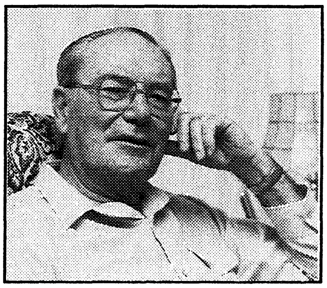

When I Think Back...

by Neville Williams

The Tropadyne and Ultradyne: Two significant variants of the early battery-powered superhet

I wasn't really surprised when a rhetorical question in the November '92 column, 'What on earth is a Tropadyne?' prompted a reply from a couple of readers (see May '93, page 40). More surprising was the fact that the Tropadyne turned out to be one of two configurations that provided notable options in the design of 1920's-style battery-powered superhets. Further circuit details have come to hand, and are presented here.

Perhaps I should admit that the original question was not only rhetorical but also tongue-in-cheek; I never expected a technically meaningful answer.

Receivers in the mid-1920's were mostly variations on a common theme: one or more conventional RF stages, followed by a regenerative detector and one or more transformer-coupled audio stages.

The popularity of individual designs varied with perception, price, presentation and performance. Even though a country schoolkid at the time, I recall two configurations that stood out from the above:

(1) The 'Neutrodyne', featuring neutralised (or stabilised) RF stages but otherwise conventional, and

(2) 'Superheterodynes', in which incoming signals were converted to a lower 'intermediate' frequency, at which exceptional gain and selectivity could be achieved.

Both configurations acquired a certain mystique, such that possession of either one — but *especially* a superheterodyne — set its owner apart from other 1920's-style enthusiasts.

Mystique notwithstanding, many designers/suppliers side-stepped both principles, possibly because of patent restraints and/or hesitation about adopting technology that might confuse vendors, customers and local 'experts' alike. However, to keep up appearances, some of them appear to have dreamed up names for otherwise conventional receivers, terminating in the magic syllable 'dyne'.

Reflecting on this, and motivated by sheer curiosity, I reached down my copy of Morgan McMahon's book *Vintage Radio — 1887-1929*, containing a list of receivers current in America during the period 1921-1930. I gave up part way through the 22-page alphabetical file but, as you will note from the accompanying panel, it includes quite an assortment of odd-sounding '-dynes', promoted in the years 1924-26.

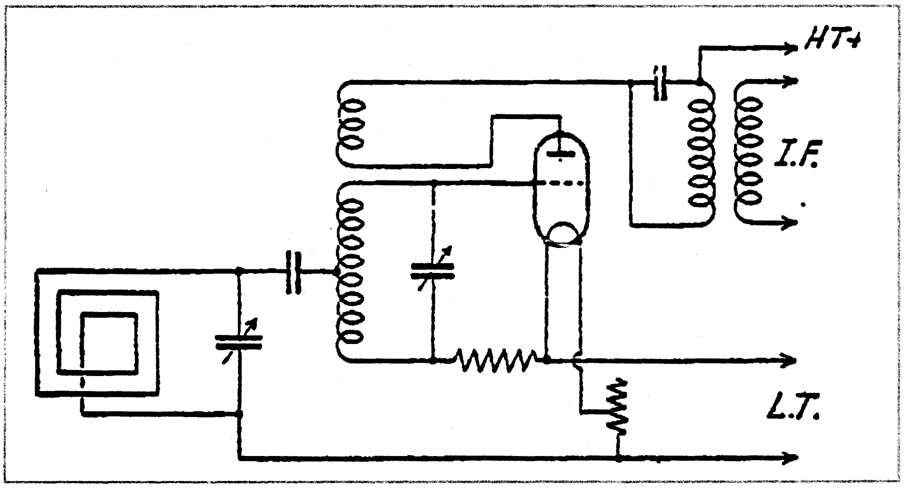

Fig.1: The frequency changer stage in a Tropadyne receiver, reprinted from our May 1993 issue. It was supplied to us, in the first instance, by Michael Eager of Brighton, Vic.

