How to build a *1920's Style*

By David Whitby

Tubes are almost gone, but not forgotten. Now is the time to assemble this little gem, to bring an ancient circuit to life again and gain a valuable memento of the past "golden radio era."

Wireless Receiver!

AMID THE EVER INCREASING PACE AND ADVANCEMENT OF electronics technology there exists a growing interest in the history of radio or *wireless* as it was then known.

The collecting and restoration of vintage receivers components, and all manner of paraphernalia from the pioneering days has become an established hobby, with a growing number of clubs, societies, and publications being formed around the world to cater to the many enthusiasts of this relatively small area of antiquity.

The author was first bitten by the vintage radio bug whilst involved in designing vintage data communications equipment in the mid 1970's. Was it brought on by an overdose of plastic microchips, a touch of nostalgia for *the good old days*, or simply a desire to find out where all *this started*? Probably all three, but it wasn't long before all sorts of strange and dusty haunts were being explored in search of crystal sets, vacuum tubes, books, and innumerable other relics of the technological past.

The 1920's

The one-tube set described here* came about as the result of a desire to build a radio receiver from scratch, using the circuits and techniques of the 1920's. The wireless literature of the era shows the 1920's to have been a most active and interesting period with great technical improvements having been effected during and after World War I, and then the *coming of age* with the advent of broadcasting during the early 1920's.

There was phenomenal growth in the component and set manufacturing industry with large numbers of new firms springing up almost overnight, but with only a handful being destined to last out the decade. The surge of public interest and intrigue at *wireless*, the new wonder has possibly not been equaled since—even by video or computers. That was truly the era of the *home brew* set, a large proportion of receivers being made at home from plans published in the numerous wireless magazines of the time.

That set, while not intended to duplicate a particular design of the era, contains many early circuit and construction techniques, and has the appearance and feel of the genuine article. It has been named the Unidyne in keeping with the many other *dynes* of the era (Neutrodyne, Solidyne, Infradyne, etc.)—the name Unidyne was actually used on a British home-constructor's set of around 1924.

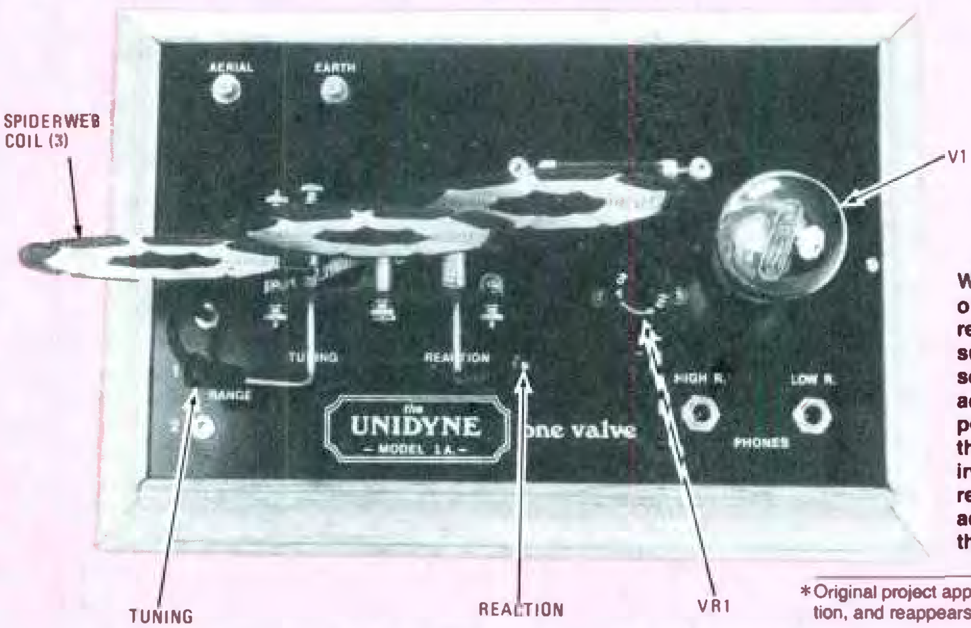
As much use as possible has been made of original type materials, such as a mahogany base, bakelite panel, cotton-covered wire, spiderweb coils, and early-type tubes.

For those who have an interest in the pioneering days, building the Unidyne wireless set will provide hands-on experience in such skills as the ancient art of spiderweb-coil winding, variometer tuning, leaky-grid detection, "A" and "B" batteries, and swinging coil-reaction control—all essential knowledge for the vintage radio builder.

