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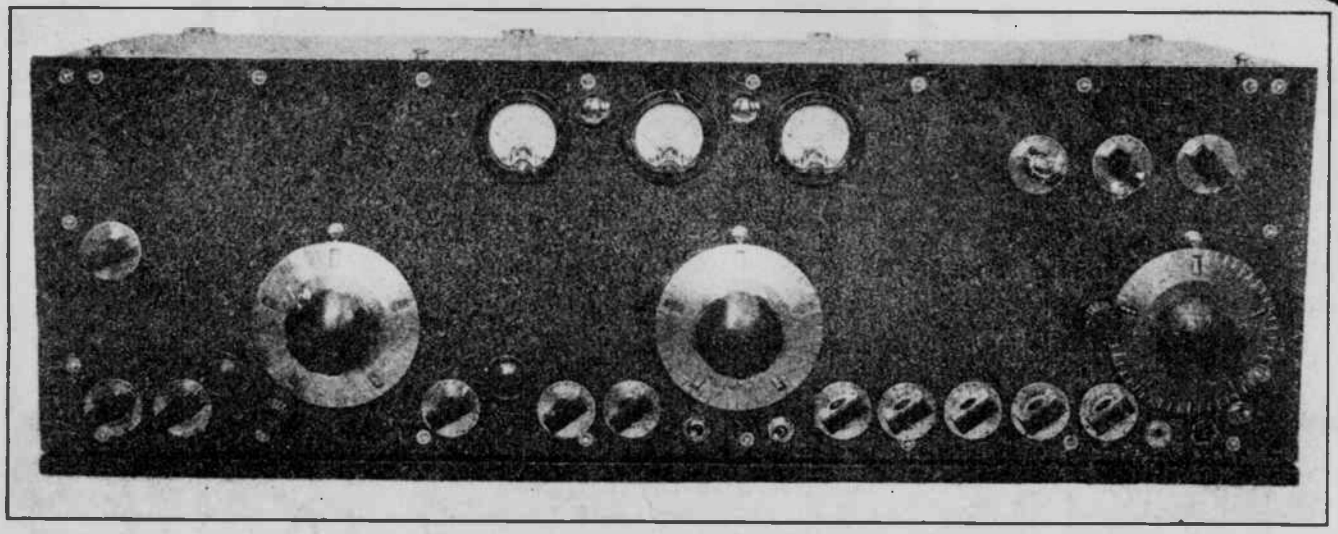
THE HORN SPEAKER

RADIO NEWS FOR OCTOBER, 1936



FRONT VIEW OF THE HIGH-SENSITIVITY, HIGH-SELECTIVITY RECEIVER FOR AMATEUR USE
Here is a new communications type receiver that has "everything." The utmost in sensitivity, it will tune "like a hair" when you need it, includes two kinds of a.v.c., triple or quadruple detection and many other features.

The Radio News Laboratory Model

5-10-20 METER SUPER

(Communications Type)

By Frank H. Jones

THIS experimental laboratory model RADIO NEWS 5-, 10- and 20-meter Communications type receiver to be described, was discussed in its technical details with our very good friends, Laurence Cockaday and S. Gordon Taylor as early as 1935—especially, the unusual features of triple-detection for procuring desirable effects in steepening the opposite sides of the over-all selectivity curve of this receiver. Four frequency changes are resorted to in one hook-up to take advantage of super-regeneration at the high frequencies in the neighborhood of 30 megacycles, for a.v.c. effect. There is also some noise-quenching effect besides the inherent a.v.c. action, which helps the regular over-all a.v.c. circuit of the entire receiver combination.

No startling ideas are embodied in this set. Some schemes are unusually combined to make for flexibility. A receiver of this type is bound to be rather complicated, and somewhat expensive. It's not for the bargain hunter. It is, nevertheless, straight-forward in design, and relatively simple in operation. Numerous dials and small knob controls are shown, but this does not mean that you use all of them all of the time, not by any means. Most of them are rarely touched, but when conditions arise for their need, they are there to help you bring in that elusive signal, and to let you complete a 100 per cent QSO. If all signals came in loud and in the clear, a very simple receiver would suffice.

Naturally, any good communications receiver must have high sensitivity. This one has all you can possibly use. When you are working in the 20-meter amateur band on phone, you want selectivity of a very high order. However, do not expect to separate phone signals with any intelligibility or quality left over, if the unwanted signal is *literally* right on top of the one you want who may be considerably weaker. It just can't be done with present methods of carrier modulation, all claims to the contrary, notwithstanding. There must be at least about a k.c. difference to make the attempt at a QSO

I DESIGNED this receiver for the advanced amateur who wishes to have at the touch of a control all of the recourses known to the radio-reception art. Originally, it was planned to follow rack-and-panel commercial design, but this idea was dropped, as it was thought that more amateurs might tackle the job of building this receiver if a less pretentious model were laid out. Also, lest there be any mistake at the start, let me say that this is not a combination all-wave receiver for the BCL. It is strictly a short-wave receiver for communications service in the 5-, 10- and 20-meter bands and mainly for phone.—*Frank Jones*, CO6OM.

worthwhile. Personally, I would rather not talk with a friend over amateur radio, if I can't hear his voice in its natural tones. Amateurs can not have exclusive frequency assignments, so naturally, in crowded channels, there is bound to be some strong signal on top of a weaker one, at some times. Selectivity, then, must be good enough to get a weak phone signal one or two k.c. away from a more powerful one. A crystal filter will do a little better than this.

Straight, inherent close-up selectivity can also do the job in good shape. However, we have all the methods available in this Laboratory Model, although the crystal is used in an unusual manner. Besides the crystal filter, there are numerous methods of obtaining a high order of selectivity, and these are all incorporated in this receiver.

Certain absolutely essential features for such a set may be enumerated:

(a) Highly-efficient coil forms, in combination with high-grade condensers, and isolantite or victron insulation to help in obtaining high "Q" circuits.

(b) Absolute stability in the oscillator circuit or circuits. This can only be obtained by using crystal controlled oscillators and harmonic amplifiers.

(c) No regeneration in any circuits where you don't want it.

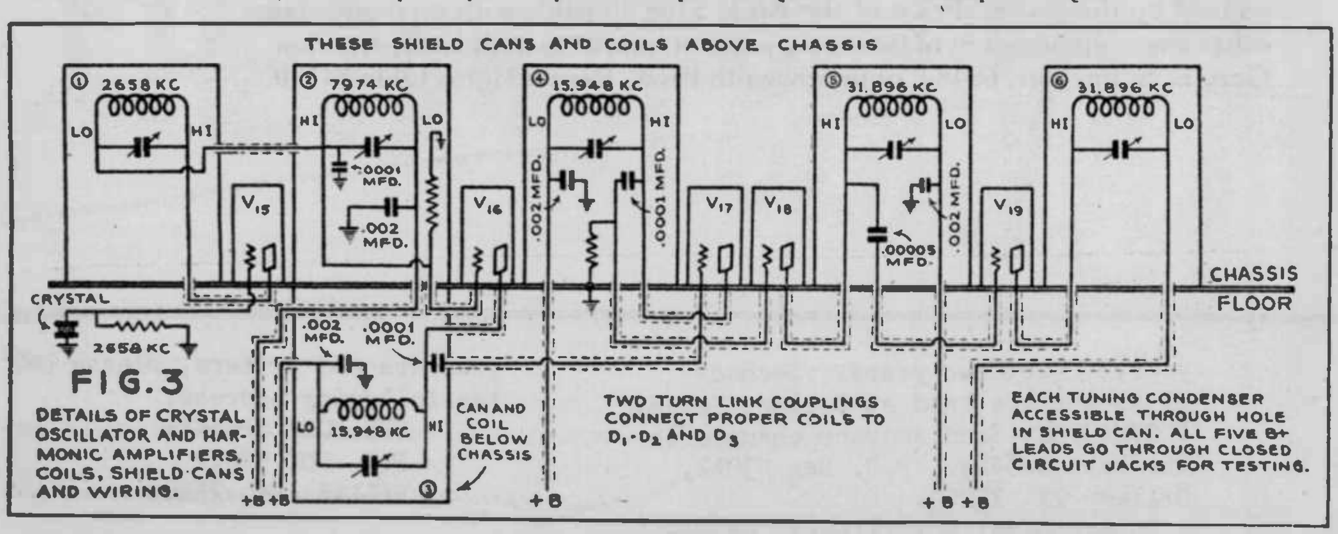
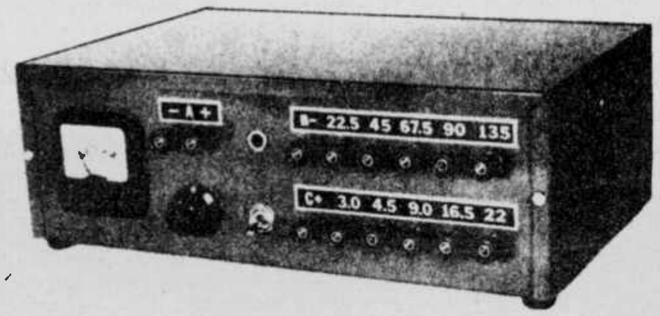


FIG.3 DETAILS OF CRYSTAL OSCILLATOR AND HARMONIC AMPLIFIERS, COILS, SHIELD CANS AND WIRING.

REGULATED D. C. POWER SUPPLIES
HIGH PERFORMANCE/LOW COST

RADIO COLLECTORS,

The RCS-728 Power Supply is designed for the radio collector who wishes to power-up the battery-operated radios of the 1920's, without using costly batteries or hum producing early type battery eliminators.
Since 1971 the RCS-728 has been the collector's choice. Check the specifications below and order with satisfaction guaranteed.



RCS-728 POWER SUPPLY

SPECIFICATIONS

GENERAL------------ Input: 117 VAC, 60 CPS, 75 Watts maximum, fuse protected. Dimensions: 12"W x 8"D x 4½"H. Weight: 6 lbs. Color: Brown hammertone. Semiconductor complement: 11 Diodes, 5 Zeners, 1 Transistor; 2 I.C. Regulators. Meter: 0-8 VDC, 2¼". Output connections: Fourteen Five-Way binding post. Controls: On-Off switch, "A" supply voltage adjustment and Neon lite power on indicator. Construction: Uses custom made power transformer and two P.C. boards of glass epoxy composition to mount all parts.

