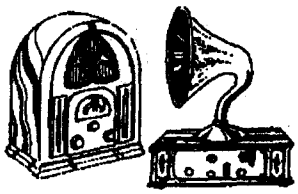
Vintage Radio

by PETER LANKSHEAR



RCA's first TRF receiver

In 1925, the Radio Corporation of America released its first TRF receiver for domestic broadcast reception. Built by General Electric, the Radiola 20 offered ganged tuning, two RF stages and a regenerative detector, using a circuit which had similarities to the well-known Browning Drake design. It provided a high order of performance, for a high but attainable price.

The Radio Corporation of America was incorporated in October 1919, in a takeover of American Marconi by a consortium of General Electric, American Telephone and Telegraph, Westinghouse, and the Wireless Specialty Apparatus Co. Between them the consortium members held not only the very important Armstrong Regeneration and Superheterodyne patent rights, but also they controlled just about every other major radio patent — which other manufacturers could not use without an RCA licence.

With close affiliations to overseas organisations (Australia's Amalgamated Wireless being a case in point), RCA had access to worldwide developments. This, together with their patent monopoly, gave them the potential to be the world's leader in radio technology. It is important to realise that prior to 1930 RCA had no manufacturing facilities of its own, but concentrated on operating and on marketing products made by its principals.

An interesting situation arose here. AWA were the agents for RCA receivers sold in New Zealand, but because AWA made their own receivers, often with a strong RCA influence — even to the extent of taking over the name 'Radiola' — Australian RCA imports were handled by Australian General Electric until 1930, when import restrictions cut them out altogether. RCA sets sold in Australia could not display the name 'Radiola'.

Initially, RCA had not been keen to become involved in the broadcasting craze, which they had regarded as ephemeral. But when it became clear that broadcasting would not go away, it began selling receivers designed and built by GE, Westinghouse and WSA.

RCA did not exploit its very powerful position effectively. Although by late 1925 the US industry's 'standard' receiver consisted of two RF stages, a detector and two audio stages, no RCA radios had previously been of this type.

For various reasons, including previous overproduction, the company had not made regular annual model changes, and consequently, for the 1925-26 season, they had an odd range of receivers on offer. Some was old stock, the 'bottom of the line' model being the primitive two valve variometer-tuned regenerative Westinghouse Radiola III — discounted to only $15. Then there was the 1924 'first generation superheterodyne' from GE, reduced to $116 but still expensive.

With one exception, all the new 1925 RCA models were superheterodynes, ranging from the $195 model 24 to a stratospheric $575 for the model 30. Comparative rates are not available, but it would not be unreasonable to multiply these prices by a factor of 10 for a guide to today's values.

RCA needed a current model that was priced more competitively. Their answer was the Radiola model 20 TRF, priced at $102.50 but still in the upper price range. To quote two examples, this was nearly 60% dearer than the equivalent $65 Stewart Warner 300, described in this column for May 1991, and 30% more than the 20C Atwater Kent. To be fair though, the RCA 20 was a more complex and higher performance receiver.