Despite the antiquity of the design, the set is a surprising performer: and, at night—given a reasonable long wire antenna (and preferably a ground)—it will pull-in many country and interstate stations, once one has become adept at manipulating the tuning and reaction controls.

Circuit Details

The circuit is of the leaky-grid, regenerative-detector type (Fig. 1), built around a single battery-operated triode vacuum tube. The one pictured is a Marconi-type 210LF which has a British 4-pin base and a 2-volt filament. You don't have to use that triode tube, for just about any RF tube of the period will work as well. (The editor has used a 37 and 76 vacuum tubes in similar circuits. Other tube types you may want to try are the 24A, 26, 27, 40, 57, 75, 2A6, 6C5, UY227, and just about any other antique triode tube even though it was designed for audio work.)



WE CALL IT THE UNIDYNE! This simple one-tube device functions as a leaky-grid, regenerative-detector circuit that has surprisingly excellent *pull-in* power and sensitivity. Tuning is accomplished by actuating the tuning lever that in turn positions the left spiderweb coil closer to the center spiderweb coil, thereby increasing the combined inductance in the tuned-resonant circuit. Regenerative feedback is achieved by toying with the reaction lever that positions the right spiderweb coil.

*Original project appeared in Electronics Australia, November, 1983 edition, and reappears here by permission.

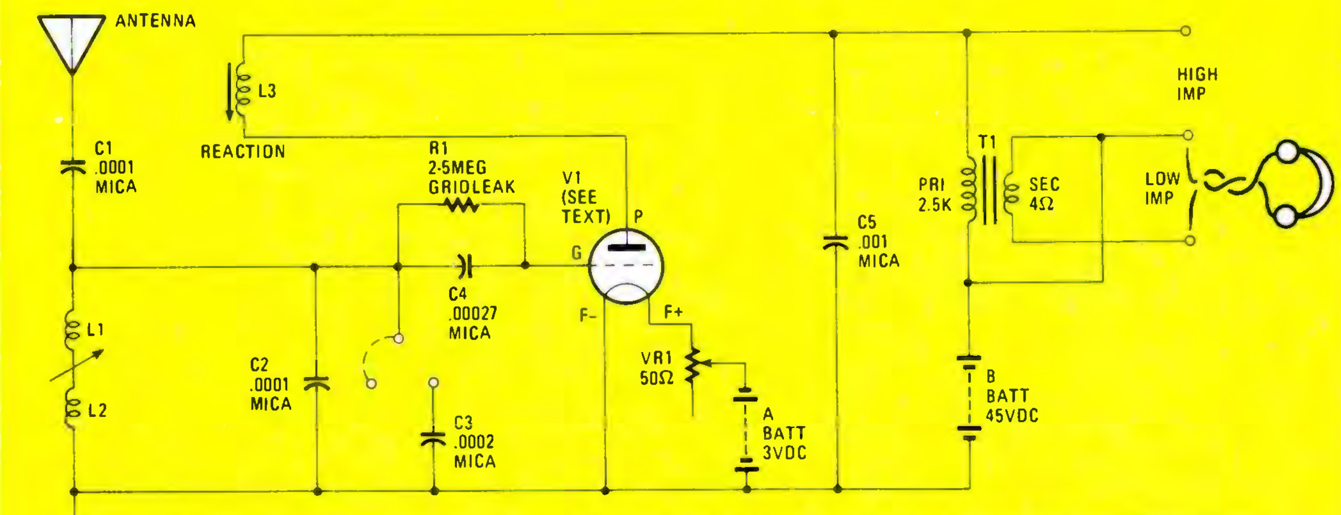


FIG. 1—THE UNIDYNE uses one triode vacuum tube in a regenerative circuit. The coupling between L1 and L2 provide the inductance variation to tune the circuit. L3 provides regenerative (positive) feedback to pep-up the signal. Use this circuit and the text in place of a parts list.

Filament current is supplied by two D-cells (for 2-volt filaments) mounted in holders under the panel. The tube plate supply (B battery) is 45-volts DC made up of five No. 216 (or P1) 9-volt DC batteries mounted in a specially made holder also under the panel. You can freely substitute battery types as requiredin your design.

For tube filaments and heaters requiring more than 2-volts DC you may have to add more batteries, or *cheat*! As the power requirements increase to the filaments, you may want to substitute a hidden step-down filament transformer for economy's sake. It all depends on the tube you use.

Audio is output into headphones, and the older the headphones appear, the more authentic in appearance will be the receiver in which they are plugged. An audio-output transformer T1 provides either high impedance (1000- to 4000-ohm) for the golden-oldie headsets, or low impedance for modern stereophones.