"A" SUPPLY--------- Adjustable output, .3 to 7.0 volts, voltage regulated, 2.25 amps maximum, automatic current limiting. Regulation: 1.5% maximum change, no load to full load. Ripple: Less than 15 mv p-p at full load.

"B" SUPPLY----------- Output: 22.5, 45, 67.5, 90; 135-140 VDC, 5% tolerance, voltage regulated up to .04 amps maximum load all taps combined. Regulation: 5% maximum change, no load to full load. Ripple: Less than 15 mv at full load.

"C" SUPPLY---------- Output: 3, 4.5, 9, 16.5, 22.5 VDC, 3% tolerance, voltage regulated, .015 amps maximum. Regulation: 4% maximum change, no load to full load. Ripple: Less than 7 mv.

TERMS------------------ Available completely assembled or in an easy to assemble kit form complete with all parts including a punched cabinet. Price assembled is 137.50 PPd. and is guaranteed for a period of one year from defects in material and workmanship. Guarantee does not cover misuse or damage caused by the owner. Price of the Kit is $108.50 PPd., with no guarantee other than replacement of defective parts at time of assembly. Order from: Gary B. Schneider, 6848 Commonwealth Blvd., Parma Hgts., Ohio 44130.

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(d) Some regeneration where you do want it, and so controlled as to be "non-finicky" and have a high degree of "stay-putedness."

(e) A crystal filter to use if you want to, but applied in this receiver in a new way.

(f) A double input circuit of very high gain to off-set tube-noise and certain types of fading, and to give a good signal-to-noise ratio. Both a vertical and a horizontal antenna are used with this receiver at the same time and means, to be described later, to pick out the signal on the antenna with the best signal-voltage, noise-voltage, ratio. A sort of diversity-effect receiver, although out of phase voltages are not successfully handled.

(g) You must have a very high gain before the 1st. detector or mixer. This receiver has FOUR STAGES of t.r.f. before the first detector. This set up spells goodbye to image frequencies, and contributes to a very high conversion factor in mixer No. 1.

(h) All possibly interacting circuits must be completely shielded. Some parts must be double shielded. With the antenna tip plugs pulled out, there is no pick up from a powerful transmitter 3 feet away.

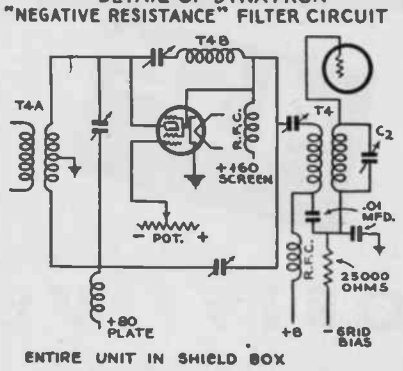
(i) Compactness in design has many advantages, and the new metal tubes are part of the answer to this problem, although these new metal tubes are getting so small, that there is more space required for the associated by-pass condensers and resistors, than there is for the tubes themselves.

(h) In line with the idea of compact-

EXPLANATORY DIAGRAMS

The two diagrams below show Mr. Jones' ideas, explaining the use of frequency changers to steepen the sides of the resonance curve of the receiver. At the left is Figure 4 and at the right is Figure 17.

FIG. 2 DETAIL OF DYNATRON "NEGATIVE RESISTANCE" FILTER CIRCUIT



ENTIRE UNIT IN SHIELD BOX

THE DYNATRON FILTER

Figure 2. Showing the basic circuit of the experimental filter-circuit employed by Mr. Jones.

Design Features

The basic idea back of the 20-meter circuit in this particular superheterodyne receiver was to obtain a very considerable part of the selectivity in the tuned-radio-frequency stages. While it is generally easier to obtain good selectivity in the low frequency stages it was thought possible to design four stages of tuned radio-frequency input, in which the gain per stage did not run much greater than that sufficient to offset losses and give some useful gain per stage. As you will note by inspection of the circuit diagram in Figure 1, the second, third and fourth t.r.f. stages have the grid leads tapped down about two-thirds on the secondaries or grid sides of the transformers. The tuning condensers are across all of the turns of each coil. Tapping down on the secondaries also gives a better impedance match to the grids of the tubes. This procedure was not adopted in the first stage as we wished to get as high a signal voltage as possible on the grids of the first tubes.

Further inspection of the diagram will show that a crystal filter can be switched into the circuit between the second and third stages if its use appears desirable. The fourth stage is so designed as to make available a small amount of regeneration. This makes possible a further increase in selectivity of the t.r.f. portion of the receiver and can be utilized as a beat oscillator.

It was found after actually testing out the receiver that very good reception results could be obtained solely with the use of this t.r.f. portion. This combination can be made use of by turning switch No. 2 which puts the audio circuit of the National 1-10 unit directly after the first detector. It might be well to point out here that the audio circuit of the 1-10 unit is the only audio circuit of the receiver and is used as the audio portion in the various combinations in which this receiver can be operated. Headphone operation may be had in any combination of this receiver by plugging into the phone jack.

While this receiver is intended to be used with well-designed antennas, we find on test that a foot of wire on one of the antenna jacks was sufficient to bring in perfectly audible signals from Europe or Argentine, using only the tuned-frequency portion of the receiver. Naturally if there is much QRM, more selectivity is required than can possibly be obtained in the t.r.f. stages, although in this particular combination the selectivity is really quite remarkable, even without the use of the crystal. However, making use of the regeneration available in the fourth stage, the selectivity can be greatly increased even though we use only the t.r.f. portion of the receiver.

The normal way of operating the 20-meter portion of this receiver, for maximum sensitivity and selectivity, makes use of two frequency changers. Referring to both the main circuit in Figure 1 and block diagram Figure 17, it will be apparent that the frequency is changed in the first mixer, D1, to frequencies in the range between 1500 and 1900 kc. In mixer D2, the frequency is again changed to a band between 700 and 1100 kc. The signal is then amplified in tube V8 and rectified in tube V9.

It should be particularly noted that this receiver uses fixed oscillator frequencies for all mixers, controlled from one single, master, crystal-controlled oscillator. Consequently it is necessary that all of the intermediate amplifiers and the second and third detectors employ variable tuning. Using the circuit as described up to this point covers tubes V1 to V9 inclusive, and comprises the r.f. portion of the 20-meter circuit. The two-stage audio portion of the 1-10 receiver is normally coupled to the output of detector No. 3.

It was thought worthwhile, as this is an experimental receiver, to make still another combination available. It will be noticed that the twelfth harmonic is selected from the crystal frequency, then amplified and mixed in the third detector to produce a frequency in or near the 10-meter band. For obtaining this combination, simply throw Switch 4 off normal and connect the link coupling from the tapped choke to the input binding-posts of the 1-10 portion of the receiver. This combination adds an inherent a.v.c. action of the super-regenerative detector.

For operation on 10 meters, two combinations are available, and this also applies to any signal from 10 meters down. The 1-10 receiver with a suitable antenna connection to the input binding posts of the 1-10 portion, can be operated straight through, which consists of one stage t.r.f., a superregenerative detector followed by two stages of audio. The superregenerative detector circuit, even with a tuned r.f. circuit before it, does not have too great selectivity, although the sensitivity is sufficiently high for receiving distant stations at good signal strength. In this particular receiver the selectivity of 10-meter signals may be very greatly increased by making use of the following combination. V24 is an ultra-high, variable-frequency oscillator, electron-coupled to the detector circuit in V25. An inspection of the circuit diagram of the 1-10 portion of the receiver or of the actual 1-10 receiver will show that there is a tap for regeneration on the grid coil of the 955 acorn tube. The points X, Y and Z may be opened up in the 1-10 and a link circuit, as indicated, may be connected at points X and Y so that the incoming 10-meter signal, after passing through the 954 amplifier tube is applied to the mixer circuit, V25, and heterodyned by V24, preferably to a 20-meter frequency, then taking the audio from V6. Further selectivity may be obtained by using regeneration in V5 or by switching in the crystal filter and tuning V24, since the crystal demands a fixed intermediate frequency.

Five-meter signals may be handled in an identical manner.

In the first experimental model that we developed, there was included a regenerative, dynatron filter circuit, to be used similarly to a crystal-filter circuit. This circuit works well and has wonderful possibilities, but it was found, however, to be somewhat tricky in operation. (See the basic idea in Figure 2.) Its action is similar in some respects to the crystal filter and is tuned and phased in like manner. Originally it was built in a shielded can with the same physical dimensions as the crystal-filter circuit, and was intended to be plugged in, as was also the crystal filter. You can have a lot of fun experimenting with it and maybe you can whip the bugs out of it. If we do we'll let you have it in another story.

A view of completed receiver is shown at heading of this description.

Before going much farther, you had better take a look at the complete circuit of the entire receiver, shown in Figure 1. Note that the crystal circuit is in the t.r.f. section as was originally, the dynatron filter. With the crystal, this seems to restrict the filter to the 20-meter band and one frequency at that, whereas, the dynatron filter was tunable over the whole band. The point is this: You are not going to have lots of QSO's with everybody in the band. Also the selectivity of this receiver is so good that you can work (ordinarily) with *no filter!* There will be, however, certain friends and acquaintances with whom you want to work at any time. OK. Have made up 20-meter crystals to correspond with those with whom you want to carry on day-in and day-out contacts. With the right crystal, you don't even have to line up the crystal in the amplifier. You just shove it in, and tune to that frequency. A flip of the crystal switch puts the crystal filter in circuit or out. Note that such resonator crystals for the receiver should be ground about .5 per cent lower in frequency than the twin crystal to be used at the transmitting end of the circuit.

The Crystal on 10

However, when you are working from 10 meters and down, and the ten meter section is switched for super-het operation in place of super-regeneration operation, the crystal in the normal t.r.f. section of the receiver, then becomes a filter in intermediate section for ten meters or less.

Note that with triple and sometimes quadruple detection, the problem of three absolutely stable oscillators is solved by the use of a fundamental crystal-controlled oscillator on 2658 kc. and then picking out various harmonics and amplifying as necessary. Thus every heterodyning oscillator voltage "stays put" in its relation to the various detectors. (See details of crystal oscillator in Figure 3.)