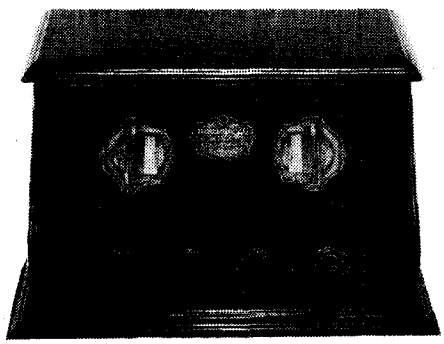
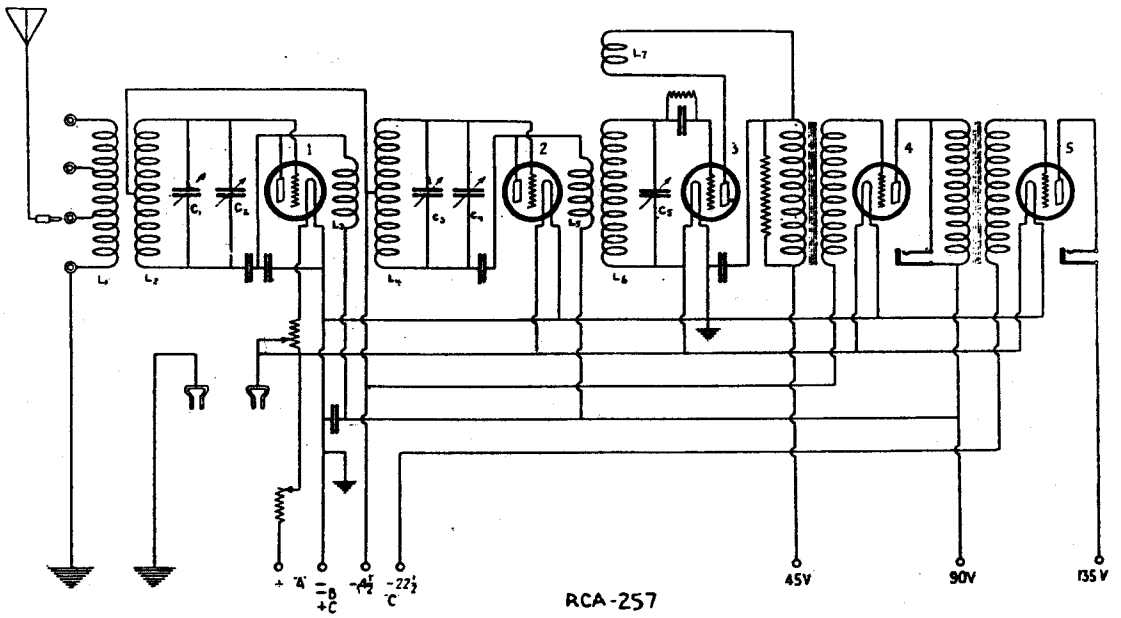


Fig.1 (above): This table model version of the RCA 20 has an overall black cabinet made by the Salt-Smith Trust of Salem, Indiana.

Fig.2 (left): The more common finish was natural wood with black stained borders, as shown on this floor model — which incorporates a battery box made by the Jamestown Mantel Co. Note the optional plug-in filament voltmeter to the right of the four lower controls.

High price, quality

The cabinet styling and internal construction of the RCA 20 reflect the 'up market' character of RCA receivers.



The schematic for the RCA 20. No values are given for the three fixed capacitors, but the HT bypass is known to be 2uF and suitable bypass values for the detector grid leak and anode are 250pF. The grid leak resistor is not critical, and can be any value between 1M and 3M. The regeneration howl suppressor resistor across the primary of the first audio transformer is typically 100k.

RADIO CORP. OF AMERICA		
NATIONAL SERVICE DIVISION		
233 BROADWAY, N. Y. C.		
RADIOLA 20		
SCHEMATIC DIAGRAM		
Dwg. No. NS-20-1	Date 11-25-1925	
Dwn. By M.E.G.	Ckd. By	Appd. By

Whereas the average 1925 receiver was pretty functional, comprising a rectangular box with a front panel featuring three large tuning knobs, two smaller filament control knobs and the odd switch, RCA receivers were more ornate, with some attempt to look like a piece of furniture.

All the 1925 RCA receivers had similar cabinets featuring a sloping front panel, lift-up lid and and elaborate routed decoration on the front and sides. As can be seen from the photographs, there were two Model 20 colour options, one being all black and the other two-toned, with black edgings around polished wood enclosed within the routed patterns.

The main panel was sloped at a 45° angle, with two large thumbwheel controls and ornate brass escutcheons. One, as would be expected, was the tuning control — in this case labelled 'station selector' — but the other one, called 'amplification', was not a volume control. It was in fact a regeneration control, working through a linkage to adjust a feedback or 'tickler' winding.