Signals picked up by the antenna are fed via C1 (Fig. 1) to the tuning circuit consisting of L1, L2, C2, and C3. Tuning is carried out by varying the inductance of the L1-L2 combination. Inductors L1 and L2 are identical flat radially wound *spiderweb coils* connected in opposition so that as their relative mechanical coupling is varied there is more (when close coupled) or less (when loosely coupled) cancellation of the equal and antiphase inductances. That sounds like mumbo-jumbo, but it means that the total inductance is varied over a range that will tune in AM broadcast stations. Known as *variometer* tuning, that system was popular in various forms in the early days; it soon gave way to the fixed inductance/variable capacitor system which is still used today, in order to cover the entire broadcast band two plug-selectable fixed capacitors (C2, C3) are used.

The RF signal selected by the tuning circuit is detected by the grid of the tube, the detection system being known as *leaky-grid* or *cumulative-grid* detection. In simple terms, the grid/filament combination of the tube may be looked upon as a diode, with the triode concept of the tube ignored for the moment. On positive half-cycles of the incoming signal, the diode conducts, current flows through R1, a voltage is developed across R1, and C4 is charged to that voltage. The polarity of the charge is negative toward the grid and positive towards the filament. On the following negative half-cycle the diode does not conduct, but the grid is held negative by the charge on C4. That charge, however, commences to *leak* (discharge) away through R1. If the next positive half cycle is weaker than the previous one, the voltage across C4 will continue to fall. If it is stronger, the C4 voltage will rise. The time constant for R1/C4 is so chosen that it is just short enough to allow the charge on C4 to follow the highest modulation frequency. Those grid variations are amplified by the tube's triode action, and appear as much stronger signals in the plate circuit.

Regeneration

At the same time, the RF signal applied to the grid is also amplified and appears as a stronger signal in the plate circuit. The secret of high amplification of those simple sets lies in the use of regeneration or *reaction* as it was often called. That involves the coupling back of some of the amplified RF signal into the tuning circuit in such a way as to add to or assist the original signal (positive feedback). That feedback increases the sensitivity and selectivity of the receiver and makes long-distance reception possible with simple circuitry.

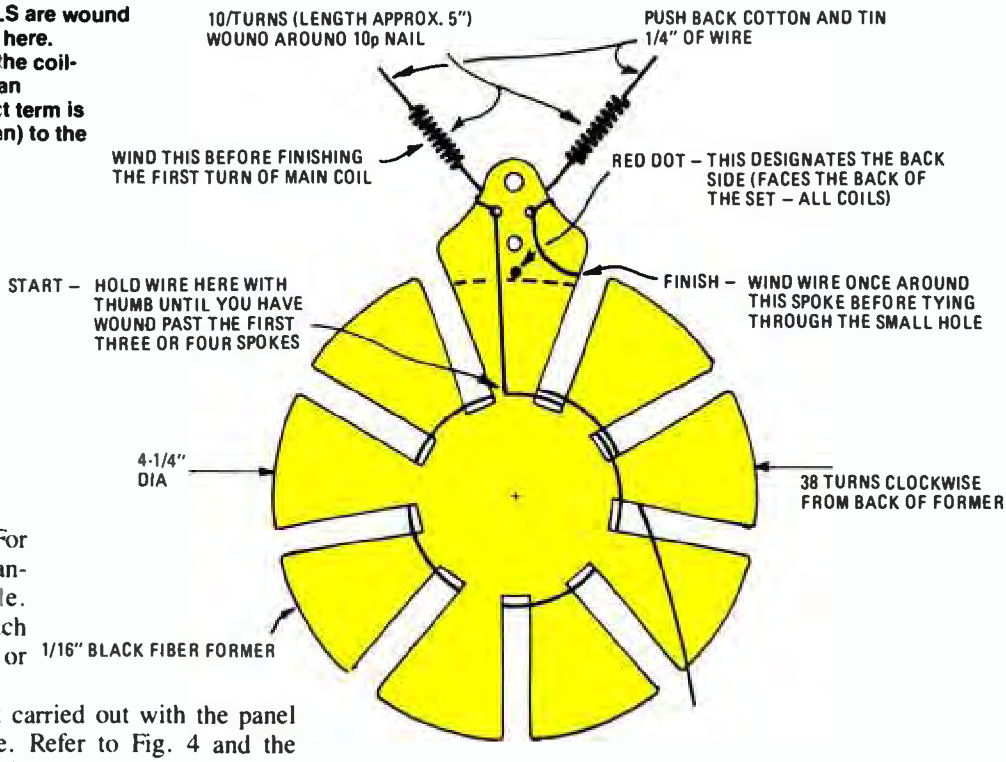
Regeneration is accomplished in this case by a third spiderweb coil connected in the plate circuit and arranged with variable mechanical coupling to the other coils to enable the amount of regeneration to be precisely controlled. In use, the reaction coupling is increased until the set is just short of the point of oscillation, or howling, and it is at that point that the receiver is in its most sensitive and selective condition.

