Acrosound Output Transformers

Until such time as an amplifier can be coupled to a loudspeaker without the use of an impedance matching device such as a transformer, the output transformer will continue to be the single most important component in an audio amplifier. Obviously, the frequency range of the system cannot exceed that imposed by the transformer; the power capabilities cannot be greater than the transformer permits; the distortion cannot be lower than that inherent in the transformer; the overall fidelity must be bounded by the limitations set by this one critical item.

The ideal transformer must have many requisites. For push-pull design it must have extremely accurate reactive balance between the primary halves so as to maintain true out-of-phase operation throughout a very wide frequency band. Its inductance must be high even at low flux densities in order to provide full bass response even at the lowest volume levels. It must have sufficient core material to avoid saturation and consequent low frequency distortion and response droop at high levels. It must have low leakage reactance and close coupling to give full undistorted high frequency response. Lastly, its design should minimize phase shift so that degenerative feedback can be carried from secondary winding to an early stage in the amplifier without introducing instability even outside the useful audio range.

There can be no compromises with the above characteristics if high fidelity reproduction is the goal. The term "high fidelity" has many definitions, but when we of Acro Products Company speak of fidelity reproduction, we have one unequivocal meaning in mind — a high fidelity amplifier is one in which the signal at the input is reproduced at the output at any level within the power rating of the amplifier without noticeable change. This fidelity can only be achieved through use of an output transformer with unusually high capabilities and amplifier circuits of sound design.

It is a common misconception that the use of negenerative feedback will improve the characteristics of a transformer. This fallacious thinking is based on the idea that sufficient feedback will flatten the response curve and extend the frequency range of a transformer. Uufortunately, this is done at the expense of distortion, and it is simple to indicate how this happens.

First of all, when frequency response is limited and feedback is used, there is less voltage fed back at the points in the audio spectrum where response is down than at midfrequencies. At the edges of the pass band, the amplifier must deliver more power than at middle frequencies in the attempt to level the response curve. This has a serious consequence. For example, a 10 watt amplifier which is down 3db at 30 cps must deliver the same output voltage as would be necessary to produce 20 watts of power at 30 cps when feedback is used in an attempt to equalize the low frequency output. Even transformers which show flat response curves, do not necessarily deliver as much power at low and high frequencies as in the middle range. In fact, only the Acrosound transformers deliver *full* rated power at 20 cps. If the transformer is the cause of the original loss of low frequencies, it cannot possibly deliver higher output at those frequencies without a considerable rise in distortion. These considerations hold also for high frequencies, and thus, feedback around a transformer with limited response increases the low and high frequency distortion — just at the points where distortion is most noticeable and most irritating to the discriminating listener. The muddy bass and shrill treble which is characteristic of many amplifiers at high levels is directly attributable to this factor.

In addition, the same factors which cause limited frequency response are also the causes of excessive phase shift and limited power range. When phase shift is present in large degree, the signal fed back is *in* phase at some frequencies instead of 180 degrees out-of-phase. Therefore, only a small proportion of feedback can be used before motorboating or squealing is experienced. The benefits of feedback cannot be fully realized in that case. It is impractical to attempt to use the amplifier with the maximum feedback — the threshold beyond which instability appears. If this is attempted, transient instability occurs, and the amplifier distorts under dynamic conditions even though its steady state measurements may seem satisfactory.

It may seem surprising that even though the critical frequency band for audio use extends from 30 cps to 15 kc, it is necessary for the output transformer to pass a band essentially flat from 10 cps to 40 kc. One of the reasons for this is the necessity for feedback even with triode amplifiers if really high fidelity is sought. The wide transformer range minimizes distortion at the edges of the effective audio spectrum when feedback is used. Then too, inaudible high frequencies will beat together in the ear to produce audible beat notes. This factor adds "presence" to musical reproduction which has inaudibly high overtones that indirectly contribute to audible realism in reproduction.