What's in a name?

From what I remember, such patently contrived names didn't cut much ice with the 'bush' wireless enthusiasts that I knew as a lad.

So it was that my initial 'gut' reaction to 'Tropadyne', 70 years on, was to dismiss it as just another meaningless term. According to my *Macquarie Dictionary*, 'troppo', as a colloquial adjective, could even signify a degree of mental unbalance! Of course had I studied the dictionary a little more closely, I would have noticed that 'tropo' (one p) is a word form denoting variation or change.

More to the point, in his *Practical Superhet Book* (Cassell & Co, London, undated) Editor Bernard E. Jones says:

The word Tropadyne is derived from the Greek tropia, to change, and dyne, denoting force; the term referring to a single valve acting both as detector and frequency changer.

(For photostats from the above book, I am indebted to Clem Scott, VK4DW, of Bundamba, Qld).

In short, and as you may recall from the May 1993 issue (pages 40 - 41), the Tropadyne — sometimes spelt tropodyne — turned out to be an interesting variant of the conventional superheterodyne.

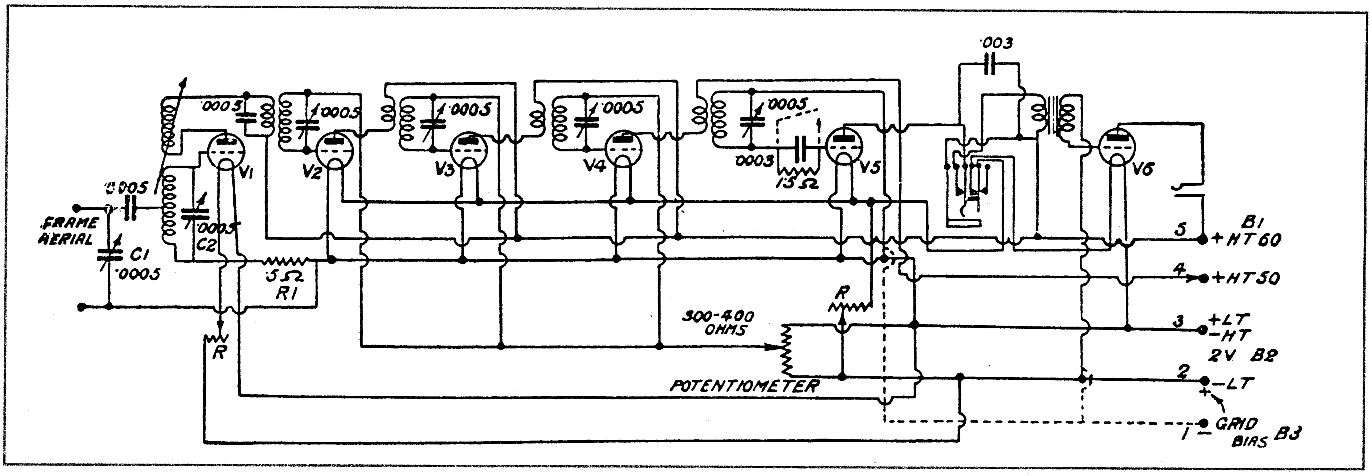

Fig.2: The complete circuit for a typical Tropadyne receiver described for home construction by Bernard E. Jones in 'The Practical Superhet Book' (Cassell & Co Ltd, London).

Whereas early battery-powered superhets required separate oscillator and mixer valves to effect the necessary frequency change, the Tropadyne managed to fill both roles with a single triode — operating in what later came to be known as 'autodyne' mode. As such, it foreshadowed a complete generation of locally mass-produced mains-powered autodyne superhets in the early 1930's, which ushered in Australia's 'Golden Age' of radio.

