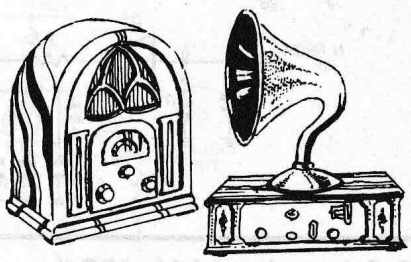
Vintage Radio

by PETER LANKSHEAR



The Kolster-Brandes 930 amplifier

As a change from radio receivers, let's look at a vintage 'hifi' amplifier. The model 930 was built in the USA in 1929 by Kolster Engineering, and used in American Columbia phonographs of the day.

In 1888, Emile Berliner patented the flat, laterally cut gramophone recording, which, unlike the earlier Edison cylinder, could be readily mass produced. Subsequent development of the gramophone has seen steady progress interspersed with significant improvements, each one regarded as a major step towards 'ultimate' reproduction. These landmarks include exponential horns, electrical recording and reproduction, magnetic tape mastering, microgroove, stereo and now digital recording and compact discs.

Important development

Radio broadcasting, the wonder of the 1920's, had serious repercussions on the recording industry. However, the same electronic technology which created broadcasting was used by the recording companies to mount a counter attack. The result, electrical recording, was a most important event in the evolution of disc recording.

For nearly 50 years following Edison's original patents, recordings were cut by the direct action of sound on a diaphragm and stylus. Reproduction was a reverse process. These acoustic recordings were very restricted in frequency response and full of resonant peaks. But by 1924, electronic recording was being successfully demonstrated and in 1925 the Bell Telephone Laboratories introduced the Western Electric system which, with a frequency response of 50Hz to 5kHz, was quickly adopted by many recording companies.

Initially, domestic users of the new 'electric' recordings continued to play them back on acoustic gramophones, but the introduction of mains powered amplifiers enabled major companies like HMV, Columbia, Brunswick and Victor to market gramophones incorporating amplifier driven moving coil speakers. The amplifier and loudspeaker from one of the early American Columbia phonographs are the subject of this story.

'State of the art'

Built in the USA 60 years ago by Kolster Engineering for the Brandes Corporation, the equipment used in the Columbia Model 930 is worth some study as an example of early technology in audio design.

The two-stage amplifier used transformer input coupling to a type '27 triode, itself transformer coupled to a pair of '45 output valves.

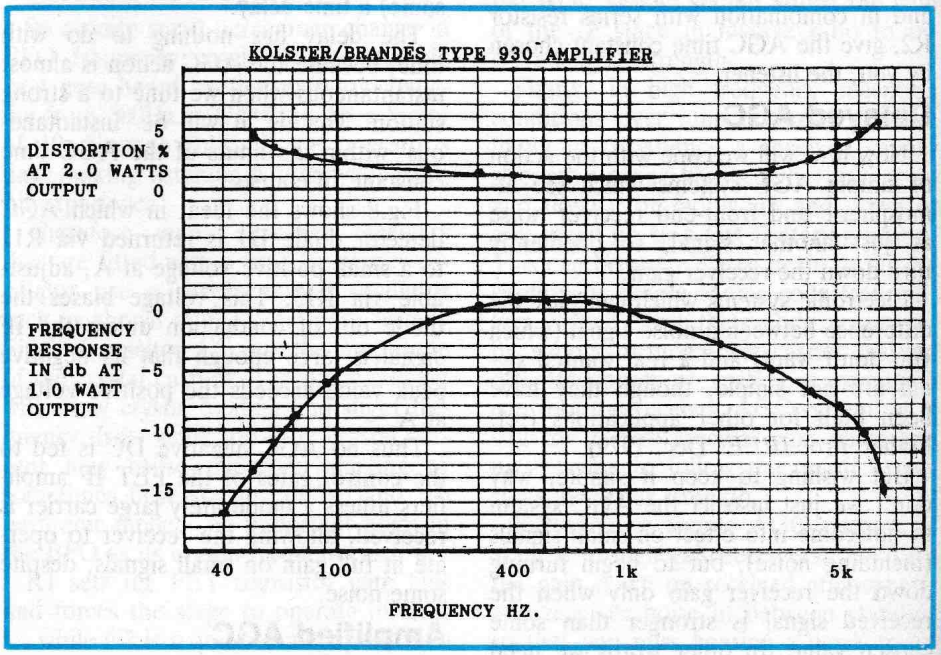
Three audio transformers for a two stage amplifier may seem a bit much, but as the amplification factor of a '27 valve was only 9 and that of the '45 a mere 3.5, much of the necessary gain, demanded by the pickup output of about a volt, came from the input and interstage transformers. Their turns ratio of 4:1 was regarded as the maximum that could be achieved with acceptable quality using unsectionalised windings – although by today's standards, their performance would be quite inadequate.