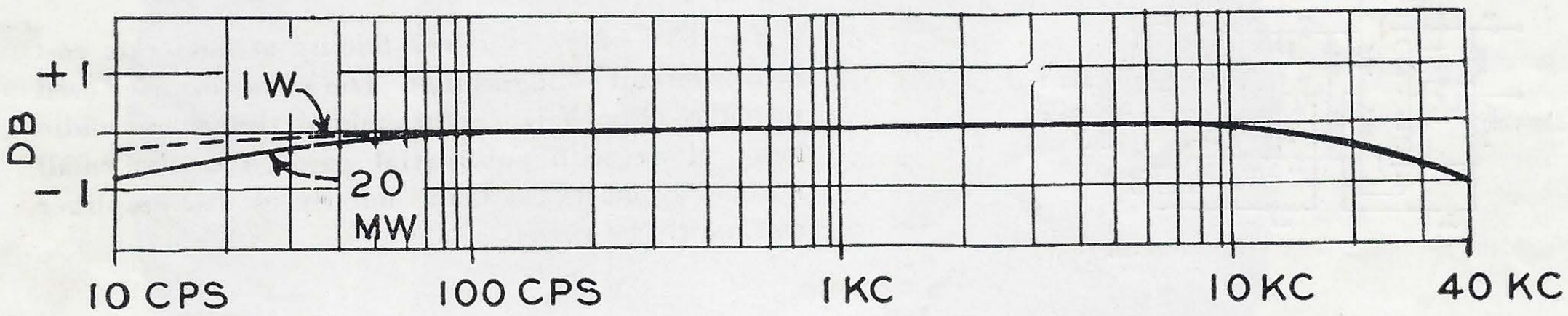
Another justification for wide frequency range is that it goes hand in hand with low phase shift. When excessive phase shift is present, it disturbs the harmonic structure of complex sounds and consequently changes the attack and decay time with resultant loss of fidelity under conditions of dynamic operation.

For all of the above reasons. even though speakers cannot reproduce the supersonic or subsonic regions, nor can the ear hear them, they must be represented in order to achieve high fidelity. Amplifiers can be built to present a wide band to the output transformer. It is the transformer which has always been the stumbling block to optimum reproduction. Even the transformers which claim response from 20 cps to 20 kc may have a fairly sharp cutoff at each end of this range so that feedback difficulties are encountered. In addition, their power handling capabilities generally start to droop at 100 cps and 10 kc or even less. This latter difficulty means that at high levels, or when bass or treble boost are used, the distortion is high within the critical range.

For years there has been need of a really outstanding output transformer. The first Acrosound transformers were designed with the objective of obtaining high fidelity regardless of cost. A truly outstanding unit was evolved which was satisfactory for the most critical laboratory work. However, it was realized that for most professional uses, and particularly for home use, there was definite need for a unit that could be mass produced at a reasonable cost. Present prices of high fidelity transformers are high and discourage their use. There is a demand for a modest cost item which is better than any commercially available.

Naturally, in a competitive market every manufacturer has been seeking quality at reduced costs. This new Acrosound series has reached that goal at the culmination of more than two years of development research in which new principles of transformer design were invoked. These transformers represent a radical departure from conventional designs and feature a symmetric coil structure that provides a new high in performance. No sacrifices have been made in quality, but the new design in conjunction with a policy of utility styling without unnecessary frills, has permitted prices within the reach of all audio enthusiasts, both engineers and experimenters who desire the best.

FREQUENCY RESPONSE



Above is the frequency response curve of an average transformer of this series. This curve was measured with the transformer matched in rated primary and secondary impedances. The transformer response can be further extended several octaves in each direction through the use of degenerative feedback. Therefore, it is obvious that these units lend themselves to any applications calling for an exceptionally wide band width. Further it can be seen that the response is still excellent even at as low a level as 20 milliwatts, the lowest listening level commonly used.

In addition to this outstanding frequency response, the Acrosound transformers feature the following characteristics:

POWER CAPACITY is rated at 20 cps, and all units deliver *full* rated power over the 20 to 20,000 cps band. This conservative rating should not be interpreted as a maximum rating. Actually, the transformers will handle double the rated power throughout the middle frequency range.

PHASE SHIFT is sufficiently low to permit over 30 db of degenerative feedback to be carried *around* the transformer without instability. The principle limitation on the permissible amount of feedback is not the output transformer, but the number of stages and the phase shift in the interstage coupling networks.