Capacitor C5 serves to bypass the RF component, which would otherwise tend to be blocked by the impedance of the headphone circuit. Transformer T1 is a 2500-ohm:3.5-ohm vacuum-tube, audio-output transformer. On/Off control is provided by the filament rheostat VR1, which disconnects the filament supply in its anticlockwise position. That also cuts off the B battery current, which flows due to filament emission. Should you have trouble finding a control of that type, include an on/off toggle switch in the A supply circuit.

Construction

Exact details for the Unidyne cannot be given because the layout of parts depends so much on the parts you obtain, and those power-supply variations you use that differ with the

FIG. 2—THREE SPIDERWEB COILS are wound identically. The details are shown here. Should you be poor at sketching the coil-former to the correct size, obtain an enlarged photo copy (the incorrect term is Xerox, but you know what we mean) to the 4-1/4-in. diameter size indicated.



author's original conception. For the same reason, a Parts List cannot be supped with that article. However, read on! There is much you can do to make your own, or compromise.

Assembly and wiring is best carried out with the panel mounted into the wooden base. Refer to Fig. 4 and the photos. The first job to be done is to prepare and finish the base. That is made from a mahogany molding (similar to a picture-frame molding) which is obtainable at lumber-supply centers and picture-frame outlets. Start by thoroughly sanding down the base with No. 100 sandpaper, taking care to always sand along the grain. Finish off by sanding super smooth with No. 280 paper observing the same precautions.

Dust down and apply one coat of satin (not gloss) clear polyurethane floor finish with a good-quality small brush, taking care to avoid runs and bubbles. Allow it to dry completely then sand lightly all over with fine paper. Apply a final even coat and leave to dry in a warm, dust-free place.

While the base is drying, the coils can be wound. The three coils are identical, consisting of 38 turns of No. 22-26 DCC (double-cotton covered) wire wound on a nine-spoke, black-fiber former as illustrated in Fig. 2. The former can be made from electrical fish paper, that stiff insulation material used to physically isolate electrical circuits. The odd number of spokes produces a coil with interleaved turns and resultant low distributed capacity and high Q. (Not bad for a 70-year-old design.)

Carefully observe the starting procedure, red dot toward the operator, and the interleaving as shown in Fig. 2. If a spoke is missed, it will be necessary to unwind and correct the error. In order to produce a neat finish, keep a firm but not too tight tension on the wire. Terminate the coil as shown. The little 10-turn coils at the start and finish are to provide flexible leads for the two coils, which are mechanically movable. Wind those coils around a 10-penny nail form, and then discard the nail.

Dip the finished coil into a solution of three parts methylated spirit to one part green drawing ink and then dry thoroughly. Repeat if the color is not vivid enough. The ink dyes only the cotton and is not easily visible on the black spider former.

THIS IS THE third of five photos of the completed Unidyne receiver described in this article. With the five photos and the drawings, you should be able to approximate the layout of parts for an effective reproduction. Position the tube socket so that the tube's label or type marking faces front.

