

TRANSFORMERS



QUALITY



RELIABILITY



The UTC organization consists of a group of specialists who have achieved an international reputation as designers and producers of quality transformer equipment.

The most modern equipment available is used in the production of UTC transformers. Both raw materials and finished units are kept under continuous engineering control to assure final perfection.

Transformer users are invited to bring their special problems to the UNITED TRANSFORMER CORP., where the services of a qualified technical staff, plus a fully equipped audio and research laboratory are available.

Bulletin U1100C

UNITED TRANSFORMER CORP.

72 - 78 Spring Street

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New York, N. Y.

ENGINEERING

UTC takes great pride in the fact that most of the modern developments in quality audio transformers have been perfected by its engineering staff. Among these developments are included the high permeability cast shield — the true hum balancing coil structure — the balanced variable impedance line which permits high fidelity response on every tap of a universal unit — the reversible mounting facilities — the separate ground terminal to assure positive connection to internal electrostatic shielding — and numerous other developments on which patents are pending.

This same type of research and development is being done every day on special units to fit specifications and problems of UTC's customers. The UTC research laboratories and staff are at your disposal. We suggest you make use of them.



audio amplifier laboratory — In this section of the UTC laboratories, the development of transformers and amplifiers for public address and broadcast use is done.

audio applications laboratory — Part of UTC service consists of the rendering of assistance to customers in the development of their own devices. UTC has helped develop mechanical toys, motors, amplifiers, recording machines, microphones, transmitters, etc. This service is at your disposal.



filter development laboratory — This division of UTC has developed some of the finest high Q coils and precision audio and carrier filters ever produced in this country. Inductors, filters and equalizers are designed and checked here to exact customers' specifications.

high power testing — This test position permits high potential breakdown tests up to 125,000 volts with stepless voltage control through the use of an induction regulator. In addition, a 500 cycle generator is used to obtain up to 300% over potential tests on transformers by direct application to the transformer primary. Loading facilities are available for loads up to 100 KVA.



PRODUCTION

The most important factor in the maintenance of UTC's high standards of quality, dependability and service, is the strong co-ordination between engineering and production departments. Every step of production is checked by thorough engineering tests from the receipt of raw material to the shipment of the finished product. Tests on raw material include electrical test of magnet wire and sheet steel before use in production and chemical check on all paper and gummed products. Tests on completed units include check for shorted turns, inductance, ratio, breakdown, overpotential test, resistance, and on Linear Standard audio components complete frequency run and hum pickup test.

vacuum impregnation — one of the UTC impregnating sets, where UTC components are fully safeguarded against adverse humidity and climatic conditions. This is the finest electrically heated and controlled equipment of its type available. Impregnation is so thorough that UTC coils can be cut through the center with a band saw and not one particle of insulation or wire will be found free of the impregnating material.



tool and model shop — Mechanical work required for Special UTC units and new UTC developments is taken care of here.

dies — over 2000 Dies and jigs are available to take care of special customers' requirements. More than 100 shapes of laminations alone are available for use in UTC products.



coil winding — One of the groups of winding machines at UTC. As many as 12 fine wire coils can be wound at one time on these machines and wire as small as number 46 can be handled. The combined facilities of the winding equipment at UTC is capable of winding over 30,000,000 feet of wire per day.



FOREWORD

Present day communications and broadcast development is characterized by an ever increasing use of wide range high fidelity equipment. The point has been reached where the sole factor governing the frequency response of matching and amplification equipment is the fidelity of the transformers used. It was this fact which started the development project which culminated in the present UTC Linear Standard audio transformer. Some of the problems encountered and their solution are described below. Not to make this description burdensome, the technical matter has been simplified as greatly as possible.

The object of this development was the production of an ideal audio transformer line. Naturally, the first step was the actual determination of the factors making up an ideal transformer. These were readily enumerated as follows:

- (a) Uniform frequency response over the entire audio range.
- (b) Negligible wave form distortion.
- (c) High efficiency.
- (d) Thorough shielding; both magnetic and electrostatic.
- (e) Positive reliability.
- (f) Flexibility.

Before going further into the analysis of these factors, it is desirable to actually consider the functions of a transformer in audio circuits.

FUNDAMENTAL TRANSFORMER

Inherently a transformer is a device presenting a means of transferring power from one circuit to another without any direct connection between these circuits.

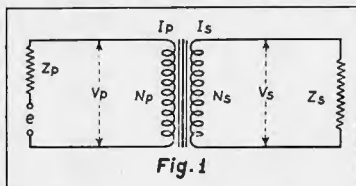


Fig. 1
Electrical circuit of an ideal transformer, with 100-percent efficiency.

In simple form, we illustrate in Fig. 1 an ideal transformer; that is, a transformer having 100 percent efficiency. In such a case the power delivered to the input will equal the power taken from the secondary, or:

(1)

$$V_p I_p = V_s I_s$$

As is well known, the voltage ratio of a transformer is directly proportional to the turns of the respective windings; that is,

(2)

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

combining (1) and (2), we obtain

(3)

$$\frac{I_s}{I_p} = \frac{N_p}{N_s}$$

From Ohm's law we know that

(4)

$$V_s = I_s Z_s$$

we can substitute (2) and (3), obtaining

$$V_p \frac{N_s}{N_p} = \frac{I_p N_p}{N_s} Z_s$$

Therefore

$$\frac{V_p}{I_p} = Z_p = \frac{(N_p)^2}{(N_s)^2} Z_s$$

This result indicates that the impedance ratio of a transformer is directly proportional to the square of the turns, and is the base upon which all impedance matching is done in audio transformers.

EQUIVALENT T NETWORK

Unfortunately, in practice, transformers which are 100 percent efficient are not obtainable. A physical

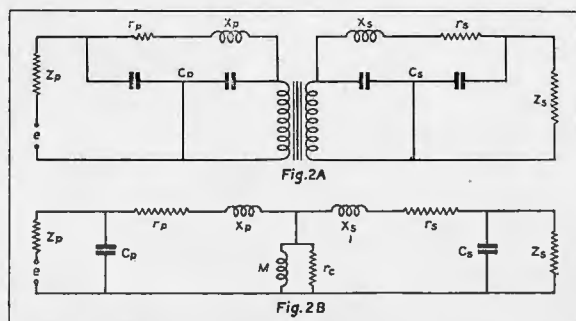


Fig. 2A illustrates a physical transformer. In Fig. 2B is shown the equivalent T network of the same transformer.

transformer is illustrated in Fig. 2-A and its equivalent T network in circuit is shown in Fig. 2-B. Here R_p and R_s are respectively the primary and secondary resistances; X_p and X_s are respectively the primary and secondary leakage reactances; C_p and C_s are respectively the distributed capacitances of the primary and secondary and their attendant circuits. In a physical transformer, M is not infinite, as some current is taken through the primary circuit with the secondary open. This is the current required to set up the flux in the core. Power is also absorbed in R_c which includes the I^2R losses in the coil windings and a small amount of loss occasioned by the eddy current losses and hysteresis losses in the core. These core losses can be reduced to an inconsiderable value if quality core materials such as the nickel iron alloys and powdered iron are used. The winding resistances are generally of small magnitude and, having no frequency discrimination, can normally be eliminated. This allows us to simplify our equivalent circuit still further as per Fig. 3, where the leakage reactance L_l and distributed capacitance C is lumped.

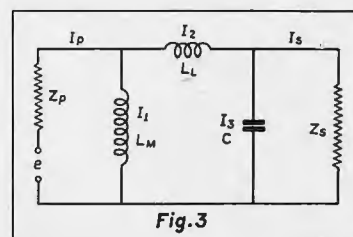
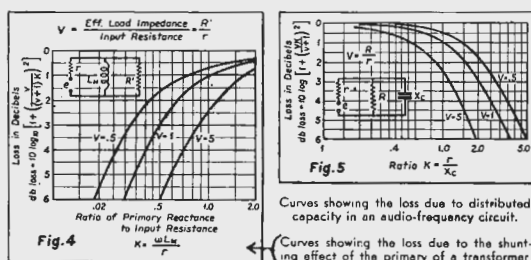


Fig. 3
A simplification of the equivalent transformer circuit shown in Fig. 2B.

UNIFORM FREQUENCY TRANSMISSION

It is apparent that for uniform frequency transmission in this circuit, I_s should be constant regardless of frequency. If all the impedances in this circuit were non-inductive, such would be the case. In practice the impedance of an inductance varies directly as frequency and the impedance of a capacitor inversely to frequency. It is therefore seen that as the frequency is reduced the impedance of L_m will also be decreased and I_s will be increased. This shunting effect of the primary inductance is the main factor controlling the low-frequency response of a transformer. Obviously the reactance of the transformer primary should be high as compared to the source impedance Z_p at the lowest frequency at which it is to function efficiently.

A curve showing the loss due to the shunting effect of the primary of a transformer is illustrated in Fig. 4.



As an example of the use of this curve, let us assume source and load impedances of 500 ohms. At the frequency at which the primary reactance is 325 ohms, there would be a 2-db loss. In other words, to design a transformer having a loss of 2-db at 20 cycles, the primary inductance would have to be such as to offer an impedance of 325 ohms at 20 cycles

COUPLING

Examining Fig. 4 once more, it is seen that as the frequency increases, L_1 increases in impedance. This naturally throws a series loss in the secondary circuit such that I_2 and the following current I_3 and I_s are reduced. The leakage inductance L_1 is due to imperfect flux coupling between the primary and secondary. If the co-efficient of coupling in the above transformer were .995, the leakage would be .5 percent. This would be at 20 cycles .5 percent of 325 ohms, or 1.625 ohms. At this frequency it is evident that the leakage reactance loss is negligible. However, the impedance of L_1 at 20,000 cycles, varying directly with frequency, would be 1,625 ohms. Naturally in a 500 ohm circuit this would be a very great loss.

The distributed capacity, C , is again effective only at the higher frequencies. Similar to the primary it is purely a shunting effect varying with frequency. Fig. 5 illustrates the loss due to distributed capacity in an audio circuit. If source and load impedances were 100,000 ohms each, it would require only 300 mmfd. to cause a loss of 2 db at 10,000 cycles.

Summarizing the above, we note that on the whole, there are three major factors governing the range of audio transformers; namely, primary inductance, distributed capacitance, leakage reactance.

FACTORS GOVERNING RESPONSE OF UTC TRANSFORMERS

To increase primary inductance on a given core structure, it is necessary to increase the turns in the windings. In effect, this at the same time increases the distributed capacitance and leakage reactance. It is therefore apparent that in attempting to improve low frequency response we must sacrifice highs, or vice versa. The choice of a balance point depends solely upon the application. However, it has also been found possible to increase the coil inductance by improving the core material so that it has a higher permeability at the particular flux densities involved in a specific application. Research in this field has developed the nickel-iron and other magnetic alloys.

One of the limiting factors to the use of nickel-iron alloys is their general sensitive nature with reference to mechanical, thermal or magnetic abuse. It was with this in mind that UTC Hiperm alloy was developed. This nickel-iron alloy has a very high permeability at the low flux densities encountered in audio units and also has low hysteresis losses. However, unlike most nickel-iron alloys, it is not extremely sensitive to temperature or mechanical shock and will stand reasonable amounts of DC without excessive saturation. This magnetic stability is of paramount importance in assuring high fidelity performance through years of operation.

The reduction of leakage reactance and distributed capacitance is quite involved. Practically all UTC transformers have had leakage reactance brought down to a minimum through the use of a semi-toroidal transformer structure in which the coils cover more than 50% of the magnetic circuit. This effects appreciably more coupling than in the normal shell type transformer structure where the coil covers only 20% of the magnetic path. In addition to this, practically all the coil structures involve accurate and multiple interleaving of windings. The extent to which leakage reactance has been reduced is seen in the frequency characteristic of the standard matching transformer illustrated in Fig. 6. The coupling in this transformer exceeds .999.



Characteristic curve of a line-matching transformer

DISTRIBUTED CAPACITANCE

Distributed capacitance can be divided up into three cumulative effects; turn-to-turn capacitance, layer-to-layer capacitance, and coil-to-coil capacitance. In a well-designed coil the layer-to-layer factor is most important. To keep this at a low value, coils can be sectionalized so that the layer length is kept low. However, this must be done very carefully so as not to increase the leakage reactance. On transformers in which the distributed capacitance is of appreciable effect, such as windings in low level grid circuits, resonant effects will generally occur in the secondary such that an increase in amplification is obtained at certain frequencies. Both load resistance and source impedance affect this resonance.

It is desirable to keep these resonance effects at a minimum, not only because of the resultant peaked characteristic, but also because of the phase shift generally occurring at resonance points. However, a small amount of resonance may be beneficial if it is kept far up in the audio range to help maintain the high frequency response on input to grid transformers. This effect has been kept within 1DB on all UTC transformers with the result that practically no phase shift or peak is obtained.

It is the combination of balanced design plus UTC Hiperm alloy that has made possible the unequalled characteristics in UTC transformers. The UTC linear standard units are entirely calibrated and guaranteed to be ± 1 DB from 30 to 20,000 cycles. Many of the units have response characteristics exceeding even these limits, and consequently typical frequency curves are shown in this bulletin for all of the various types of stock transformers available.

WAVE FORM DISTORTION

Wave form distortion in audio transformers is the result of three major causes: Saturation of the magnetic core material, lack of symmetry in pushpull windings, or resonance in a coil structure. This, of course, assumes that the impedance matching function of the transformer is correct. It is evident from an examination of the frequency curves in Linear Standard units described on the following pages that resonance has been maintained at a minimum value. The saturation of core material is an important point in audio transformers. While the nickel-iron alloys are generally superior for low level audio work, even Hiperm alloy is more adversely affected by unbalanced DC than silicon steel. It is therefore desirable, if at all possible, to keep DC out of transformer cores. Examination of some of the circuits in the latter part of the bulletin readily indicates the simple methods of choke parallel feed or resistance parallel feed to take care of this function. While in low level transformers a nickel-iron alloy is desirable because of its high permeability; at medium levels, it is found that this permeability is no greater than that of high quality silicon steels. Extending our examination still further, it is found that at high levels, such as those encountered in large output transformers, a nickel-iron alloy will saturate comparatively easily and thus cause considerable distortion. Because of this fact, in UTC output transformers designed to operate above ± 22 DB (1 watt), lap jointed laminated cores of special steel are used. This steel has a very high saturation point, (80,000 lines), and will stand large amounts of direct current without saturation.

Pushpull windings even where universal impedances are available are so arranged in UTC transformers that perfect symmetry is obtained. The coil structure is built up of alternate primary and secondary sections such that the balance of windings is kept to one part in 10,000. Interleaving of windings is of extreme importance in A prime and class B tube operation, as in such cases one tube operates at a time and consequently, each tube winding must have perfect coupling to the entire secondary.

HIGH EFFICIENCY

It is obvious that the loss in power transfer of a transformer should be kept as low as possible. In an output transformer, this loss means that an appreciable part of the actual available output power is lost before it gets

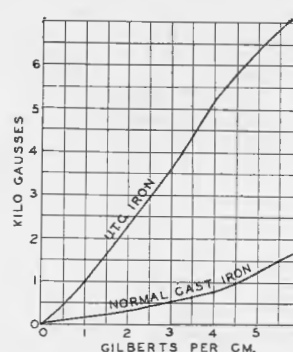
to the load. Some contemporary transformers recently tested in the UTC audio laboratories have shown losses higher than 3DB. This means that when 10 watts is available in the tube plate circuit, only five watts is actually delivered to the load. Insertion loss can be kept to a low value by operating the transformer core material at conservative flux densities and by keeping the resistances of the windings to a small value as compared to the matched impedances. UTC linear standard transformers have been designed with due consideration of these factors, with the result that the insertion loss is insignificant; in no case exceeding 1DB under worst conditions.

SHIELDING

Practically all of the new high fidelity microphones and other sound sources developed during the past five years require high amplification. One of the difficulties encountered in high amplification has been the hum pickup in audio transformers. This pickup is both magnetic and electrostatic, and several methods of shielding are possible. These can be analyzed as follows:

One method of reducing hum pickup is the use of a balanced coil structure. The true hum balancing coil is an original development of the UTC audio engineering department. It consists of a semi-toroidal coil structure in which two sets of balance coils are used. If a field of stray flux cuts across the transformer, it will induce voltages in both sets of coils, but in opposite direction. The result is practically complete neutralization of the induced voltage.

In addition to the hum balancing coil structure, it is positively necessary to have a magnetic shield of substantial effectiveness. Unequalled magnetic shielding has been made possible in UTC transformers by the development of a special magnetic shielding alloy, and also by considerable care in the design of the casting and the placing of the components therein. The UTC cast magnetic alloy is not to be confused with the so-called high permeability cases more generally used. Fig. 7 illustrates the 5 to 1 superiority of the UTC alloy over the normal



(Figure 7)

cast iron used for transformer housings. In addition to this inherent 5 to 1 advantage, the use of heavy thickness on all cast cases has further augmented the shielding effect. Considerable attention was paid during the design of these cases with reference to the proper shape for best shielding. It was found that symmetry was a very important factor. As previously stated, the hum balancing coil structure will eliminate pickup from a stray flux cutting both coils. However, if either the casting or the placing of the transformer within the casting is not symmetrical, the lines of force will be distorted and

more lines may cut one balancing set of coils than the other, with the result that the full advantage of the hum balancing principle will not be obtained. The final design was a rectangular case having perfectly vertical sides with heavy vertical corners. The uniform dimensions from top to bottom prevent any tendency for the lines of extraneous flux bending toward the section of larger dimension and reduce magnetic reluctance. The heavy corner sections tend to concentrate and direct the flux in the casting linearly so that maximum neutralization may be obtained in the coil structure.

Under certain conditions the windings of an audio transformer will transfer energy both inductively and capacitively. Capacitive coupling may cause large longitudinal pickup, particularly where the transformer is connected to a fairly long line. To eliminate this, UTC linear standard transformers have special electrostatically shielded coil structures which isolate the primary and secondary windings capacitively. To effect positive grounding, the shield leads are brought out to a separate lug on the terminal board.

RELIABILITY

To assure positive reliability of transformers, it is essential that all components, both before and after fabrication, be fully checked and tested. This is possible in the UTC organization because of the fact that every part and product going into UTC transformers is fabricated in the UTC plant. Coils are varnish impregnated under a twenty four hour vacuum-baking cycle. All units are fully sealed in their cases with moisture proof insulating compound. The combination of vacuum varnish impregnation and complete sealing has resulted in a transformer absolutely immune to adverse humidity and climatic conditions. Reliability of these transformers is so high that it is now possible to guarantee all UTC linear standard transformers for a period of three years. This guarantee is backed up by numerous tests all along the production line, and a thorough test and inspection on the finished units. The general nature of these tests can be summarized as follows:

1. Frequency range is checked at seven frequencies from 30 to 20,000 cycles with a maximum tolerance of plus or minus 1DB from standard.
2. An inductance check is used which rejects any unit having 5% less inductance than standard.
3. The ratio of transformation is checked within .1% of standard.
4. A shorted turn test is used on all coils which has a sensitivity sufficient to indicate one shorted turn out of 20,000. Any indication of shorted turns is cause for immediate rejection.
5. A high potential breakdown test is given to all units, both between windings and to ground. 1000 volts is used on low level units; on high level units, twice working voltage plus 1000.
6. A concentrated field hum pickup test is made by which absolute measurement of hum is made possible. Indication of more than 2DB pickup than standard is cause for rejection.

FLEXIBILITY

The flexibility of impedance terminations on UTC transformers has been made possible only through extreme care in maintaining good coupling between all portions of the windings. The type of winding used has made possible a wide combination of impedance connections without impairing the audio range or the efficiency of any tap. Also, to make these units more flexible and to simplify the matter of stocking these units, the UTC castings are so constructed that transformers can be mounted with either top or bottom lug connections. This prevents the spending of useless time for effecting makeshift adaptations.

In addition to the information contained herein and in the balance of this bulletin, consultation and correspondence with the Engineering Dept. of UTC are invited in connection with any problem involving audio components. Due to the specialized nature of the transformer field, it is the desire of UTC to cooperate in ascertaining the conditions to be met in order that the sale of unsuitable apparatus be avoided.



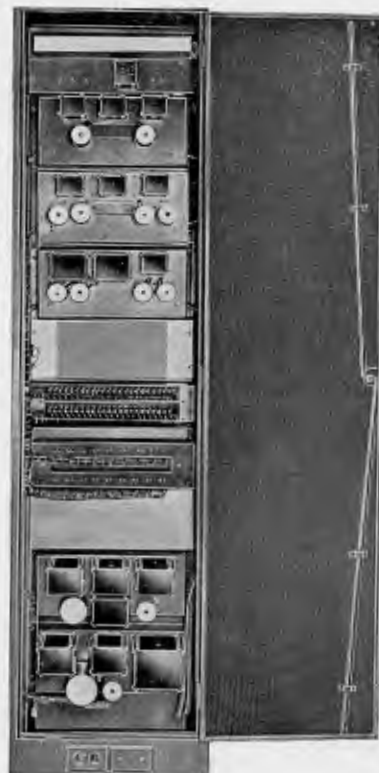
UTC HIPERM ALLOY AUDIO TRANSFORMERS are used in the new WOR 30B portable amplifiers (Front and back view illustrated) for use in remote pickup broadcasts in conjunction with the new WOR high fidelity 50,000 watt transmitter.

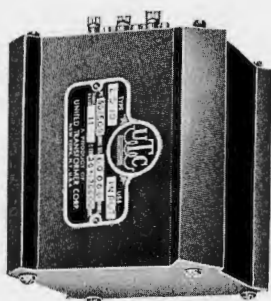
WHN, one of the larger metropolitan New York Broadcast stations, is now using UTC audio transformers in their speech input equipment. This is what their engineers found:

"The UTC transformers from actual frequency measurements are far superior to any independent type of transformers we have had occasion to use in our equipment.

A typical 3 stage transformer coupled studio amplifier recently constructed with UTC parts had an overall response down 0 at 30 cycles and down 1DB at 16,000. In addition, the total harmonic content was found to be less than four tenths of one percent."

One of the new amplifier bays recently installed by WHN using UTC transformers throughout. The entire layout was designed by G. R. Windham and Paul W. Fuelling of WHN.