Hi tech filtering

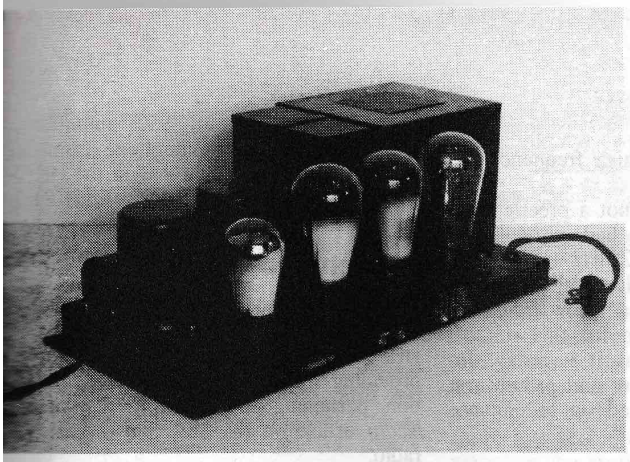
Electrolytic capacitors were not in general use prior to 1930, and some clever technologies were used to achieve satisfactory hum filtering with low capacitance paper capacitors.

In this case, the unfiltered current from the rectifier was fed to a tapping on the filter choke, with the main portion of the winding acting as a conventional filter. The remaining section of the winding was connected to earth via a 2.0uF capacitor – to form a series tuned circuit, resonant at the hum frequency of 120Hz (for a 60Hz mains supply). This induced a magnetic flux that had a 'bucking' effect on the hum component in the main winding.

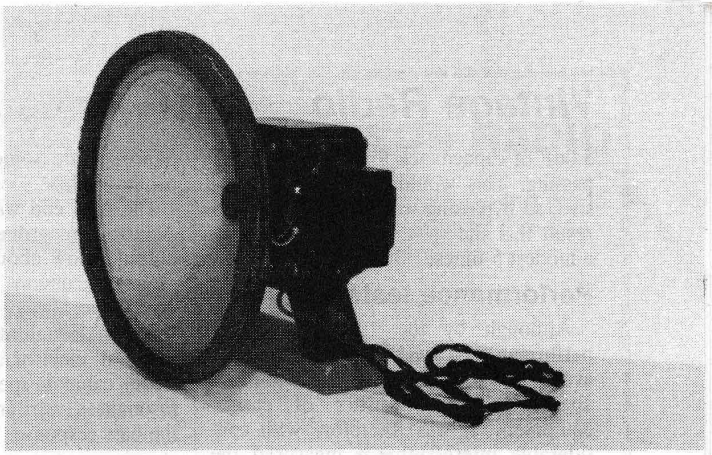
Despite the main filter capacitor being only another 2.0uF unit, the hum level



The author's measurements revealed these performance curves – good for the time. Note that there was no overall negative feedback.



With only the wiring and two small resistors underneath, the amplifier needed only a very shallow chassis. All capacitors were in the smaller rectangular box.



For its day, the 12" loudspeaker was progressive, with the centring 'spider' behind the zinc sputtered cone. Note the output transformer on the side.

at about –50dB was quite satisfactory by the standards of the day. Some American mains supplies were 25Hz at the time, and the choke was tapped to allow for this.

Advanced speaker

Loudspeakers in high grade record reproducing equipment have always been 'state of the art' and the Kolster 12-inch moving coil unit is no exception.

The first practical moving coil loudspeaker had been introduced by RCA in 1925, but it had only a 6-inch cone. As steels capable of providing sufficient flux for permanent magnet fields did not exist, the use of electromagnets was standard. However the inclusion of field windings in the HT supply for hum filtering of the output stage was not common before 1930.

Instead, it was general for the field to form part of the voltage divider and bleeder system. In the Kolster amplifier the field winding, along with a 0.5uF capacitor, does provide some filtering of the HT supply to the '27 amplifier stage.

The speaker cone is interesting, being made from zinc sprayed fabric. Early centring 'spiders' were normally in the front of the cone. Kolster were advanced in using the more compliant rear mounted spider, but it is unusual in that it was made of thin brass. Modern suspensions are, of course, made of plasticised fabric, the open spider having long since given way to a corrugated disc.