TRANSIENT RESPONSE is excellent as determined by the negligible distortion of a 20kc square wave passed through the transformer.

MODELS

12.5 Watts (approximate weight 5 lbs.)

TO-240	4,000 ohms	net cost $9.75
TO-250	5,000 ohms	net cost $9.75
TO-260	6,000 ohms	net cost $9.75
TO-270	10,000 ohms	net cost $9.75

25 Watts (approximate weight 6 lbs.)

TO-230	3,000 ohms	net cost $12.50
TO-280	9,000 ohms	net cost $12.50
TO-290	12,000 ohms	net cost $13.75

(Prices Effective October 15, 1950 and Subject to Change Without Notice)

All units have push pull primaries and secondaries tapped for 4, 8, and 16 ohm voice coils. Other primary impedances and different power ratings can be furnished to special order. Prices will be quoted on special items on request. Line windings (125 and 500 or 150 and 600 ohms) can be added to all units at an additional $6.00 net cost.

Units have 10 inch leads color coded as indicated in schematics shown on following page.

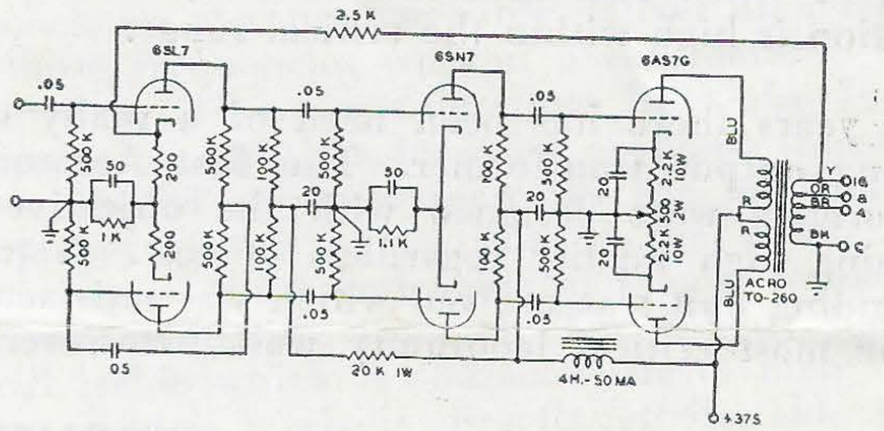
Above prices are for units in standard end bells. At an additional net cost of $2.00 per unit, the transformers can be furnished fully potted in a seamless steel case in silver gray hammertone finish.

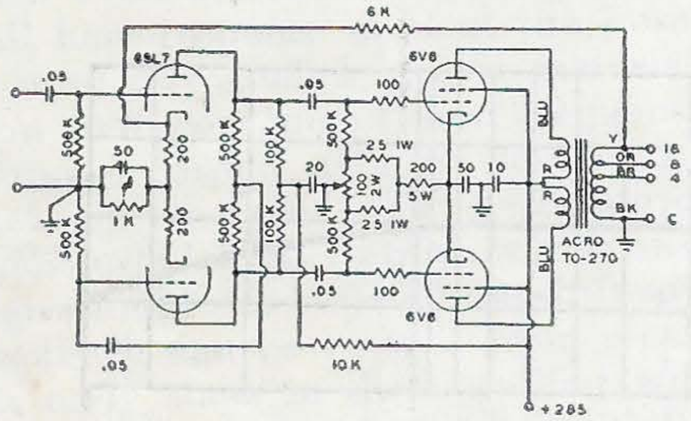
Suggested Circuits

These circuits illustrate some applications of this new line of transformers. They are all bug-free, and they provide a standard of performance which is difficult to excell. The response of these amplifiers is substantially flat from below 5 cps to over 80 kc. Within the 20 cps to 20 kc range, they will deliver full output with undetectable harmonic or intermodulation content. On measurements of all types they show up amazingly well, and in addition they will satisfy the subjective listening of the most critical observer. These are not the only circuits which could be used, of course. Any wide range, low distortion circuit which is basically stable and has balanced push pull stages will perform equally well with Acrosound output transformers.