Ganged tuning

A significant feature of the RCA 20 was ganged tuning. Until about 1927, the standard TRF had three tuning controls, creating difficulties for users who did not have three hands! The problem was well recognised, but aerial coupling methods and tolerances between tuning capacitors made ganging very difficult.

Although RCA was not the earliest to use single knob tuning, its model 20 can be regarded was the first really successful receiver to feature ganging. Even so, it was necessary for the trimmers to be manually operated. (Readers of last month's column will hopefully recall that Majestic receivers still used aerial trimming in 1930.)

The model 20 was therefore RCA's first conventional TRF, and it proved to have excellent performance, incorporating two triode RF amplifiers — neutralised for optimum gain and stability — and with regeneration for high gain and selective detection.

Although popular here and in Europe,

Fig.3: Only an ornate embossed brass badge was good enough for RCA. To avoid conflict with AWA's rights to the name 'Radiola', badges on sets intended for Australia had the name altered to Radio 20.

and for home construction, regeneration was used by few American makers, doubtless because royalties were payable to RCA and many users had difficulties with yet another control.

The inevitable two transformer-coupled audio stages completed a generally tidy design.

Late in 1924, G.H. Browning had described a sensitive receiver that was to become very popular with home constructors right through to the 1930's. Special features of the Browning Drake, as the circuit became known, were a neutralised RF stage, and regeneration controlled by a moveable feedback winding. Add a second RF stage to a Browning Drake circuit, and you have the essentials of the RCA 20.

We will never know for sure, but one could speculate that the GE design team who, after all, had not previously produced a TRF, had studied Browning's design and built on it...

Unusual construction

At this period of development, the usual internal construction of radios was for components to be mounted on a shelf or baseboard. But the RCA method was quite different, perhaps reflecting the communications and electrical engineering background of General Electric.

The model 20 receiver was built around a more or less triangular frame. Through the centre was a resilient rubber

and spring-mounted bakelite moulding, carrying valve sockets and mountings for the audio transformers and three RF coils. At the rear was a terminal board and a pair of neutralising capacitors. A pair of carbon resistors, a 2uF HT bypass capacitor and two mica capacitors rounded off the parts list.

On the front of the frame was the main sloping panel, backed by a metal plate carrying the three tuning capacitors and the regeneration control. Two filament rheostats and two three-plate variable capacitors (used as trimmers) together with a pair of phone jacks, were mounted on a narrow vertical wooden strip at the bottom front. Also on this strip were two pin jacks for monitoring the filament voltage using an optional plug-in voltmeter.

There was no shielding for the three RF coils. Instead, they were mounted mutually at right angles to avoid coupling. A complication of the neutralisation was the need for tappings on the tuning coils, and isolation of the tuning capacitor rotors by insulated flexible couplings.

The whole assembly of frame and panels fitted neatly into the cabinet, to be secured by four screws on the underside.

Dry battery power

As is well known, the standard American valve used in the vast majority of receivers during the mid 1920's was the 201A, featured in our April 1991 column. The filaments of a set of 201A valves drew 1.25 amperes, from a messy 6-volt lead acid battery which threatened to rot everything in the near vicinity and also required frequent recharging.

Although it was a most successful GE development, few RCA receivers used the 201A. They preferred instead the 3.3-volt 60mA filament general purpose type 199 and the 132mA filament type 120 output valves, and for the RCA 20 recommended a filament battery of a 4.5 volt series-parallel combination of six No.6 dry cells.

These would have increased running costs, but customers who were prepared to pay the higher prices for RCA receivers were probably quite happy to pay extra for the convenience of having dry batteries for the filament supply.