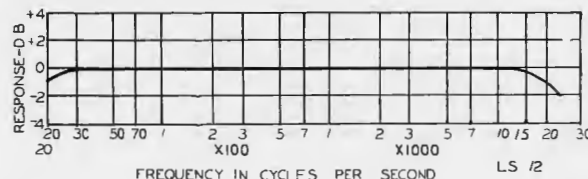
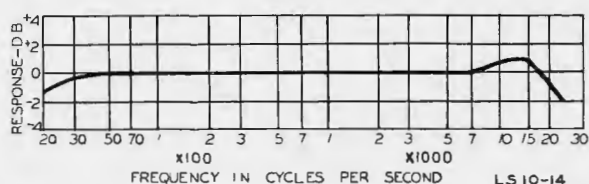
OVERALL DIMENSIONS

	Mtg. Dim.	L	W	H
LS-1	1-15/16x2-7/16	2-9/16	3-3/16	3-11/16
LS-2	2-11/16x3-11/16	3-1/2	4-3/8	4-5/8
LS-3	4-3/16x5-1/32	5	5-3/4	5-3/16
LS-4	5-3/4x5-3/4	6-7/16	6-7/16	5-3/8
LS-5	7-1/4x7-1/4	8	8	6-1/2

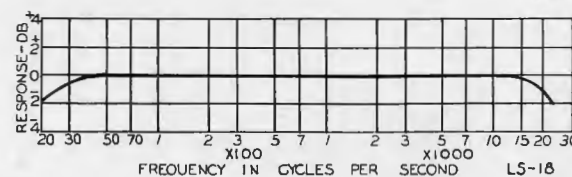
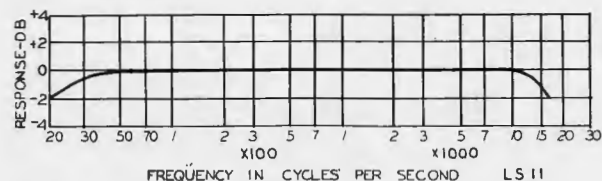


D CASE Special case illustrated at right above, used for additional shielding of low level transformers. It completely encloses the LS-1 case on **ALL** sides with 5/16" of high permeability UTC iron. Overall dimensions 3 7/16" x 3 7/8" x 4 3/4". Mtg. dimensions 1 15/16" x 2 7/16" \$7.00

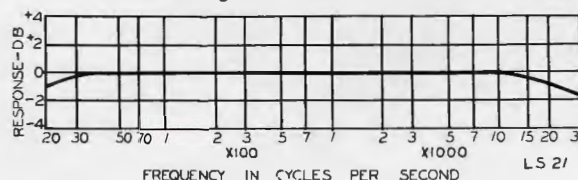
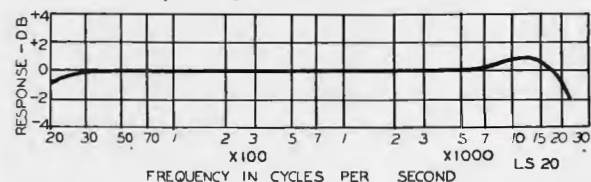
- LS-10** Primary will match 500, 333, 250, 200, 125, or 50 ohm line as required for carbon, dynamic, ribbon, or other microphones and for low impedance pickups. Secondary in two sections; overall impedance 60,000 ohms. LS-1 \$15.00
- LS-11** Primary will match a high impedance photo electric cell to one or two grids. LS-1 \$15.00



- LS-12** Primary will match 500, 333, 250, 200, 125, or 50 ohm line as required for carbon, dynamic, ribbon, or other microphones and for low impedance pickups. Secondary in two sections; overall impedance 120,000 ohms. LS-1 \$20.00
- LS-14** Primary will match one or more dynamic microphones, low impedance pickups, or parallel mixers. Primary impedance 60, 38, 30, 22, 15, 10, 5.5, or 2.5 ohms. Secondary in two sections; overall impedance 60,000 ohms. LS-1 \$20.00

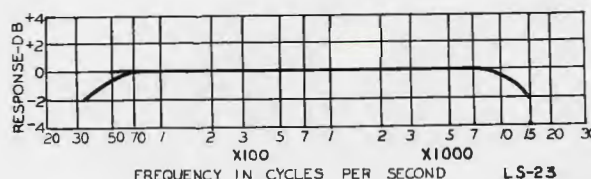
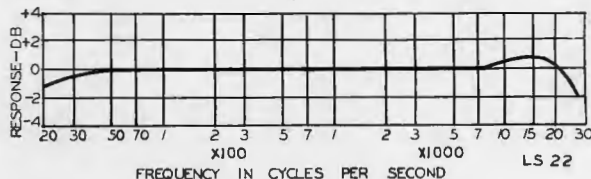


- LS-18** Primary designed for 500, 333, 250, 200, 125, or 50 ohms line to 2-50 watt grids. LS-2 \$22.00



COUPLING TRANSFORMERS

- LS-20** Cascade, single plate to single grid. Turn ratio 2:1 overall. LS-1 \$10.00

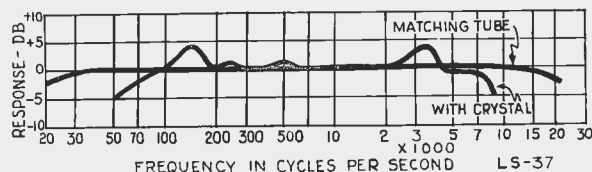
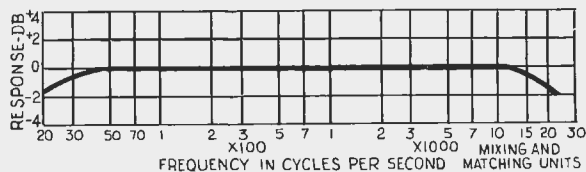


- LS-21** Input, one plate to two grids. Turn ratio 1 1/2:1 each side of center. Primary and secondary each in two sections. LS-1 \$13.00
- LS-22** Input, two plates to two grids. Turn ratio 1.6:1 each side of center. Primary and secondary each in two sections. Maximum operating level + 25 DB. LS-2 \$22.00

- LS-23 Input, two screen grid plates to two grids. Effective ratio 1:1. LS-2 20.00
 LS-24 Single plate or line to one or two grids. One primary winding will match single plate of tubes like 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, or W.E. 262A. Another primary winding designed for a carbon or voice coil microphone or a low impedance pickup. Secondary in two sections. Total secondary impedance 60,000 ohms. LS-1 20.00

MIXING AND MATCHING TRANSFORMERS

- LS-30 Mixing, carbon or moving coil microphone or low impedance pickup to a variable impedance line. Primary and secondary windings will match 500, 333, 250, 200, 125 or 50 ohm lines. LS-1 \$15.00
 LS-32 Mixing, one or more moving coil microphones or extremely low impedance pickups to a variable impedance line. Primary impedances 60, 38, 30, 22, 15, 10, 5.5, 2.5 ohms. Secondary impedances 500, 333, 250, 200, 125, 50 ohms. LS-1 20.00
 LS-33 15 watt audio line matching transformer. Input designed for 500, 333, 250, 200, 125, 50 ohms. Output designed for 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 ohms. LS-2 15.00
 LS-34 30 watt audio line matching transformer. Input designed for 500, 333, 250, 200, 125, 50 ohms. Output designed for 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 ohms. LS-3 20.00
 LS-35 60 watt audio line matching transformer. Input designed for 500, 333, 250, 200, 125, 50 ohms. Output designed for 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 ohms. LS-4 30.00
 LS-36 200 watt audio line matching transformer. Input designed for 500, 333, 250, 200, 125, 50 ohms. Output designed for 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 ohms. LS-5 50.00



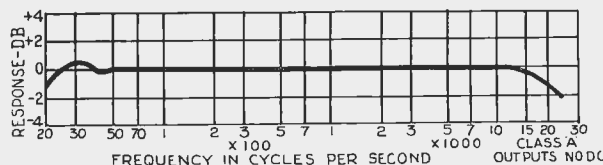
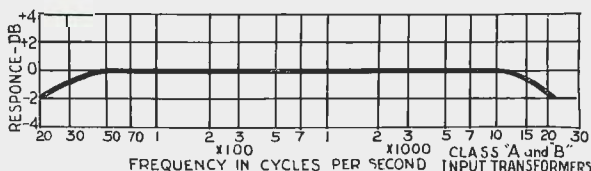
- LS-37 Crystal microphone or pickup or high-mu triode or diode detector to line. Primary in two sections; overall impedance 130,000 ohms. Secondary 500, 333, 250, 200, 125, or 50 ohms. LS-1 15.00

BRIDGING TRANSFORMERS

- LS-150 Primary 4000 ohms bridging a 50 to 500 ohm line of any level up to plus 24DB. Secondary 500, 333, 250, 200, 125, 50 ohms. LS-1 \$15.00
 LS-151 Primary 16,000 ohms bridging a 50 to 500 ohm line of any level up to plus 24DB. Secondary 500, 333, 250, 200, 125, 50 ohms. LS-1 \$15.00

A PRIME AND CLASS B INPUT TRANSFORMERS

- LS-4 Primary designed for 500, 333, 250, 200, 125 or 50 ohm lines to two class B 46, 59 or 210 grids operating at a maximum level of +32 DB. LS-2 \$25.00
 LS-5 Primary designed for 500, 333, 250, 125, or 50 ohm lines to two 203 A or 838 class B grids. LS-2 30.00
 LS-6 Push pull 45 or 59 triode plates to push pull 845A prime grids. LS-2 22.00
 LS-7 Push pull 56, 6C5, or 6C6 triodes to 45, 42, or 6F6 tubes in AB. LS-2 22.00
 LS-46 Push pull 45 or 59 plates to 2-210, 2-830, 2-800, 2-KR 18 grids in class B. LS-2 15.00
 LS-47 Push pull 2A3 plates to 2-203A or 838 grids in class B. LS-2 20.00
 LS-48 Push pull 845 plates to 2-204 or 849 grids in class B. LS-4 35.00



LOW LEVEL CLASS A OUTPUT TRANSFORMERS

- LS-50 From a single plate like the 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, W.E. 262A to 500, 333, 250, 200, 125 or 50 ohm line. LS-1 \$15.00
 LS-51 From push pull plates like the 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, W.E. 262A to 500, 333, 250, 200, 125, or 50 ohm line. LS-1 15.00

SPECIAL A PRIME AND CLASS B OUTPUT TRANSFORMERS

- LS-65 From two class B 210 or 801 plates to high and low impedance loads. High impedance load 5000, 3500, 2500, 2100, 1250, or 600 ohms. Low impedance load 30, 20, 15, 10, 7.5, 5.5, 2.5, 1.2 ohms. Secondary windings will handle 60 watts audio power. LS-4 \$35.00
 LS-66 Two class B 203A or 211 plates to 5000, 3500, 2500, 2100, 1250, or 600 ohms. Secondary windings will handle 200 watts audio power. LS-5 70.00

LS-67	Two class B 203A or two Class B 838 plates to 10,000 ohms or 2500 ohms (split secondary). Second—ary will handle 200 watts audio power. LS-5	70.00
LS-68	Two class B 203 A plates to 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5.5, 2.5, 1.2 ohms. LS-5	70.00
LS-69	Two 849 or 204A plates to 6000, 5000, 4000, 1800, 1500, or 1000 ohms. Secondary will handle up to 1000 watts audio power. Special casting	200.00
LS-169	Four 849 or six 204A tubes in push pull parallel to 5000, 4200, 3300, 1500, 1250, or 830 ohms. Secondary will handle up to 2500 watts audio power. Special casting	400.00
LS-845M	From two A prime 845 plates or Class B 800's to high impedance loads. Secondary impedances 5000, 3500, 2500, 2100, 1250 or 600 ohms. Will handle 125 watts audio power. LS-5	50.00
LS-845	From two A prime 845 plates or Class B 800's to 500, 333, 250, 200, 125, 50, 30, 20, 15, 7.5, 5, 2.5, 1.2 ohms. Will handle 125 watts audio power. LS-5	50.00

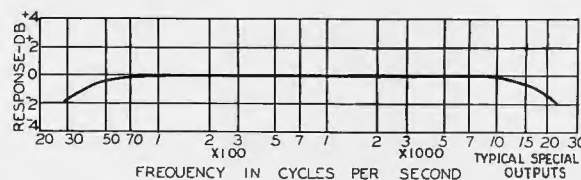
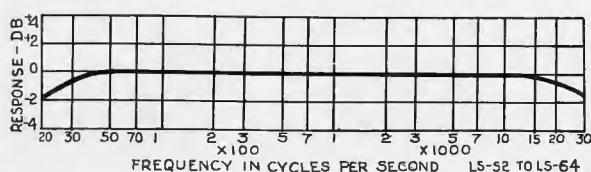
METAL TUBES—Linear Standard UTC transformers can be used with metal tubes as follows:

The 6C5 tube can be used in all audio circuits and with all transformers in place of tubes such as type 56, 27, 6C6 triode, etc.

Type 6F6 pentodes in AB either self or fixed bias and type 6F6 triodes in AB fixed bias take a plate to plate load of 8000 ohms. Use output transformers type LS-52, 53, 54. If used in push-pull parallel, the load impedance should be reduced to less than half and the output transformers to be used are LS-4451, 4452, 4453.

Type 6F6 triodes in self bias take a plate to plate load of 10000 ohms, use output type LS-61, 62, 63. To match type 6F5 hi-mu triode to a line use type LS-37.

300A TUBES For 300A Tubes in push pull use 3000 ohm, plate to plate impedance output transformers LS-55, 56, or 57. In push pull parallel use LS-58, 59 or 60.



LINEAR STANDARD CLASS A AND CLASS B OUTPUT TRANSFORMERS

Type	Primary Impedance	Will Match	Secondary Impedance	Case & Price
LS-2451	6000 ohms plate to plate and 3500 ohms plate to plate.	For 6000 ohms Class A prime 45's self bias and Class B 46's, 59's; Class A WE 252A's. For 3500 ohms Class A prime 45's fixed bias.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5 1.2.	LS-2 20.00
LS-2452	6000 ohms plate to plate and 3500 ohms plate to plate.	Same tubes as LS-2451.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-2453	6000 ohms plate to plate and 3500 ohms plate to plate.	Same tubes as LS-2451.	30, 20, 15, 10, 7.5, 5.5, 2.5 1.2.	LS-2 14.00
LS-4451	3000 ohms plate to plate and 1750 ohms plate to plate.	For 3000 ohms Four 45's in push pull parallel A prime self bias. Four WE 252A's Class A. Four 46's or 59's in Class B. For 1750 ohms Four 45's in push pull parallel A prime fixed bias.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5.5, 2.5, 1.2.	LS-4 30.00
LS-4452	3000 ohms plate to plate and 1750 ohms plate to plate.	Same tubes as LS-4451.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5.5, 2.5, 1.2.	LS-4 30.00
LS-4453	3000 ohms plate to plate and 1750 ohms plate to plate.	Same tubes as LS-4451.	30, 20, 15, 10, 7.5, 5.5, 2.5, 1.2.	LS-4 20.00

LINEAR STANDARD CLASS A AND CLASS B OUTPUT TRANSFORMERS

Type	Primary Impedance	Will Match	Secondary Impedance	Case & Price
LS-52	8000 ohms plate to plate.	Class A , push pull 250, push pull 245, single 211, 843, 842, 205D, 48.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-53	8000 ohms plate to plate.	Same tubes as LS-52.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-54	8000 ohms plate to plate.	Same tubes as LS-52.	30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 14.00
LS-55	5000 ohms plate to plate and 3000 ohms plate to plate.	For 5000 ohms Self bias push pull 2A3's, push pull W.E. 275A's, single 71A, 6B5, or single 59 triode. For 3000 ohms Fixed bias push pull 2A3's, single W.E. 52A.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-56	5000 ohms plate to plate and 3000 ohms plate to plate.	Same tubes as LS-55.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-57	5000 ohms plate to plate and 3000 ohms plate to plate.	Same tubes as LS-55.	30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 14.00
LS-58	2500 ohms plate to plate or 1500 ohms plate to plate.	For 2500 ohms Four 2A3's in push pull parallel self bias circuit. For 1500 ohms Four 2A3's in push pull parallel fixed bias circuit.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-4 30.00
LS-59	2500 ohms plate to plate or 1500 ohms plate to plate.	Same tubes as LS-58.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-4 30.00
LS-60	2500 ohms plate to plate or 1500 ohms plate to plate.	Same tubes as LS-58.	30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-4 20.00
LS-61	10,000 ohms plate to plate or 6000 ohms plate to plate.	For 10,000 ohms Push pull 59 triodes, push pull 6B5's, push pull 71A's, single 210, 41, 268A, 2A3, Class B 49's, 53's, 79's, 89's. For 6000 ohms In Class A push pull W.E. 52A's, single 31, 46, 59 pentode. In class B push pull 46's, push pull 59's.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-62	10,000 ohms plate to plate or 6000 ohms plate to plate.	Same tubes as LS-61.	6000, 5000, 4000, 1800, 1500, 1000, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 20.00
LS-63	10,000 ohms plate to plate or 6000 ohms plate to plate.	Same tubes as LS-61.	30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-2 14.00
LS-64	18,000 ohms plate to plate.	Class A push pull 845's. 50 Watts Maximum.	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2.	LS-4 35.00

COMBINED PLATE AND FILAMENT TRANSFORMERS

(available current ratings shown are DC — condenser input)

- LS-70** For use with P.P. class A 2A3, 59, 45, 47 tubes or class B 53 tubes. Primary tapped for 100, 105, 110, 115, 120, 125 volts 60 cycles A.C. Secondaries: 425 volts each side of center at 200 MA, also tapped at 375 volts each side of center. $2\frac{1}{2}$ V.C.T. 3A., $2\frac{1}{2}$ V.C.T. 3A., $2\frac{1}{2}$ V.C.T. 5A., $2\frac{1}{2}$ V.C.T. 12A., 5 V.C.T. 3A., 6.3 V.C.T. 1A., 6.3 V.C.T. 3A. LS-4 25.00
- LS-74** For use with push pull class A 250 power tubes. Primary tapped for 100, 105, 110, 115, 120, 125 volts. Secondaries 600 volts each side of center at 200 MA. $7\frac{1}{2}$ V.C.T. 3 A. $7\frac{1}{2}$ volts tapped at 5 volts at 3 A. $2\frac{1}{2}$ V.C.T. 14 amps. 5 V.C.T. at 3 amps. LS-4 25.00
- LS-75** For use with push pull class B 210 or 801 tubes. Primary tapped for 100, 105, 110, 115, 120, 125 volts 60 cycles A.C. Secondaries: 720 volts each side of center at 250 MA. $7\frac{1}{2}$ V.C.T. at 3A. $7\frac{1}{2}$ V. tapped at 5 volts 3 A. $2\frac{1}{2}$ volts C.T. 10 amps. Low voltage plate winding for fixed C bias, $2\frac{1}{2}$ V.C.T. 3 amp. windings for 82 C bias rectifiers. LS-5 30.00
- LS-180** Plate and filament transformer for a pre-amplifier. Primary 110 volts. Secondaries: 225 volts each side of center at 15 MA. 6.3 V.C.T. at 2 Amps. 6.3 volts .4 Amps for 84 rectifier. LS-1 10.00

APPLICATION OF POWER TRANSFORMERS

PLATE SUPPLY EQUIPMENT

When a commercial organization purchases components for broadcast or other communications equipment, the first factor which must be considered is the dependability of the apparatus. A two hour shut-down on a broadcast schedule may be worth many times the cost of an inferior component used. Since the actual functional operation of broadcast and similar equipment is greatly dependent upon the transformers used, considerable care should be taken in the choice of these units.

UTC has done considerable research toward the development of power supply components having high dependability. The general object of this development was the production of an ideal power and filament transformer. The first step involved was actually determining the factors making up an ideal transformer which were enumerated as follows:

- (a) Low temperature rise (heating)
- (b) Low losses (efficiency)
- (c) Good regulation
- (d) High safety factor in insulation
- (e) Rugged mechanical construction
- (f) Insulation impervious to high humidity, etc.

Before going further into the analysis of these factors, it is desirable to consider the actual operating characteristics of a power transformer.

FUNDAMENTAL TRANSFORMER

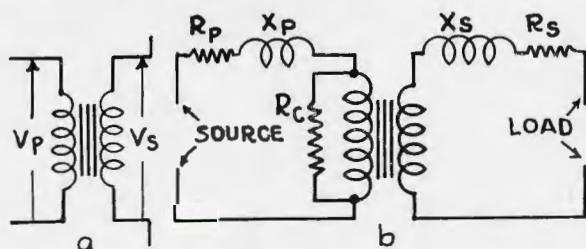


Fig. 1

Fig. 1a illustrates the ideal power transformer which is inherently a device designed to transfer power from one circuit to another with no direct connection, and generally with a change in voltage from the input to the output circuits. In an ideal transformer the input and output power is identical and the ratio of secondary voltage to primary voltage is directly proportional to the ratio of

secondary turns to primary turns. However, it is impossible to produce an ideal transformer. Fig. 1b illustrating the actual equivalent circuit of a commercial unit. Here R_p and R_s are respectively the primary and secondary resistances; X_p and X_s are respectively the primary and secondary leakage reactances; and R_c represents the losses of the magnetic core material. This may be sim-

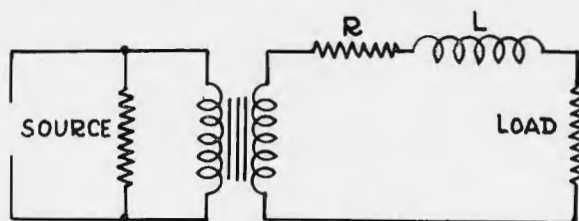


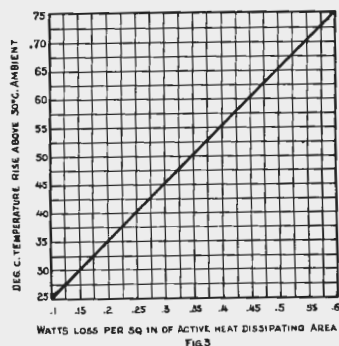
Fig. 2

plified still further to the form of Fig. 2, where the leakage reactances are lumped in L and the winding resistances lumped in R . Using this T equivalent it is immediately apparent that the voltage developed across the load will be the theoretical value less the drop in L and R caused by the load current. In addition, it will also be seen that an actual power loss takes place in R and R_c . It is this power loss which governs the available output from a transformer.

TEMPERATURE RISE

A conservatively designed transformer should not have a temperature rise exceeding 40 to 55 degrees Centigrade above ambient temperature. This is due to the danger of injury to the coil insulation when exposed to final temperatures of 85 degrees and above. This maximum temperature which the coil insulation can withstand forms the definite limit to which the temperature rise and the consequent available power output must be held. Similar to other electrical apparatus carrying power, it is found that the final temperature rise of a transformer is dependent on the total transformer losses, which produce heat, and the rate at which this heat is dissipated. As the heat radiating surface area is increased, the rate of dissipation of heat is also increased and the internal transformer temperature is decreased. Radiation of heat is also dependent to some extent on the colour of the surface, and it has been found that a black surface may reduce the temperature of a transformer 5

to 10 degrees Centigrade. In view of this UTC Linear Standard power components are given a dull black finish having a high heat radiation co-efficient. Fig. 3 illus-



trates the effect on final temperature rise caused by different ratios of transformer loss to transformer heat dissipating surface.