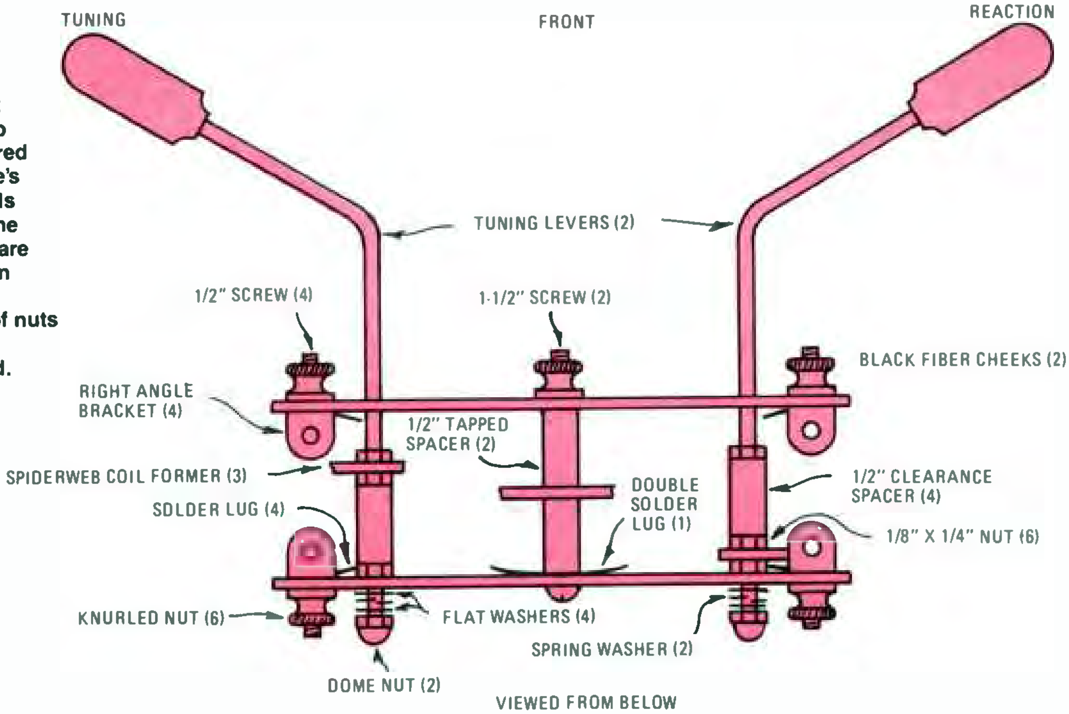


FIG. 3—THE ASSEMBLY that contains the three spiderweb coils is made and then secured to the surface of the Unidyne's breadboard. The outside coils should be mounted with some stiffness, so that when they are positioned they will remain in place. Use 1/2-inch, tapped spacers and same number of nuts as spacers to effect coil positioning as the author did.

The assembly of the complete tuning/reaction unit is next and is shown in Fig. 3. The coils and tuning levers are supported by front and back cheeks made of the same black fiber material as the coil formers. The tuning levers from 1/4-in. soft steel rods and tapped as required. Black plastic knobs or handles are expoxied to the ends. Follow the drawing in Fig. 3 and the photos to make two tuning levers. Attach the tuning and reaction levers to two of the coils, taking careful note of the difference in the arrangement of nuts and spacers between those two as shown in Fig. 3.

Tighten all nuts firmly with a nutdriver, ensuring that the levers are fixed close to the vertical center line of the coils and through the outermost hole on the long spoke of the former. The red dot on the coil former should face the back of the tuning unit on all three coils.

Attach the fixed coil to the back cheek, noting the arrangement in Fig. 3, and tighten the 1½-in. screws into the ½-in. tapped spacers at the front of that coil as shown.

Fit the threaded shafts of the tuning and reaction coils into the back cheek, turning coil to the left and reaction coil to the right and fasten loosely (do not tighten yet) with the flat washers, spring washer and dome nut as shown.

To fit the front cheek, move the levers to the vertical position, insert the ends of the lever into the appropriate holes in the cheek, and push the cheek down the levers, around the bends, and over the two central screws. Thread two knurled nuts onto those screws, and the assembly will now be mechanically stable.

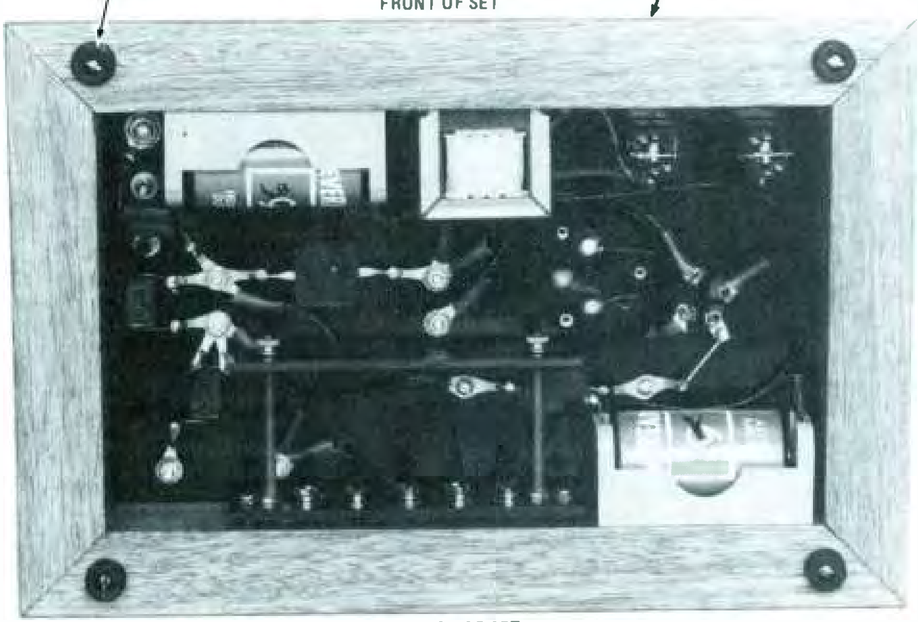
Attach the right-angle brackets and solder lugs, using ½-in. × ⅛-in. screws and knurled nuts as shown, and solder the coil wires to the lugs as directed below.