The a.v.c. circuit is conventional, but seems to maintain very good control even on very weak signals, and on phone even in the presence of a very strong adjacent signal, the a.v.c. keeps control, due primarily to the high order of selectivity of the receiver, especially in the 20-meter band. However, in case of necessity, the a.v.c. can be switched off, as there are cases of a very weak signal to be received, with a very strong one right on top.

Multi-detection

Let us consider for a few moments, part of my reasons for the multi-detection circuit. In my experience most selectivity curves of intermediate or other radio frequency amplifiers show a slight dis-symmetry. (See Figure 4) that is, one can notice that one side of the curve seems much steeper than the other. Advantage of this effect is taken by using triple or quadruple detection, as when the whole receiver is used on 20 meters, for example.

By so selecting the beating frequencies from the oscillator and oscillator amplifier sections, the carrier, as it goes through the receiver, is in effect filtered steeply on one side, then the carrier is in effect "turned over" and filtered steeply on the other side and so on over again on the third frequency change (and the fourth if used). Notice the diagrammatic representation of this steepening of the sides as the carrier progresses through the receiver, in Figure 4.

RADIO NEWS FOR OCTOBER, 1936

ness, it may be said that the really ideal layout for a communications receiver, is the relay rack form. This allows complete isolation of the various sections and has many additional advantages. However, the amateur usually likes his receiving equipment spread out handily on a convenient operating table. In the design of this receiver, this necessitated a cabinet rather longer, horizontally, than usual, to get the receiver into reasonable table dimensions.

(k) Power-pack plus "B" supplies are outside the receiver where they should be for complete absence of hum troubles, heating, etc.

(l) James Lamb's contribution of the noise-silencer circuit, would not have been integral with this receiver if we had finished it last summer. This circuit has been incorporated in our Laboratory Receiver, and is a distinct asset, on 5 10 and 20 meters.

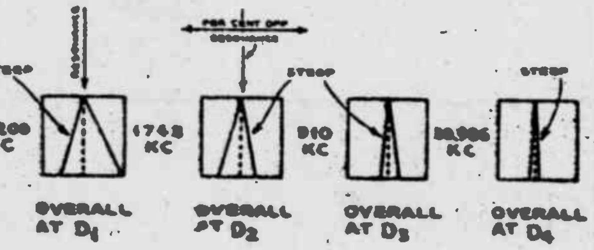
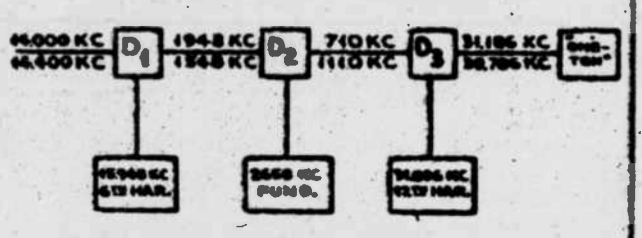


FIG. 4 SHOWING HOW SUCCESSIVE FREQUENCY CHANGES STEEPENS FIRST, ONE SIDE, AND THEN OPPOSITE SIDE OF SELECTIVITY CURVE. THIS ACTION EFFECTIVELY MAKES FOR VERY SHARP TUNING, DUE TO EXTREME STEEPNESS OF BOTH SIDES OF CURVE. DIAGRAMS TRACE A TYPICAL CARRIER THROUGH ALL FREQUENCY CHANGES.

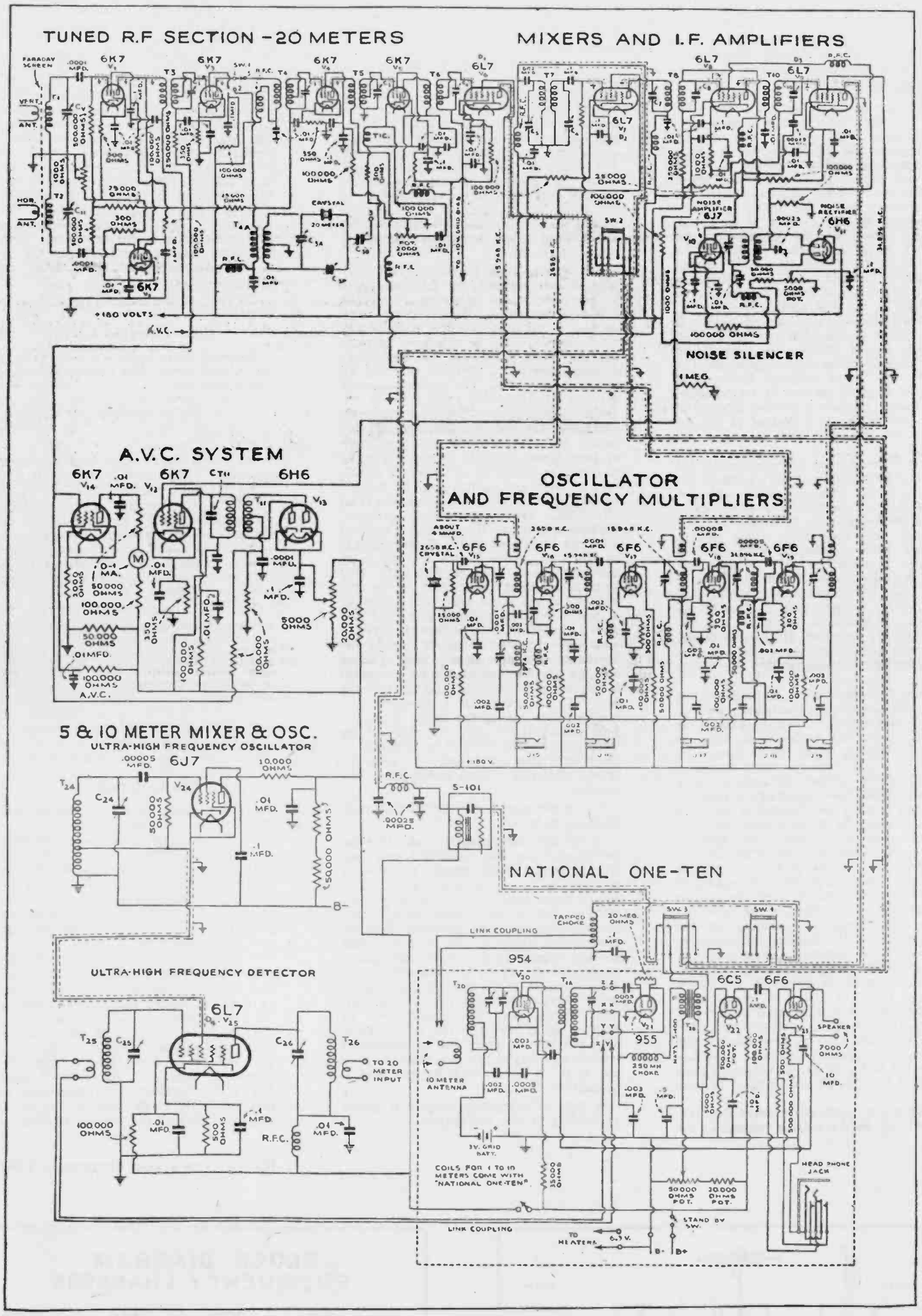
BLOCK DIAGRAM FREQUENCY CHANGERS



FOR COILS 710-1110 USE NATIONAL 550 KC AND TAKE OFF ABOUT 1/2 TURNS FOR T6.

FIG. 17

Radio News for October, 1936



How to Make Copies of Instantaneous Records

Past issues of RADIO-CRAFT have discussed numerous methods of making instantaneous records, but the methods of making copies of the original have not been given sufficient thought. The author describes several means which may be used by the home recordist.

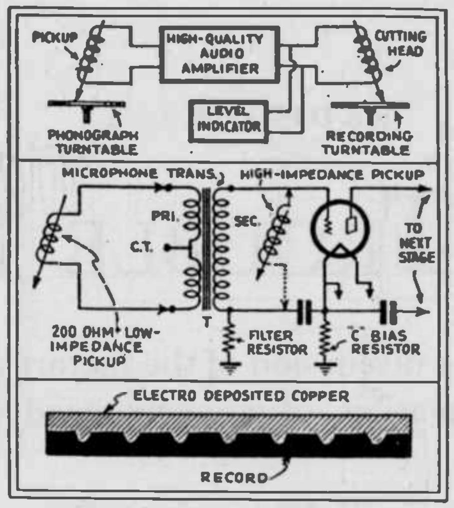


Fig. 1, above. *A "dubbing" circuit layout.*
Fig. 2, center. *Connections of both high- and low-impedance pickups.*
Fig. 3, below. *Cross-section of copper and wax records.*

By GEORGE J. SALIBA, B.S.

ONE of the great problems of the home recordist, judging from the volume of mail, seems to be his difficulty in obtaining duplicates of his recordings.

In photography, the amateur is obviously very fortunate in that at a very slight additional cost, his negative can be made the source of a great many pictures; and in the professional field of recording, the original *master* is also, at low cost, the source of many copies, through the modern application of the principles of electroplating. To the instantaneous-recording amateur, however, the problem is quite different and a trifle more expensive.

At the present time, there are two methods available whereby the recordist can obtain copies, the first being known as "dubbing," and the second as "processing." *Dubbing*, a word descriptive of the first of the two copying processes, is convenient for the home recordist, being derived from "doubling," an old term in the phonograph field; it means the direct production of one or more duplicate positives from a master positive.

In the days of soft-wax cylindrical records, direct duplicates were made by the use of a single reproducing machine, acoustically connected to several recording machines. Since this was before the days of the microphone and amplifier, the sound, reproduced mechanically from the original record, was "piped" to the cutters on the several recording machines. Another method of obtaining direct record duplicates was a mechanical *pantograph* arrangement. Today, we "pipe" our sound electrically over wires.

Duplication by "Dubbing"

A typical electrical "dubbing" layout for the home recordist is illustrated in block form in Fig. 1. The procedure in making a duplicate instantaneous recording is to play back the original record through an amplifier, the output of which is connected to the cutting head that is cutting the second or duplicate record. In other words, the set-up is the same as that used in making the original record, except that the microphone is replaced by the electric pickup, turntable and record.

The amplifier used must be the same one that was used in making the original record; although any good quality audio amplifier may be used. Since the output of the electric pickup is about one *volt*, whereas that of the microphone is in the order of *microvolts*, the gain required in dubbing instantaneous records is not nearly as great as that required in making the original recording.