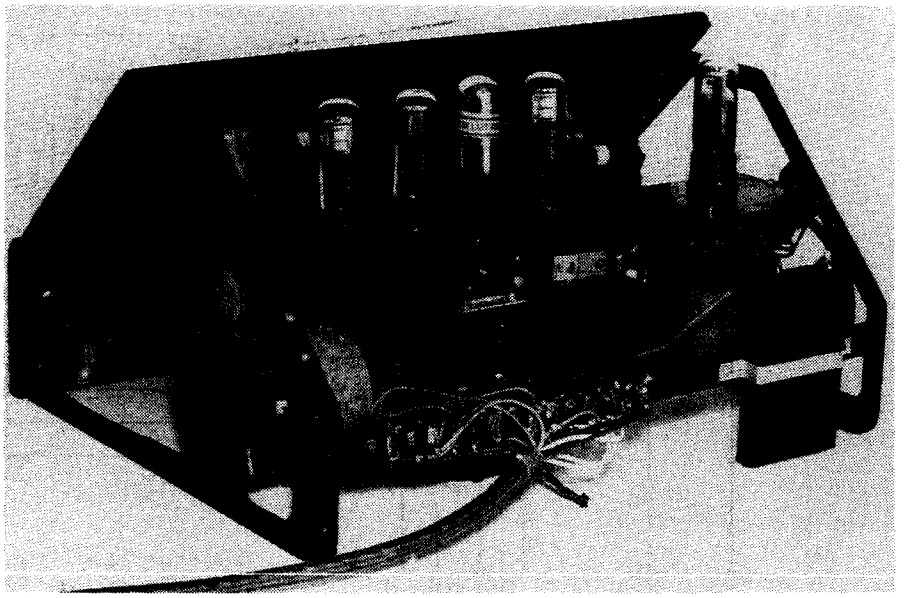


Fig.4: In this rear view of the chassis, the detector coil with its primary mounted inside on three spacers is visible at lower left. The set's three coils are mounted mutually at right angles, underneath the sprung valve deck.

The 20 in operation

Ganged tuning does make operation of the RCA 20 simpler than its contemporaries, but even so, some skills have to be developed for good results. By later standards, regeneration control is not very smooth and the thermal inertia of the filaments delays the response to adjustment of the gain control.

The tuning control is not calibrated in frequency, but has a surface suitable for pencil marking of station locations. As tuning is varied, a small amount of trimmer readjustment is required.

As would be expected, with controls adjusted correctly, and connected to a reasonable aerial, the 20 is better than its contemporaries and is comparable with some modern receivers. In a suburban location, the limiting factor is background noise.

The number of surviving RCA 20 receivers rescued by collectors shows that it was a durable receiver. Although not common here, two of the RCA Victor 'Alhambra' models and some Canadian Westinghouse receivers were based on the model 20, which proved to be popular and it remained in production until late 1927 — by which time it had become a floor model, with a new and larger cabinet.

Next month we will describe some restoration procedures for this and similar receivers. ❖

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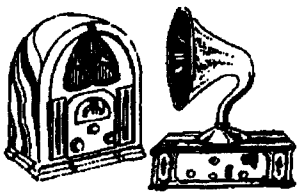


Renovating an RCA Model 20

In last month's column we looked at the model 20, RCA's first conventional TRF receiver, which was sold between November 1925 and the end of 1927. Although it was a relatively expensive model, more than 135,000 were produced and today it is well represented in collections. This month we have some restoration hints for the 20 and similar receivers.

The set I selected for the subject of this month's column is one of the 'single-colour black' models, and when found, it was in a fairly disreputable state. Unfortunately, the cabinet needed more than cosmetic treatment. The lid was distorted and the veneer had long open splits in several places.

Flat-topped radios have always, it seems, been irresistible to owners of pot plants, with the result that years of watering mishaps often do irreparable damage. I suspect that this set was a classic example. Even the layer of veneer on the inside of the lid was damaged, although fortunately the labels and instruction card remained in good condition.

To compound the problem, the cabinet had been given the all-too-common treatment of a coating of varnish, probably in the vain hope that it would 'freshen up' the appearance. Of course it didn't, but instead now provided real difficulties in restoring the original finish. As the lid would have to be renewed anyway, it seemed that although removal of the original polish should always be a last resort, the most practical approach in this case would be to strip the finish from the panels and sides.