TEMPERATURE UNDER OVERLOAD

Figure 3 is frequently useful in determining the temperature rise of a transformer when operated under abnormal or overloaded conditions. When a transformer is used under no load condition a considerable portion of the time, as in testing apparatus or distribution transformers, it is customary to make the iron losses small so that a minimum of power is wasted in the idling condition. However, most transformers used in the communications fields are operated at full load continuously. Under this condition it has been found that the best proportions are obtained when the iron and copper losses are approximately equal. To analyze overload conditions let us call the iron loss .5 and the copper loss .5. If the output power is brought above normal only the copper loss will be effected. Let us assume that we start with a transformer having a normal rise of 45 degrees or having approximately .3 watts loss per square inch of active surface. Now let us take the case where the transformer is overloaded 50%; for example a 200 mil plate transformer operated at 300 mils. As the copper loss is proportional to the square of the current we have a condition where the new copper loss equals $.5 \times 1.5$ squared or 1.13. operated at 300 mils. As the copper loss is proportional to the square of the current we have a condition where the new copper loss equals $.5 \times 1.5$ squared or 1.13. Adding this to the iron loss of .5 which has not been altered we obtain a total loss of 1.63. Multiplying our .3 watts per square inch by this figure, a ratio of .49 watts per square inch is obtained. An examination of the curve shows that this will result in a final temperature rise of 52 degrees.

As one becomes accustomed to the idea of lower temperature rise in a transformer being made possible by better heat dissipation, one begins to question the advantage of placing transformers in enclosing castings or sheet metal cases which apparently reduce ventilation. This has been eliminated in UTC transformers by the use of a special insulating compound which is poured into the case. This compound which has a large Gilsonite content has a very high co-efficient of heat transfer with the result that the transformer heat is quickly carried to the outer case. As this outer case has a larger exposed area than the transformer itself, it is found that the final

temperature with the case will be LESS than that of an open unit.

LOSSES-EFFICIENCY

As previously stated, the main losses in a transformer are the iron losses and the copper losses. In large transformers, and particularly in transformers operating at higher frequencies than 60 cycles some additional loss is caused by eddy currents in the copper conductors. The iron losses in a transformer can be kept at a proper point by the use of low flux densities. The use of low flux densities also decreases the magnetizing or no load current of the transformer very appreciably and tends to reduce extraneous fields. This is an important point in modern high gain amplifiers. Copper loss is naturally kept low by the use of large conductors.

It is frequently assumed that a large transformer will be superior from the angle of losses, efficiency, and heating as compared to a smaller unit of equivalent rating. Care must be taken in the application of this statement. The use of large quantities of material if coupled with poor engineering may be a detriment. A large quantity of steel operated at the same flux density as a small unit will have an iron loss in direct proportion to the bulk of the cores. In addition, the larger bulk of copper made necessary may have greater losses than that in the smaller units. UTC has spent much time on the development of power transformers and care has been taken in all UTC units to obtain the optimum design so that the greatest efficiency and safety factor is effected.

REGULATION

The regulation of plate transformers is becoming an exceedingly important factor in modern amplifiers using class B or class AB tube operation. Referring to Fig. 2 it is seen that the loss in voltage sustained with an increase in transformer load current is caused by L and R, the leakage reactance and DC resistance of the transformer windings. In small transformers R is by far the larger effect. The resistance of the windings can be kept down by the use of large wire sizes, but more important than this is the question of getting as much copper in a given space as possible. The coils in UTC transformers are wound on machines designed by UTC with this main thought in mind. In large transformers, particularly plate transformers which require considerable spacing between layers and windings for insulation, the reactance loss L becomes a more important factor than R as respects regulation. This effect has been reduced to a minimum in UTC transformers through the use of interleaved windings.

INSULATION

The insulation used in a transformer must have a high safety factor, taking into consideration the most severe conditions which may be encountered in service. Many materials used for insulation purposes will deteriorate with age or heat. Considerable care must be taken in the use of these materials. As previously stated, temperature has a decided effect upon most insulating materials. The dielectric strength of some materials is cut to less than half by a change in temperature from 50 to 100 degrees Centigrade. UTC uses mica almost exclusively at the points of high voltage stress in Linear

Standard power transformers. This transformer insulation material, while costly, is unequalled in dielectric strength and is practically unaffected by temperature, age, or the presence of ozone caused by high voltage corona.

In addition to mica, some of the insulating materials used in transformers are pressboard, bakelite, paper, enamel, cotton, varnished cambric, etc. The effect of moisture on practically all of these materials is highly detrimental. This can be overcome by proper impregnation. The UTC method of impregnation is ideal and accounts for the wide popularity of UTC material in foreign countries and those parts of the U. S. where high humidity and poor climatic conditions tend to cause quick failure of ordinary components. UTC coils are given a 14 hour drying in special dehydrating ovens. They are then inserted into a heated vacuum tank for a number of hours. When the coils and tank are at a uniform temperature a vacuum-draining pump is used for two hours, which quickly evaporates any moisture left in the coils and withdraws it. Heated varnish is then admitted into the tank and forced into the coils under pressure. Continuing the cycle the coils are placed in baking ovens for 14 hours at the end of which time the coils are removed thoroughly impregnated and both filled and covered with a flexible, clear varnish coating absolutely impervious to moisture. As a double precaution, some units go through another identical cycle after being laminated. In addition to the impregnating process most smaller UTC transformers are poured with an insulating compound having a moisture absorption of less than 1% and a melting point (ball and ring) of about 250 degrees. Some of the larger transformers are oil-filled. This also tends to keep the insulation in good condition and moisture-free.

MECHANICAL CONSIDERATIONS

A number of unusual points will be encountered in the mechanical side of UTC power units. Within normal limits of weight, UTC transformers are produced in square castings which have a high dissipating area and which can be mounted with lugs at either top or bottom. In larger units end castings are used which completely enclose and protect the coil but which leave the laminations directly exposed to the air to obtain maximum radiation. While both poured and open units are well clamped to prevent vibration, wherever possible, the bolts are kept outside of the lamination as this has been found to produce a considerable reduction in iron loss. Where the bolts must pass through the lamination they are insulated so that eddy effects are not produced.

USE OF TRANSFORMERS

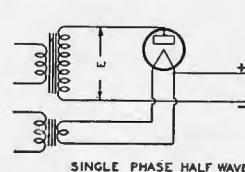
A perfect transformer may be quickly ruined if used improperly. As most power units in communications work are used in conjunction with rectifier circuits, a knowledge of the operation of these circuits will help considerably in assuring proper choice and use of accessory components.

Peak inverse voltage and peak plate current are the important factors to be considered in the choice of rectifier tubes. The values for a number of the standard type tubes are listed below:

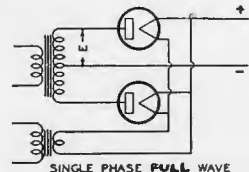
Tube Type	Peak Inverse Volts	Peak Plate Current
82	1,400 volts	.40 A.
83	1,400 volts	.80 A.
66	7,500 volts	.60 A.
66A	10,000 volts	.60 A.
72	7,500 volts	2.5 A.
72A	10,000 volts	2.5 A.
869	20,000 volts	5 A.

The peak inverse voltage can normally be assumed as 1.4x RMS AC voltage from the transformer. The peak plate current is a little more difficult to determine, and is affected very considerably by the form of filter into which the rectifier operates. Most standard circuits use choke input filters, in which case the current available is .66 X the peak plate current.

STANDARD RECTIFIER CIRCUITS

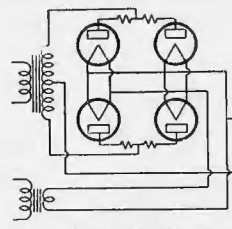


(Figure 4)

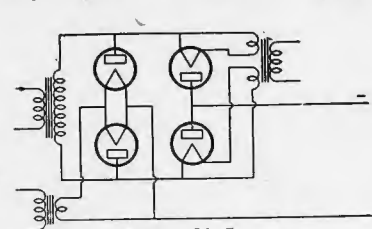


(Figure 5)

Figures 4 to 9 illustrate typical rectifier circuits applicable to communications use. The single phase half wave circuit of figure 4 is not very popular due to the fact that the ripple is of greater magnitude and being of lower frequency than other systems is more difficult to filter. With choke input, the DC voltage will be approximately .45 that of the RMS voltage E. Figure 5 illustrates the full wave single phase circuit which is most commonly used and with which every engineer is familiar. Figure 6

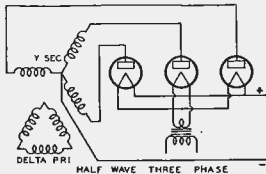


(Figure 6)

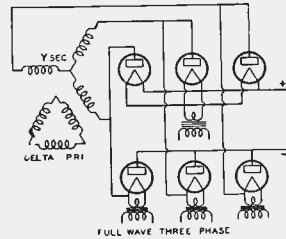


(Figure 7)

is identical in nature with figure 5, except that four tubes (more if desired) are used to obtain higher current output. The resistors shown in the plates of these tubes are highly essential. Otherwise, one tube will generally take most of the load with the natural result that the tube life is greatly decreased. In cases where good regulation is desired a center tapped balancing reactor can be used in place of the resistors. These reactors are simpler and less expensive than the use of resistors. They permit better regulation and less power loss. Figure 7 illustrates a bridge circuit. While this circuit involves four tubes, it has the great advantage that high DC voltages can be obtained without expensive (high peak inverse voltage) tubes and with low voltage transformers. In many cases where full wave rectification has been used and it is desired to increase the DC voltage, it is possible to use the entire secondary output of the plate transformer, and with rectifier tubes in bridge connection, twice the DC voltage will be obtainable. Of course, this reduces the current output due to the transformer current carrying limitations. Figures 8 and 9 are similar in nature to figure 5, except that they are applied to three phase



(Figure 8)



(Figure 9)

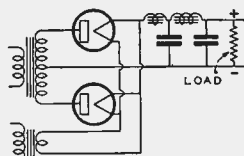
circuits. In the circuit of figure 8, each tube carries current for one-third of a cycle. The circuit of figure 9 is very commonly used for high power transmitters where three phase power supply is available, due to the high DC voltage which is obtainable. This circuit has an added advantage in that the ripple frequency is high, being six times the supply frequency, allowing easy filtering.

Analyzing these rectifier circuits, we obtain the values indicated below as the maximum operating and output values for any of the tubes described above.

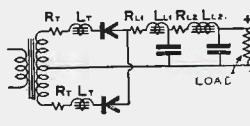
Fig. No.	Trans. Volts E	DC Output Volts at Input to filter	DC Output Current
4	.7 x peak inv. voltage	.45 x E	.33 x peak plate current
5	.35 x peak inv. voltage	.9 x E	.66 x peak plate current
6	.35 x peak inv. voltage	.9 x E	1.32 x peak plate current
7	.7 x peak inv. voltage	.9 x E	.66 x peak plate current
8	.43 x peak inv. voltage	1.12 x E	.83 x peak plate current
9	.43 x peak inv. voltage	2.25 x E	1.0 x peak plate current

As an example, if we apply these figures to the 866 tube, we find that in a full wave circuit, (fig. 5), the maximum transformer voltage E each side of center tap is .35 x 7500 or 2650 volts. This gives us a DC voltage at the input to filter of 2650 x .9 or 2400 volts. The maximum DC output is .66 times the peak plate current of .6 amperes, or 400 MA. Naturally, voltages and currents lower than these values can be used. Where a saturated input reactor is used, the allowable DC is reduced somewhat. However, as these saturated reactors are normally used in conjunction with a class B amplifier load, the high DC and peak plate currents are generally of short duration reducing the tube life by an amount which is not excessive.

PREDETERMINING DC VOLTAGE



TYPICAL PLATE SUPPLY
(Figure 10)



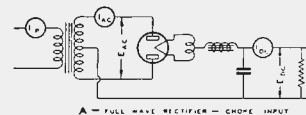
SIMPLIFIED FORM FIG 10
(Figure 11)

Actually, in practice, the DC voltage in which we are interested is that out of the filter. If we examine our complete circuit closely (fig. 10), we find that it can be reduced to the simpler form of fig. 11. Here we have the ratio of transformation such that E volts are induced

in the transformer secondary. From the theoretical DC output which is .9 x E, we must subtract all the voltage drops, which include the drop across R_t (the transformer resistance), across L_t (the transformer leakage reactance), across V (the tube drop), across RL_1 and RL_2 (the choke resistances). If the transformer regulation is known, a value of E can be obtained which already incorporates the transformer losses. The DC output is then (.9 x E) minus 15 (the normal voltage drop across a mercury vapor tube), (minus $IDC \times (RL_1 \text{ plus } RL_2)$). This gives us a definite means of predetermining our DC output voltage from a rectifier using a choke input filter.

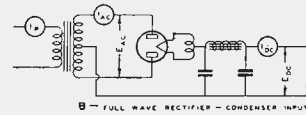
TYPICAL PLATE SUPPLIES

In many cases a particular transformer may be used under



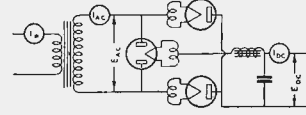
A - FULL WAVE RECTIFIER - CHOKE INPUT

EDC - 435 V
IDC - 100 MA
EAC - 1100 V
IAC - 71 MA
IPRI - .6 MA



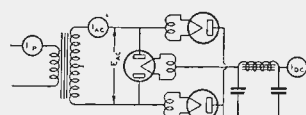
B - FULL WAVE RECTIFIER - CONDENSER INPUT

EDC - 675 V
IDC - 100 MA
EAC - 1100 V
IAC - 103 MA
IPRI - .9 MA



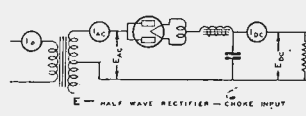
C - BRIDGE RECTIFIER - CHOKE INPUT

EDC - 860 V
IDC - 100 MA
EAC - 1100 V
IAC - 96 MA
IPRI - 1.1 A



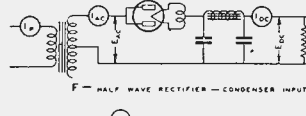
D - BRIDGE RECTIFIER - CONDENSER INPUT

EDC - 1200 V
IDC - 100 MA
EAC - 1100 V
IAC - 148 MA
IPRI - 1.65 A



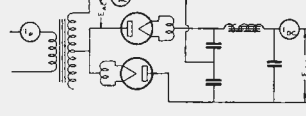
E - HALF WAVE RECTIFIER - CHOKE INPUT

EDC - 480 V
IDC - 100 MA
EAC - 550
IAC - 120 MA
IPRI - .9 A



F - HALF WAVE RECTIFIER - CONDENSER INPUT

EDC - 580 V
IDC - 100 MA
EAC - 550 V
IAC - 190 MA
IPRI - 1.45 A



G - VOLTAGE DOUBLER RECTIFIER

EDC - 1080 V
IDC - 100 MA
EAC - 550 V
IAC - 310 MA
IPRI - 1.55 A

(Figure 12A to G)

different circuit conditions. Figure 12A to G illustrates some of the standard single phase rectifiers more commonly used with typical voltage and current conditions obtained. Comparing A and B, it is soon that when changing the circuit from choke input to condenser input an increase in DC voltage is obtained. However, examination of the primary and secondary transformer currents indicates an increase of almost equal magnitude. If the same power transformer were used, this would mean that while the DC voltage is raised, the DC current will have to be reduced in almost the same amount to keep the power transformer at normal rating. In other words, the DC power will still remain practically the same.

A similar condition applies when a transformer normally used for full wave rectification is changed over for a bridge circuit as C. While the voltage here is practically twice that available in a normally full wave circuit; due to the high increase in primary current the DC load current must be reduced to approximately 60% of the value obtainable in full wave rectification. An examination of the other circuits shown will indicate the method of approach in the use of any of the other circuits with a standard transformer. This can be tabulated as follows, if we take the full wave rectifier with choke input as a standard and let the values of E dc and I dc be one, the same transformer will provide the following values of E dc and I dc in the other circuits shown:

Figure	DC Voltage	DC Amps.
A	1	1
B	1.55	.68
C	2.	.6
D	2.76	.42
E	1.	.62
F	2.4	.39
G	5.	.25

To simplify calculations a number of typical rectifier circuits using standard components are listed below. Naturally, standard components available will not take care of all requirements which may come up. However, UTC specializes in the construction of transformers to exact specifications, and can give quick delivery on units to the exact requirements of a particular user.

TYPICAL SINGLE PHASE RECTIFIER SYSTEMS

Trans. Type No.	R.M.S. Volts Each Side	Single Phase Full Wave Rectifier Fig. 1						Single Phase Bridge Rectifier Fig. 2					
		D. C. Mils	D. C. Volts	Rect. Tubes	L ₁	L ₂	T ₂	D. C. Mils	D. C. Volts	Rect. Tubes	L ₁	L ₂	T ₂
LS-108	750	220	580	66	LS-97	LS-93	LS-80	135	1200	Four 66's	LS-97	LS-91	LS-120
	900	200	710					125	1460				
LS-76	1200	220	960	66	LS-97	LS-93	LS-80	135	1970	Four 66's	LS-97	LS-91	LS-120
	1450	200	1170					125	2390				
LS-77	1200	400	930	66	LS-98	LS-96	LS-80	250	1955	Four 66's	LS-97	LS-93	LS-120
	1450	350	1150					215	2385				
LS-78A	1200	550	930	Four 66's	LS-93 Paralleled	LS-96	LS-81	340	1950	Four 66's	LS-98	LS-96	LS-120
	1450	500	1150					310	2375				
LS-109	1600	300	1285	66's	LS-98	LS-93	LS-80	185	2645	Four 66's	LS-97	LS-92	LS-120
	2000	250	1635					155	3340				
LS-110	2500	600	2000	Four 66A's	LS-93 Paralleled	LS-96	LS-81	370	4155	Four 66's	LS-98	LS-96	LS-120
	3000	500	2445					310	5015				
LS-106	2800	1150	2350	72A	LS-199	LS-99	LS-82	700	4620	Four 66A's	LS-199	LS-99	LS-120
	3500	1000	3000					600	5825				
LS-111	3000	1650	2540	72A	LS-113	LS-113	LS-82	1050	4920	Four 66A's	LS-199	LS-99	LS-120
	3500	1600	3000					1000	5820				

(Write UTC for information on any rectifier requirement which is not noted above)

PLATE TRANSFORMERS

LS-108	Primary 100, 105, 110, 115, 120, 125 volts; 50 to 60 cycles. Secondary 900 volts each side of center, tapped at 750 each side, 200 MA DC. LS-4	\$25.00
LS-76	For use with push pull 50 watt tubes. Primary tapped for 100, 105, 110, 115, 120, 125 volts, 60 cycles A.C. Secondaries: 1450 V. each side of center at 200 MA.; also tapped at 1200 volts each side of center. Secondary winding may be joined in parallel. LS-5	45.00
LS-77	For use with 50 watt Class B and A Prime tubes. Primary tapped for 100, 110, 120, 220, 230 and 240 volts, 50-60 cycles A.C. Secondary winding 1450 volts each side of center at 350 MA.; also tapped at 1200 volts each side of center. Special casting	60.00
LS-78A	For use with 200 watt tubes, AF and RF. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary winding 1450 volts each side of center at 500 MA.; also tapped at 1200 volts each side of center. Special casting	75.00
LS-109	Primary 100, 110, 120, 220, 230, 240, volts; 50 to 60 cycles. Secondary 2000 volts each side of center, tapped at 1600 each side, 250 MA DC. Special casting	60.00
LS-110	Primary 100, 110, 120, 220, 230, 240, volts; 50 to 60 cycles. Secondary 3000 volts each side of center, tapped at 2500 each side, 500 MA DC. Special casting	100.00
LS-106	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 3500 volts each side of center, tapped at 2800 each side, 1 amp. D.C. Special casting	180.00
LS-111	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 3500 volts each side of center, tapped at 3000 each side, 1.6 Amp. DC. Special casting	250.00

THREE PHASE PLATE TRANSFORMERS

LS-112	Primary 200, 210, 220 volts — 3 phase Delta connected; 50 to 60 cycles. Secondary designed to deliver 3000 volts DC. on High tap, 2500 volts DC on low tap. 500 MA DC. with half wave rectification. Will deliver 6000 volts DC or 5000 volts DC in full wave rectification at 300 MA.	240.00
LS-113	Primary 200, 210, 220 volts — 3 phase Delta; 50 to 60 cycles. Secondary designed to deliver 3000 volts DC or 2500 volts DC at 1 Amp. with half wave rectification. Will deliver 6000 volts DC or 5000 volts DC in full wave rectification at 600 MA	340.00
LS-114	Primary 200, 210, 220 volts — 3 phase Delta; 50 to 60 cycles. Secondary designed to deliver 3000 volts DC. or 2500 volts DC. at 1.7 Amp. with half wave rectification. Will deliver 6000 volts DC. or 5000 volts DC. in full wave rectification at 1 Amp.	425.00
LS-115	Primary 200, 210, 220 volts — 3 phase Delta; 50 to 60 cycles. Secondary designed to deliver 6000 volts DC. or 5000 volts DC. at 1.5 Amp. with half wave rectification. Will deliver 12000 volts DC or 10000 volts DC in full wave rectification at .9 Amp.	800.00

BIAS SUPPLY TRANSFORMERS

LS-116	This Transformer combines a full wave plate and filament winding to supply fixed bias for tubes such as 42, 45, 2A3, 6F6, 250, 210, etc. Primary 100, 105, 110, 115, 120, 125. Secondary tapped for 50, 75, and 100 volts each side of center 30 MA. Filament 5 Volt CT to take care of type 82 or 80 tubes. LS-2	10.00
LS-79AX	Primary tapped for 100, 110, 120, 220, 230, 240 volts; 50-60 cycles A.C. Secondary tapped to supply fixed C bias for class B 203's, 830B's and class A 845's with 82 rectifiers. LS-3	20.00
LS-107	For use as fixed bias plate transformer. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary designed to supply fixed C bias both for Class B 849's or A prime 845's. LS-4	25.00