Unique 'front end'

Fig.1, reproduced from our May '93 issue, illustrates the basic principle of the Tropadyne frequency changer. Further to summarise the original text, the valve functioned as a variable self-excited oscillator by virtue of the tuned grid circuit and an associated anode feedback winding.

A tuned loop (or frame) antenna was connected between the LT supply ('earth') and, through a capacitor, to the mid point of the oscillator coil. Being the nodal point as far as the oscillatory voltage was concerned, very little oscillator signal could be diverted into the antenna circuit, thereby alleviating a radiation problem that bugged most other superhets of the day. Conversely, the top half of the oscillator coil offered a ready path to the grid for incoming signals selected by the tuned loop, thereby allowing heterodyne mixing to take place.

As a matter of interest, in an article on 'Non-Radiating Regenerative Detectors' (*Radio News*, USA, October 1924, p.496), Clyde Fitch pointed out that the Tropadyne input configuration could equally serve to block extraneous radiation from ordinary regenerative detectors which were allowed to oscillate, either inadvertently or deliberately — when copying CW Morse signals.

The same Clyde J. Fitch described a complete six-valve Tropadyne superhet in the August 1924 issue of *Radio News* (USA), made available to me, per photostats, by Don Sutherland of Wanganui in NZ. An accompanying advertisement for a constructional blueprint and booklet described it as a 'new' circuit which is 'spreading like wildfire'. It is also claimed to be 'the only receiver with tunable intermediate transformers'.

In a drop-in panel, the Editor commends the six-valve Tropadyne as equalling the performance of existing eight-valve superhets, because (a) it had obviated the need for a separate oscillator valve and (b) the tuned IF transformers were more efficient in terms of gain and selectivity than the usual 'unequalised' type.

On the subject of radiation, he says that the Tropadyne was virtually radiation-free, 'thereby not interfering with other receiving stations. Most superheterodyne circuits, as is well known, are powerful radiators'.

Consistent with this last statement, Fitch's Tropadyne included a normal tuneable input coil having 29 turns of 20-gauge ssc (single silk-covered) wire on a 3" former. A 20-turn primary spaced 1/2" from the earthy end provided for external antenna and earth connections. On the front panel, a switch/jack was so wired that plugging in a frame aerial substituted it for the coil.

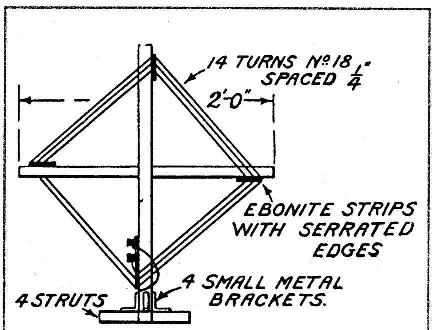

Fig.3: Details of a home-made loop (or frame) antenna. It could be used with receivers other than the Tropadyne.

British circuit

A similar receiver to the above was described for home construction by Bernard Jones in the *Practical Superhet Book*, mentioned earlier. Jones does not discuss the origin of his design, but my tip is that it was inspired by Fitch's article in *Radio News*.

Intended primarily for British experimenters, Jones' six-valve Tropadyne (shown in Fig.2) was marginally more compact than the *Radio News* design, calling for a baseboard measuring 23" x 7-3/4" and a panel of 24" x 7-1/8".

Despite the low oscillator radiation, Jones recommended routine use of a frame antenna (Fig.3) on the grounds that its inherent directivity could offer additional rejection of unwanted signals and noise interference. If the constructor opted instead for a conventional outdoor antenna and earth, he would have to provide a separate antenna coil, housed in a protective box external to the main receiver.

Curiously, Jones offered no guidance as to the choice of valves, beyond evidence from the illustrations that the prototype was fitted with general-purpose triodes with European four-pin bases. Cossor 'Wuncell' valves receive passing mention as one possible option — these were economical dull-emitter types introduced around 1924. (The Fitch version would normally have used the power-hungry American 201-A's.)