From the front of the upright tuning unit:

1. Tuning coil—left wire to left rear lug. Right wire to central lug.
2. Fixed coil—left wire to left front lug. Right wire to central lug.
3. Reaction coil—left wire to right rear lug. Right wire to right front lug.

(Continues on page 98)

FIG. 4—HERE IS a drawing of the underside of the Unidyne. Solder lugs are used to facilitate point-to-point wiring. Try to obtain old parts in as many instances as possible. The author could not find old phone jacks, so modern ones were used. In fact, if you can locate some pin jacks, that would be better. However, from the outside, no one could tell the age of the jacks. ▶



HERE'S THE UNIDYNE bottom-side up. Compare it to the drawing at right. Note that the author added modern-day rubber feet to the picture-frame cabinet.

1920's WIRELESS RECEIVER

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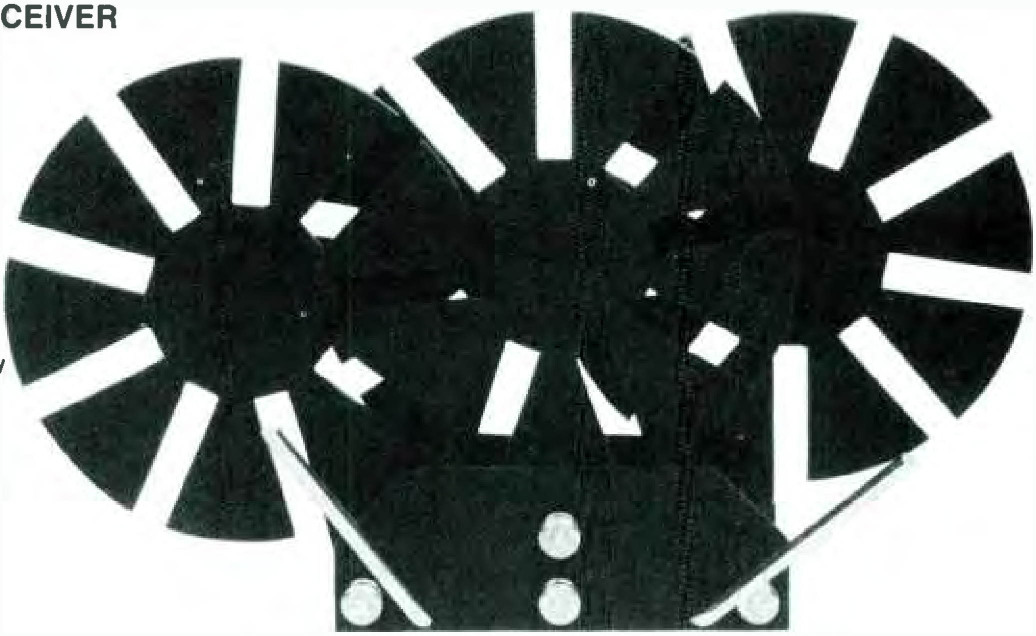


THE SPIDERWEB coil assembly is shown here for illustrative purposes so that you would be able to duplicate it. Actually, the coils should be wound prior to assembly. Fabricate some type of insulating knob material to fit over the levers. That would greatly reduce the effect of body capacitance while tuning.