FILAMENT TRANSFORMERS

LS-80	Filament transformer for two 866 mercury vapor rectifier tubes. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary: 2½ V.C.T. 10 A. 12,000 volts insulation. LS-3	\$15.00
LS-81	Filament transformer for four 866 mercury vapor rectifier tubes. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary: 2½ V.C.T. 20 Amps. 12,000 volts insulation. LS-3	20.00
LS-82	Filament transformer for two 872 mercury vapor rectifier tubes. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary: 5 V.C.T. 20 amps. 12,000 volts insulation. LS-3	20.00
LS-84	Filament transformer for two 203A, 211, 17C, 845, 852, or 860 tubes. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondary: 10 V.C.T. 7 A. 10,000 volts insulation. LS-3	15.00
LS-85	Filament transformer for 866 and 50 watt power tubes. Primary tapped for 100, 110, 120, 220, 230, 240 volts, 50-60 cycles A.C. Secondaries: 2½ V.C.T. 10 A. 2-10 V.C.T. 3 A. windings. 10,000 volts insulation. LS-3	25.00
LS-86	Filament transformer for 2½ volt heater tubes. Primary tapped for 105, 115, 125 volts, 50-60 cycles A.C. Secondary 2½ V.C.T. 6 amps. 2500 volts insulation. LS-1	7.50
LS-87	Filament transformer for 2-WE 252 A's or 1-5Z3, 83 rectifier. Primary tapped for 105, 115, 125 volts, 50-60 cycles A.C. Secondary 5 V.C.T. 3 amps. 2500 volts insulation. LS-1	7.50
LS-88	Filament transformer for 6.3 volt heater tubes. Primary tapped for 105, 115, 125 volts, 50-60 cycles. Secondary 6.3 V.C.T. 2 amps. 2500 volts insulation. LS-1	7.50
LS-89	Filament transformer for WE 262 A or 271 A tubes. Primary tapped for 105, 115, 125 volts, 50-60 cycles. Secondary 10 V.C.T. 1.5 amps. 2500 volts insulation. LS-1	7.50
LS-118	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 11 volts 10 Amps. For 849's or 204A's. LS-3	20.00

FILAMENT TRANSFORMERS FOR THREE PHASE AND BRIDGE RECTIFIERS

LS-119	Primary 100, 105, 110, 115, 120, 125 volts; 50 to 60 cycles. Secondaries 5 V.C.T. 3 amps., 5 V.C.T. 3 amps., 5 V.C.T. 6 amps. For bridge rectifier using 83 or similar tubes. 5000 volt insulation. LS-3	15.00
LS-120	Primary 110, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondaries 2½ V.C.T. 5 amp., 2½ V.C.T. 5 amp., 2½ V.C.T. 10 amp. For bridge rectifier using 866 tubes. 12000 volt insulation. LS-3	25.00
LS-121	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondaries 5 V.C.T. 10 amp., 5 V.C.T. 10 amp., 5 V.C.T. 20 amp. For bridge rectifier using 872 tubes. 12000 volt insulation. LS-4	35.00
LS-122	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 2½ V.C.T. 15 amps. 12000 volts insulation. LS-3	17.50
LS-123	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 2½ V.C.T. 5 amps. 12000 volts insulation. LS-2	12.00
LS-124	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 5 V.C.T. 10 amp. 12000 volts insulation. LS-3	15.00
LS-125	Primary 100, 110, 120, 220, 230, 240 volts; 50 to 60 cycles. Secondary 5 V.C.T. 30 amp. 12000 volts insulation. LS-3	24.00

SCOTT-CONNECTED FILAMENT TRANSFORMERS

The Scott-connected filament transformer is one of the most modern methods of minimizing carrier hum. Its efficiency is so great that most of the newer broadcast stations are specifying Scott-connected transformers in their original design. Scott-connected transformers are now standard equipment on the more expensive transmitters manufactured by the largest broadcast organization in the country.

- | | | |
|---------------|--|-------|
| LS-127 | Primary 200, 210, 220 volts three phase, 50 to 60 cycles. Secondaries 10 V.C.T. 3 1/2 amp. each; 90 degrees out of phase for 203A tubes. LS-3 | 32.50 |
| LS-128 | Primary 200, 210, 220 volts three phase 50 to 60 cycles. Secondaries 10 V.C.T. 7 amp. each; 90 degrees out of phase. For 4 203A tubes. LS-4 | 45.00 |
| LS-129 | Primary 200, 210, 220 volts three phase 50 to 60 cycles. Secondaries 11 V.C.T. 4 amp. each; 90 degrees out of phase. For 204A or 849 tubes. LS-4 | 45.00 |

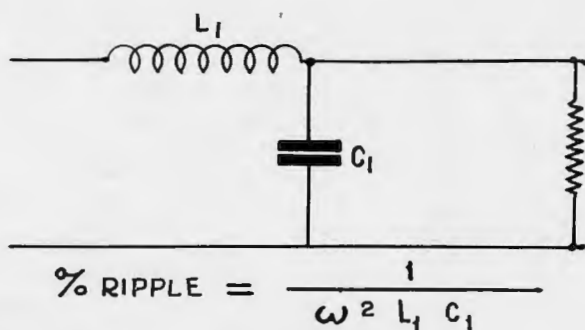
POWER SUPPLY FILTERS

Power supplies for modern radio equipment are generally obtained by rectifying an AC supply. This process is carried out in two steps. In the first step, the AC voltage is converted to a pulsating DC. In the second step this pulsating DC is passed through a filter which smooths out the pulsations to a point approaching the smoothness of direct current. The filter unit serves the function of supplying electrical inertia to the change in magnitude of the pulsating current. The pulsations in the rectified DC are multiples of the power supply frequency if a half wave rectifier is used and are multiples of twice the power supply frequency if a full wave rectifier is used. Similarly in a three phase half wave rectifier the pulsation frequency is three times the power supply frequency and in a three phase full wave rectifier six times the power supply frequency. The function of the filter circuit is to attenuate both the fundamental frequency and the corresponding harmonics to a point that is not objectionable. Economic considerations generally determine the extent of this attenuation.

REGULATION

Another factor which must be considered in connection with filter circuits is the question of power supply regulation. In addition to the regulation or change between no load and full load caused by the resistance drop in the filter chokes, the regulation of the rectifying circuit or unit itself must also be considered.

As an example, a typical half wave rectifier may have a 50% regulation from no load to full load as compared to a typical full wave rectifier having 10% regulation. In some filters a condenser is placed immediately after the rectifying unit to assist filtering. Under no load conditions this condenser tends to store the electrical energy so that a peak voltage equal to 1.4 times the RMS voltage applied to the plates is obtained. As a load is applied, the charge built up on this first condenser is drained and the peak voltage can no longer be maintained, the DC voltage dropping to a point approaching the average value. It is rather difficult to pre-determine in a simple manner the exact DC voltage using this type of filter. As the ratio of load current to capacity is increased, the voltage will tend to drop down.



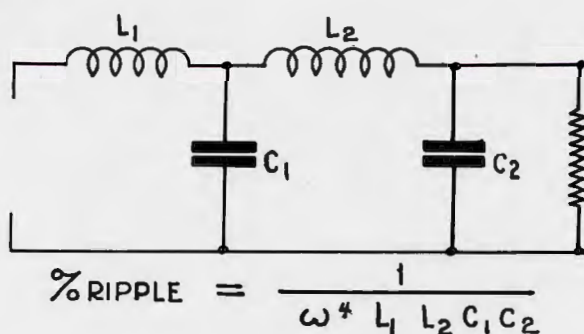
(Figure 1)

On the other hand, if a condenser having infinite value could be used, the peak voltage would be maintained regardless of load current. A typical instance where the ratio of capacity to load current is high may be found in the anode supply of a cathode ray tube. In this type of filter a condenser of 1 Mfd is generally used and a current of approximately 1 MA is drained. Under this condition, a half wave rectifier with 710 volts on the plate will effect a DC output voltage of 1000.

To improve regulation, a bleeder is generally used. This consists of a resistance shunted across the DC output and in most cases drains approximately 10% of the full load current. Another device frequently used to maintain good regulation, where the current changes through a wide range, is a swinging choke preceding the first condenser. With proper design, increasing load will lower the impedance of this choke sufficiently to allow the voltage to build up across the condenser following. In computing regulation, the IR drop in the chokes must always be considered.

VARIATORS

Certain applications such as class B audio amplifiers produce wide changes in DC current with a corresponding tendency for poor power supply regulation. In many of these applications, distortion or non-linear modulation may be produced by the voltage fluctuation of the power supply. To offset this condition, the UTC engineering staff have developed a form of saturable choke which is inserted in series with the primary of the plate transformer. A DC winding is coupled to this choke and inserted in series with the DC load. As the load is increased, the series choke is saturated and more AC voltage is impressed across the plate transformer primary which consequently compensates for the additional drop in rectifier and filter circuit. This form of UTC control unit is termed a Variactor. In most cases these variactors are made on special order only. However, a few are maintained as stock items. As a typical instance of the application of the UTC Variactor we can take the case of a class B-46 amplifier. A typical ordinary plate supply for this purpose delivers 400 volts on the plate at no signal and 350 volts on the plate at maximum audio output. Using a Variactor, the voltage can be actually made to start at 400 and end up with 405 volts and at full load.



(Figure 2)

HUM

After analyzing the filter requirements with reference to regulation, the next point is the analysis of the actual hum suppression desired. Since in a rectifying system the attenuation of all frequencies is desired, a low pass filter is used which theoretically should have a cut off point at zero frequency. However, this theoretical condition would entail inductance and capacitance elements of infinite value. For practical purposes, the magnitude of these elements are controlled by economical considerations but in any case must be sufficiently large to attenuate the lowest frequency present. To exactly determine the ripple at the output of a filter, is a rather complex proposition. Fortunately in all commercial applications the reactance of each condenser is small compared with the reactance of the preceding inductor and the reactance of the final condenser is small compared with the resistance of the load. Under this condition, the analysis of ripple may be simplified and can be evaluated as indicated in figures 1 and 2. To simplify this calculation, the chart of figure 3 has been prepared, from which the attenuation of hum in typical, practical circuits can be readily obtained. In most cases, the higher harmonics can be practically neglected as the attenuation of this type of filter varies as the 4th power of the frequency.

RESONANT CIRCUITS

To improve the filtering efficiency, resonant or hum-bucking circuits are sometimes used. The most practical device of this nature is the UTC hum-bucking choke which is available in a number of standard ratings. In typical rectifiers, the use of

hum-bucking chokes will increase the filter efficiency 4 times as compared to an equivalent amount of inductance and capacity in a standard filter. Figure 4 illustrates a typical hum-bucking circuit.

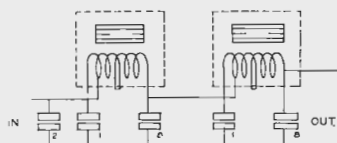
CAUTIONS

A number of important points must be watched in the use of filter circuits. One important fact is that at least one of the filter inductances should always be placed in the positive leg. If all inductors are used in the negative leg, the distributed capacitance of the transformer winding will by-pass the rectifier and allow a non-filterable residual voltage to appear across the load.

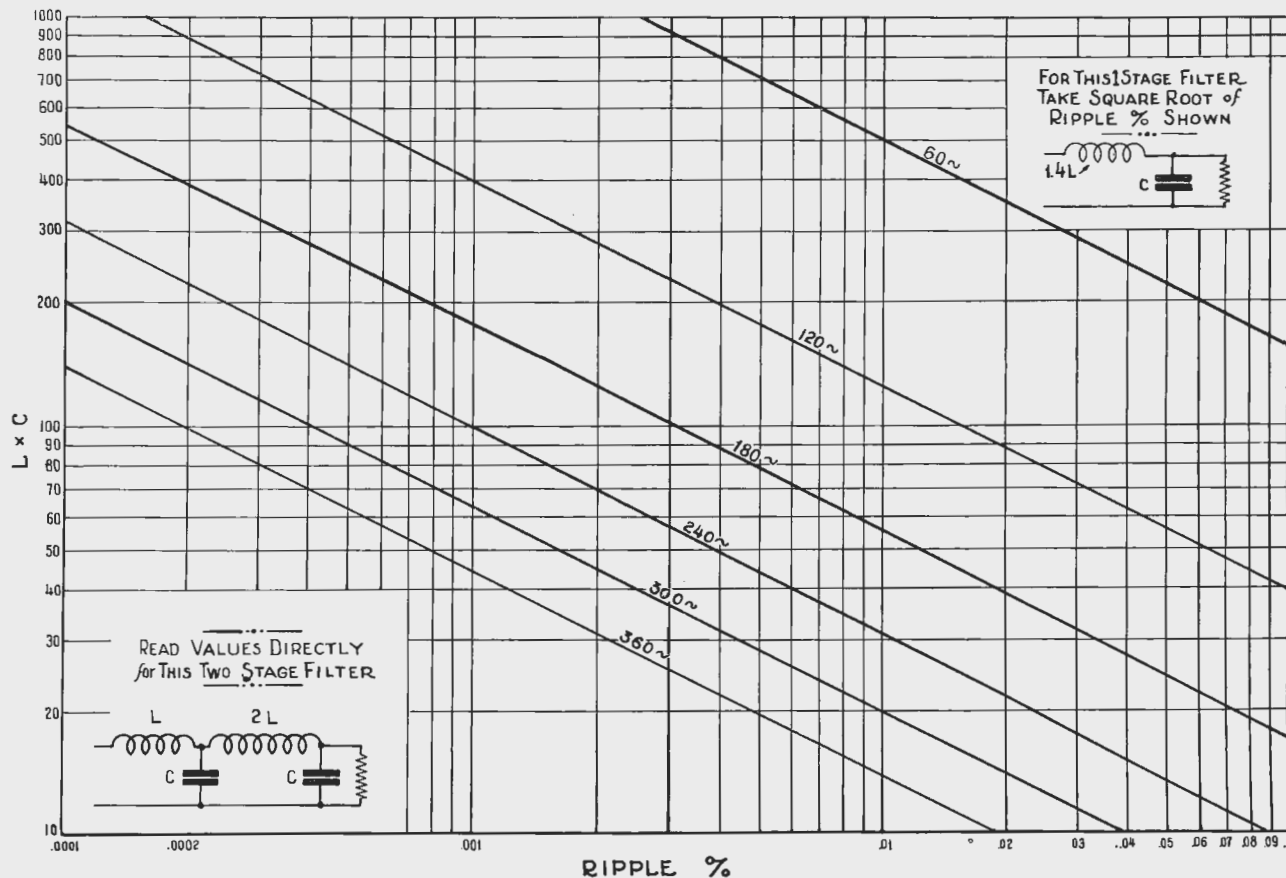
Another important point is the fact that there should be a negligible coupling between the filter inductors. If a co-efficient of coupling of even 1% occurs between the first and later filter chokes, the amplitude of the higher harmonics across the load becomes very appreciable. To prevent this UTC Linear Standard chokes for use in high attenuation filters are housed in high permeability cast cases.

Choke input circuits are always used in polyphase rectifiers and should also be used with high power single phase rectifiers because of the high ratio of average to peak current that is obtainable with choke input.

The first condenser in a filter circuit should be capable of operating continuously with a DC voltage equal to the peak AC voltage applied to the rectifier. This also applies to the first filter choke. It is important in the use of the chart of figure 3 and the formulas of figures 1 and 2 that a knowledge of the actual inductance and capacity values be had. Many condensers have been found to be far poorer than their rated capacity, particularly in the electrolytic type. The inductance of filter chokes varies appreciably with DC and many units are not rated with inductance at the actual value of DC used. To prevent misrating, the actual inductance versus DC curves of UTC Linear Standard chokes are illustrated in figures 5, 6, 7, 8, 9, 10 and 11.



(Figure 4)



(Figure 3)

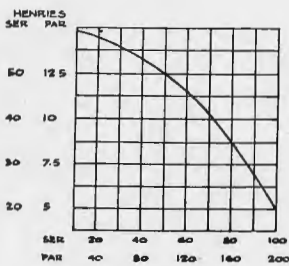


Fig. 5 LS-90

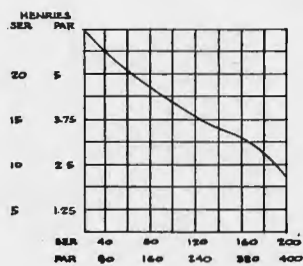


Fig. 6 LS-91

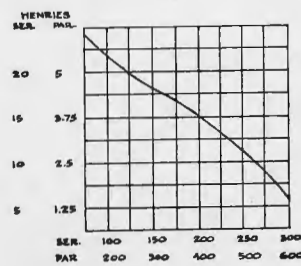


Fig. 7 LS-92

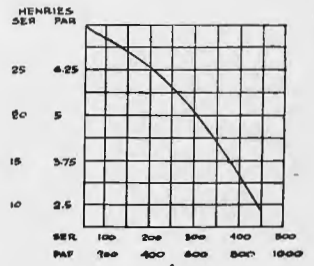


Fig. 8 LS-93

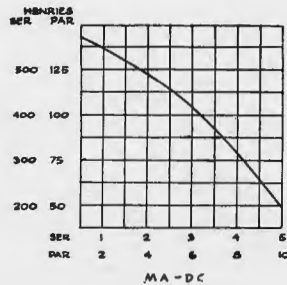


Fig. 9 LS-94

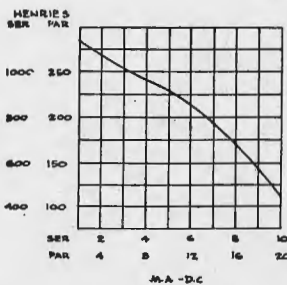


Fig. 10 LS-95

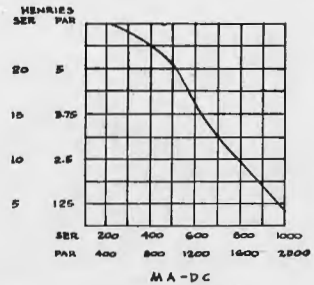


Fig. 11 LS-96

FILTER AND AUDIO REACTORS

LS-90	Hum-bucking split tapped filter choke. 50 henrys 50 MA.; 510 ohms D.C. in series. 12.5 henrys 100 MA; 127.5 ohms D.C. in parallel. LS-2	\$8.50
LS-91	Hum-bucking split tapped filter choke. 14 henrys 125 MA; 200 ohms D.C. in series. 3.5 henrys 250 MA; 50 ohms D.C. in parallel. LS-2	8.50
LS-92	Hum-bucking split tapped filter choke. 16 henrys 175 MA; 96 ohms D.C. in series. 4 henrys 350 MA; 24 ohms D.C. in parallel. LS-3	15.00
LS-93	Hum-bucking split tapped filter choke. 26 henrys 200 MA; 112 ohms D.C. in series. 6.25 henrys 400 MA; 28 ohms D.C. in parallel. LS-4	25.00
LS-96	Hum-bucking split tapped filter choke. 20 henrys 500 MA; 90 ohms D.C. in series. 5 henrys 1000 MA; 22.5 ohms D.C. in parallel. LS-5	40.00
LS-94	Split winding parallel feed audio choke. 320 henrys 3 MA; 6400 ohms in series. 80 henrys 6 MA; 1600 ohms D.C. in parallel. LS-1	10.00
LS-95	Split winding parallel feed audio choke. 720 henrys 5 MA; 3600 ohms D.C. in series. 180 henrys 10 MA; 900 ohms D.C. in parallel. LS-2	20.00
LS-97	Swinging class B choke. 8-40 henrys 200 MA; 100 ohms D.C. LS-3	15.00
LS-98	Swinging class B choke. 8-40 henrys 400 MA; 90 ohms D.C. LS-4	25.00
LS-99	Hum-bucking split tapped filter choke. 20 henrys 1 Ampere; 50 ohms D.C. in series. 5 henrys 2 Amperes; 12.5 ohms D.C. in parallel. Special casting	60.00
LS-105	Swinging class B choke 8-40 henrys 1 Ampere; 50 ohms D.C. Special casting	60.00
LS-1100	Filter choke for low voltage high current power supplies .05 henrys 2.5A; .5 ohms. LS-2	8.00
LS-1110	Hum bucking split-tapped filter choke. 20 henrys 350MA; 80 ohms DC resistance in series. 5 henrys 700 MA; 20 ohms D.C. resistance in parallel. LS-5	32.00
LS-1120	Hum bucking split-tapped filter choke. 12 henrys 700 MA; 65 ohms DC resistance in series. 3 henrys 1.4 A; 16 ohms D.C. in parallel. LS-5	40.00
LS-1130	Split filter choke. 12 henrys 1.7 A. 35 ohms D.C. in series. 3 henrys 3.4A.; 9 ohms D.C. in parallel	100.00
LS-1140	Filter choke. 10 henrys 2.5A.; 22 ohms D.C. resistance. Special casting	230.00

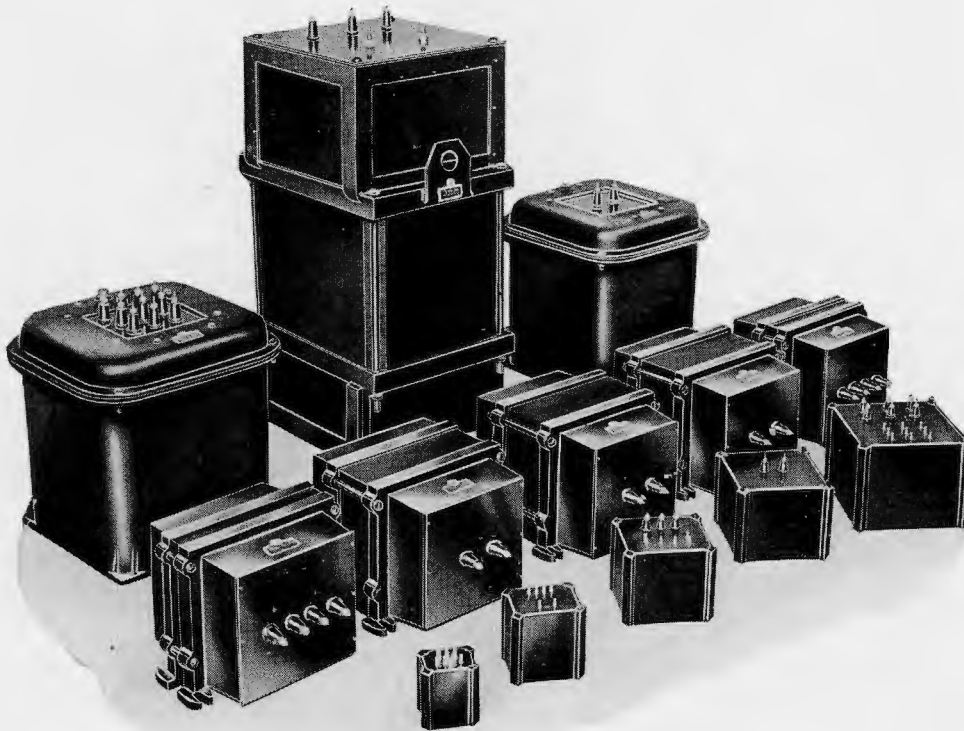
MODULATION REACTORS 10,000 VOLTS INSULATION

LS-100	50 henrys 100 MA; 500 ohms D.C. LS-3	\$17.50
LS-101	50 henrys 175 MA; 350 ohms D.C. LS-4	25.00
LS-102	50 henrys 350 MA; 250 ohms D.C. LS-5	40.00
LS-103	50 henrys 500 MA; 175 ohms D.C. Special casting	60.00
LS-104	30 Henrys 1A.; 80 ohms DC 20,000 volts insulation. Special casting	125.00

BALANCE COILS FOR PARALLEL OPERATION OF RECTIFIERS

LS-130	Centertapped reactor to equalize the load between two rectifiers of the 80, 81, 82, 83, 83V, 5Z3 or similar tubes used in parallel. LS-2	8.50
LS-131	Centertapped reactor for balancing current through two rectifiers of the 866 or 866A type connected in parallel. LS-3	15.00
LS-132	Centertapped reactor for balancing current through two rectifiers of the 872 or 872A type connected in parallel. LS-4	40.00

TYPICAL UTC LINEAR STANDARD COMPONENTS



The transformers illustrated above are typical transformers as supplied by UTC to broadcast stations and commercial organizations. The UTC organization manufactures the most complete and diversified group of transformers produced in the entire world. The scope of activity is partially illustrated by the following products which UTC produces.