As indicated by the slanted arrow on the schematic, the oscillator coil was a variocoupler as shown in Fig.4, connec-

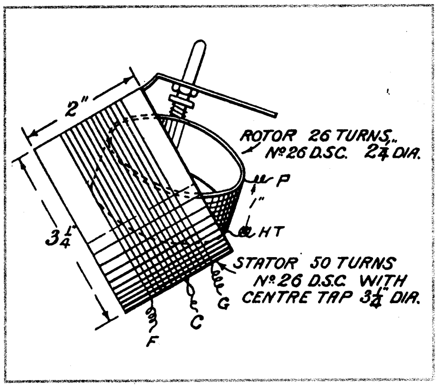

Fig.4: A hand-made variocoupler oscillator assembly by which the intensity of oscillation could be controlled by varying the inclination of the anode winding.

tions being so phased that the valve would oscillate most strongly with the coils set in parallel. Axial rotation of the inner coil would then progressively reduce the amplitude of oscillation, as also would a reduction in filament voltage by operating rheostat 'R'.

Incidentally, the grid return resistor R1 should read 0.5 megohm, rather than 0.5 ohm as shown.

IF transformers

The circuit calls for four IF (intermediate frequency) transformers. Referred to by Jones as 'high-frequency transformers', they could be home-constructed or purchased ready-made as 'Tropaformers'.

Home construction involved fabricating four ebonite cheeks for each transformer, and cementing them onto an ebonite tube so as to accommodate two bobbin windings as shown in Fig.5.

All four secondary windings required 1000 turns of 30-gauge ssc wire, preferably layer wound with thin wax paper between layers. The primary windings comprised 500 turns of the same wire, wound in the same direction.

Each transformer had to be fitted with an identical core, comprising thin silicon steel laminations measuring 1/2" by 2-1/4", stacked to a thickness of 1/4", wrapped to a push-fit inside the central tube.

The tuning capacitors shown in the circuit were 500pF mica dielectric types, small enough to fit inside the same housing as the windings and be internally connected across the secondary. Jones says that at 3000 to 7000 metres (100 to 43kHz), dielectric losses are not a problem.

He specifies that each IF transformer assembly should be accommodated in its own box made up from 1/4" fretwood, with internal measurements (approx) 2-7/8 x 1-3/4 x 2-1/8 inches. Each should be lined internally with tinfoil (earthed) to exclude nearby long-wave transmissions, and fitted with terminals in the manner of 1920's-style audio transformers.

By having the capacitor spindles protruding from the top of the box, it was possible to fit each with a 0 - 100 knob to facilitate tuning and subsequent re-setting.

Adjustments, alignment

As we pointed out in the earlier article, by providing for the IF transformers to be adjusted in situ to a selectable frequency, the Tropadyne evidenced much greater deliberation than the average superhet of the day — where the IF ended up at some unspecified frequency, by virtue of fitting somebody's 'matched set' of high frequency transformers.

As it is, those specified for the Tropadyne may provide a valuable reference for vintage radio enthusiasts wishing to recreate an old-time superhet.

The gain and stability of the IF channel depended on the setting of a 300 - 400 ohm potentiometer. Described at the time as a 'Stabiliser', its normal role was to vary the potential of the RF amplifier grids relative to the filament supply.

In this Tropadyne circuit, returning the IF amplifier grids to A-plus would impose a positive bias relative to the negative end of the filament. Grid current would flow, lowering the grid input impedance and reducing the 'Q' of the IF transformers. Any regenerative tendency would be reduced, thereby reducing the gain.

Rotating the control towards the other extreme would have the opposite effect, so that it could behave rather like a regeneration control.

If the Stabiliser could not cope with unduly strong local signals, the loop antenna could conceivably be deflected or detuned. But the Jones receiver offers a further option, possibly adapted from the Fitch circuit.