For this reason, the sound level must be watched very carefully to prevent overloading. If, for instance, the feed-screw is cutting 92 lines per inch, the cutter may "double track"—cut over to the next sound track—with the result that the new record will not track. Of course, this condition is not so likely to occur when pre-grooved blanks (which, as stated in previous articles, are only 80 lines to the inch), are used; nevertheless, difficulty may be experienced in keeping the recording head on the record.

Quality of Recording

It must be borne in mind that to obtain good results a good pickup is absolutely essential; and may be of either "high impedance" or "200 ohms" rating.

Since the primary impedance of the standard *microphone* input transformer used in the set-up for making the original record is 200 ohms, the 200-ohm *pickup* must be connected directly to the primary as shown in Fig. 2. If a high-impedance pickup is used, the connections are made across the secondary of the transformer; or, preferably, direct to the tube, as shown in dotted lines. For the latter connection, a pickup adapter may be used.

In "dubbing," the quality of the new, duplicate record will not be as good as the first record; or as good as duplicates obtained by "processing." In the first place, the question of needle scratch is to be taken into consideration. Since the original record had a certain amount of "surface" noise which is readily picked up and recorded, the dubbed record will have about twice the amount of scratch as the original. Of course, if exceptional care had been exercised in making the original and if the original record blank had been stamped from good material, then, the surface noise would be very small and the quality of the new record would very nearly approach the original.

Some people recommend the use of a scratch filter: in the writer's opinion this is detrimental to good quality, since the scratch frequency is in the neighborhood of 4000 cycles, and all frequencies above this figure must be cut out if the scratch is to be eliminated. However, for voice records *only*, the use of a scratch filter is permissible. These scratch filters may be obtained ready made: in reality they seldom are anything more than an ordinary tone control of the general type so popular on many radio receivers today; when adjusted for bass reproduction the high notes are cut out and the scratch disappears.

If several copies are to be made, the same "original" record must not be used, for after a few "dubs," it becomes too worn for good dubbing (although still sufficiently good for ordinary reproduction). The solution to this problem is to use each dubbed record as an "original" from which to make another. However, when it is realized that the scratch is additive, and the level of the surface noise after making a dozen copies is above the recording level, it becomes evident that the possible number of copies that can be made with the "dubbing" system is limited.

Obtaining Multiple Stampers

Processing, the second method of making copies of the original record, is costly and is the logical one to choose only where a great many records are desired; since it necessitates hiring the services of a commercial sound recording studio of the type which specializes in producing a limited number of records, say, in lots of a hundred.

The procedure followed is the same as that for the production of commercial phonograph records, in that a "master," "mother," and "stamper" are required before the pressing can be done.

HOME RECORDING

(*Continued from page 726*)

The following detail description will show why the home recordist will find it practically impossible to produce his own duplicates by the "process" system.

The instantaneous record is dubbed onto a soft-wax disc, the surface of which is then treated—usually, by dusting with very fine graphite to make its surface conductive.

An electrical connection is then made to this graphite surface and the soft-wax immersed in an electroplating bath. After a certain time, during which the plating solution is kept in motion, with respect to the wax, and the current densities are carefully controlled, there is deposited on the surface of the wax a layer of copper.

Since the graphite layer upon which this copper is built is *very thin*, and very uniform in character, the copper "plate" which has now been formed will fit tightly into each of the minute grooves on the wax.

In Fig. 3, for example, the dark portion represents the cross-section of the grooves on a soft-wax and therefore the shaded portion represents the cross-section of the copper which has been plated onto the surface of the soft-wax.

This copper layer when separated from the wax constitutes an exact copy of the original recording, except that it is "negative" in character.—that is, bearing *ridges* where the original or positive record bore *grooves*. This thin layer of copper, only a few thousandths of an inch thick, is called a *matrix*, or sometimes a "master negative."

After being reinforced with a backing of thicker metal, it may be used in the record-press to make just a few of the familiar black pressings or finished records.

For the amateur who only wants a few copies, the production of this matrix will be as far as he need have his commercial studio go in the processing; but if several hundred copies are required, then it would be unwise to try to get along with this one matrix for there would be grave danger of losing the entire recording because of some accidental damage to it. Therefore, an additional electroplating process must be resorted to in order to provide enough stampers for use in making finished records.

Obtaining Multiple Stampe s

The first of these steps is to e ectroplate the matrix or master *negative* to obtain one or more master *positive* records, sometimes known as "mother" records, which are in all respects similar to the finished record, except that they are composed of metal (instead of the familiar black compound); these become the new source from which are derived, by electroplating, as many (negative) stampers as may be required for use in producing the finished or positive records.

The final step in the process of producing a finished record is the pressing of the black compound, or "record stock," using a stamper as a die.

The record stock is heated on a steamtable until it becomes quite soft, rolled into a plastic ball, and then placed on the stamper, which is heated by steam inside the press to much the same temperature as the steamtable. The press is then closed and then the record material under hydraulic pressure of more than a ton per square inch, is pressed into the minute sound-grooves of the stamper. Cold water is then turned into the dies, and after a short interval the press is opened and the record separated from the stamper. It is then ready for immediate use if desired. This operation is repeated as many times as required to provide the desired number of copies.

An Alternative Recording Method

One method, whereby copies have been made fairly successfully, uses the home recordist's original metal recording as the wax master, the disc being treated the same as the wax by graphiting the surface and then electroplating it to obtain a copper negative. The process from here on is the same as described above.

The only objection to this method is the shallow groove, for in making the original cut the groove was compressed into the metal, no material being removed. As a result, the groove is only about .0015-in. deep, as compared to the .003-in. deep groove that is cut into wax. Difficulty therefore might be experienced in playing back with a steel needle if the pickup and turntable are not level. This process is not recommended if many high-quality copies are desired.

In conclusion, it might be stated that the amateur must not expect too much from the "processed" records if his own original is not *very* good; while in "dubbing" even good records there is, as has been previously stated, a loss in efficiency which cannot be avoided; and if the original was only fair, the new record might be quite poor. *The original record must be very good if the copies are to be good.* Otherwise, money spent will be wasted—unless the copies are desired for sentimental reasons. As has been repeatedly stated, the making of very good records is not at all difficult if only care and patience in conjunction with good apparatus are used.

738 RADIO-CRAFT June, 1932

SUPERHET TROUBLE SHOOTING

A comprehensive discussion of the factors governing the theory and operation of superheterodyne receivers.

By E. BUNTING MOORE

THE current popularity of the superheterodyne has brought the development of this highly efficient circuit to a point far beyond its status a year ago, with both manufacturers and builders; but, whereas the former have engineering staffs to keep them out of trouble, the man who builds his own finds many pitfalls along the road to success; which to the engineer, are comparatively easy to avoid.

It is the purpose of this article to endeavor to present solutions to many of these problems, together with an analysis of their causes, and what is more important, means of correcting them, in simple nontechnical language.

Tracking

Probably the greatest mystery to the average layman is the "tracking" of the oscillator and tuning condensers. Assuming the frequency of the intermediate amplifier to be 175 kc., it is necessary for the oscillator circuit to be tuned at all times to a frequency 175 kilocycles *higher* than the R.F. circuits. (175 kc. lower would be equally good, but using a higher frequency is simpler from a constructional angle.) To illustrate the relation, a few points on the broadcast band are indicated as follows:

With the R.F. circuits tuned to	the oscillator must be tuned to
1500 kc.	1675 kc.
1250 kc.	1425 kc.
1000 kc.	1175 kc.
750 kc.	925 kc.
550 kc.	725 kc.
500 kc.	675 kc.

The frequency to which a tuned-circuit resonates is a function of its inductance times its capacity, or LC. That is, a circuit with a .0005-mf. condenser and a coil of 200 microhenries, has an LC equal to .0005 times 200, or .1, and the circuit will tune to 600 meters; any change in the relative values of the coil or condenser, provided the other is changed oppositely, will result in LC remaining .1. A .00025-mf. condenser with a 400-microhenry coil or a .001-mf. condenser with a 100 microhenry coil would tune to 600 meters.

The LC product varies inversely as the square of the frequency. That is, for double the frequency, the LC drops to *one-quarter* its former value; for three times the frequency, LC is one-ninth its former value. Illustrating, if the LC for 600 meters (or 500 kc.) is .1, LC for 1000 kc. is .025, one-quarter as much; for 1500 kc. it is .0111, or one-ninth as much.

With a single coil, then, to cover the band from 1500 to 500 kc. a condenser is required, which, including all stray capacities in the set, has nine times as much maximum capacity as its minimum.

At the same time the oscillator, covering the band from 1675 kc. to 675 kc. (which is only a tuning range of 2½ to 1) requires a maximum capacity equal to the *square* of 2½ (which is 6¼) times its minimum capacity. The reduction of the maximum capacity of one section of the variable condenser can easily be accomplished by inserting in series with this section a fixed condenser of such value as to reduce the maximum capacity to 6¼ times the minimum. Since the minimum varies considerably, this condenser is usually made so that it may be adjusted with a screw driver. See Fig. 1.

Because the highest frequency of the oscillator is 1675 kc. for tuning-in a 1500 kc. signal, and the minimum capacity of both tuning and oscillator condensers are about the same, the oscillator coil must be sufficiently smaller than the R.F. coils to make this 175 kc. difference at the zero setting of the dial. Figuring again with the same data (with the same capacity, the inductance changes inversely as the square of the frequency) it appears that the oscillator coil should be a little more than 80 percent of the inductance of the R.F. coils.

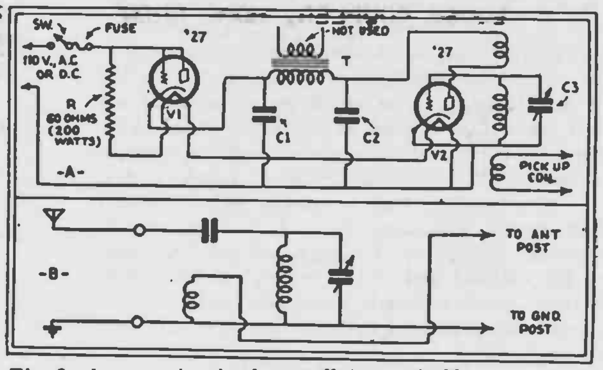


Fig. 2, above. *A simple oscillator suitable for superheterodyne servicing.*

Fig. 3, below. *A band-pass filter that may be attached to a radio set.*

Aligning the Tuning Condensers

Now we come to the actual process of aligning the tuning controls. To do this properly, an oscillator of the simplest kind is required. A suitable one is shown in Fig. 2. C1 and C2 may be ordinary 1 or 2 mf. bypass condensers. C3 can be any .00035- or .0005-mf. variable condenser that may be in the "junk box." T is any filter choke, audio choke, or even the primary of an old audio transformer.