- Aircraft—portable audio and power components weighing but 6 oz. completely poured with compound in drawn metal containers.
- Television transformers linear from 30 to 200,000 cycles.
- High Q audio reactors with Q factor (L/R) as high as 200 and over.
- Audio equalizers and filters.
- Saturable control reactors.
- Battery chargers and speaker field exciters.
- Rectifiers for broadcast and industrial applications.
- Automatic voltage regulators.
- Oscillation transformers.
- Plate and distribution transformers up to 200 KVA 100,000 volts.
- High potential and high current test sets.
- Audio and carrier frequency amplifiers for special applications.

Write to us if you are interested in any items running along parallel lines to the above. UTC consulting service is gratis.

HIPERM



ALLOY



OVERALL DIMENSIONS

- H1 Case 1-7/8 x 2-3/8 x 3
H2 Case 2-3/8 x 3 x 3-3/4

MOUNTING DIMENSIONS

- H1 1-3/8
H2 1-11/16 x 2-3/8

This new group of transformers, specifically designed for portable use, are extremely compact and light in weight. The fidelity of these units measures up to high quality broadcast standards, being uniform in response from 30 to 20,000 cycles. These high fidelity transformers are the smallest quality transformers of their class, and have only been made possible through the development of **Hiperm Alloy**, a nickel iron alloy having extremely high initial permeability. This alloy is not only used for the core material, but also for the shielding case, affording a maximum of shielding with a minimum of size and weight. Another unique feature developed to make possible the small size of these units is the elimination of all extended mounting flanges or feet. These are replaced by simple threaded metal inserts in the case allowing mounting with terminals either up or down, so that the units can be mounted either on rack panel or metal chassis with no waste space.

COUPLING TRANSFORMERS

- | | | |
|--------|--|-------|
| HA-105 | Cascade, single plate like 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, WE262A, 864, 57 triode, 77 triode to a single grid. Turn ratio 2:1 overall. H-1 | 9.00 |
| HA-106 | Input, single plate like 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, WE26A, 864, 57 triode, 77 triode to push pull grids. Turn ratio 1 1/2:1 each side of center. H-1 | 11.00 |
| HA-107 | Input, two push pull plates like 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, WE 262A, 864, 57 triodes, to push pull grids. Turn ratio 1 1/2:1 overall. Primary and secondary in two sections. H-2..... | 15.00 |

INPUT TRANSFORMERS (TO ONE OR TWO GRIDS)

- | | | |
|--------|--|---------|
| HA-100 | Variable impedance line to single grid. Primary will match 500, 333, 250, 200, 125, or 50 ohm line, as required, for carbon or voice coil microphones, electro-magnetic or oil damped pickups. Secondary impedance 60,000 ohms. H-1 | \$12.50 |
| HA-101 | Variable impedance line to single or push pull grids. Primary will match 500, 333, 250, 200, 125, or 50 ohm line, as required, for carbon or voice coil microphones, electro-magnetic or oil damped pickups. Secondary in two sections for series or parallel connection. Overall impedance of windings in series 120,000 ohms, impedance of each winding 30,000 ohms. H-1 | 15.00 |
| HA-102 | Velocity ribbon microphone to single grid. Secondary impedance 90,000 ohms H-1..... | 12.50 |
| HA-103 | Dynamic voice coil microphone to single grid, secondary impedance 90,000 ohms. H-1..... | 12.50 |

MIXING, MATCHING AND OUTPUT TRANSFORMERS

- | | | |
|--------|---|-------|
| HA-108 | Variable impedance line for mixing carbon or voice coil microphones, electro-magnetic or oil damped pickups to a variable impedance line. Primary and secondary windings will match 500, 333, 250, 200, 125, or 50 ohm line. H-1..... | 12.50 |
| HA-109 | Matching, velocity ribbon microphone to a 500, 333, 250, 200, 125 or 50 ohm line. H-1..... | 12.50 |
| HA-110 | Matching, dynamic voice coil microphone to a 500, 333, 250, 200, 125, or 50 ohm line. H-1 | 12.50 |
| HA-111 | Matching, crystal microphone or pickup to a 500, 333, 250, 200, 125, or 50 ohm line. H-1..... | 12.50 |
| HA-112 | Matching, high impedance photo electric cell to a 500, 333, 250, 200, 125 or 50 ohm line. H-1..... | 12.50 |
| HA-113 | Output, from a single plate like the 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, WE 262A, 864, 57 triode, 77 triode, to a 500, 333, 250, 200, 125, or 50 ohm line. H-1..... | 12.50 |
| HA-114 | Output, from push pull plates, like 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, WE 262A, 864, 57 triodes, 77 triodes to a 500, 333, 250, 200, 125 or 50 ohm line. H-1..... | 12.50 |

FILTER AND AUDIO CHOKES

- | | | |
|--------|---|-------|
| HC-115 | Split winding parallel feed audio choke. May also be used as a push pull audio choke. 400 henrys 2.5 MA; 7000 ohms in series. 100 henrys 5 MA; 1750 ohms in parallel. Capacity of windings for push pull connection 20 MA each side. Inductance with no unbalanced D.C. 500 henrys. H-1..... | 8.50 |
| HC-116 | Split winding parallel feed audio choke. May also be used as a push pull audio choke. 600 henrys 8 MA; 4000 ohms D.C. in series. 150 henrys 16 MA; 1000 ohms in parallel. Capacity of windings for push pull connection 40 MA each side. Inductance with no unbalanced D.C. 1000 henrys. H-2..... | 15.00 |
| HC-117 | Hum-bucking tapped filter and audio choke 60 henrys 15 MA; DC resistance 3000 ohms, alloy core. H-1 | 8.50 |
| HC-127 | Hum bucking tapped filter and audio choke, 60 henrys 40 MA. D.C. resistance 1000 ohms, alloy core. H-2 | 15.00 |

HIGH AND LOW FREQUENCY AUDIO EQUALIZERS

HC-118	Low frequency equalizer tapped for resonance at either 25, 50, or 100 cycles. Will bring up low frequencies to compensate for losses in disc and film recording, etc. H-2.....	20.00
HC-119	High frequency equalizer tapped for resonance at either 4000, 6000, 8000, or 10,000 cycles. Will bring up high frequencies to compensate for losses in disc and film recording, etc. H-2.....	20.00
HC-120	Surface noise (scratch) filter for disc recording; tapped for sharp resonance and maximum loss at 2500, 3500, or 4200 cycles. H-2.....	20.00
HC-121	Speaker voice coil equalizing network provides gradual cutoff for low frequency speaker beyond 1300 cycles and gradual cutoff for high frequency voice coil or crystal speaker (tweeter) below 4000 cycles. Specify speaker type number and its impedance when ordering. H-2.....	25.00

PRE-AMPLIFIER POWER AND FILAMENT TRANSFORMERS

HP-122	Plate and filament supply for a portable pre-amplifier using 6 volt heater tubes. Primary 115—60 cycles AC. Secondaries 220 each side of center at 15 MA. 6.3 V.C.T. at 1.2 amps. 6.3 Volt. .4 amps for 84 rectifier. H-2.....	10.00
HP-123	Plate and filament supply for a portable pre-amplifier or tuner using 6 volt heater tubes. Primary 115—60 cycles. Secondaries 275 each side of center at 35 MA. 6.3 V.C.T. at 2 amps. 6.3 volt .4 amps for 84 rectifier. H-3.....	15.00
HF-124	Filament transformer. Primary 115—60 cycles. Secondary 6.3 V.C.T. 1.2 amps. H-1.....	7.50
HF-125	Filament transformer—primary 115—60 cycles. Secondary 2 1/2 V.C.T. 5 amps. H-1.....	7.50
HF-126	Filament transformer. Primary 115—60 cycles. Secondary 10 V.C.T. 1.2 amps. For use with WE 262A tubes. H-1.....	7.50

Where the highest fidelity is an absolute requirement UTC Linear Standard components, which are at present housed in high permeability cast iron cases, can be furnished in **Hiperm Alloy** cases—thereby reducing both size and weight—at no additional cost.

UNIVERSAL CLASS A, CLASS B OUTPUT CHOKES

These chokes are tapped so that they can be used as autotransformer couplers from the audio modulation stage to Class C stages. A variety of impedance matching taps are brought out on each unit effecting an arrangement so that the coupler will readily accommodate push pull RF, single end RF with the DC adding, or single end RF with the DC bucking. The units are huskily constructed and air gaps are arranged to take care of the maximum DC currents.

The Huc chokes may also be used to couple the output stage to RF pentodes like the RK 18, 20, 860 and 803 for screen plate modulation.

HUC-20	Will handle 20 watts audio power. It can be used with Class B 46's, 59's, 53, 6A6, 79 etc.; or class A 2A3's, 250's, 210's, Class A prime 42's, 45's etc. PA-2.....	\$ 7.00
HUC-50	Will handle 50 watts audio power. Suitable for use with class B 210's, 801's, 830's, 841's, push pull parallel 46's, 59's, 6A6's, push pull parallel 45's A prime, push pull parallel 250's, 2A3's etc. PA-3.....	12.50
HUC-100	Will handle 100 watts audio power. Suitable for use with class B 800's, 211E's, A prime 845's, 284A's, etc. PA-4.....	20.00
HUC-200	Will handle 200 watts audio power. Suitable for use with class B 203's, 830B's HK354's, single Eimac 150T, push pull parallel A prime 845's, 284A's, push pull parallel 800's etc. PA-5.....	32.50
HUC-500	Will handle 500 watts audio power. Suitable for class B 204's, A prime 849's, Eimac 150T's, push pull 212D's in A prime, etc. UTS Case.....	80.00

Typical circuits and impedance combinations of UTC modulation output chokes.
For further information on these chokes see UTC Sheet No. 112.

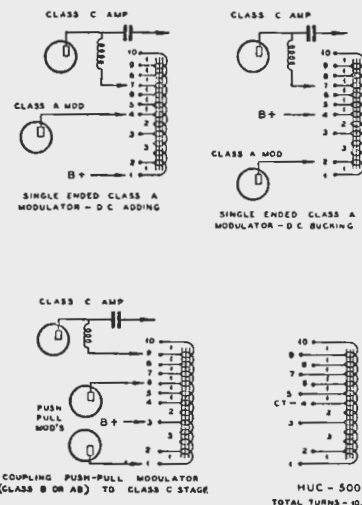
Secondary Impedances for Plate to Plate Loads of									
P	B	P	Sec. Ratio	1,750 Ohms	3,000 Ohms	5,000 Ohms	6,000 Ohms	7,000 Ohms	8,000 Ohms
6	3	1	.25	.....	.....	.....	1,500	1,750	2,000
6	3	1	.39	.....	1,180	1,360	2,000	2,350	2,750
5	3	2	.44	.....	1,320	1,530	2,200	2,650	3,100
6	3	1	.56	.....	1,700	1,950	2,800	3,500	4,500
5	3	2	.695	.....	2,100	2,450	3,500	4,200	5,500
6	3	1	.76	1,350	2,300	2,650	3,800	4,550	5,300
6	3	1	1.0	1,750	3,000	5,000	6,000	7,000	8,000
5	3	2	1.35	2,350	4,050	4,720	6,750	8,100	9,500
6	4	3	1.55	2,700	4,650	5,400	7,700	9,300	11,000
5	3	2	1.8	3,150	5,400	6,300	9,000	10,800	12,600
6	4	3	2.25	3,950	6,800	8,000	11,200	13,500	16,000
8	6	4	2.306	5,350	9,200	10,700	15,000	18,036	.....
8	6	4	1.4	7,000	12,000	14,000	20,000	.....	.....
10	8	6	1.625	11,000	19,000	.....	.....	.....	.....
18	8	6	1.625	11,000	19,000	.....	.....	.....	.....

EXAMPLE—A Class C tube, with 1,300 volts on the plate, draws a current of 235 mills. Its Class C load is therefore $\frac{1,300}{.235}$, or 5,500 ohms. The modulator tubes have a plate-to-plate load of 10,000 ohms.

Referring to the chart, select that value which is closest to 5,500 and which appears in the column headed by 10,000 ohms. This is 5600. The terminal connections to be used will then be found in the first four columns at the left end of the line in which the 5,600 appears. These are:

Terminal	P	B	P	Sec.
Tap. No.	6	3	1	8

One common power supply must be used for the modulator and class C amplifier.





The Public Address series of audio, filter and power units described below are designed to satisfy the demand for a popular priced quality line having the many exclusive and Universal features associated with UTC products. All cases are finished in a black eggshell enamel to suit exacting commercial requirements as to appearance. Each transformer may be fastened to chassis or rack panel with lugs either at top or bottom. The housings are physically symmetrical and similar in construction and when grouped in finished equipment present a thoroughly professional appearance. Transformers PA-134, 135 and 136, are now manufactured in the hum-bucking type of construction. In consequence they have an extremely low hum pickup and are excellent for low level work.



MOUNTING DIMENSIONS (With Flange)

PA-1	1-15/16 x 2-7/16
PA-2	2-7/16 x 3-7/8
PA-3	3-1/16 x 4-5/16

(Without Flange)

PA-1	1-13/16
PA-2	1-5/8 x 3-1/16
PA-3	1-13/16 x 3-7/8

OVERALL DIMENSIONS

	L	W	H
PA-1	2 1/2	3	3
PA-2	3-1/6	4 1/2	3 1/2
PA-3	3 3/8	4 7/8	4 1/4

INPUT TRANSFORMERS, CLASS A

PA-131	Transformer from 1 plate to 1 grid. 3:1 ratio. PA-1	\$4.50
PA-132	From 1 plate to 2 grids. 2:1 ratio each side. Split sec. PA-1	5.00
PA-133	From 2 plates to 2 grids. 1.75 ratio each side. Primary and secondary each in two sections. PA-1	6.00
PA-233	From 2-56 plates to 45 A prime grids PA-1	6.00
PA-134	500, 200, or 50 ohm line to single grid. PA-1	6.50
PA-135	500, 200, or 50 ohm line to push pull grids. PA-1	7.50
PA-136	Single plate or pickup and carbon mike or low impedance pickup to one or two grids. PA-1	7.50

MIXING, MATCHING TRANSFORMERS

PA-137	Mixing 500, 200, or 50 ohm line to 500, 200 or 50 ohm line. PA-1	\$5.50
PA-138	Audio line matching. Will handle 20 watts audio power. Input 500 or 200 ohm line, Output 16, 8, 5, 3 and 1.5 ohms. PA-2	7.50
PA-139	Audio line matching. Will handle 30 watts audio power. Input 500 or 200 ohm line. Output 16, 8, 5, 3, 1.5 ohms. PA-3	12.50

CLASS A OUTPUT TRANSFORMERS

PA-140	From a triode plate like 864, 27, 112A, 55, 30 to 500, 200 or 50 ohms.	\$6.50
PA-141	From push pull triode plates like 864's, 27's, 112A's 30's to 500, 200 or 50 ohms.	7.50

REACTORS

PA-40	Filter choke. 12 henrys. Max. D.C. 200 MA. Resistance 110 ohms. PA-2	\$4.50
PA-41	Class B input filter choke for 46, 53, and 59 tubes. Max. D.C. 200 MA. Resistance 100 ohms. PA-2	4.50
PA-43	Filter choke. 15 henrys. Max. D.C. 165 MA. Resistance 375 ohms. PA-2	4.50
PA-44	Filter choke. 30 henrys. Max. D.C. 100 MA. Resistance 375 ohms. PA-2	4.00
PA-45	Parallel feed audio choke, 250 henrys. Max. D.C. 15MA. Resistance 4500 ohms. PA-1	4.50
PA-46	Center tapped audio choke for P.P. 245, 59, 2A3 and 250 tubes. Over all inductance 50 henrys. Max. D.C. 125 MA. Resistance 725 ohms. PA-2	5.50
PA-47	Center tapped audio choke for P.P. connection. Overall inductance 300 henrys. Max. D.C. 10 MA. Resistance 4750 ohms. PA-1	5.50

POWER and FILAMENT TRANSFORMERS

PA-21	Plate transformer for single 45, 47, 59 or class B 79 tubes. Primary 115 V. A.C. 60 cycles. Secondaries: 300-0-300 at 75 MA; 2 1/2 V.C.T. 3 A., 6.3 V.C.T. 2.5 A., 2 1/2 V.C.T. 6 A. PA-3	\$ 8.00
PA-22	Plate transformer for push pull 45, 59, 47, 2A3 tubes, or class B 53's. Pri. 115 V. A.C. 60 cycles. Secondaries: 400-0-400 at 125 MA; 2 1/2 V.C.T. 5 A., 2 1/2 V.C.T. 10 A., 5 V.C.T. 3 A. PA-3	10.00
PA-23	Plate transformer for class B 46 or 59 tubes. Primary 115 V. A.C. 60 cycles. Secondaries: 570-0-570 at 150 MA; 2 1/2 V.C.T. 5 A., 2 1/2 V.C.T. 10 A., 5 V. 3 A. PA-3	12.00
PA-24	Plate transformer for push pull 250 tubes and tuner. Primary 115 V. A.C. 60 cycles. Secondaries: 600-0-600 150 MA; 2 1/2 V.C.T. 10 A., 7 1/2 V.C.T. 2.5 A., 7 1/2 tapped at 5 V. 3 A., 5 V.C.T. 3 A. PA-3	13.50
PA-426	Plate transformer for class B 6A6 and A prime 42 tubes. Pri. 115 V.A.C. 60 cycles. Secondaries 400-0-400 at 125MA; 2 1/2 V.C.T. 6 A. 6.3 V.C.T. 4 A. 5 V.C.T. 3 A. PA-3	10.00
PA-425	Plate transformer for parallel push pull 45 A prime tubes. Pri. 115 V. A.C. 60 cycles. Secondaries 400-0-400 at 200 MA; 2 1/2 V.C.T. 6 A.; 2 1/2 V.C.T. 10 A., 5 V.C.T. 3 A. PA-3	12.50
PA-25	Secondary. 2 1/2 V.C.T. 10 amps. PA-1	4.50
PA-26	Secondary. 5 V.C.T. 3 amps. PA-1	4.50
PA-27	Secondary. 6.3 V.C.T. 2.5 amps. PA-1	4.50
PA-28	Secondary. 7 1/2 V.C.T. 3 amps. PA-1	4.50
PA-427	Plate transformer for parallel push pull 45 A prime tubes. Pri. 115 V.A.C. 60 cycles. Secondaries 400-0-400 at 200 MA; 2 1/2 V.C.T. 3 A., 6.3 V.C.T. 3 A, 5 V.C.T. 3 A. PA-4	12.50

PA SERIES OF CLASS A AND CLASS B OUTPUT TRANSFORMERS

Type	Primary Impedance	Will Match	Secondary Impedance	Case & Price
PA-15	8000 ohms plate to plate.	Class A, in push pull: 250's, 245's, 43's. Single: 211, 843, 842, 205D, 48.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-16	5000 ohms plate to plate or 3000 ohms plate to plate.	For 5000 ohms In push pull: self bias 2A3's, W.E. 275A's. Single: 59 triode or 71A. For 3000 ohms In push pull: Fixed bias 2A3's, single W.E. 52A.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-17	2500 ohms plate to plate or 1500 ohms plate to plate.	For 2500 ohms Four 2A3's in push pull parallel self bias. For 1500 ohms Four 2A3's in push pull parallel fixed bias.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-3 10.00
PA-18	4000 ohms plate to plate.	Four 250's in push pull parallel.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-3 10.00
PA-19	10,000 ohms plate to plate or 6000 ohms plate to plate.	For 10000 ohms Class A push pull 59 triodes, 71A's, 6B5's, single 210, 41, 268A, 2A3. Class B push pull 49's, 53's, 79's, 89's. For 6000 ohms Class A push pull 52A's, single 31, 46, 59 pentode. Class B push pull 46's, 59's.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-48	4000 ohms plate to plate.	Class A push pull 48 triodes or pentodes.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-710	20,000 ohms plate to plate or 14,000 ohms plate to plate.	For 20,000 ohms Push pull 210's. For 14,000 ohms Push pull 47's, 2A5's, 42's used as pentodes.	500, 200, 16, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-245	6000 ohms plate to plate and 3500 ohms plate to plate.	For 6000 ohms Class A prime 45's self bias. Class B 46's and 59's. Class A WE 252 A's. For 3500 ohms Class A prime 45's fixed bias.	500, 200, 15, 8, 5, 3, 1.5 ohms.	PA-2 7.00
PA-445	3000 ohms plate to plate and 1750 ohms plate to plate.	For 3000 ohms Four 45's in push pull parallel A prime self bias. Four WE 252A's in push pull parallel class A. Four 46's or 59's in push pull parallel class B. For 1750 ohms Four 45's in push pull parallel A prime fixed bias.	500, 200, 15, 8, 5, 3, 1.5 ohms.	PA-3 12.50
PA-448	2000 ohms plate to plate.	Class A push pull parallel 48's.	500, 200, 15, 8, 5, 3, 1.5 ohms.	PA-3 10.00
PA-720	6000 ohms plate to plate and 3500 ohms plate to plate.	For 6000 ohms Class B 203's. For 3500 ohms A prime 845's.	500, 200, 15, 8, 5, 3, 1.5 ohms.	PA-5 32.50

BALANCE COILS

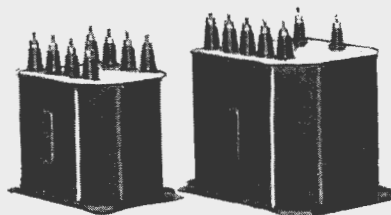
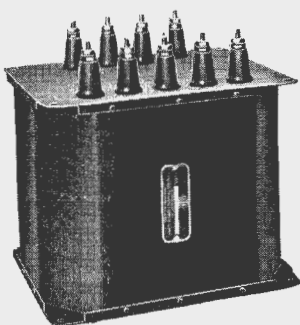
The new UTC development which permits paralleling mercury vapor rectifier tubes with equal current distribution.