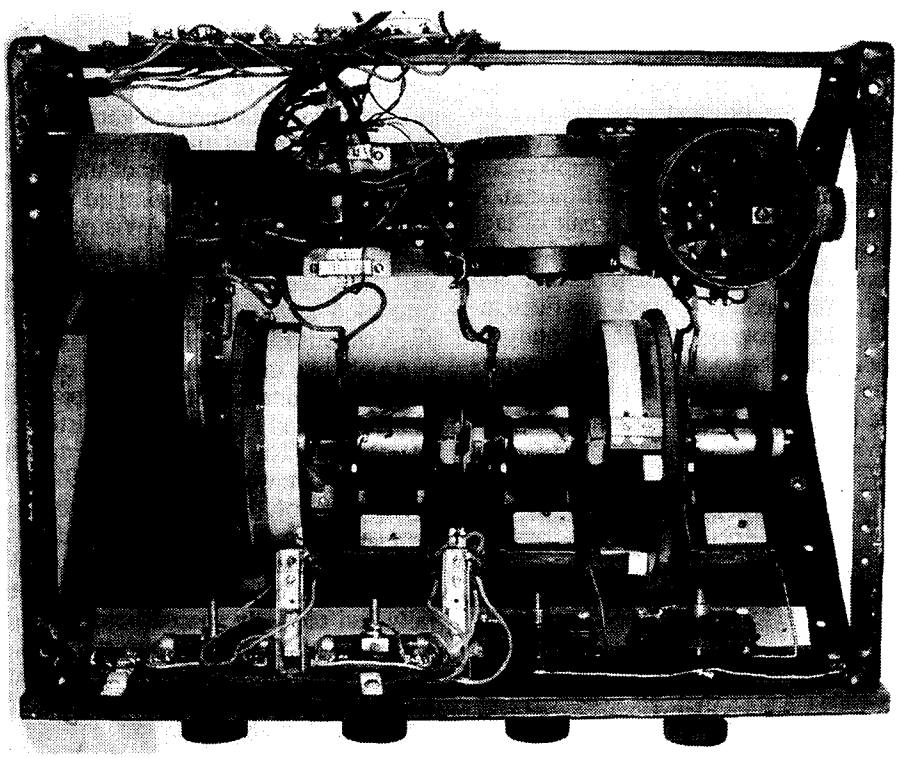


Fig.1: An underneath view of the RCA 20 chassis, before removal of the front panels. Between the detector coil at top left and the RF stage coil are the audio transformer mounts. The RF verniers and filament rheostats are at the bottom.

Dismantling

The first step was to withdraw the internals by undoing four screws on the underside of the cabinet, allowing the chassis frame complete with the control panels to be slid out. The removal of eight wood screws released the sloping panel covering the tuning and regeneration controls. The badge and escutcheons were removed and the tiny screws carefully stowed away. Replacements are hard to find!

Component removal from the small vertical panel was more involved. Undoing the machine screws through their dial plates freed the vernier tuning capacitors. Their knobs were removed and their connecting leads were unsoldered from the main tuning capacitors. Similarly, the volume and battery setting controls were released, but as their knobs are moulded onto the shafts, the wiper arms were disconnected. As there seemed to be no way to remove the jacks from the panel, these were disconnected from their leads and masked during spraying.

Next the lid and its length of piano hinge, lid stay and labels were removed. To assist in positioning them on a new lid, a template was made by cutting a piece of paper to size and rubbing the indentations with a pencil, in the same manner as a coin rubbing. A firm of fine furniture restorers successfully made a replacement lid.

Removal of the old finish was simply a matter of very careful scraping, mostly with a wide chisel held vertically. As the interior and back were in good condition, the finish was retained. Difficult spots, especially the routed patterns, were treated with paint stripper. Finally, after some minor damage was repaired the surfaces were prepared by sanding with 220 grit garnet paper, wrapped round a cork sanding block.