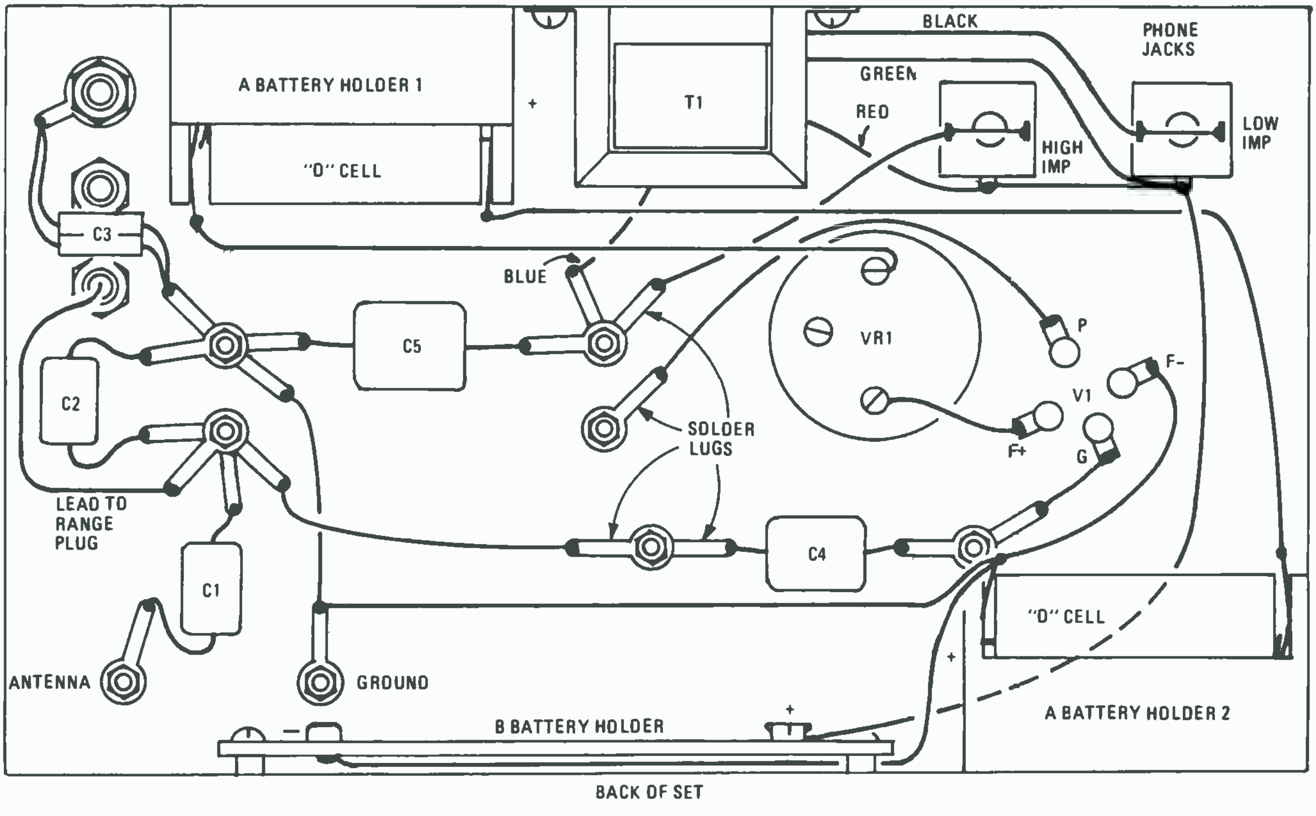
The dome nuts on the end of the lever shafts can now be tightened just enough to allow easy, smooth movement of the coil levers. In some cases it may be necessary to add one or two flat washers under the dome nuts to produce enough friction with the nuts fully tightened. The small knobs on the end of the tuning and reaction levers are pushed on with a twisting action and the tuning unit is now ready to be fitted to the panel.

Assuming the base is completely dry the three battery holders and T1 can be screwed to the inside of it before the panel is attached. Those are fitted with the brass roundhead screws, into drilled pilot holes in the wood, taking care to note the relative polarities of the battery holders and the orientation of T1 from Fig. 4.

The two D-cell holders are standard modern components and the B battery holder (supplied complete) is fabricated from a bakelite strip with five sets of battery clips rivetted to it and a clamp to hold the batteries in position.

Next fit the bakelite panel into the base with reference to Fig. 4 and fasten it with the two screws provided. The panel is pre-loaded with the tube socket pins, with VR1, and the antenna and ground terminals.

Fit the tuning reaction unit to the panel using the ⅝-in. long, round-head screws and tighten the nuts under the panel firmly using a nut driver. Fit all the solder lugs as shown in Fig. 4 using a flat washer under the nut in each case and then fit the phone jacks. The grid leak, and C4 combination is mounted using ⅝-in. long screws with the nuts on top of the panel. The grid leak is held between those nuts and two knurled nuts, as seen in the photograph.



A HEADSET, or *cans* as they were called, will dress up the Unidyne should they happen to be of ancient vintage. Connection to the cord was made to terminals on the earpieces.