PA-10B	Center tapped choke to equalize the load between two 80's, 81's, 82's, 5Z3's, 83's, etc.	PA-2 case	\$5.00
PA-11B	Center tapped choke to equalize the load between two 866's, 866A's.	PA-3 case	10.00
PA-12B	Center tapped choke to equalize the load between two 872's, 872A's.	PA-5 case	25.00

UTC TRANSMITTING COMPONENTS

Mounting Dimensions

PA-1	1-15/16 x 2-7/16
PA-2	2-7/16 x 3-7/8
PA-3	3-1/16 x 4-5/16
PA-4	3-3/4 x 5-7/32
PA-5	4-3/4 x 6-3/8



OVERALL DIMENSIONS

	L	W	H
PA-1	2 1/2	3	3
PA-2	3-1/16	4 1/2	3
PA-3	3 5/8	4 7/8	4 1/4
PA-4	6	4 1/2	4 3/4
PA-5	7	5 3/8	5 1/2

The transmitting type of UTC Class B audio, filter and power components have been developed for and are now widely used by Commercial Telephone, Telegraph, Communication and Broadcast systems. They are particularly well adapted for use in AMATEUR TRANSMITTER applications.

All audio, filter and power units are fully shielded in symmetrically housed cases and present a thoroughly professional appearance when grouped in finished equipment. PA type cases may be mounted with terminals on top or below the chassis. All units are fully impregnated and then sealed in their cases with a special heat dissipating compound.

INPUT TRANSFORMERS CLASS B, A PRIME

PA-49	Push pull 45 or 59 plates to push pull 845 A prime grids. PA-2.....	\$ 7.50
PA-50	Driver plate to 19, 49, 53, 6A6, 79 or 89 grids. PA-1.....	5.50
PA-51	Driver 46 or 59 plate to 46 or 59 grids. PA-1.....	5.50
PA-52	Push pull 45 or 59 plates to 2-46 or 2-59 grids, or push pull 2A3 plates to 2-841 grids. PA-1.....	6.50
PA-53	Push pull 42, 45, 50, or 59 plates to 2-242A's, 2-800's, 2-830's, 2-RK 18's or 2-210 grids. PA-1.....	7.50
PA-54	Push pull 2A3 plates to 2-203A grids. PA-2.....	8.50
PA-55	500, 200 or 50 ohm line to 2-46 or 2-59 grids. PA-2.....	7.50
PA-56	500, 200 or 50 ohm line to 2-203A grids. PA-2.....	10.00
PA-57	Push pull 2A3 plates to 2-830B, 2-800, 2-RK18 or 2-210 grids. PA-2.....	7.50
PA-58	Driver 2A5, 42 or 45 triode plate to two 2A5, 42 or 45 A prime grids. PA-1.....	5.50
PA-59	500, 200 or 50 ohm line to 2-830B, 2-800, 2-RK18 or 2-210 grids. PA-2.....	7.50
PA-238	Push pull parallel 2A3, 45, 50 plates to four 838 or 203 Class B grids. PA-3.....	17.50
PA-239	Four 2A3, 45, 50 or two 211, 845 plates to Class B 204 or 849 grids. PA-3.....	17.50
PA-501T	Four 2A3, 45, 50 or two 50T, 211, 845 plates to Class B 150T grids. PA-3.....	17.50
PA-512	500, 200 or 50 ohm line to two 150T, 204, HF 300 or 849 grids. PA-3.....	20.00

FILAMENT TRANSFORMERS

Types PA-34 to PA-127 tapped at 105-115, 220, 230 Volts A.C., 50/60 cycles

PA-34	2 1/2 V.C.T. 10 amps for 2-866's—5000 V. insulation—PA2.....	\$7.50
PA-120	2 1/2 V.C.T. 10 amps for 2-866's—10,000 V. insulation—PA-3.....	9.00
PA-121	5 V.C.T. 20 amps for 8-872's—10,000 V. insulation—PA-3.....	14.00
PA-122	7 1/2 V.C.T. at 6.5 amps for 2-800's, RK-18's, 825's, 210's. 5000 Volt insulation—PA-3.....	11.00
PA-123	2-7 1/2 V.C.T. 6.5 amp windings for 800's, RK-18's, 825's, 210's—5000 V. insulation—PA-3.....	14.50
PA-124	10 V.C.T. 7 amps for 2-203 A's, 242 A's, 211's, 845's, 852's, 860's, 217 C's. 10,000 V. insulation—PA-3.....	12.00
PA-126	2-14 V.C.T. 12.5 amp windings tapped at 11 or 10 volts. 5000 V. insulation—for 04 A's, 49's, F100 A's—PA-4.....	20.00
PA-127	2 1/2 V.C.T. at 10 amps 10,000 volt insulation, 2-10 V.C.T. 3.5 amp windings. 5000 V. insulation—PA-3.....	15.00
PA-29	Secondaries. 2 1/2 V.C.T. 5 A., 2 1/2 V.C.T. 5 A., 5 V.C.T. 3 A. PA-2.....	6.25
PA-30	Secondaries. 2 1/2 V.C.T. 5 A., 7 1/2 V.C.T. 2.5 A., 7 1/2 V.C.T. 2.5 A. PA-2.....	6.75
PA-31	Secondaries. 2 1/2 V.C.T. 5 A., 5 V.C.T. 3 A., 7 1/2 V.C.T. 2 1/2 A. PA-2.....	6.75
PA-32	Secondaries. 5 V.C.T. 3 A., 5 V.C.T. 3 A., 5 V.C.T. 3 A. PA-2.....	6.75
PA-33	Secondaries. 5 V.C.T. 3 A., 7 1/2 V.C.T. 2 1/2 A., 7 1/2 V.C.T. 2 1/2 A. PA-2.....	6.75

NOTE: Types PA-29, 30, 31, 32, 33 are insulated for 2000 volts. Primaries designed only for 115 volts A.C., 50/60 cycles.

SPECIAL OUTPUT TRANSFORMERS

PA-601	Primary arranged to match 838 or 203 Class B plates to 6500, 5000 or 3500 ohm RF load. PA-5 case	\$32.50
PA-438	Primary arranged to match push pull parallel 838 or 203 Class B plates to 6,000, 4000 or 3000 ohm RF load. Special casting.....	50.00
PA-489	Primary arranged to match 204A, HF 300 or 849 Class B plates to 6500, 5000, or 3500 ohm RF load. Special casting.....	125.00
PA-150T	Primary arranged to match Class B 150 T's or HK 354's in A prime or Class B at various plate voltages. Specify primary plate voltage and secondary RF load when ordering. Special casting.....	125.00

CLASS B OUTPUT TRANSFORMERS

Type	Primary Impedance	Will Match	Sec. Impedance	Price	Case
PA-20	10,000 ohms plate to plate. 6,000 ohms plate to plate.	10,000 ohms Class B 49's, 53's, 79's, 89's, 6,000 ohms Class B 46's, 59's.	5,000, 3,500 ohms.	\$7.00	PA-2
PA-60	6,000 ohms plate to plate.	Class B 203's.	3,000, 2,500 ohms.	30.00	PA-5
PA-62	10,000 ohms plate to plate. 6,000 ohms plate to plate.	Class B 830B's. Class B 203's.	10,000, 2,500 ohms.	32.50	PA-5
PA-70	8,000 ohms plate to plate.	A prime 2A5's, 42's.	5,000, 3,500 ohms.	7.00	PA-2
PA-71	6,000 ohms plate to plate.	Class B 46's, 59's.	14,000, 3,500 ohms.	7.00	PA-2
PA-80	12,500 ohms plate to plate.	Class B 800's, RK18's, 825's.	5,000, 3,000 ohms.	20.00	PA-4
PA-82	12,500 ohms plate to plate. 8,000 ohms plate to plate.	12,500 ohms Class B 800's, RK 18's, 825's. 8,000 ohms Class B 242A's, 211E's.	20,000, 5,000 ohms.	25.00	PA-5
PA-83	8,000 ohms plate to plate.	Class B 210's, 830's, 841's.	18,000, 4,500 ohms.	12.50	PA-3
PA-201	6,000 ohms plate to plate and 3,500 ohms plate to plate.	6,000 ohms. Class B 46's, 59's. A prime 45's self bias. 3,500 ohms A prime 45's fixed bias.	5,000, 3,500 ohms.	7.00	PA-2
PA-401	3,000 ohms plate to plate and 1,750 ohms plate to plate.	3,000 ohms Four 46's or 59's in class B. Four 45's A prime self bias. 1,750 ohms Four 45's A prime fixed bias.	5,000, 3,500 ohms.	12.50	PA-3
PA-84	6,000 ohms plate to plate and 3,500 ohms plate to plate.	6,000 ohms Class B 203's. 3,500 ohms A prime 845's.	6,500, 5,000, 3,500 ohms.	32.50	PA-5

CLASS B INPUT SWINGING CHOKES*

Type	Swinging Action	Current Range	Maximum DC Oper. Voltage	Ohmic Resistance	List Price	Case
PA-101	5 to 25 henrys.	15 to 150 MA	450	115	\$5.00	PA-2
PA-103	5 to 25 henrys.	20 to 200 MA	600	110	8.00	PA-3
PA-105	6 to 30 henrys	25 to 250 MA	1300	90	12.00	PA-4
PA-107	20 to 100 henrys	25 MA to 250 MA	2600	240	20.00	PA-5
PA-109	5 to 25 henrys	75 to 500 MA	1300	60	20.00	PA-5
PA-1C	5 to 25 henrys	100 to 1000 MA	4000	50	35.00	UTS

TRAP RESONANT SMOOTHING CHOKES*

Smoothing Chokes have an off center tap for hum bucking arrangements.

Type	Inductance	DC Output	Ohmic Resistance	List Price	Case
PA-100	8 henrys	150 MA	115	\$5.00	PA-2
PA-102	10 henrys	200 MA	110	8.00	PA-3
PA-104	12 henrys	250 MA	90	12.00	PA-4
PA-106	35 henrys	250 MA	240	20.00	PA-5
PA-108	10 henrys	500 MA	60	20.00	PA-5
PA-1S	10 henrys	1000 MA	50	35.00	UTS

* Test voltage is twice maximum peak voltage plus 1000 volts.

MODULATION CHOKES

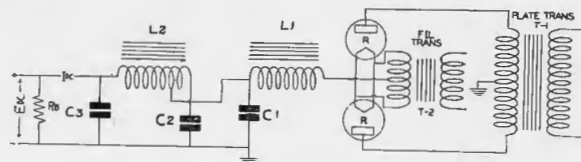
Type	Inductance	D.C. Output	Ohmic Resistance	List Price	Case
150	30 Henrys	125 MA	550	12.50	PA-3
151	30 Henrys	200 MA	425	20.00	PA-5
152	30 Henrys	400 MA	300	32.50	PA-5

PLATE TRANSFORMERS

Primary 105, 115, 220, 230 volts A.C. 50/60 cycles

PA-110	515 or 625 each side of center at 200 MA.	PA-3	\$10.00
PA-111	750 or 900 each side of center at 250 MA.	PA-4	18.00
PA-112	1250 or 1400 each side of center at 400 MA.	PA-6	35.00
PA-113	1600 or 2000 each side of center at 400 MA.	PA-6	57.50
PA-114	2500 or 3000 each side of center at 500 MA.	UTS case	76.00
PA-154	3500, 4000 each side of center at 500 MA.	UTS case	100.00
PA-115	C bias plate transformer for class B 203A's, 830B's, 800's or 210's using one or two 82 rectifiers.	PA-3	10.00
PA-116	1250 or 1400 each side of center at 200 MA.	PA-5	25.00
PA-117	3500 or 3000 each side of center at 1 ampere.	UTS case	115.00

RF				CLASS B							DRIVER			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RF Tubes	Plate Volts	Plate Current	RF Load Impedance W=Ohms	Coupling Transformer Type No.	Audio Output Watts	Audio Output DB	Class B Output Tubes	Plate Volts	Bias Volts	Class B Load Plate to Plate W=Ohms	Input Transformer Type No.	Turns Ratio Input Trans. Total Primary to 1/2 secondary	Driver Tube	Level into Driver DB
203A, 211E, 242A	1,000	400MA	2,500W	PA-60 or PA-62	225	46	203A's	1,000	38	6,000W	PA-54	3.2:1	2A3's	+8
852's, 860's	2,000	200MA	10,000W	PA-62	225	46	203's	1,000	38	6,000W	PA-54	3.2:1	2A3's	+8
203A	1,000	400MA	2,500W	PA-62	180	45	830B's	1,000	33	10,000W	PA-57	2:1	2A3's	+7
852	2,000	100MA	20,000W	PA-82	100	42	800's	1,000	55	12,500W	PA-57	2:1	2A3's	+7
800's, RK-18's Single	1,000	200MA	5,000W	PA-82	140	43	242A's	1,000	60	8,000W	PA-53	2.5:1	42's A Prime	-6
203A, 211, 242A	1,000	200MA	5,000W	PA-82	100	42	211E's	1,000	100	8,000W	PA-53	2.5:1	42's A Prime	-6
Single 203A, 211, 242A	1,000	200MA	5,000W	PA-80 or PA-82	100	42	800's	1,000	55	12,500W	PA-53	2.5:1	42's A Prime	-7
210's, 830's single														
203A, 211	630	140MA	4,500W	PA-83	50	39	210's	600	66	8,000W	PA-53	2.5:1	42's A Prime	-7
210's, 830's	500	110MA	4,500W	PA-83	30	37	210's	500	52	8,000W	PA-53	2.5:1	45's	0
46's	400	115MA	3,500W	PA-20	23	36	46's	400	0	6,000W	PA-51	3:1	Single 59	-3
210's	450	130MA	3,500W	PA-20	23	36	46's	400	0	6,000W	PA-51	3:1	Single 59	-3
Single 800, 825	800	57MA	14,000W	PA-71	23	36	46's	400	0	6,000W	PA-51	3:1	Single 59	-3
46's	350	100	3,500W	PA-70	18	35	42's A Prime	350	35	8,000W	PA-58	1.6:1	Single 42	-7



The rectifier schematic illustrated is typical of the single phase full wave circuit most popular for transmitting plate supplies.

The first choke is of the saturated type and the second has a tap for trap resonant filtering. The overall regulation of the grouped components shown is excellent for class B applications. The ripple voltage ranges from 1/10% to 2/10% depending upon load. The bleeder resistor R_B should throw away 10% of the total plate current. In other words R_B equals $E_{dc}/I_{dc} \times 10$.

PLATE TRANSFORMER						FILAMENT TRANSFORMER						L1		L2		C1	C2	C3
D.C. Voltage	D.C. MA	Rectifier Tube.	Volts Each Side	Amps	Type No.	Volts	Amps	Type No.	Henrys	Type No.	Henrys	Type No.	Type No.	Type No.	Type No.			
400	200	83	515 or	.2	PA-110	5	3	PA-26	5-25	PA-103	10	PA-102	4	1	4			
500	200	83	625		PA-110	5	3	PA-26	5-25	PA-103	10	PA-102	4	1	4			
600	250	66	750	.25	PA-111	2 1/2	10	PA-34	6-30	PA-105	12	PA-104	2	1	2			
730	250	66	900	.25	PA-111	2 1/2	10	PA-34	6-30	PA-105	12	PA-104	2	1	2			
1050	200	66	1250	.2	PA-116	2 1/2	10	PA-34	6-30	PA-105	12	PA-104	2	1	2			
1190	200	66	1400	.2	PA-116	2 1/2	10	PA-34	6-30	PA-105	12	PA-104	2	1	2			
1050	400	66	1250	.4	PA-112	2 1/2	10	PA-34	5-25	PA-109	10	PA-108	2	1	2			
1190	400	66	1400	.4	PA-112	2 1/2	10	PA-34	5-25	PA-109	10	PA-108	2	1	2			
1370	400	66	1600	.4	PA-113	2 1/2	10	PA-34	5-25	PA-109	10	PA-108	2	1	2			
1720	400	66	2000	.4	PA-113	2 1/2	10	PA-34	5-25	PA-109	10	PA-108	2	1	2			
2160	500	66	2500	.5	PA-114	2 1/2	10	PA-120	5-25	PA-109	10	PA-108	2	1	2			
2620	500	66	3000	.5	PA-114	2 1/2	10	PA-120	5-25	PA-109	10	PA-108	2	1	2			

The UTC Varitone is a revolutionary audio device which permits full control of the frequency response of any audio amplifier or receiver. Using this device, tone correction can be effected for defects in acoustic conditions or overall audio response. It is also possible to produce new tonal effects from phonograph recordings or radio reception and to bring back notes which would otherwise be lost completely. Due to the high equalization obtainable with the Varitone, some loss in gain is effected. If the amplifier or receiver does not have gain to spare, it may be necessary to add an additional stage of audio frequency amplification. The Varitone is made in three types, as follows:

VT-1 This Varitone is incorporated with a universal audio transformer. Two primaries are provided. One is suitable for working from a single or double button microphone, a low impedance pickup, or a line; the other primary is designed to work out of the plate of a tube or from a high impedance pickup. The secondary winding is centertapped and is equally suitable for working into one or two grids. The types of response curves possible are shown in curves A to H. List Price\$8.50

VT-2 The VT-2 is a varitone control unit, incorporated with an impedance matching device so that it can be connected directly across a 200 or 500 ohm line, or low impedance pickup or mike, or in shunt with the plate circuit of any triode or a high impedance pickup. The circuit is not changed in any other way. The VT-2 is solely an addition for tone correction. The original audio circuits are not disturbed. The response curves possible are shown in curves A to H. List Price\$6.00

VT-3 The VT-3 is a complete self-contained unit which does not use external control. The components are adjusted so that 10 db. equalization is effected at 80 and 7000 cycles. This unit is connected directly from plate to B plus of first audio triode. No other alteration is made. List Price\$5.00

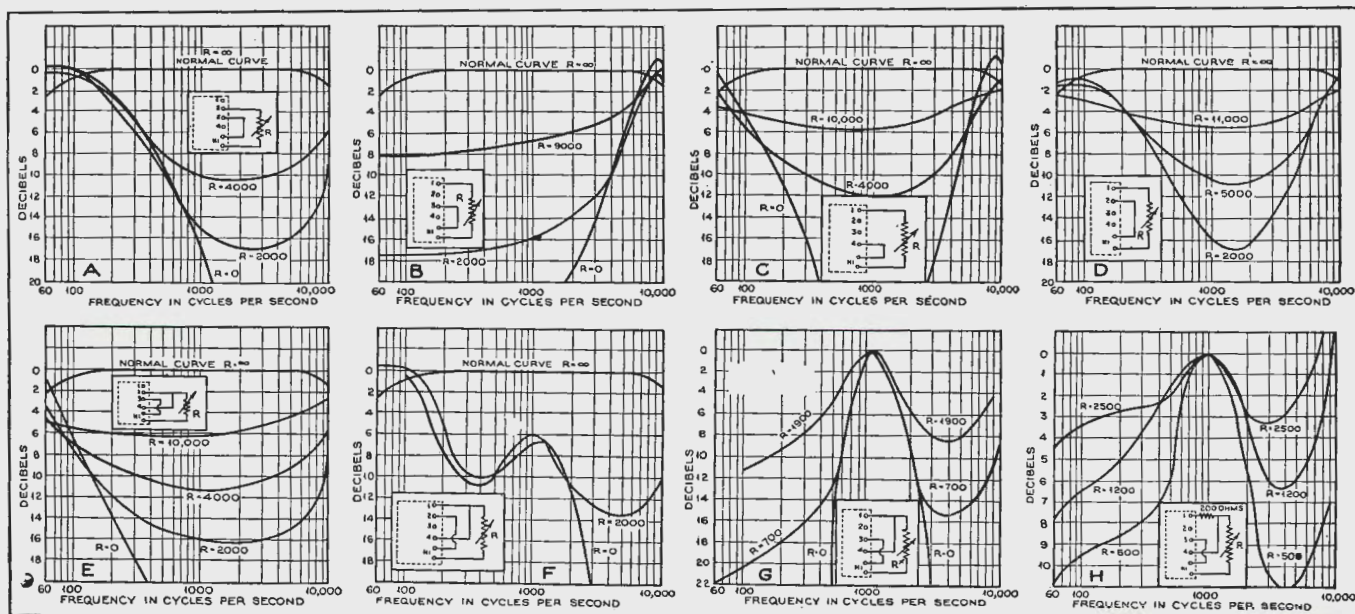
VT-4 The VT-4 is a complete self contained wired unit including a variable control so arranged that with the control at one end high fidelity performance is effected by the increase of low and high frequencies, and with the control at the other end the high response is reduced to diminish static, line noises, and heterodyne whistles. The unit is connected directly from plate to B plus of first audio triode. This unit is designed to work in the plate circuit of low impedance tubes such as 01A, 12A, 30, 31, 26, 27, 37, 55, 56, 85, 262A, 864, 57 triode, 6C6 triode, 77 triode, etc. List Price\$6.00

VT-5 The VT-5 is similar to the VT-4 except that it is designed to work out of high impedance tubes such as all screen grid tubes, all pentodes, 2A6, 40, 75, other hi mu triodes, etc. List Price\$6.00



VT 1

	Overall dimensions			Mounting dimensions
	L	W	H	
VT-1	2 1/2	3	4	1-15/16 x 2-7/16
VT-2	2 1/2	3	3	1-15/16 x 2-7/16
VT-3	2 1/2	3 1/2	2	3- 3/16
VT-4	2	2 3/8	2	1- 3/8
VT-5	2	2 3/8	2	1 3/8

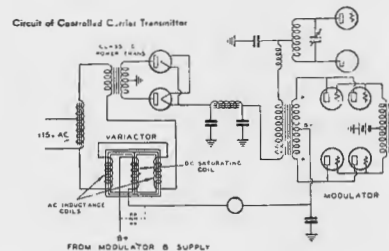


The **UTC Variactor** method of controlled carrier modulation is one of most forward steps in radiotelephony. Phone men have acclaimed it as the most economical and practical, least critical and simplest of any controlled carrier system in use.