A modulated oscillator calibrated to 175 kc. is also an absolute necessity. Since this calibration must be very exact, it is hardly advisable for the experimenter to try to make this, but rather to either have one calibrated by a competent Service Man; to buy one of the many which are available for service work at a comparatively low cost; or to have the intermediate amplifier adjusted by a Service Man. The importance of exactly tuning the I.F. transformers to 175 kc. cannot be too strongly emphasized. The entire success or failure of the receiver depends upon this one point.

Now set the trimmers on the tuning condensers in about the center of their range; tune in a local station as nearly as possible to 1500 kc. and adjust the trimmers for maximum volume in exactly the same way as a T.R.F. receiver. If some of them tune too high or too low, change the oscillator trimmer up or down sufficiently, so that the R.F. tuning condensers will line up with it properly.

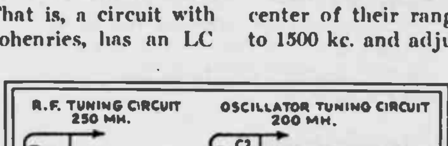


Fig. 1
Arrangement of tuning condensers in R.F. and oscillator tuning circuits.

Tune in a station as near as possible to 550 kc. When it is brought in properly, take a small piece of wire and short circuit the oscillator section of the tuning condenser; the station will, of course, disappear. Now take the oscillator already described, and with one turn of insulated wire wrapped loosely around its coil, connect one terminal to the grid cap of the first detector. Do not make a physical connection between the wire and the oscillator coil, just wrap it *once* around the coil.

Rotate the external oscillator dial until the station is again heard. Now, leaving the oscillator condenser in the set shorted, take off the wire leading to the external oscillator and turn the latter off. Do not touch the tuning dial on the set. Take the short off the oscillator condenser and readjust its padding condenser until the station again comes in at maximum volume.

Now, retune the set to a 1500 kc. station, or as near to it as possible. Readjust the trimmers on the R.F. condensers, do not touch the trimmer on the oscillator condenser, only very slight adjustments of the R.F. trimmers should be necessary here.

If the above instructions have been carried out properly, the set should now be in perfect alignment at all points on the dial, and changes in the trimmers at any point on the dial should not be necessary.

Poor sensitivity on one end of the band, as compared to the other end, or on both ends as compared to the middle, is almost invariably a sign of improper tracking, and can be corrected by making the adjustments already described. Lack of sensitivity all over the band, provided all other things are correct, is usually an indication that the intermediate transformers are not tuned accurately. As already stated, the adjustment of the intermediates to exactly 175 kc. is of extreme importance.

"Birdies"—sounds like a regenerative receiver passing stations at various points on the band—are caused either by the intermediates being tuned to some frequency other than 175 kc., or by insufficient selectivity in the R.F. tuning circuits. An easy way to find which is the cause is to short the oscillator tuning condenser, and then rotate the dial with the volume control turned well up. Under these conditions, no stations should be heard, in fact the receiver should be absolutely silent. If stations *are* heard at some points, without the oscillator tube operating, it is a certainty that the intermediates are not tuned properly. If the set is silent without the oscillator working, but whistling "birdies" are heard when it is working, the selectivity of the R.F. stations is insufficient. The simplest way of correcting this is to use a much shorter antenna, or to remove turns from the primary of the antenna coil. A very small condenser, of the order of .0005-mf., (a midget variable will do) inserted in the antenna lead, will very often eliminate the whistles without appreciably cutting down the sensitivity of the set.

Occasionally, on some supers, there will be found repeat points about 350 kc. off the proper place for a station. There are two remedies for this—either those already described for "birdies" (which will usually be found on sets having the repeat points) or by improving the shielding of the set from direct pickup; as, for example, mounting a set which has the chassis unshielded on the bottom, on a metal plate, so that the bottom will be shielded. Covering the top of the chassis with a grounded metal plate, so as to shield the variable condenser sections and grid caps is often very helpful.

Microphonic audio howls will be found troublesome in some imperfect supers, and the builder, naturally attributing it to a bad tube, will hunt in vain for the tube that is causing the trouble. Actually, the howl may be caused by vibration in the plates of the variable condensers. It can usually be cured by mounting the entire chassis on a piece of sponge rubber, allowing the entire chassis to vibrate, instead of just the condenser plates.

Some sets will have ample selectivity so far as music is concerned, but on a station next to a powerful local, the loud notes of the local will "carry over" with a kind of scratching blast. This is a sign that the local is modulating a band more than 10 kc. wide, and inasmuch as the trouble originates in the air, it cannot be completely eliminated. It can, however, be considerably ameliorated by the addition of a band-pass stage (see Fig. 3) ahead of the tuner. This will reduce the amount of signal from the local that reaches the grid of the first R.F. amplifier tube, but will not seriously affect the strength of the signal from the station to which the set is tuned.

Some sets will be found which work very nicely over a portion of the band, usually the high frequency end, but which stop working entirely on other portions. This is caused by the oscillator tube having incorrect voltages, so that it stops oscillating in spots.

Occasionally, a set will be found which has perfect quality on full volume, but when reduced, the quality "goes to pieces." If this is the case, examination of the tubes will probably disclose a '24 in a socket where a '35 or '51 should be. Proper placement of the tubes will make this right. This trouble applies to T.R.F. sets only; the use of a '24 in an amplifier socket in a set built for the multi-mu tubes will invariably produce this phenomenon.

No reference has been made here to account for poor results due to improper connections, wrongly placed parts, or similar troubles which would apply to any receiver. It is presumed that the correct hookup has been followed throughout, and the receiver is free from all defects in wiring, parts, or similar mistakes on the builder's part.

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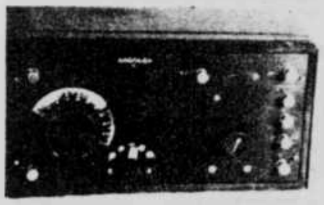
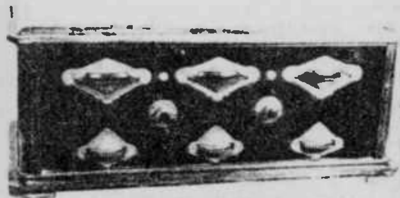
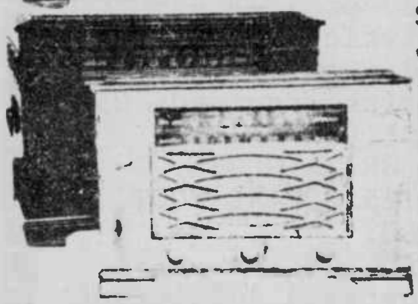
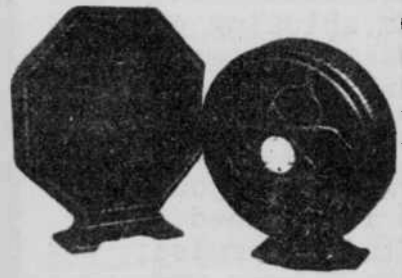
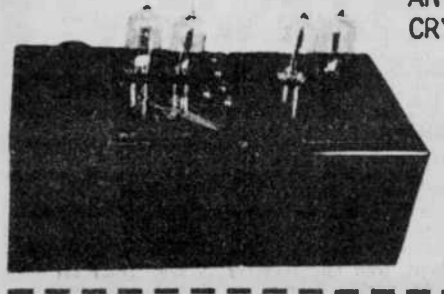
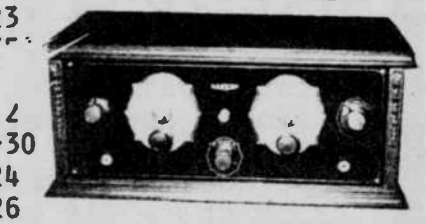
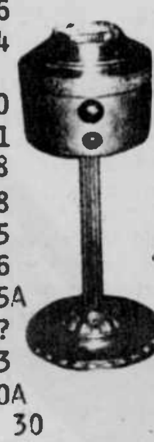
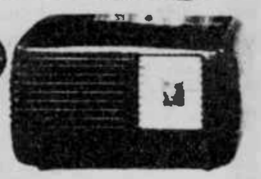
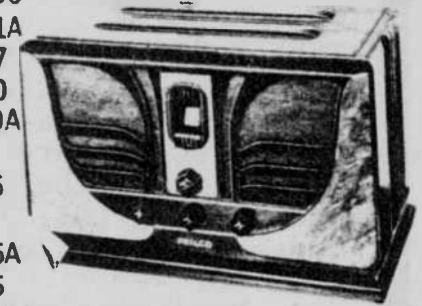
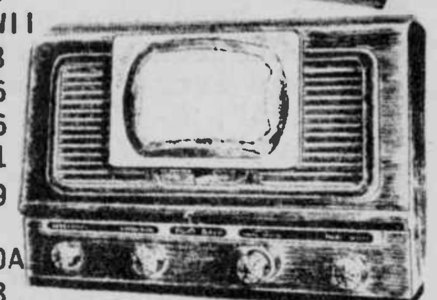