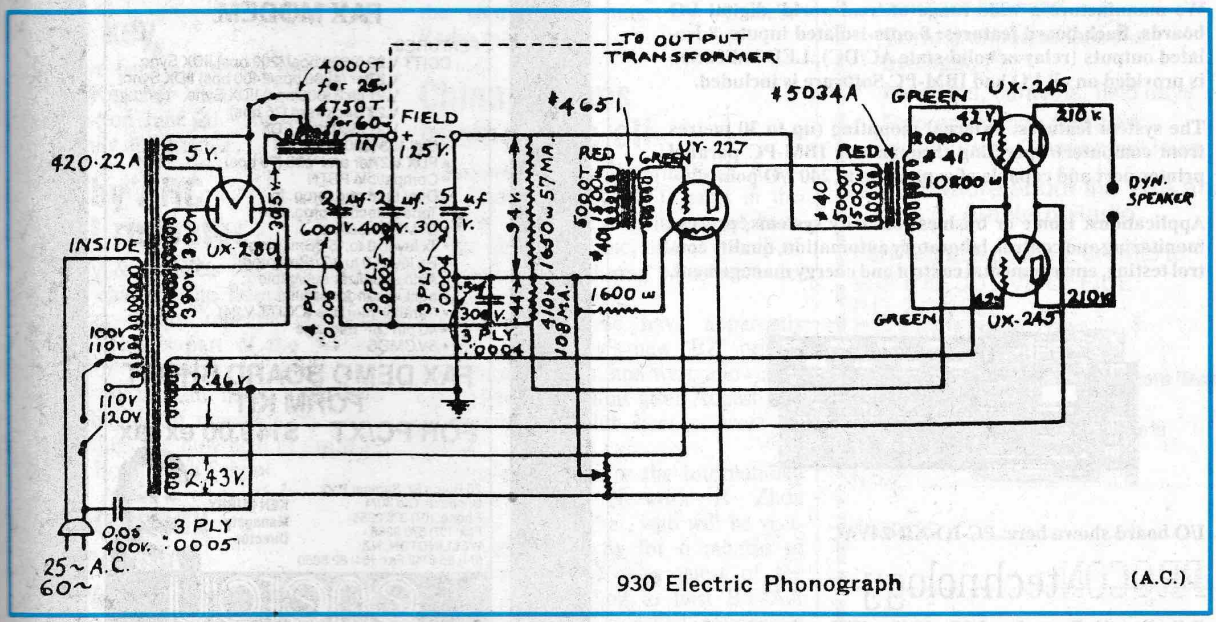
Novel features

An uncommon feature of the circuit diagram is the listing of 'plies' for the capacitors.

At the time, the working voltages of paper capacitors were governed by the number of plies or layers of dielectric paper. Each ply of .0005" was rated at about 200 volts DC, but as paper is liable to have random pinholes, an extra ply was included for safety.

Note also that resistance values are shown using what appears to be a 'w' symbol. This is an obsolete use of the lower case Greek letter Omega (ω) instead of the modern use of the upper case symbol (Ω).

The 1600 ohm cathode bias resistor for the '27 would have needed at least



Copied from an elderly manual, the circuit is rather rough but shows how the valves were used. Note the 'ply' ratings for the capacitors, and the novel series-resonant filtering system.

5.0uF of capacitance for satisfactory bypassing. This would have been expensive, so bypassing was ignored, with the result that the valve gain was halved to a modest 5 times!

Performance tests

Although by the 1950's, amplifier performance curves were frequently available, very little has been published about the characteristics of earlier equipment. It was, therefore with considerable interest that I measured the performance of the 930. Measurements were made with an AWA self-zeroing Distortion & Noise Meter, connected across a 6 ohm resistor replacing the speaker voice coil. Signal source was an AWA Audio Oscillator connected through a 10k series resistor.

The poor frequency response results from the use of simple winding configurations in the audio transformers. Later valve amplifier designs incorporated elaborate transformer winding configurations and resistance coupling.

There was no point in extending the response above the recorder limit of 5kHz. In fact, the high noise level of shellac recordings and pickup resonances made some high frequency roll off desirable.

The bass end was not a precise area. Acoustic recordings had virtually no output below about 250Hz and to limit groove excursions, electrically recorded discs have always had a low frequency roll off. Equalisation for this roll off was not electronic as it is today. Instead, cabinet, speaker and pickup arm resonances were relied on to enhance the bass response.

Low distortion

Recordings, pickup and loudspeaker would each have created more distortion than the amplifier, a situation that exists to this day. My measured power output of 2 watts at less than 1% distortion into the load resistor is a very good performance and corresponds closely to the theoretical maximum for push-pull class A operation of a pair of '45's.

Note that this amplifier was produced before the use of overall negative feedback for flattening frequency response and reducing distortion and noise.

For reference, at 210 volts HT a single '45 was rated to produce 1.0 watt at 5% distortion to the primary of the output transformer.

The Kolster/Brandes 930 amplifier shows clearly that gramophone reproduction has come a long way in the last 60 years. Who knows what the next 60 years will bring?

Welcome feedback

I am indebted to well known radio historian Mr Winston Muscio, who was an STC Engineer from 1933 to 1980, for providing me with additional information pertaining to the April *Vintage Radio* article on the STC 506 portable radio.

In July 1939, the 506 was in fact superseded by a 1.4 volt portable, the 510, using British made Brimar rather than Australian or Raytheon valves.

The 510 was featured and very favourably reviewed in *Australasian Radio World* for July/August 1939. Pictures show a cabinet much in the style of the 506, but about half the height (and with it a very youthful Winston Muscio).

Thanks gain for that further information, Mr Muscio. And if other readers have additional information on any of the equipment discussed in this column, please don't hesitate to write to me, care of *EA*.