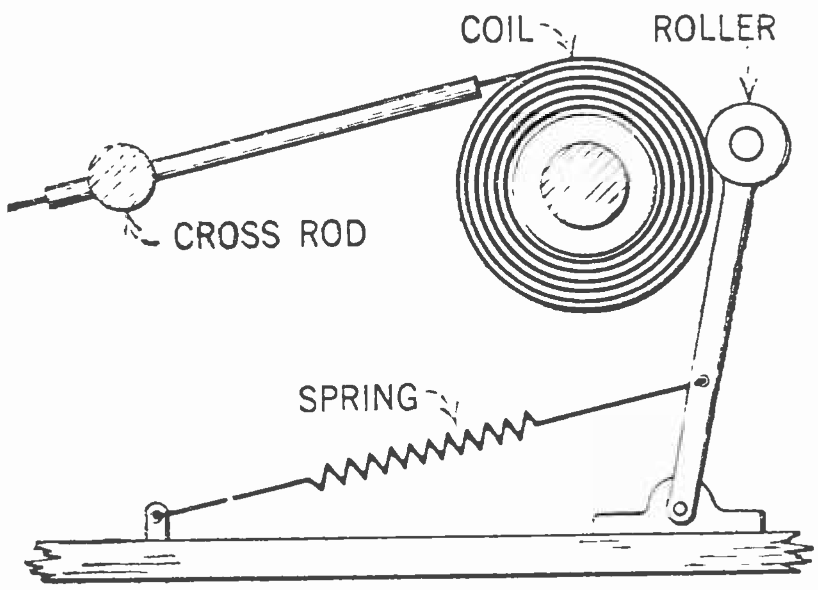


FIG. 8

A detail showing how the roller with spring tension keeps the layers in place

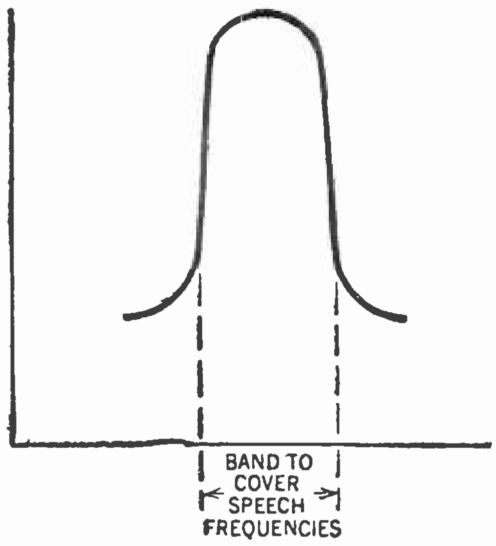


FIG. 9
A curve showing the range of audible frequencies covered by the Hanscom coils

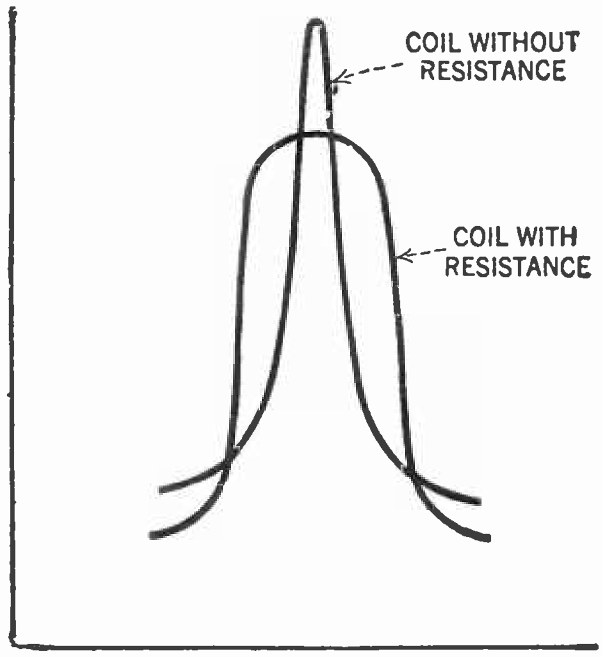


FIG. 10
Illustrates the difference between the Hanscom and other coils, the latter having the tendency to distort by reason of the side bands being chopped off

trols the feed mechanism various effects can be produced, but for average work a $\frac{3}{8}$ of an inch spiral has been found satisfactory. This produces a coil which is $\frac{3}{16}$ of an inch thick. In winding certain kinds of wire it was found advisable to use a roller with a spring tension against the outer edge of the coil as in Fig. 8.