SPEAKER, RADIOLA 103	'27
COIL, TRANSMITTER	14A
CONDENSER, TRANSMITTER	14A
SCR-59 TRANSMITTER	WWI
TUBE, TRANS.	23
TRANSFORMER, OSC.	14
RCA/WESTINGHOUSE RA-DA	23
FEDERAL 58	22
CRYSTAL SET, SIGNAL	18
CRYSTAL SET,M-W	22
TUBE, ELECTROSCIPE	30
TUBE, DEFOREST W/SOCKET	20A
RESISTOR BOX, BRAUN	25A
SPKR, ROLA	26
RADIOLA IIIA	24
RADIOLA III	23
RADIOLA BALANCED AMP	23
FREED-EISEMANN NR-5	23
CIRCLE CRYSTAL SET	23A
NEUTROWOUND	26
CROSLEY 51	24
RADIO & TELEG KEYS (9)	1860-1940
MICROPHONES (4)	30A
SPKR, CROSLEY DYNACONE	60
CRYSTAL SET, RADIO SERVICES	24
CARCO 1-TUBE	24
AK-20 COMPACT	25
AK-33	27
AERIOLA SR	22
AERIOLA SR AMP (NU BOX)	22
GREBE SYNCHROPHASE	25
FRESHMAN MASTERPIECE	25
MISC SOUNDERS, COILS,ETC.	EARLY
AK-46	29
SPKR, PEERLESS	27
CUSTOM SUPERHET RECVR.	24A
JACKSON BELL PETER PAN	36
INT'L RADIO KADETTE	32
PHILCO 84B	34
PETER PAN (NEEDS BEZEL)	33
SAXONY BICYCLE RADIO	46A
GE J-62	41
AK-145	34
SCOTT HI-FI ALL-WAVE	34
JACKSON-BELL 62 CATHEDRAL	30
SPEAKER, RADIOLA 100A	1926
SPEAKER, RADIOLA 100	25
SPKR, SONORA (OPEN)	24
SPKR, SONORA (NO GRILLE)	24
SPKR, MAGNAVOX	26
SPKR, PHILCO	27
HEADPHONES (1 BOX MISC)	
POWER SUPPLIES & CHARGERS	
OLD PARTS, WIRE	
REJUVINATOR, TUBE	25A
DRAPES, RCA, PROMOTIONAL	35A
TUBES, RARE, HISTORICAL, BOX	
TUBES, SCARCE OLD ('99, '01A,ETC)	
TUBES, 1927-1950, NEW & USED, 2000	
HAM GEAR	
TESTERS	
ANTENNA, S/W, ORIGINAL BOX	40A
CRYSTAL SET KIT, ORIG BOX, CUBS	

PHILCO 46-200	'46
WESTINGHOUSE 185	49
RCA MX552	49
PHONES & MIKE	
RADIOLA 26 (NEEDS GRILLE)	24
TV, HALLICRAFTERS 505, WOOD	48
TESTERS (2)	
ANTENNA, LOOP, PORTABLE	24
ZENITH CONSOLE	41
SPKR AK TYPE-M	23
SPKR, WESTERN ELEC.	24
SPKR, AM-PLI-TONE	22A
SPKR, DICTOGRAND	22
SPKR, RADIOLA UZ-1325	23
MICROPHONES, BROADCAST	[illegible]
COLONIAL "NEW WORLD"	
SILVERTONE 6050	[illegible]
CRYSTAL SETS, HOME-BRE	[illegible]0-30
AK-20 BIG-BOX	24
A-C DAYTON XL-25	26
GILFILLAN GN-5	26
PHILCO 45	34
HALLICRAFTERS SX-25	
ZENITH TRANS-OCEANIC 5G40	50
ZENITH 7G605	41
RADIOLA 17	28
RADIOLA 62 CONSOLE	28
FRESHMAN MASTERPIECE	25
SPEAKER, TOWER SHIP	26
CRYSTAL SET, CIRCULAR	25A
LOOSE COUPLER, HOME-BREW	?
SPEAKER, BALDWIN	23
LAB METER (NEEDS SUSPENSION)	30A
AVALON "A" CATHEDRAL	30
KELLER-FULLER "RADIETTE"	30
SIGN, STAND-UP, TUBE	31A
FALCK "NO-BATTERY" CONS	27
AK-72 CONS.	30
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MISC XTALS, HDWE	
PHILCO 610T	36
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EMERSON U5A	35
TRANSMITTER ARC-5	WWII
GAROD PORTABLE	48
EMERSON 508	46
SILVERTONE 6002	46
PHILCO TRANSITONE PT-26	41
TV, MOTOROLA PORTABLE	49
RESOURCE MAT'LS (LITERATURE)	
COIL, SPARK	20A
RADIOLA 17	28
AK-35	26
ZENITH PORTABLE	41
TV, MOTOROLA	47
TV, PILOT 3"	47
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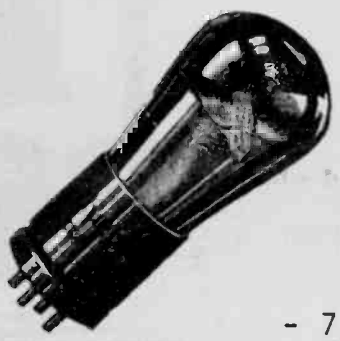

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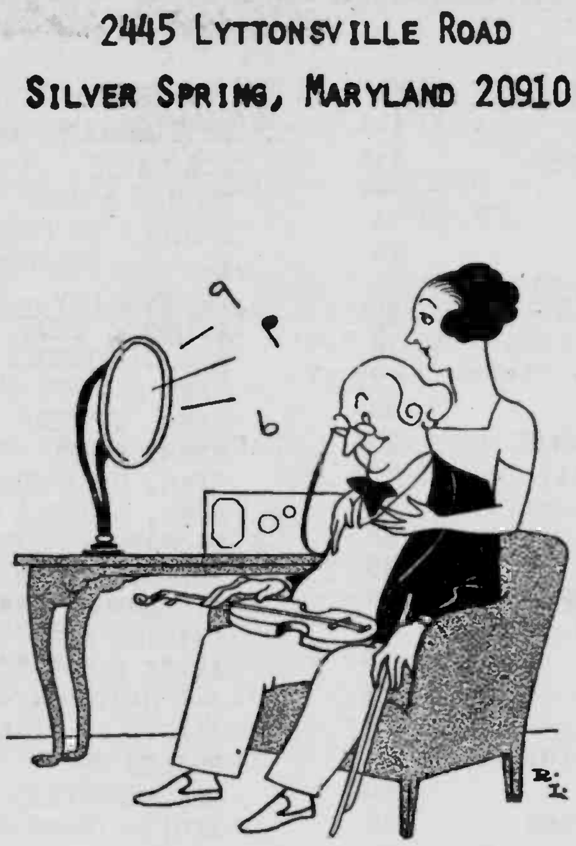

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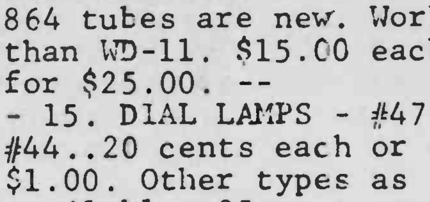

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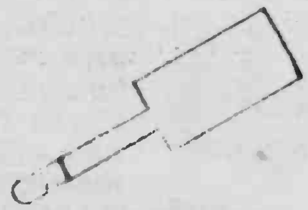

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LIQUIDATION SALE

WE ARE OVERSTOCKED ON CERTAIN TUBE TYPES AND OTHER ITEMS. THIS IS OUR SUMMER LIQUIDATION SALE. THIS SALE ENDS 31 AUGUST 1982. ORDER BEFORE THAT TIME AND SAVE!!!!!!!

THE FOLLOWING TUBES ARE AVAILABLE IN LIMITED QUANTITIES AT ONLY $2.00 EACH: PLEASE REMEMBER THAT OUR MINIMUM ORDER IS $5.00.

0Z4, 1A5, 1A7, 1C6, 1E7, 1F5, 1G6, 1H5, 1LC5, 1LC6, 1LN5, 1N5, 1P5, 1Q5, 1T5, 5U4, 5Z3, 6A6, 6AC5, 6AC7, 6AE5, 6AG7, 6B6, 6C5, 6C8, 6F8, 6G6, 6L5, 6N7, 6P5, 6R7, 6SA7, 6SD7, 6SK7, 6SN7, 6SR7, 6SU7/6188, 6V6, 6Y6, 6Z5, 6Z7, 6ZY5, 7A5, 7A7, 7A8, 7AD7, 7C5, 7C7, 7E6, 7E7, 7L7, 12AH7, 12C8, 12F5, 12J7, 12SF5, 12SJ7, 12SR7, 12Z3, 33, 34, 37, 38, 39/44, 41, 46, 50L6, 76, 89. These tubes are fully guaranteed (see Catalog No. 20 and do carry the PUETT ELECTRONICS SILVER LABEL.

THE FOLLOWING TUBES ARE AVAILABLE IN LIMITED QUANTITIES AT ONLY $3.00 EACH:

1LB4, 1LD5, 1LG5, 6C6 (substitute for 77), 6D6 (substitute for 78), 6Q7, 6SJ7, 84/6Z4, and type 10 - regular price for type 10 in Catalog No. 20 is $9.00!!!

HERE ARE A FEW OTHER SAVINGS --- 7F8 (regular $10.00) - $8.00; type 30 (reg.$9.00) - $6.; type 56 (good substitute for type 27!!!) regularly $6.00 - sale price $4.00; type 78 - regularly $9.00 - sale price only $5.00!!!

ORDER YOUR SALE PRICED TUBES AS SOON AS POSSIBLE. WE HAVE ONLY A LIMITED QUANTITY WHICH WE CAN SELL AT THESE SAVINGS. ALL TUBES FULLY GUARNATEED (see Catalog No. 20).

HERE ARE STILL A FEW OTHER SAVINGS WHICH YOU WILL WANT TO TAKE ADVANTAGE OF DURING THIS SALE: --- ORDER AS OFTEN AS YOU LIKE - THESE PRICES GOOD THRU 31 AUGUST 1982!!!

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THE ANTIQUE RADIO RESTORATION HANDBOOK Volume 1 or Volume 2 (Reg. $3.95) . . . . $2.95 ea.