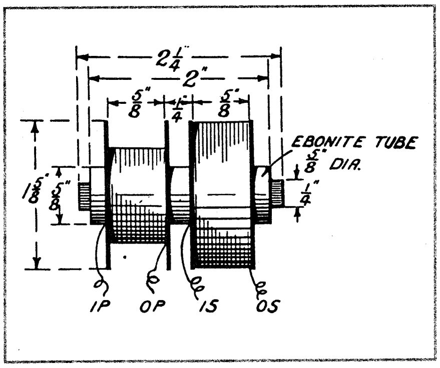

Fig.5: Winding details for a Tropadyne superhet IF transformer as discussed in the text. In the absence of a suitable resonating capacitor, it may be possible to contrive one from an old-style compression type mica 'padder'.

It caught my eye because of the dotted line above the detector grid components — a 300pF capacitor and what I am sure should be a 1.5 megohm resistor (not 1.5 ohms as shown).

If a listener found that the available signals in the area were unduly powerful, the option was to short out the grid components and return the grid circuit (as per the dotted line) to a suitable negative tapping on a 'C-' (bias) battery — typically -1.5V or more. This would change the detector from the traditional 'grid-leak' mode to 'anode bend', reducing its gain but increasing its ability to cope with high-level signals.

The dotted line also suggests the possibility of returning the grid of the output valve to a suitable negative bias, as in the Fitch receiver — a measure which would possibly reduce both distortion and battery drain.

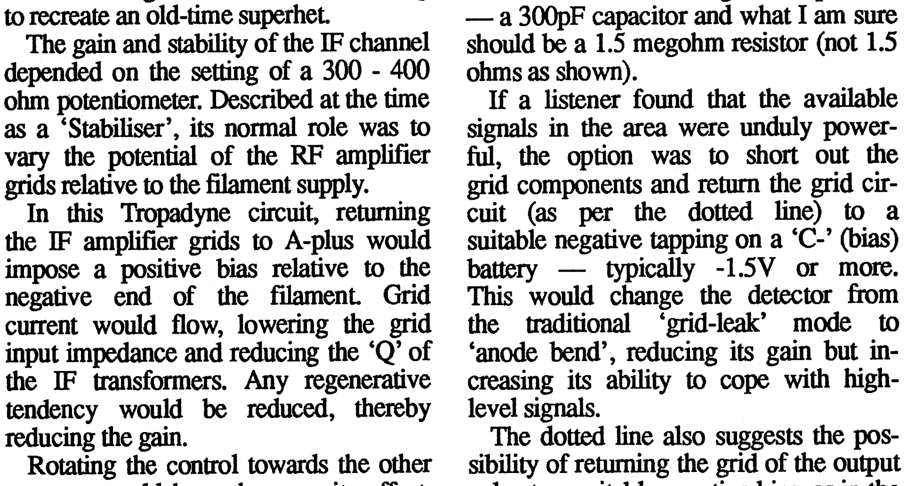

Fig.6: A plan view of Bernard E. Jones' Tropadyne. Note the variometer behind the front panel, between the two tuning capacitors, and the four IF transformers along the back, each surmounted by its own tuning knob.