Black wooden radio cabinets were finished in two ways. Although some were coated with black lacquer, many like the RCA 20 were stained and then sprayed with clear nitrocellulose lacquer.

A couple of coats of black spirit stain on the exterior provided sufficient colour. The inside of the new lid was given a coat of mahogany stain. Before spraying, the inside and back, which did not require refinishing, were protected with paper and masking tape. Then a couple of coats of clear lacquer were applied with a spray gun.

Brass polishing

The final job before reassembling the cabinet was polishing the brass escutcheons and dial plates. They too had been coated with varnish, and to avoid any possibility of scratching during its removal, they were given a coat of paint stripper and put in a plastic bag to prevent evaporation. Once the varnish had softened, the metalwork was given a scrubbing with soap and a nail brush before being polished with Brasso and a soft cloth.

The trick with polishing escutcheons is to not be too thorough. Completely burnished surfaces do not look right on old equipment, and indeed were often not so originally. A good rule is to concentrate on the high spots and larger flat surfaces, leaving recessed portions shaded.

After thoroughly removing residual polish, a light coat of clear lacquer was applied from an aerosol container.

Internal inspection

With the cabinet renovated, the condition of the internal components was thoroughly checked. In common with the great majority of receivers of this vintage, the audio transformers had long been replaced, in this case with miniature general purpose types that looked very clearly unoriginal.

Fortunately, one of the original transformers, although open circuited, was still with the set, and by advertising in a vintage radio magazine, a second RCA unit was located. Both were rewound to the original specifications. These are: primary 3000 turns 44 swg (0.08mm); secondary 12,000 turns 44 swg (0.08mm); core size 1/2" square; and window 1" x 5/8".

A problem frequently encountered in restoration is identification of alterations and missing components. Vintage radio societies are often good sources of data, especially of major brands, and members will often help with advice and information. In this instance, I was fortunate in having a copy of the original service data and access to a couple of model 20's owned by local collectors.

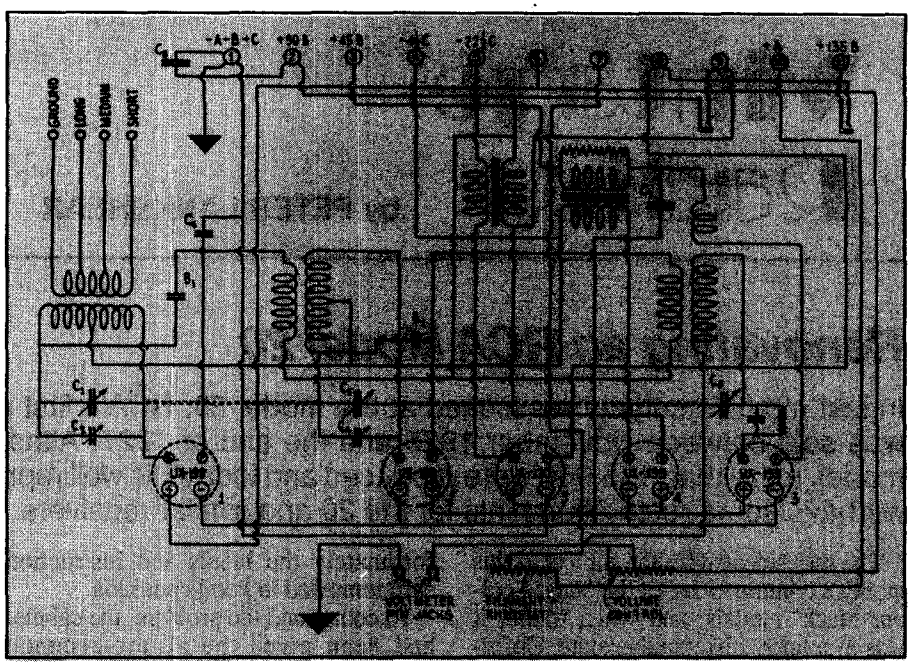


Fig.2: The 'continuity diagram' for the RCA 20 is based on the physical layout, and is useful for tracing the wiring.