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(4) ZENITH Owners manuals for Chassis Nos. 5407, 5638, 5903 plus technical data & schematic $4.55 each.
(5) NATIONAL RADIO PRODUCTS CATALOG 1939 including all communications receivers $2.95
(6) INSTRUCTION MANUAL (with schematic etc.) for NATIONAL HRO (1936) w/2.5 volt or 6 volt tubes . $2.95
(7) TROUBLESHOOTING IN D.C., A.C. & BATTERY SETS (N.R.I.) 1933 - 29 pages of good service data . $3.95
(8) PILOT TUNER MODEL T-601 (one of the first FM tuners c. 1946) - 88 - 108 MHz $2.95
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PUETT ELECTRONICS

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NOT IN CATALOG NO. 20

NEW

PUBLISHED IN

1904

FIRST PRINTING
1902

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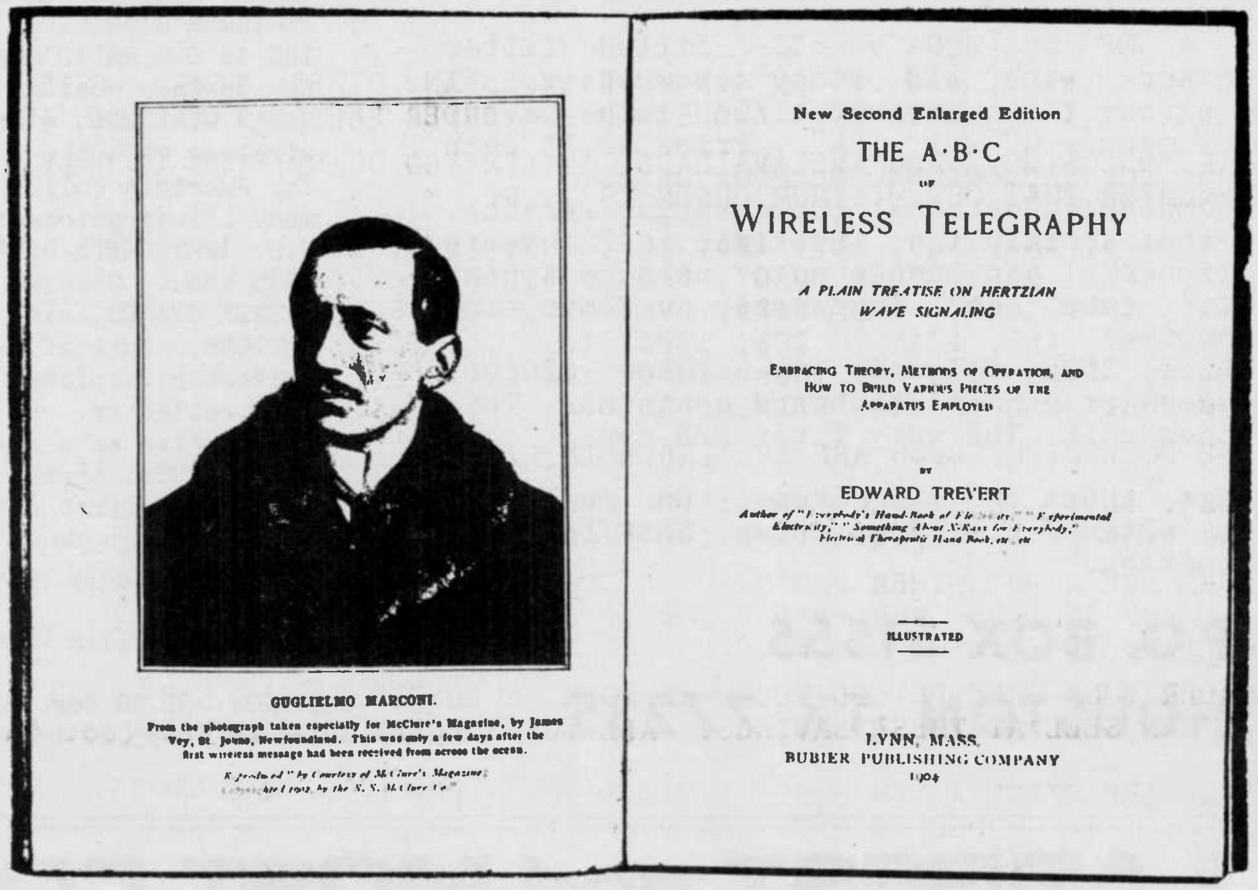

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THIS 116 PAGE BOOK CONTAINS 36 PHOTOGRAPHS, DRAWINGS AND ELECTRICAL DIAGRAMS!!!
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ALL THIS AND MUCH MUCH MORE!!! ORDER YOUR COPY OF THIS VERY EARLY WIRELESS BOOK TODAY!!!!

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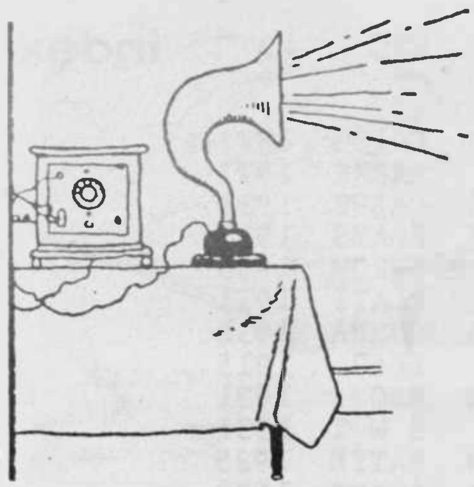

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I WILL SELL THESE RADIOS FOR TOP CASH OFFER OR WILL TRADE FOR MARCONI OR IP OR SE SETS. PLEASE CALL AFTER 6 P.M. -- NO COLLECT CALLS.. (815) 964-8199. 1. BREADBOARD-- 2. UNITED WIRELESS TUNER, C. 1907-- 3. MIGNON TUNER, NOVEMBER 12, 1915-- 4. SIGNAL TUNER, C. 1921-- 5. C H STOELTING CO., CRYSTAL SET, 1 OF 2, C. 1912-- 6. COLBY'S TELEGRAPH SCHOOL, C. 1913-- 7. DEFOREST RJ9, C. 1916-- 8. DEFOREST INTERPANEL, C. 1921-- 9. WILSON MC GUIRE, C. 1921-- 10. AK VARIATION, ALL ORIGINAL-- 11. IP-76, MADE FOR U.S. NAVY, 1907-- 12. DEFOREST EJ1, SERIAL NO. 20, C. 1916-- 13. DEFOREST RJ-8, C. 1916-- 14. 3 PIECE AMRAD, NEW CONDITION W/TAG--

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FOR SALE: CATHEDRAL, BATTERY and AC RADIOS from 1920's and 1930's. Please send self addressed stamped envelope. J. Albert Warren, Box 279, Church St., Waverly, PA 18471.

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TUBES, NEW AND USED, FOR EARLY ELECTRIC RADIOS. SASE FOR FREE PRICE LIST. SAM FAUST, CHANGEWATER, NJ 07831.

****
FOR SALE. PILOT 3" TV, OLD BATTERY SETS, SPEAKERS, HEADPHONES, OLD RADIO BOOKS AND MAGNAZINES, CRYSTAL SETS, RADIO PARTS AND SEVERAL THOUSAND RADIO TUBES. BILL LAVERTY, 1012 W. GENEVA STREET, EGG HARBOR, NJ 08215.

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FOR SALE - RIDER MANUALS, RADIO AND TV. RADIOS- BATTERY AND AC. CATHEDRALS. SEND S.A.S.E., CLARENCE STEVAHN, P. O. BOX 576, WISHEK, ND 58495 (701) 452-2790.

****
OLDE TYME RADIO HAS ACQUIRED A supply of Riders Radio Manuals. Any of you who may need fillers should contact us. Cost is $10,000 per manual plus shipping. For address see main ad.

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FOR SALE: 1/2 TON OF TRANSFORMERS and choke coils, new and used, $5.00 to $15.00 plus shipping. James Fred, Cutler, IN 46920.

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FOR SALE- USED PARTS, for 1924 Super- Zenith, Model VII, 1929 Majestic model 90-B radios. Also tubes about 350 different types. Elmer Nelson, 11 S. Church St., Princeton, IL 61356.

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WANTED

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WANTED: SCOTT PHILHARMONC. Prefer Napier console. Dick Howe, 9318 Wickford, Houston, TX 77024 or call (713) 680-9945 collect.

WANTED: 1923 OR EARLIER RADIO NEWS, Science and Invention, Modern Electrics, Any pre 23 mags or catalogs. Also any Grebe receivers or amps. Also need HZ. Ray Garner, Rt. 1, Box 320, Big Sandy, TN 38221.

$50 REWARD for xerox of manual for c.1969 Air Force VLF SIGNAL SIMULATOR. Contact#: FO-9603-69-C-0571. Part#: 11045. H. Layer, AV-SFSU, 1600 Holloway, San Francisco, CA 94132.

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WANTED: SCHEMATIC DIAGRAM FOR A KEMPER K-52 portable. Also need info on loop antenna for same, mine's missing. all letters answered. Jim Pollard, 4107 Loma Alta Dr., San Diego, CA 92115.

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WANTED A BALDWIN, BRANDES OR WESTERN ELECTRIC HEAD PHONES IN GOOD OR EXCELLENT CONDITION. ORIN W. BAKE, 603 W. CHESTNUT STREET, OXFORD, OH 45056.

WANTED: CHASSIS FOR PHILCO 6 OR Zenith 5-S-29. Escutcheon plate and speaker bolts with ornamental Phillips heads for Philco 20. Also knob for AK cathedral. Gary C. Hill, 1507 Ridge Ave., New Castle, PA 16101

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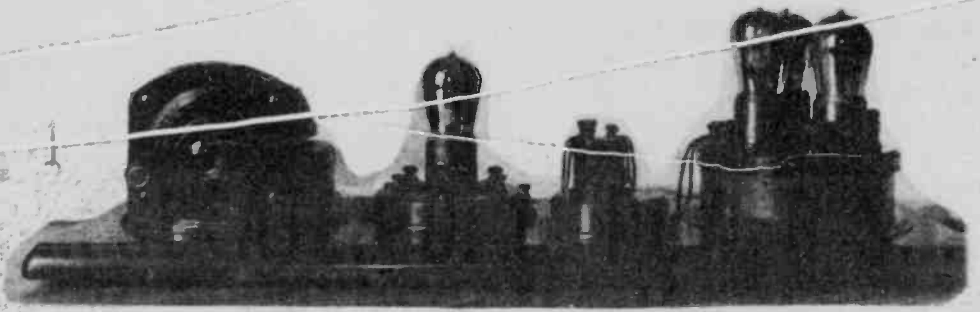