For the intermediate frequency circuit of the super-heterodyne, the writer has used two coils in series, each containing about one thousand turns of No. 36 wire with a .00025 mfd. condenser across the two coils. Various kinds of inductances can be wound on the machine, providing the hole at the end of the nozzle is large enough to permit the wire to run freely through it.

ADVANTAGES OF THESE COILS

THE greatest advantage of these coils is their small size. The magnetic field caused by the coil is naturally small and they can be mounted without much fear of coupling effect with other parts of the apparatus.

In any form of radio inductance designed for reception of music and speech, it is necessary to cover a band of wavelength sufficient to avoid distortion of the voice or music. This is illustrated in Fig. 9 and in the coils designed by the writer this is obtained by the

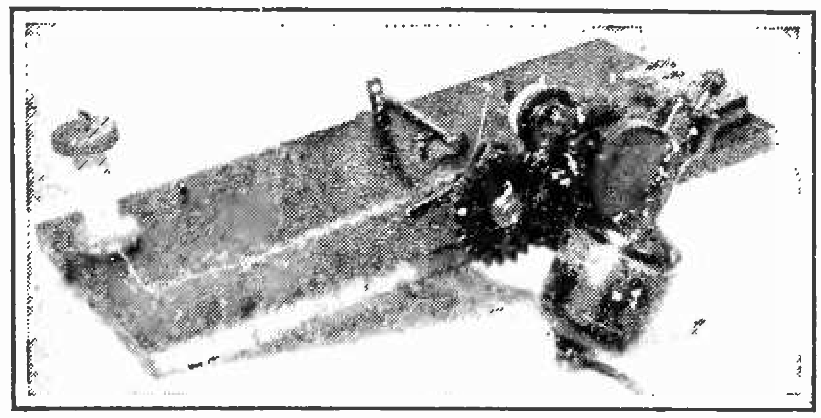


FIG. 11
Shows a rear view of the winder. A worm-drive motor supplies the means for rotation

resistance in the coils which tends to broaden the tuning sufficiently as illustrated in Fig. 10.

To those who are experimentally inclined, the construction of a coil winder as described will be diverting. The writer can assure those who attempt it that they will wind many coils and near coils before the results are entirely satisfactory. This is not said to discourage those who might desire to build it, but rather as a word of warning. Stick to it and it will work!

THE WINDING DATA FOR THE HANSCOM 'SUPER' COILS

INTERMEDIATE-FREQUENCY transformer—Primaries:—In the first stage, the primary coil consists of 500 turns of No. 36

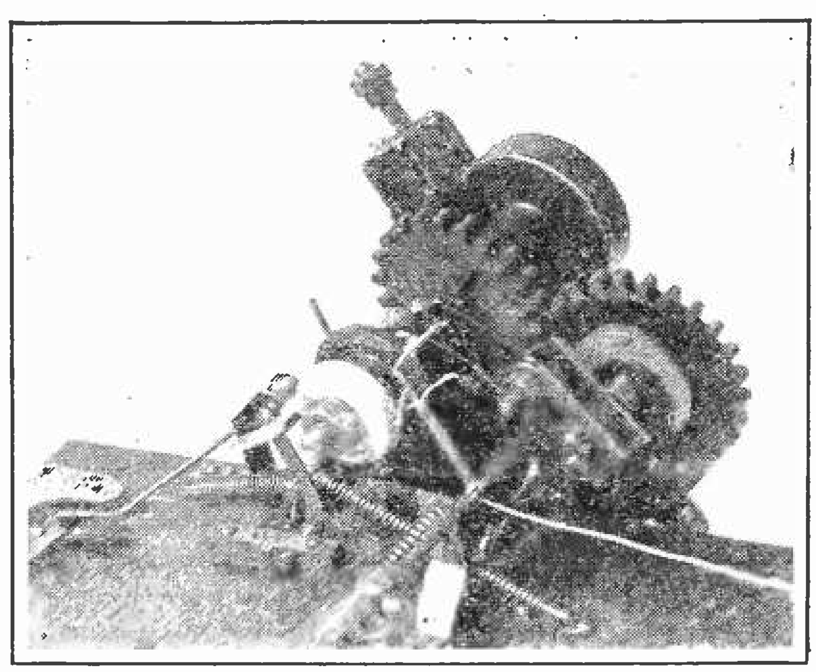


FIG. 12
The nozzle and cam units are clearly shown. An oscillator coil is on the winding bushing