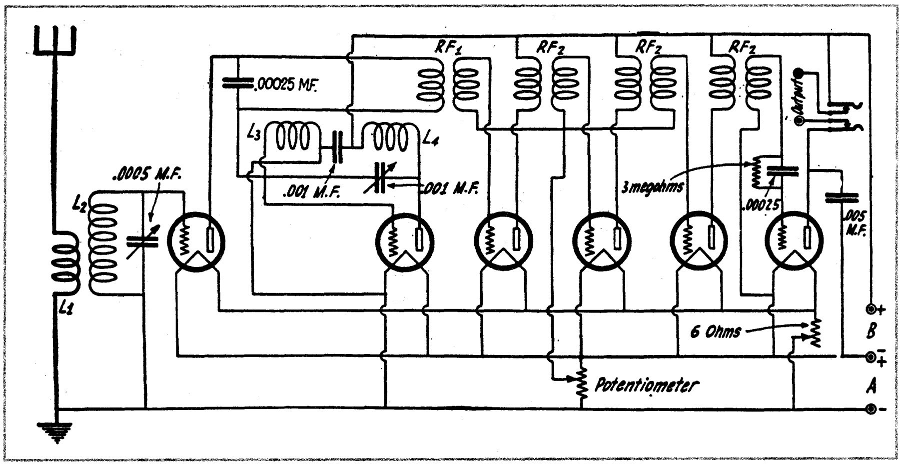

Fig.7: Circuit details of the Ultradyne receiver as described by Robert E. Lacault in the February 1924 issue of 'Radio News' (USA). No audio stages are included.

Whistles & squawks

Fig.6 gives a good idea of what Jones' home-made Tropadyne looked like. He assures his readers that the completed receiver is relatively easy to adjust, but I doubt that those accustomed to ordinary TRF sets of the day would have found it so. In brief, the reader is told to set the main potentiometer at mid position and all HF (IF) amplifier tuning capacitors at about 50°, whatever that means. The frame antenna should also be orientated edge-on to a direction from which signals might reasonably be expected to come. Then:

Set the oscillator coupler at about 20 degrees(?), set the oscillator tuning close to one extreme(?) and rotate the antenna tuning capacitor slowly through its full travel, listening carefully for a possible signal. If unsuccessful, advance the oscillator tuning by about 2 degrees and repeat the process.

A signal may ultimately be encountered accompanied by a 'slight squeak'. If so, turn the potentiometer slightly towards the positive end. When the squeak disappears, tune the signal for best results and try nudging the HF amplifier capacitors this way and that, beginning with the one following the mixer.

The objective is to peak the HF transformers for best results on the weakest audible signal, after which the HF capacitor settings can be left as is, and the settings recorded for future reference.

Meanwhile, persistent carrier squeaks or whistles may hopefully be corrected by adjusting the potentiometer, reducing the oscillator coupling by means of the variometer and/or reducing the value of the mixer grid leak R1.

The listener is advised to record the panel control settings for all stations as they are identified, but there is no mention of the fact that, with such a low IF, certain stations will appear at two quite different settings of the oscillator. Note would also need to be taken of the antenna orientation for individual stations.

One observation, however, left me completely at a loss:

A steady beat note in the receiver indicates a broken connection and this should be traced out and remedied!

In these days, with refined circuits, experience and instruments to hand, frequency conversion, oscillator grid current, circuit tracking, image reception and so on are no big deal. But they certainly would have been for listeners back in 1924, trying to make sense of contemporary superhets by interpreting whistles, squeaks and squawks!

Now, the Ultradyne

The Ultradyne is a further variation of the 1920's-style superhet, described by Robert E. Lacault AMIRE in the February 1924 issue of *Radio News* (USA), for which I am once again indebted to Don Sutherland of Wanganui, NZ. From the date, it would appear to be a near-contemporary of the Tropadyne.

The author R.E. Lacault is said to have spent four years in research work in the Radio Division of the French Signal Corps. As such, he might not have been far removed from where the superhet is claimed by some to have been conceived.

Lacault, it seems, was convinced that there was a more appropriate way to heterodyne two signals in a superhet, than by feeding them both to the grid of a detector/mixer. The incoming signal could be fed to the mixer grid while the oscillator could quite separately modulate the anode supply — an adaptation of what occurred in speech modulated transmitters of the day.

According to Lacault, the potential advantages were a higher modulated output

'Come, dyne with us!'