Immediately apparent were some rust spots on the frame, which were treated with 'rust killer' solution and touched up with black enamel.

Missing was a metal-cased HT bypass capacitor, which should have been mounted at the rear of the 'chassis'. Fortunately the original rectangular case was ordinary tinplate, and it was not difficult to make a convincing replica box using metal from a flattened fruit can. A piece of fibre fitted with a pair of tags served as a terminal strip. Before the seams were soldered, a modern 2.2uF 200 volt working capacitor was fitted inside. The progress in half a century of capacitor manufacture is readily apparent in the small amount of space occupied in the box by the new capacitor. An application of black enamel from an aerosol can finished the job.

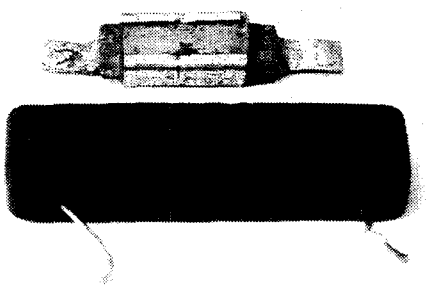


Fig.3: The internals of an old AWA mica capacitor are virtually identical with the early RCA construction.

The detector grid leak and capacitor had been replaced by modern components, and although they were out of sight under the valve shelf, I decided to replace them with some components that would be rather more appropriate.

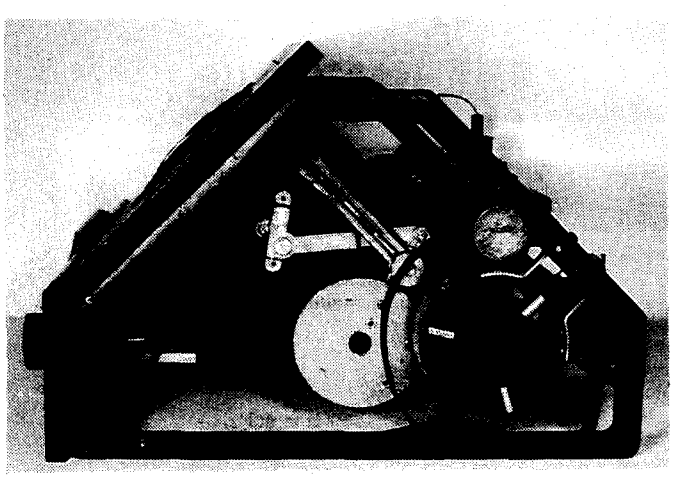
Authentic substitute

Originally, the capacitor had comprised a number of narrow strips of thin brass and mica clamped together. Studying one, I realised that it was almost identical with the internals of the black composition-covered types used at one time by AWA. A 250pF AWA mica capacitor was squeezed with a pair of pliers, and sure enough the coating crumbled away to reveal a 'genuine' RCA capacitor!

An old one megohm, one watt carbon resistor was attached, the pair dipped in red enamel and I had a very realistic replacement. (The RMA resistor colour coding system was not in use in 1925).

Refitting of the audio transformers was easy. The cases were provided with lugs to bolt them together, and the original mounting brackets, which coincidentally had correctly spaced holes for the substitute transformers, were still in position. With the rewound transformers remounted, the loomed wiring was attached to their terminals.

A new battery cable was needed. An essential part of every battery powered receiver, these were made from coloured textile insulated wire with an overall