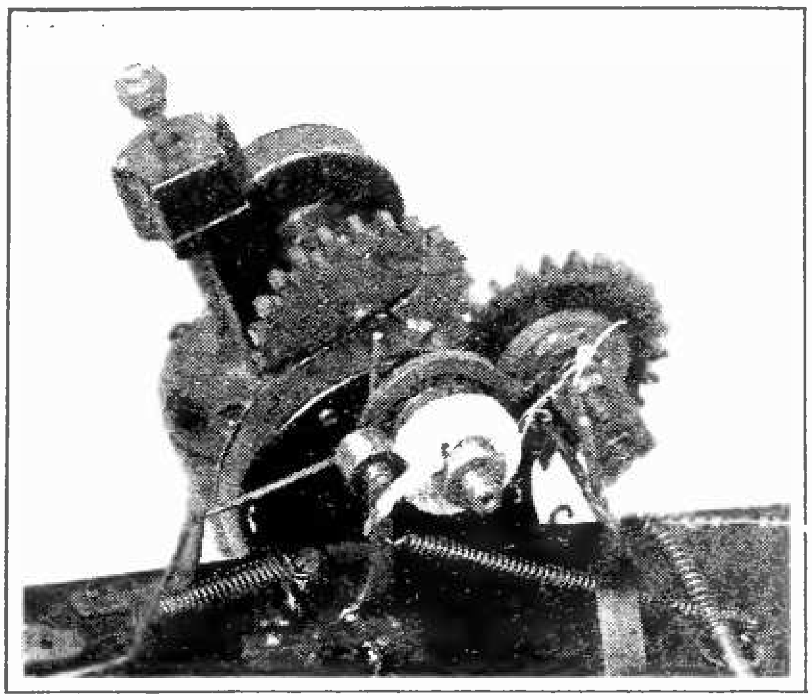


FIG. 13
Another view of the cam and nozzle. Here, also, is shown the method of obtaining tension on the roller bearing, provision for binding and the counter details

s. s. enamel wire. The second stage coil consists of 600 turns of the same wire and the third stage coil consists of 1000 turns of the same size wire.

Secondaries:—Connect two coils in series, each consisting of 1,000 turns of No. 36 s. s. enamel wire for each stage. The first stage coil is tuned by two .0005 mfd., micadons while the second and third stage coils are tuned by a .00025 mfd. micadon, one for each stage.

Oscillator Coils, Grid Circuit:—Two coils are connected in series. The number of turns for these coils depends upon the size of the oscillator tuning condenser and usually varies between 125 and 160. Double cotton covered wire varying in size from No. 24 to No. 26 may be satisfactorily used.

Plate circuit:—Connect two coils in series, using the same size wire as for the grid coils. As few turns as are necessary to make the tube oscillate uniformly over the entire range of the oscillator condenser are used. This number varies between 50 and 75. The inside diameter of the coils is approximately $\frac{5}{8}$." The overall dimensions of a single coil are $\frac{3}{16}$" x $1\frac{1}{2}$".