To illustrate how many variations on names ending in '- dyne' were promoted by receiver manufacturers in the 1920's, here's an extract from a listing given in Morgan McMahon's book *Vintage Radio — 1887-1929*:

A.C.Dayton	'24 Super Polydyne
	'25 XL series Polydyne
Adams-Morgan	'25 Paradyne series
Atwater Kent	'23 Radiodyne
Blue Seak Mfg	'25 Cincodyne
Chelsea Radio	'25 Regenodyne series
Cleartone	'24 Clearodyne series
	'25 Super Clearodyne
Crosley Radio	'24 Trirdyn
De Witt	'25 Reactadyne
	'25 Super Reactadyne
Diva Radio	'24 Superdyne
Globe Electric	'24 Duodyne series
	'25 Duodyne series
	'26 Duodyne
Leutz Corp.	'24 Super Pliodyne
	'25 Universal Pliodyne
	'26 Imperial Pliodyne
Indiana Mfg	'25 Hyperdyne series
Kodel Mfg	'25 Logodyne series
Lytton Inc	'25 Way-O-Dyne
	'25 Super Way-O-Dyne
Magnus Elec	'24 Magnadyne
Metro Elec	'25 Metrodyne
Nassau	'25 Magnadyne

(.....and so on, through the alphabet)

(increased mixer gain) and isolation of the oscillator signal from the grid circuit (decreased radiation). That Lacault attached considerable weight to the latter was evidenced by the fact that he strongly recommended the use of a conventional antenna and earth, even if only a wire strung around the room one foot from the walls and ceiling. Failing a proper earth, a counterpoise could be substituted — comprising a similar length of wire spread out under the carpet.

Fig.7 shows the schematic circuit of Lacault's Ultradyne, relying on what he called the 'modulation system' of frequency conversion. As shown, the incoming signal is fed directly to the grid of the mixer valve, without the usual coupling capacitor and resistor required by a 'cumulative grid' detector.

The anode connects, as normal, to the primary winding of the first IF transformer but is not fed from the B+ line. It returns, instead, to the grid of the local oscillator such that the mixer valve could conduct only during brief, positive-going peaks of oscillator signal. (No wonder they intermodulate!)

The second valve was/is manifestly the oscillator although, even after re-drawing it, I was still unsure as to whether the published diagram was as Lacault would have intended. However, his philosophy is clear enough as also is the fact that, unlike the Tropadyne, there was never any thought of doing without the oscillator valve. Valves three, four and five are general purpose triodes (e.g., 201-A's) serving as IF amplifiers with their bias controlled by a (typically) 400-ohm ('stabiliser') potentiometer.

All four IF 'Ultraformers' (RF1 etc) are wound as three 'pies' supported by nonmetallic cheeks and washers, held together by a central bolt and mounting bracket. (Pictured in Fig.8). In each case, the secondaries comprise 1100 turns of 30-gauge dsc (double silk-covered) wire, comprising 550 turns in each of the outer slots, wound in the same direction and connected in series.

The primary of RF1 comprised 300 turns of 28g dsc wire wound into the centre slot and shunted elsewhere with a 250pF capacitor. In RF2, RF3 and RF4 the primaries, also wound in the centre slot, comprised 500 turns of 28g dsc wire.

Without shielding, iron cores and provision for external tuning, the ultraformers would have lacked the refinements of the tropaformers described earlier and, by inference, its potential

Fig.8: This advertisement from the April 1924 issue of 'Radio News' (USA) offered detailed constructional information for the Ultradyne, presumably modified to provide for audio amplification and loudspeaker operation.

gain and selectivity. Except for the 'unequalised' (untuned) ultra- formers, the setting-up routines would have been no less confusing than for the Tropadyne. Be that as it may, Lacault is lavish in his praise of the on-air performance of the Ultradyne, as judged on headphones in his New York apartment.

To operate a loudspeaker to advantage, he concedes that one or two audio stages would need to be added, plus extra battery power, bringing it up to the phyical proportions of conventional seven or eight-valve contemporary superhets.

To sum up, both designs reflect a considerable degree of initiative. But as '-dynes' go, and despite the enthusiastic backup by the Phenix Radio Corp, I'd have to rate the Fitch/Jones 'tropa' ahead of Lacault's 'ultra'! ❖