The **UTC Variactor** controlled carrier modulation system:

- Increases blanket DX coverage many times
- Almost doubles Class C tube ratings and will double to quadruple Class B linear tube ratings
- Allows power consumption savings of 50% or over
- Reduces interference between stations tremendously
- Increases Fidelity

UTC bulletin 11CC gives full details on this new system of transmission.



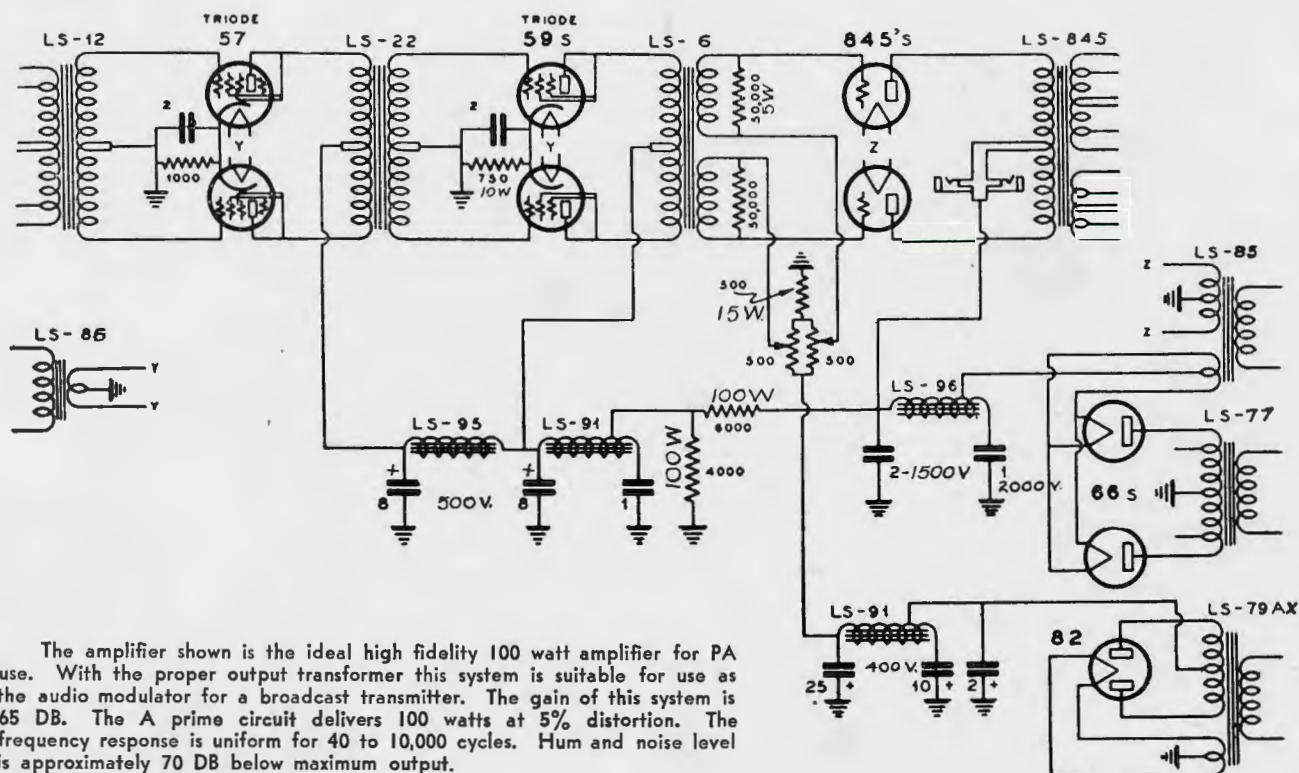
The Essential Variactor Unit Required for Controlled Carrier Modulation Is Now Available in Six Types to Take Care of Transmitters From 25 to 800 Watts Output.

CV VARIATORS FOR CONTROLLED CARRIER CLASS C

	List Price
CV-1 25 to 50 watts maximum input controlled class C	\$ 7.50
CV-2 50 to 100 watts maximum input controlled class C	10.00
CV-3 100 to 170 watts maximum input controlled class C	15.00
CV-4 170 to 300 watts maximum input controlled class C	20.00
CV-5 300 to 500 watts maximum input controlled class C	25.00
CV-6 500 to 800 watts maximum input controlled class C	33.00

AV AUTOTRANSFORMERS FOR CV VARIATORS—115/170 VOLTS AC

	List
AV-1 for use with CV-1	\$ 5.00
AV-2 for use with CV-2	6.00
AV-3 for use with CV-3	7.00
AV-4 for use with CV-4	9.00
AV-5 for use with CV-5	12.00
AV-6 for use with CV-6	15.00



The amplifier shown is the ideal high fidelity 100 watt amplifier for PA use. With the proper output transformer this system is suitable for use as the audio modulator for a broadcast transmitter. The gain of this system is 65 DB. The A prime circuit delivers 100 watts at 5% distortion. The frequency response is uniform for 40 to 10,000 cycles. Hum and noise level is approximately 70 DB below maximum output.

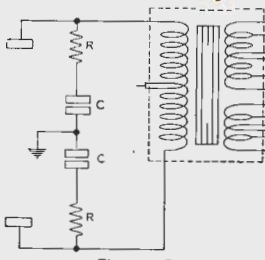


Figure 3

Upon examination of the schematic layouts which follow, it will be found that a number of important and exclusive UTC circuit improvements have been incorporated.

In a large number of circuits a fixed C bias supply has been provided for the output tubes. As is well known, the normal output of an amplifier reproducing speech or music is not a continuous uniform value but a succession of valleys and peaks. These peak conditions will in many cases drive the grids of the output tubes positive. Naturally when this occurs, there is a tendency both for grid current and plate current variation. These effects tend to introduce strong harmonics into the output. In a self biased amplifier, the plate current flows through the bias resistor and any variation of plate current causes a variation in the bias voltage of the tube, which is further amplified by the tube itself. Fixed bias eliminates this effect entirely, and consequently allows higher power outputs to be obtained from a given pair of tubes. The distortion due to the flow of grid current in the input circuits is kept to a low value in UTC transformers inasmuch as a low DC resistance is incorporated in the windings of the input transformers.

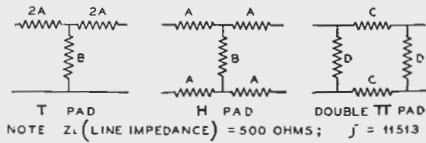
The use of fixed C bias also makes possible the operation of the power tubes in an overbiased condition. If the bias is increased about 20 percent above the normal rated tube value, it will be found that the plate current variation will be large even before positive values of grid voltage are reached. With fixed bias, no grid distortion is effected because of this plate current variation. Also a large increase in power output is made available. This feature is particularly valuable with 2A3 tubes, but is applicable as well to the tubes used in the other circuits shown with fixed C bias.

Another circuit feature that will be noted is the wide use of push pull stages. The additional quality improvements resulting from push pull readily explain this. Push pull allows the cancellation of even order harmonics, and also of plate supply and filament supply hum.

However, it is often difficult to perfectly match tubes for full cancellation. To offset this, a number of the fixed C bias circuits show a 2 arm potentiometer as the bias voltage resistor. These arms allow individual adjustment of the tube bias so that through the use of a plate current milliammeter the tubes may be perfectly balanced.

It is essential for high quality that all circuits in an audio amplifier be properly matched. This is difficult to do in the output stage of class B tubes working to a speaker load. The plate load of class B tubes is quite critical in value and is readily matched if working into an RF stage which is practically non-inductive and constant in value. However, a speaker load is inductive and consequently varies in impedance with the frequency of the signal, as for example, a speaker system which is 500 ohms at 1000 cycles might show an impedance of 5000 ohms at 10,000 cycles. To compensate for this, an equalizing network should be used, as illustrated in Fig. 3. For 46 or 59 tubes, $R = 3000$ ohms and $C = .08$ mfd. For 19, 53, or 79 tubes $R = 5000$ ohms and $C = .05$ mfd. For 49, 89, or 203A tubes, $R = 6000$ ohms and $C = .04$ mfd.

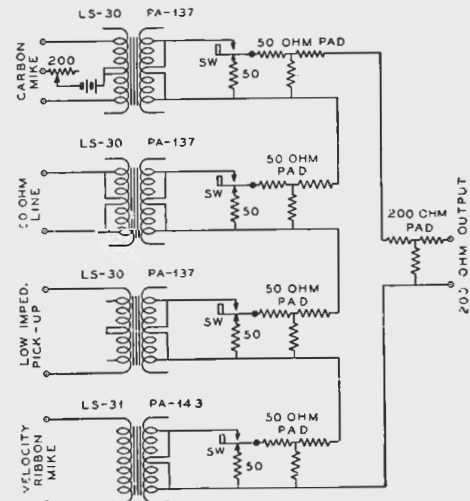
ATTENUATION NETWORK DATA



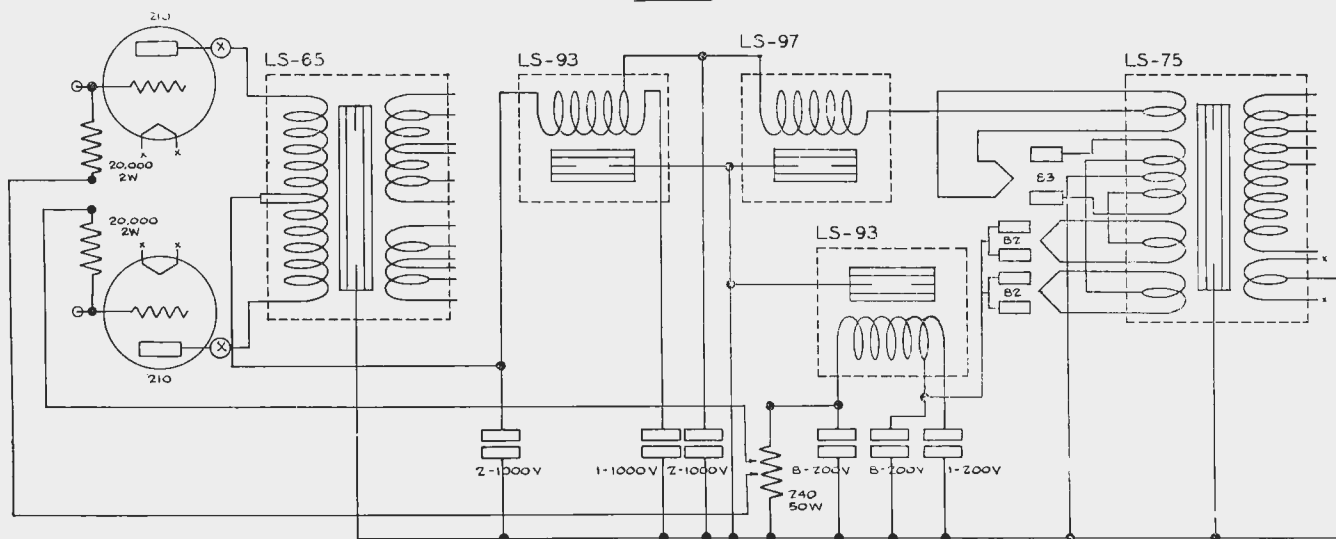
ATTENUATION	$A = \frac{Z_L}{2} \times \tanh\left(\frac{N}{2}\right)$ $B = \frac{Z_L}{\sinh(N)}$ $C = \frac{Z_L}{2} \times \sinh\left(\frac{N}{2}\right)$ $D = \frac{Z_L}{\tanh\left(\frac{N}{2}\right)}$			
NO. DB	A	B	C	D
.1	1.440	43420	2.879	86850
.2	2.878	21720	5.755	43440
.3	4.318	14480	8.635	28950
.4	5.758	10850	11.52	21710
.5	7.193	8635.	14.40	17380
.6	8.635	7232.	17.29	14480
.7	10.07	6193	20.17	12420
.8	11.51	5421.	23.06	10870
.9	12.95	4818.	25.95	9656.
1.0	14.33	4333.	28.85	8690.
2.0	25.65	2152.	58.08	4364.
3.0	42.75	1420.	88.08	2925.
4.0	56.58	1049.	119.3	2209.
5.0	70.03	822.4	152.0	1785.
6.0	83.08	669.4	186.8	1505.
7.0	95.65	558.0	224.0	1308.
8.0	107.7	473.1	264.3	1162.
9.0	119.1	405.9	308.0	1050.
10.0	129.9	351.3	355.8	962.5
15	174.5	183.6	680.8	756.3
20	204.5	101.0	1233.	611.2
25	223.5	56.40	2216.	559.5
30	234.7	31.65	3949	532.7
35	241.3	17.79	7027.	518.0
40	245.1	10.00	12500	510.1
45	247.2	5.624	22230	505.7
50	248.5	3.163	39530	503.2
55	249.2	1.775	70300	501.8
60	249.5	1.0	125000	501.0
65	249.8	.5623	222300	500.5
70	249.8	.3163	395400	500.4
75	249.9	.1779	703000	500.2
80	249.9	.10	1250000	500.1
85	250.0	.05620	2223000	500.1
90	250.0	.03161	3954000	500.0
95	250.0	.01879	7027000	500.0
100	250.0	.010	12500000	500.0

It is often necessary to couple two sources of input, such as a tuner and microphone, to an amplifier. To properly do this and still obtain full efficiency from the amplifier gain control, some attenuation should be available at one of the sources. This is readily done with an attenuator based on the illustrated chart. The data shown has been computed to great accuracy, and is suitable for use in making attenuators for laboratory or professional applications. Obviously, a group of fixed attenuator units can be made into a variable pad. For example, a 10 DB T type network would use 2 series resistors of 260 ohms each and one shunt resistor of approximately 350 ohms.

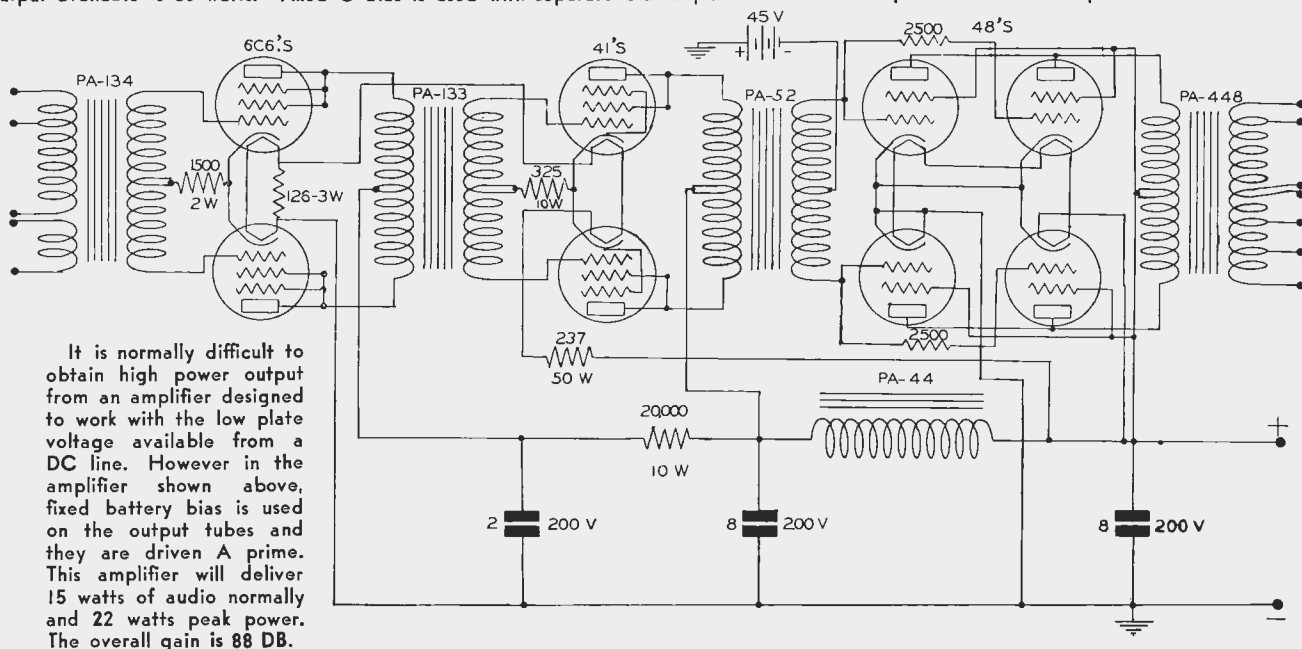
For a line impedance other than 500 ohms multiply all resistor value by $Z_x/500$ where Z_x is the impedance desired.



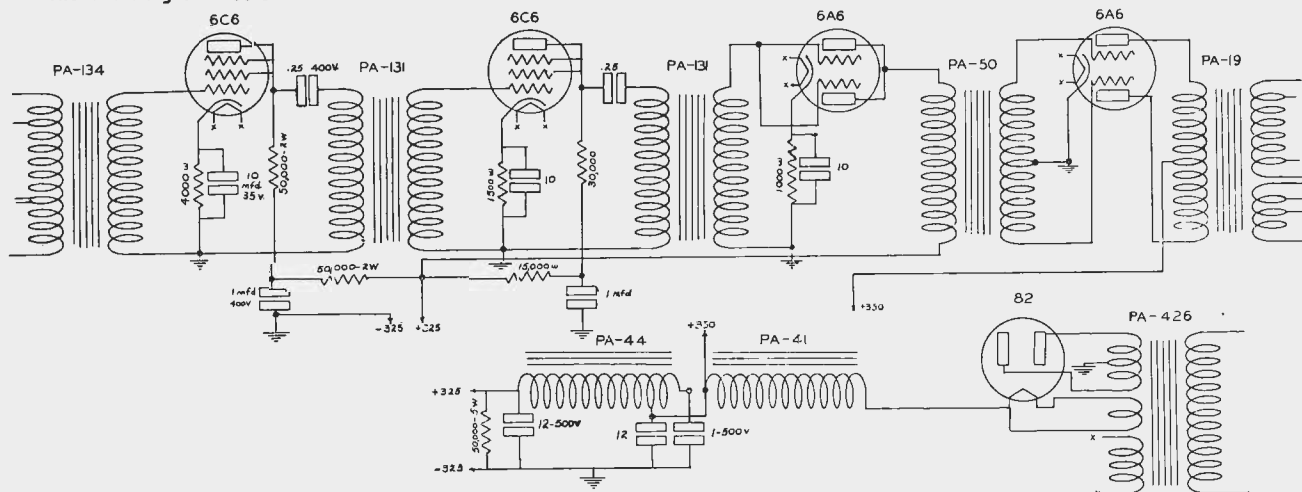
Four position series mixer



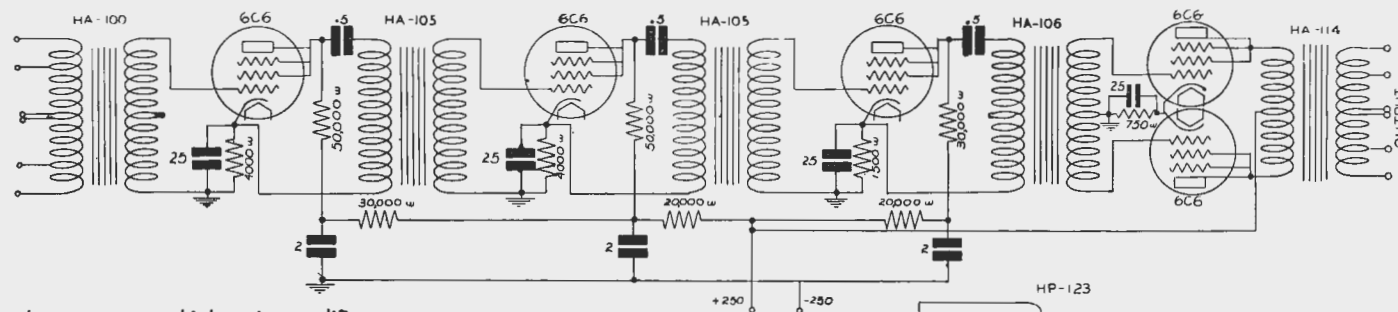
Class B 210 output power stage for voice coil or R.F. connection. If graphite or carbon plate power tubes are used, maximum power output available is 60 watts. Fixed C bias is used with separate bias adjustment to balance plate current of output tubes.



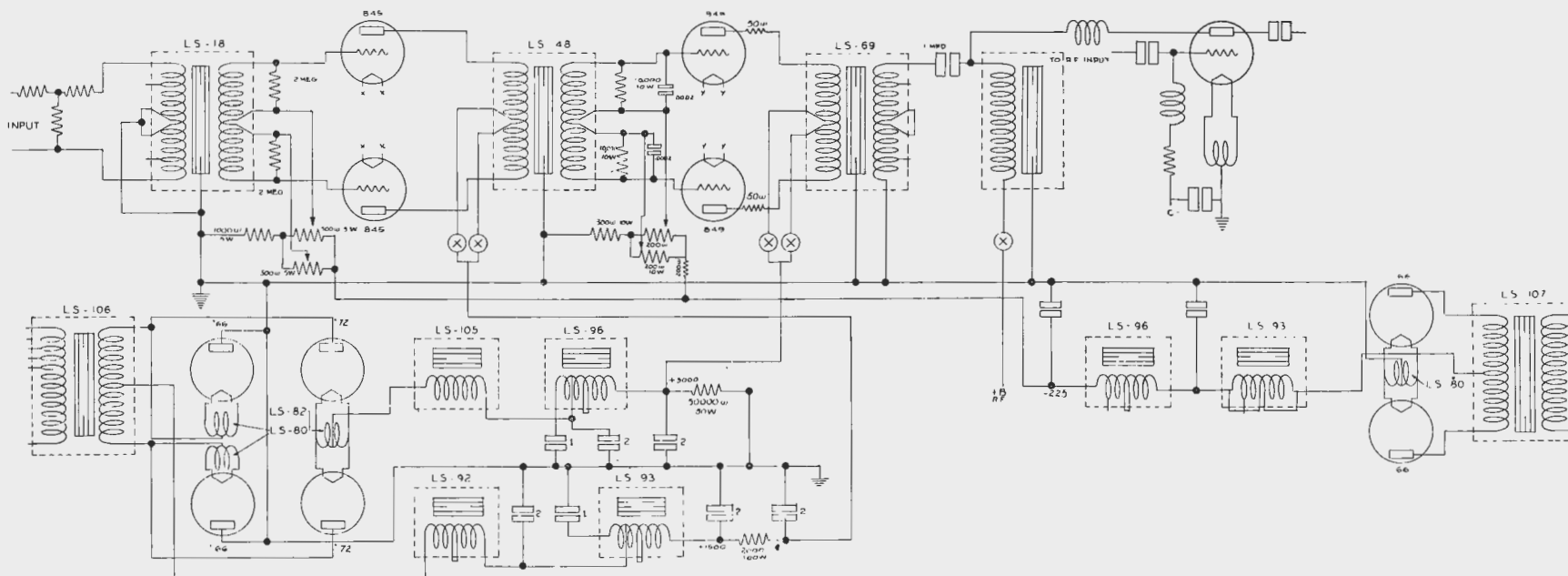
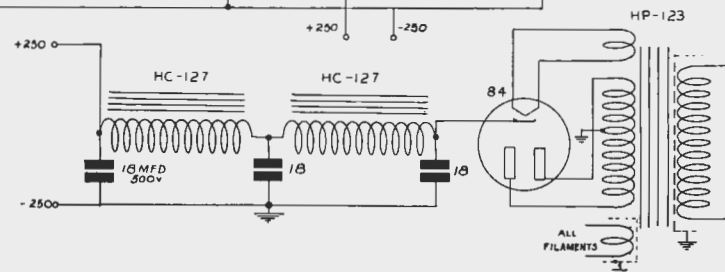
It is normally difficult to obtain high power output from an amplifier designed to work with the low plate voltage available from a DC line. However in the amplifier shown above, fixed battery bias is used on the output tubes and they are driven A prime. This amplifier will deliver 15 watts of audio normally and 22 watts peak power. The overall gain is 88 DB.