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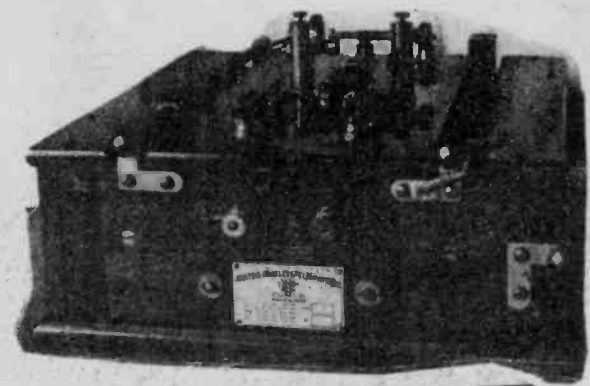

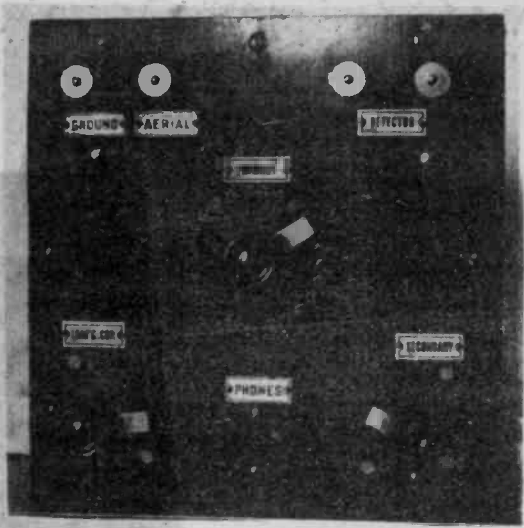

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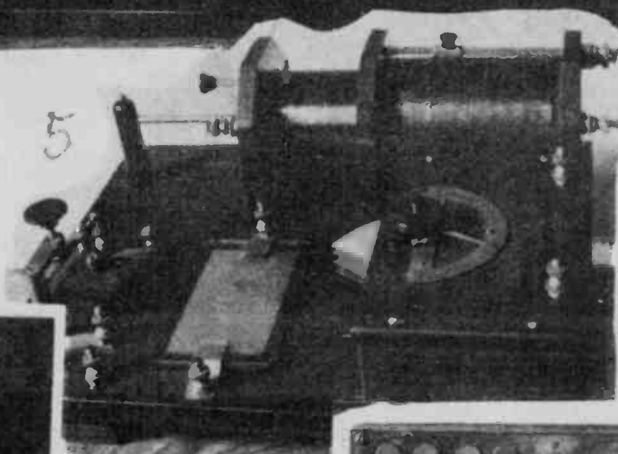

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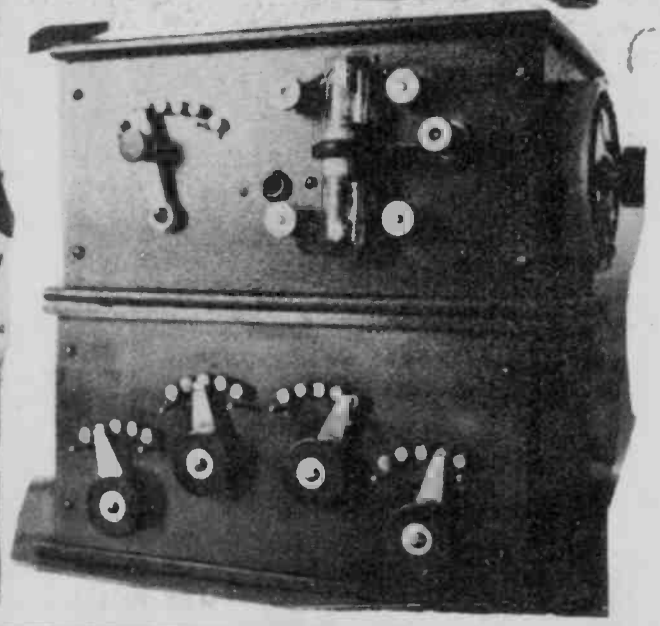

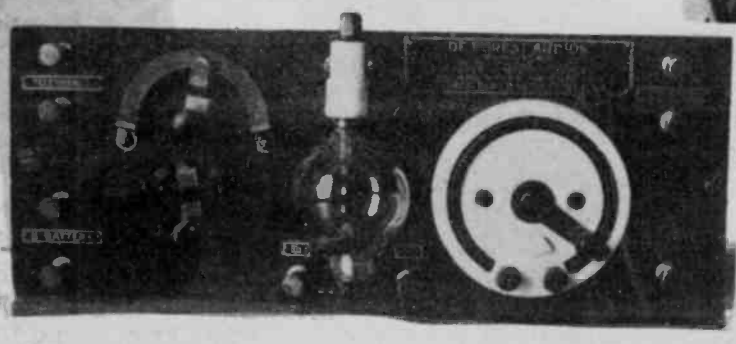

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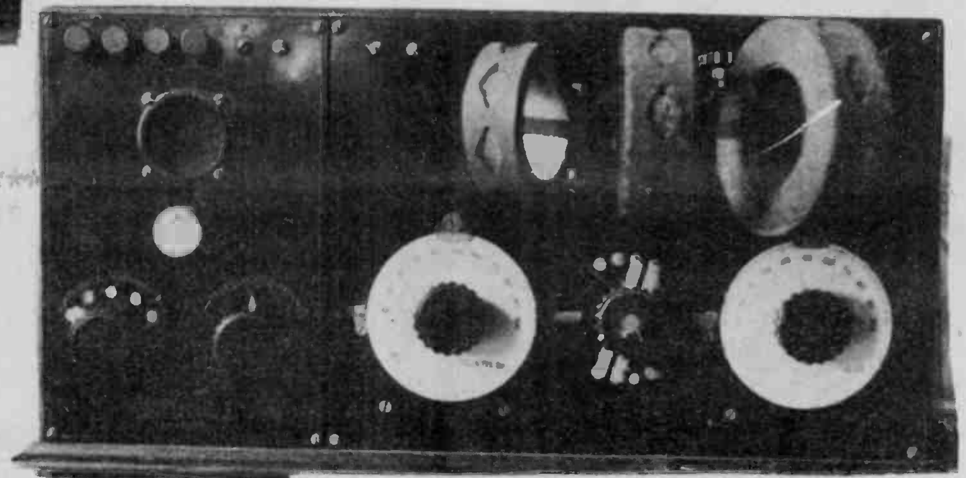

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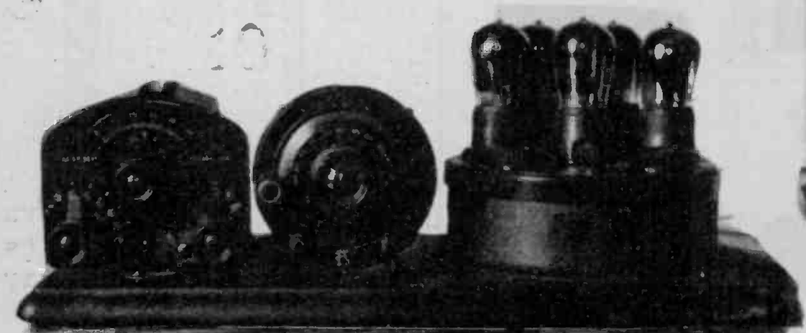

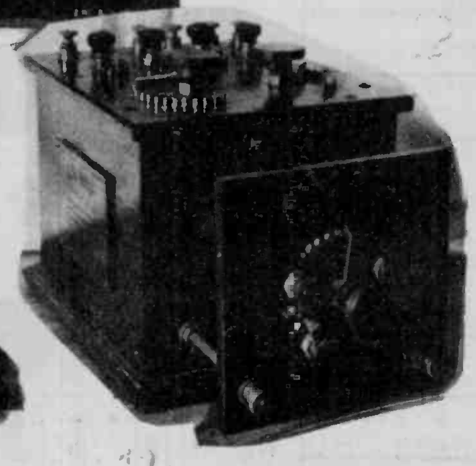

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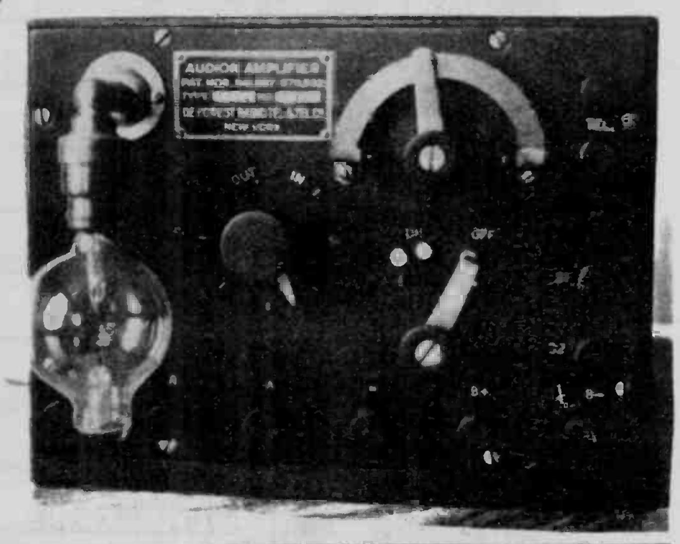

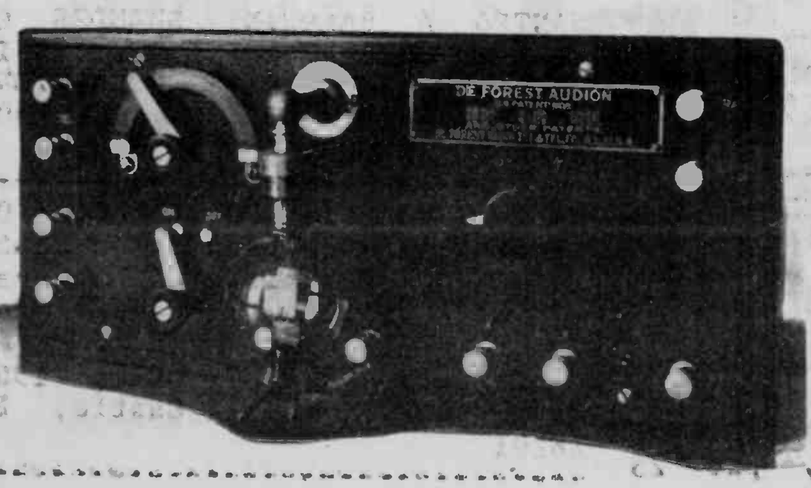

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