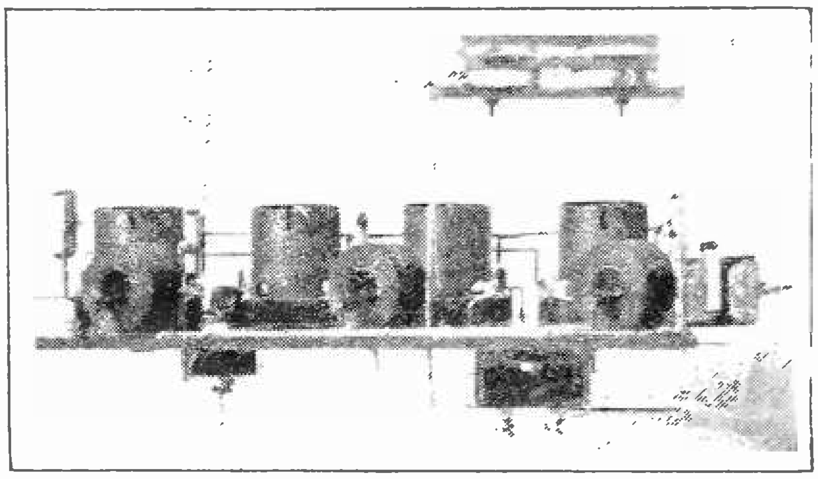
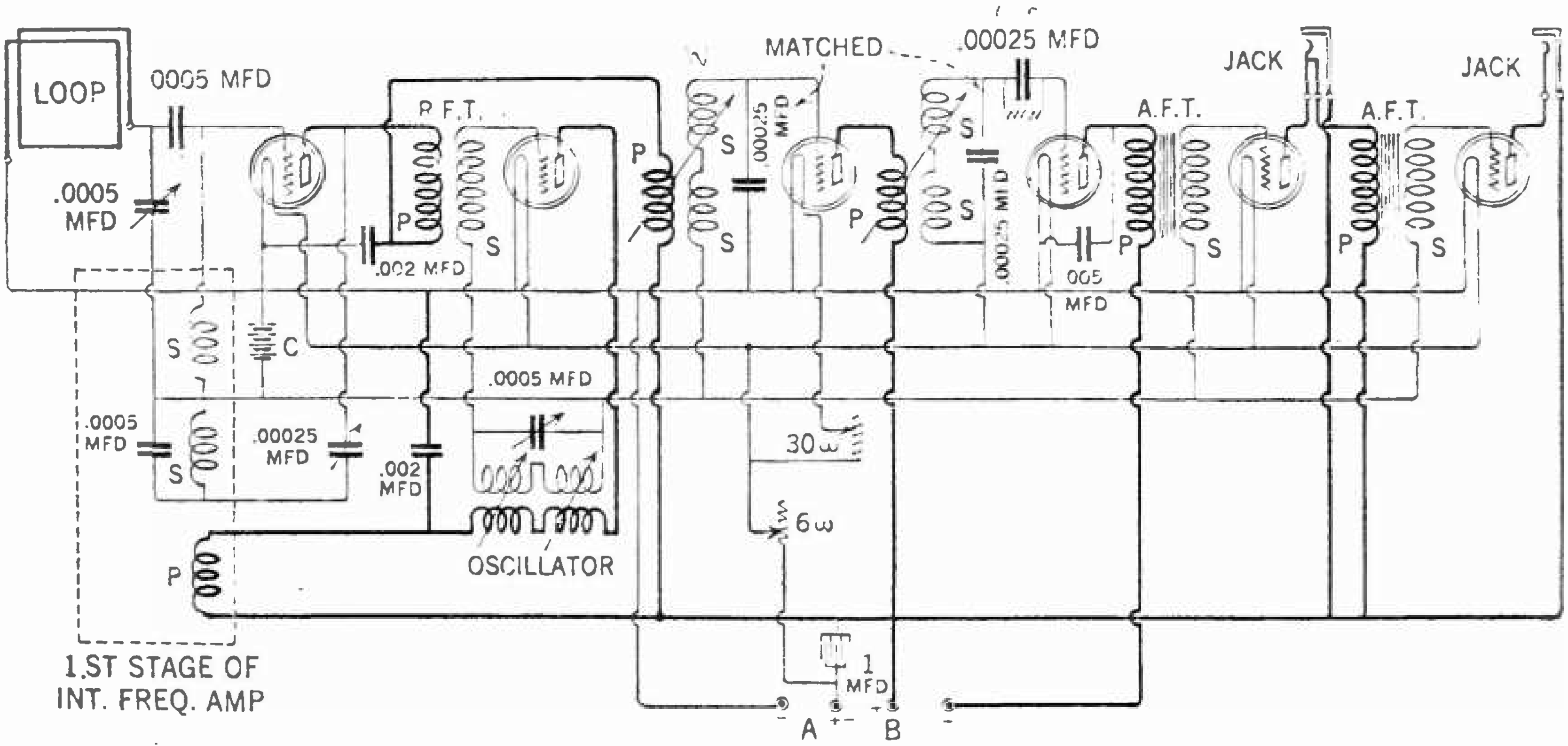


FIG. 14
A completed set of intermediate-frequency amplifier coils mounted in position in an I. F. unit of a second harmonic super-heterodyne receiver

It is important that the .00025 mfd. condensers be matched. A small variable neutralizing condenser may be shunted across one of them and varied until the values of both are equal. This may be considered as one of the minor and semi-permanent adjustments of the receiver.



A CORRECTED CIRCUIT DIAGRAM OF THE SECOND HARMONIC "SUPER"
Minor corrections have been made, particularly in that the by-pass condenser on the first audio-frequency primary is connected from the plate to the negative filament lead instead of as shown on page 44 of Radio Broadcast for November, 1924