TO-260

The potentially excellent 6AS7 has been shunned by many constructors because of the difficulties of driving it without an interstage transformer. In this circuit, the push pull driver and the application of inverse feedback permit ample output at low distortion levels.



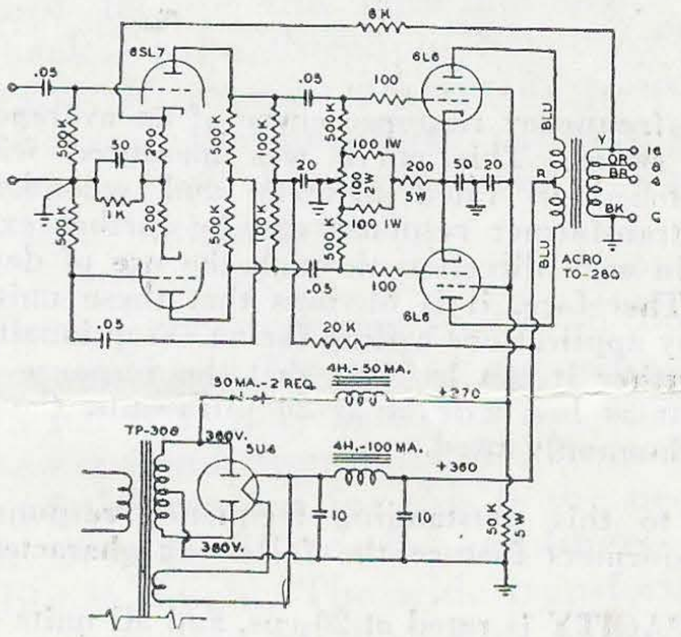


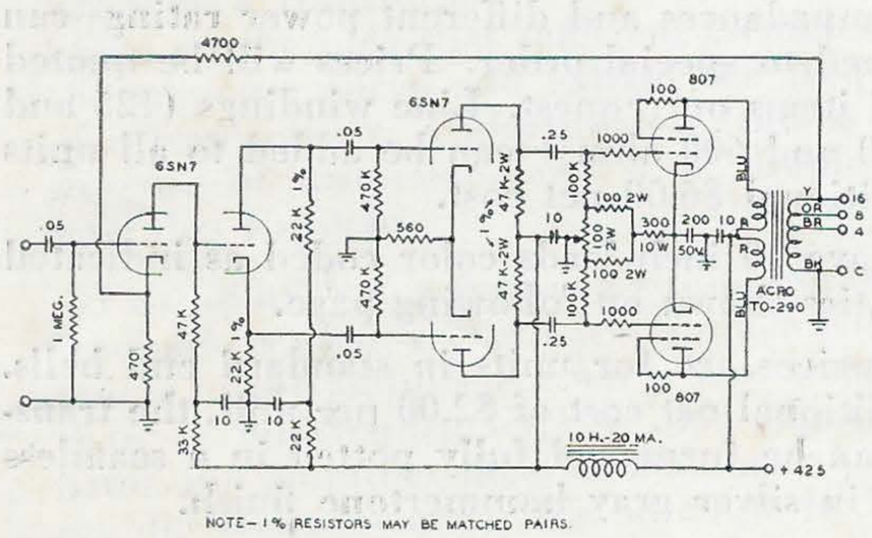
TO-270

The 6V6 offers excellent fidelity at moderate cost in this circuit configuration. The phase inverter used provides close balance throughout the entire audio band along with substantial gain. For the small number of parts used, the fidelity of this amplifier can hardly be surpassed.

TO-280

For those who prefer beam power output tubes, this 6L6 circuit offers excellent possibilities for high fidelity along with greater efficiency than triodes permit. An ingenious method of supplying the screens from a low impedance source with good regulation is an important factor in the excellent performance obtained.





NOTE—1% RESISTORS MAY BE MATCHED PAIRS.

TO-290 Williamson Circuit

This circuit is that designed by D. T. N. Williamson and described in Wireless World (August, 1949). This version has been adapted to use American components; but aside from the approximate 12 watt limitation on undistorted power, it realizes the full capabilities of the original circuit which has been universally acclaimed as one of the best ever heard.