Wiring

Arrange to support the set upside down and begin wiring by trimming and fitting the mica capacitors to the lugs as shown in Fig. 4. The main wiring is carried out with the black cloth or rubber covered wire supplied and a spaghetti sleeve is fitted over each lug after soldering. The wiring is fairly straightforward, and should present no problems if Fig. 4 is followed carefully.

When finished double check the wiring to avoid the possibility of 45 volts appearing on the tube filament (a lot of vintage tubes went that way in days of old) or of the B-battery being shorted (they give a very short life that way).

If all is well you can install the batteries and the tube, connect the phones, and hear what 1983 programs sound like on a 1925 radio set. If the set does not operate, check with a multimeter that the filament voltage is reaching the filament and that the B battery voltage is reaching the plate. With the filament lit up (just visible) and VR1 full on there should be just under 2 volts across the filament due to the residual resistance of VR1. Of course, the prior statement depends on the tube type you use.

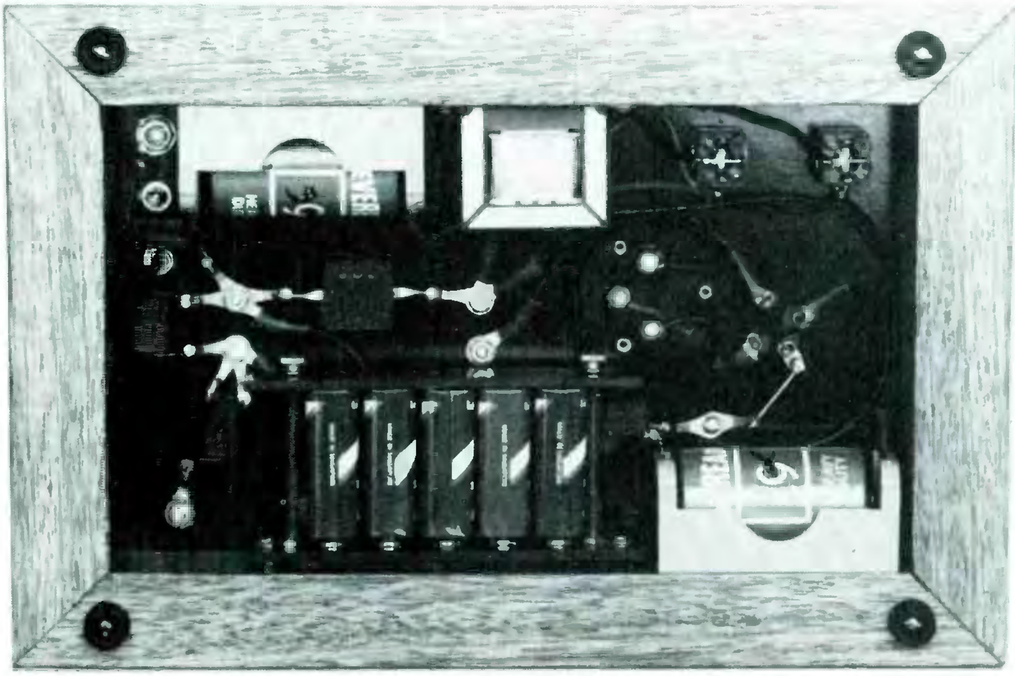
The filament current is 90-110 mA with fresh batteries and the B battery current varies from 0.4 mA to 1.5 mA depending on the signal strength and the tube type. The B batteries will have a very long life (almost shelf life) and it should only be necessary to replace the two D cells from time to time if the set is used fairly frequently (those are not very expensive).

The set works quite well, in most locations, with an indoor antenna of ten to twenty feet but an outdoor antenna and an ground will boost reception remarkably, especially in country areas. Any ground will also almost completely remove the effects of hand or body capacity on the tuning of the set.

The set attracts attention wherever it is seen; and while the great enjoyment is in building and operating it, there is also much pleasure in explaining and demonstrating it.

You may have trouble finding all the parts you need to assemble the Unidyne, as the author did; however, continue to scrounge the flea markets in your area and you'll be surprised to discover how rewarding that search can be. In fact, you may very well be on your way to setting up a small radio museum.

Overall, the project will have served its purpose if it stimulates an interest in the origins of our particular branch of technology, with the knowledge that knowing where we have come from can often help us see more clearly where we are going. Happy vintage listening! ■



THE COMPLETED UNIDYNE with batteries in place is ready for its first DX. Except for the modern-day batteries, you are looking back over 60 years of radio history. The author scrounged some old mica capacitors. If you are unable to obtain "micas,' look for tubular types that hint of days gone by. Neatness counts, so dress up the leads.