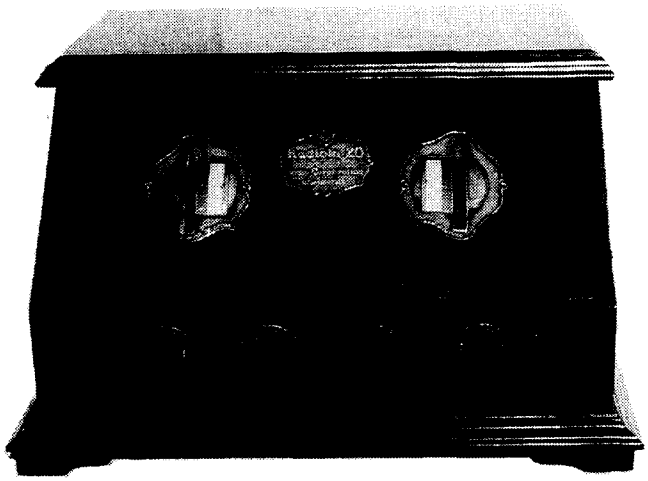


Fig.4 (left): Another view of the RCA 20's unusual construction. At the lower centre is the moveable regeneration coil, with its cranked arm connected to the 'amplification' thumbwheel. Fig.5 (right): Reassembled and with its new lid, the RCA 20 is operational and ready for display.

braided cotton covering. Fortunately, this type of cable is available from specialist suppliers and a two-yard length was obtained and connected. The cotton covering was cut back at each end and protected from fraying by whipping for an inch or so with waxed linen thread.

Substitute valves

Type 199 valves were first in production about 70 years ago and are now scarce, although good used replacements are available at about A$25 each. Obviously, for initial testing at least, it would be prudent to use some valves that are a little less expensive.

UX-based general purpose triodes with similar filament current ratings will operate satisfactorily in a model 20. A practical choice is the more readily available 2.0 volt type 30, which although having a 40% greater amplification factor than the 199, has similar bias requirements. Similarly, the type 31 is a plug-in replacement for the 120. Of course, the filament voltage should be reduced from 3.3 to a maximum of 2.0.

When using type 30 valves, reducing the detector HT voltage may give a smoother regeneration control. Other suitable valves are the Philips A409 in place of the 199 and the B405 replacing the 120.

With a set of type 30 and 31 valves in the sockets of my receiver, a horn speaker was plugged into the speaker jack. As reversed connections to a horn speaker will reduce the strength of the magnets, a check was made that the positive speaker lead was connected to the jack sleeve. An outside aerial and a good earth were connected. Unlike later practice, the earth terminal in an RCA 20 is not connected internally but must be connected separately.

The battery eliminator described in *EA* for March 1990, and also in my book *Discovering Vintage Radio* is ideal for this type of receiver. With the eliminator connected and the filament and bias voltages adjusted, the receiver was switched on. It worked, but the RF stages were unstable. It was clear that re-neutralisation would be necessary.

Neutralising

Triode tuned RF amplifiers are inherently unstable due to the internal grid-plate capacitance, and various methods were used to stabilise them. Series grid resistors were popular, but the best method was *neutralisation* as used in the RCA model 20. In effect a bridge circuit is arranged, so that the feedback via the grid-plate capacitance is balanced by an out-of-phase signal fed back to the grid via a small adjustable capacitor.

Although detuning and decreasing the filament voltage may help stabilise the RF amplifier stages in receivers of this type, correct neutralisation is essential for full performance. There are no short cuts, and hit and miss methods will not work. In any event, the basic method is simple enough. With a cold valve in the socket of the stage being balanced, the neutralising capacitor is adjusted to give *minimum* output.

The receiver was carefully tuned to a strong mid-band signal, with the regeneration control set well back. Then a dummy valve was prepared. The time-honoured instruction was to saw off a filament pin of a good valve! No one would do that today, but the same effect can be achieved by temporarily covering one filament pin with thin cellulose tape, so it is insulated.

With the dummy valve in the first RF socket, there was still some output from the speaker. The neutralising capacitors, similar to the more familiar mica trimmer, are mounted on the rear of the valve shelf. With a non-metallic screwdriver, the end capacitor was adjusted for minimum output. This adjustment is quite sharp and positive — a real 'null'.

The same procedure was then repeated with the second RF stage, using the other neutralising capacitor.

Now the receiver was stable and its performance much improved. All that remained was to fit it back into its case, producing the fine restored set shown in the photo of Fig.5. ❖