The 6A6 tube lends itself very well to PA work, particularly for mobile use. The amplifier shown will deliver 12 watts of audio. It can be either battery or A.C. operated. 6 Volt tubes are used throughout. The gain of approximately 100 DB makes this amplifier suitable for use with some of the new low level microphones and pickups.



The schematic circuit shown above covers a high gain amplifier suitable for recording or broadcast station remote pickup and studio use. The maximum power output is 1 watt and the overall gain is 140 DB. It is suitable for use with dynamic, crystal, or velocity microphone input. Special output transformers are available for glow lamp recording or for coupling to a monitoring speaker. A complete highly filtered AC power supply is shown, but where maximum flexibility is desired, batteries are customarily used. A 6 volt storage battery is used for the filament and 250 volts of B battery for the plate. This entire audio amplifier weighs only 9 lbs. and fits in a space 5 x 4½ x 9. The frequency response is uniform from 60 to 10,000 cycles.



The above schematic covers the complete circuit of a 1000 watt class B modulator power stage including plate and bias voltage supplies. A duplex bridge rectifier for the 849 plate supply and a full wave rectifier for the 845 plate supply effects maximum economy in cost and operation. It also permits practically complete isolation of the driver and output plate supplies; which is of considerable advantage, as the plate current swing of the 849 tubes is quite high. Potentiometers are incorporated in the bias supply circuit to balance the plate currents of both driver and output tubes. The filter condensers used in the bias supply are 25 mfd. Though not shown, it is also advisable to have a 25 mfd. condenser from each 849 grid return to ground. While the balancing of plate current—the 849 plate and grid resistors—and the 849 grid condensers complicate the circuit somewhat, the final results are well worth the trouble. The power output of 1000 watts is based on 5% harmonic distortion and the frequency discrimination is negligible from 40 to 12,000 cycles. The overall gain of this power stage is 27 DB.

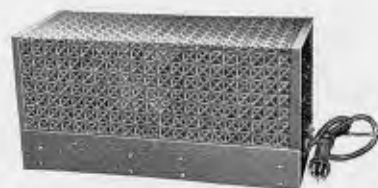
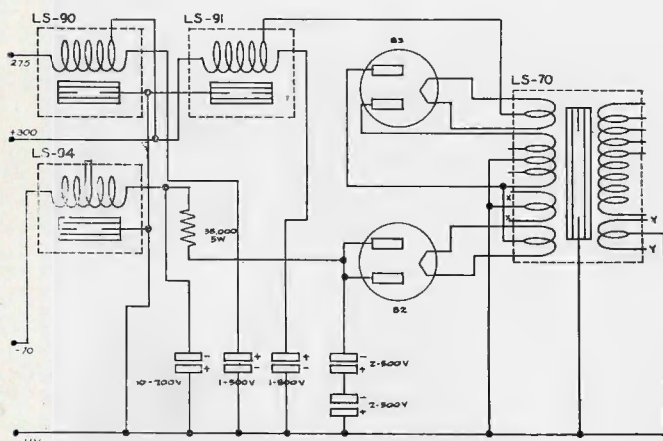
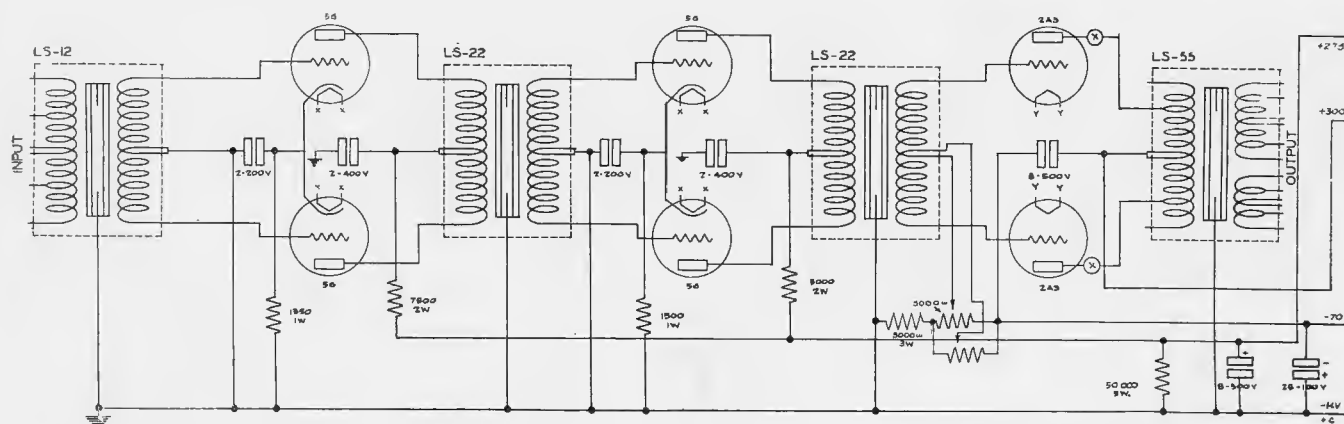
The triple push pull fixed bias 2A3 amplifier circuit shown below will satisfy the most discriminating Broadcast stations and audio laboratories. The undistorted class A output is 15 watts, the gain is 80 DB. The amplifier is uniform in response from 30 to 12,000 cycles. A trap resonant rectifier filter is used for highest filtering efficiency, audio and power sections are mounted on separate drilled, heavy gauge metal decks. All LS audio filter and power components fully shielded and doubly sealed against adverse climatic conditions. List price of complete transformer kit \$152.50 [includes drilled decks and perforated protective covers—all transformers mounted at factory at no extra cost] 40% discount or net price of \$91.50 to Universities, Broadcast Stations or dealers. Purchase through your local U.T.C. distributor.



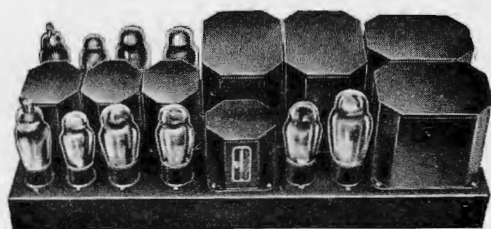
2A3 Power Supply



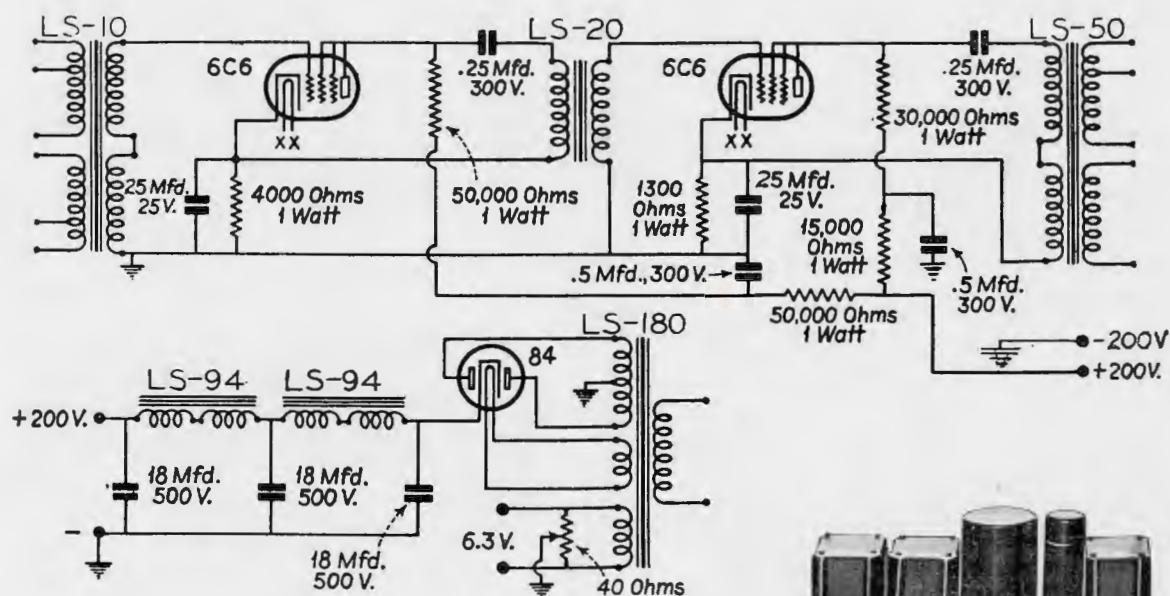
2A3 Audio Amplifier



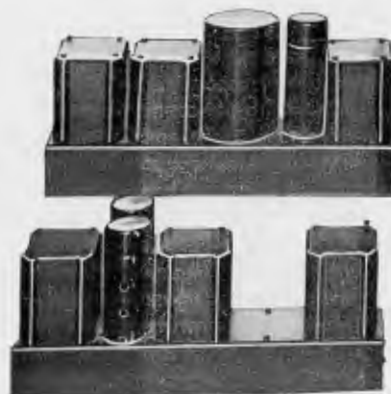
2A3 amplifier and power supply
with perforated protective covers
fully mounted.



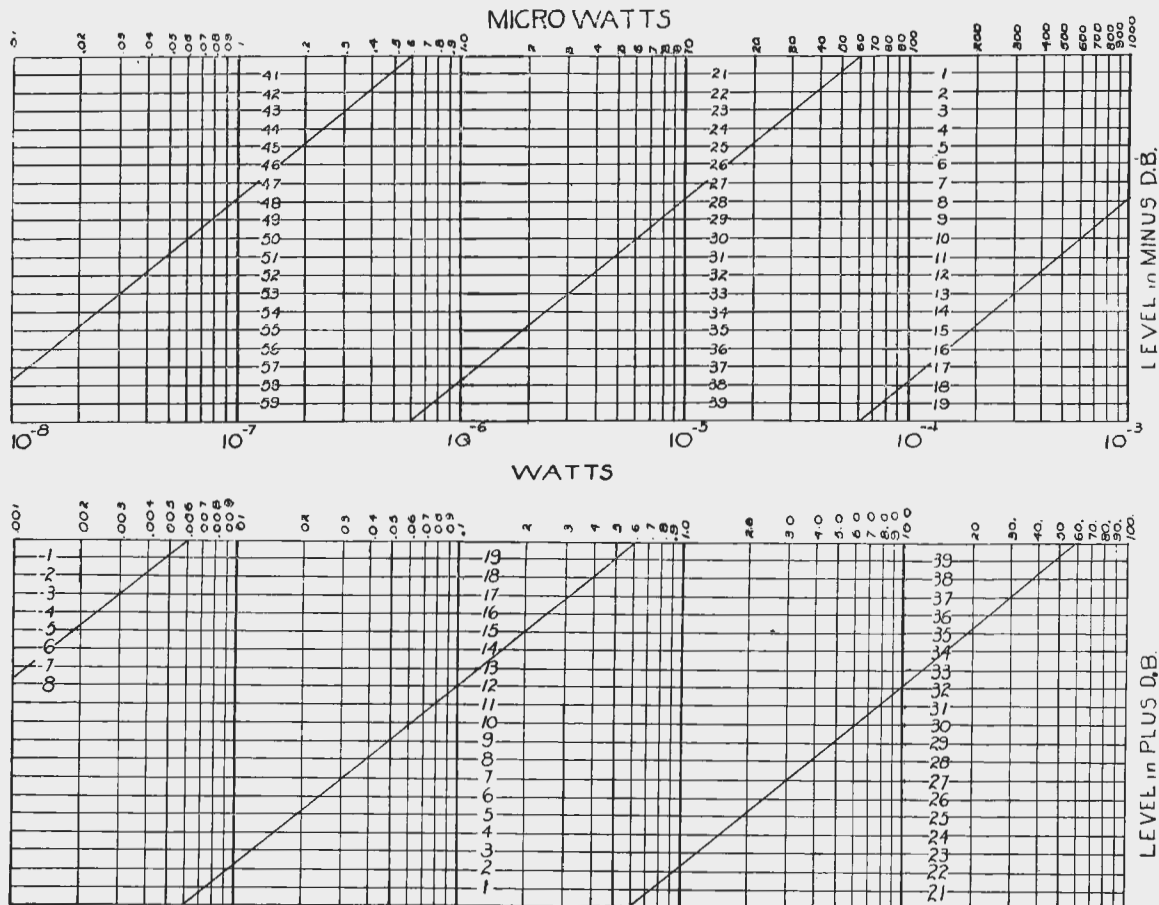
List price of complete transformer kit \$77.25 (includes stamped chassis and perforated cover—all transformers mounted on chassis at factory at no extra cost). Regular 40% discount or net price of \$46.35 to Universities, Broadcast stations or dealers. Purchase through your local U.T.C. distributor.



The 6C6 pre-amplifier circuit shown above is particularly adapted for use with Crystal, Ribbon and Voice Coil microphones. The audio section may be used separately for battery operation or with its highly filtered power supply from an AC source. The response is linear from 30 to 12,000 cycles. The gain is 58 DB and power output plus 7B. List price of complete transformer kit, audio and power \$81.00 [includes drilled audio and power decks—all transformers mounted at factory at no extra cost] 40% discount, or net price of \$48.60 to Universities, Broadcast stations, dealers. Purchase through your local UTC distributor.



DECIBEL DATA



WATTS

To set up a standard of electrical energy comparison, the use of the decibel has been based on a reference level of 0DB at a power level of .006 watts. In other words, energy levels greater than .006 watts are + DB compared to reference level and energy levels less than .006 watts are — DB compared to reference level.

The chart above indicates power level in watts against DB as compared to .006 watts reference level. The DB equivalent of any specific value of audio power can be immediately determined. This chart can also be used for determining DB gain or loss if the two powers are known. The DB equivalent of these powers can immediately be located on the chart. Subtracting these DB equivalents (algebraically) we obtain the gain or loss in DB. For example, let us consider an amplifier which requires 1 volt at 500 ohms input to drive the

output to 12 watts. The power input equals $\frac{E^2}{R}$ or $\frac{1}{500} = .002$ watts.

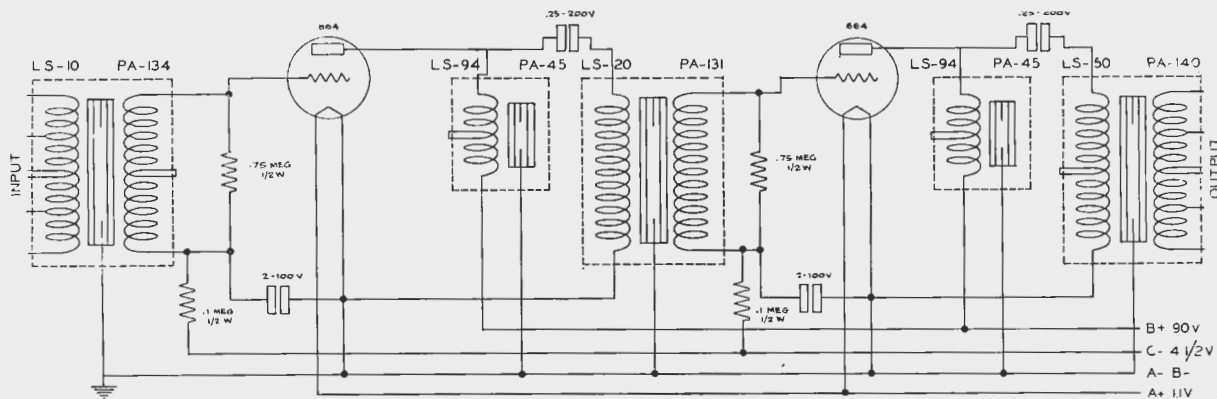
The DB equivalents for input and output powers are then seen to be approximately — 5 DB and + 33 DB respectively. The overall gain is then 33 — (5) or a total of 38 DB.

The table below is intended for the conversion of power or voltage ratios to DB. If voltage ratios are used, it is necessary that the same impedance apply to both voltage measurements. The lesser value of power or voltage should be taken as the numerator of the ratio so that the ratio itself will be less than unity. Whether the DB value obtained is a gain or loss is naturally governed by whether the output power or voltage is greater than the input or less. Current ratios are naturally the same as voltage ratios. If the loss or gain is greater than 20 DB, the following additional step must be taken:

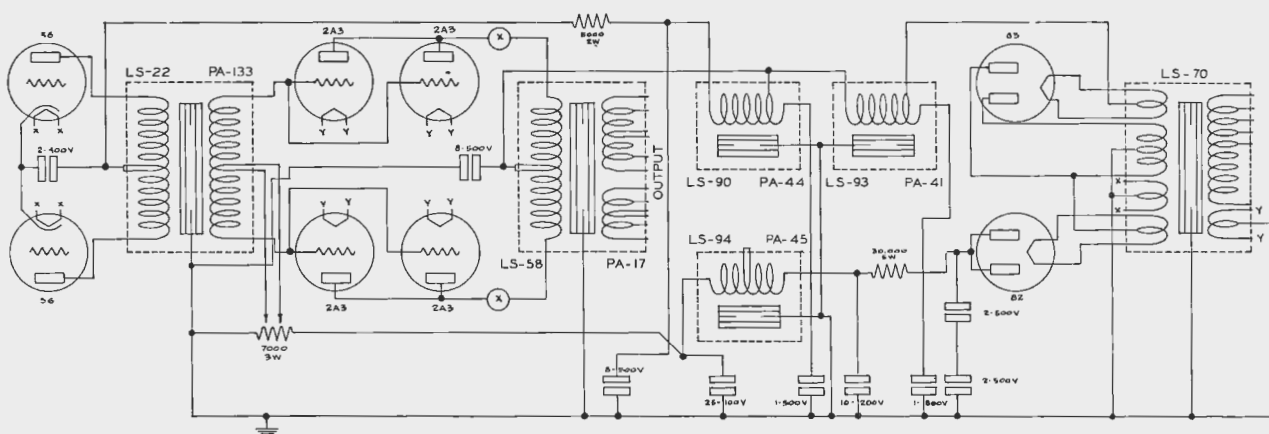
For voltage ratios, move the decimal point one point right for each 20 DB; in other words, if we have a ratio of .00041, move point 3 figures to the right, making .41 and add 60 DB to the DB equivalent of .41 (7.74 DB). This gives us a total of 67.74 DB.

For power ratios, the same method applies, except that the decimal point is moved one figure to the right for each 10 DB.

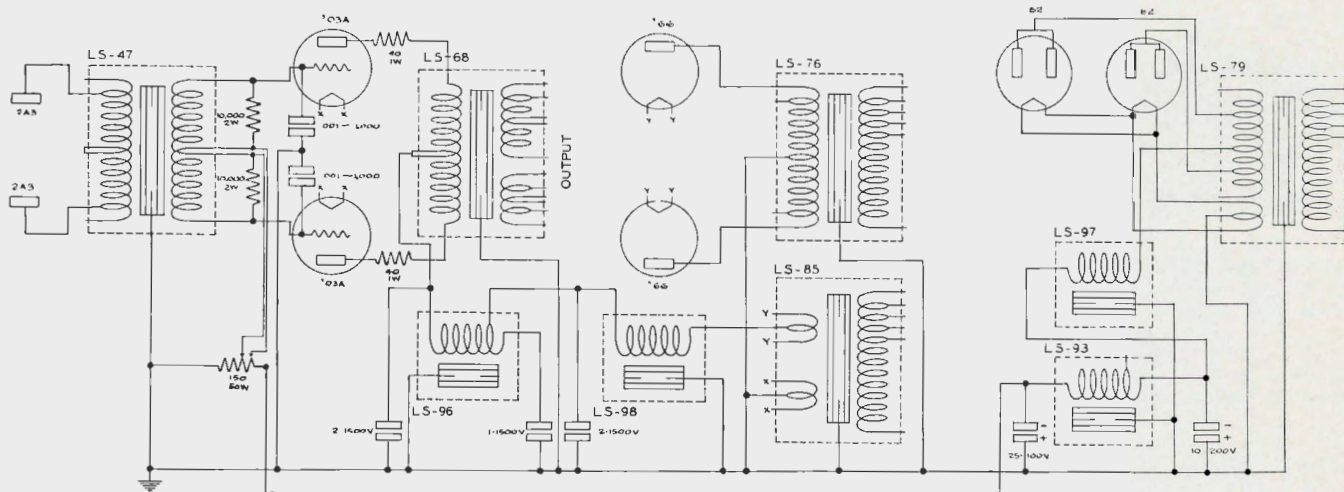
DB	$\frac{I_2}{I_1}$	$\frac{P_2}{P_1}$	DB	$\frac{I_2}{I_1}$	$\frac{P_2}{P_1}$	DB	$\frac{I_2}{I_1}$	$\frac{P_2}{P_1}$
0	1.00	1.00	2.36	.76	.578	5.35	.54	.292
.18	.98	.96	2.62	.74	.548	5.68	.52	.27
.35	.96	.922	2.85	.72	.518	6.02	.50	.25
.54	.94	.884	3.10	.70	.49	6.94	.45	.203
.72	.92	.846	3.35	.68	.462	7.96	.40	.16
.92	.90	.81	3.61	.66	.435	9.12	.35	.123
1.11	.88	.774	3.88	.64	.41	10.5	.30	.09
1.31	.86	.74	4.15	.62	.384	12.0	.25	.063
1.51	.84	.706	4.44	.60	.36	14.0	.20	.04
1.72	.82	.672	4.73	.58	.336	16.5	.15	.023
1.94	.80	.64	5.04	.56	.314	20.0	.10	.01
2.16	.78	.608						



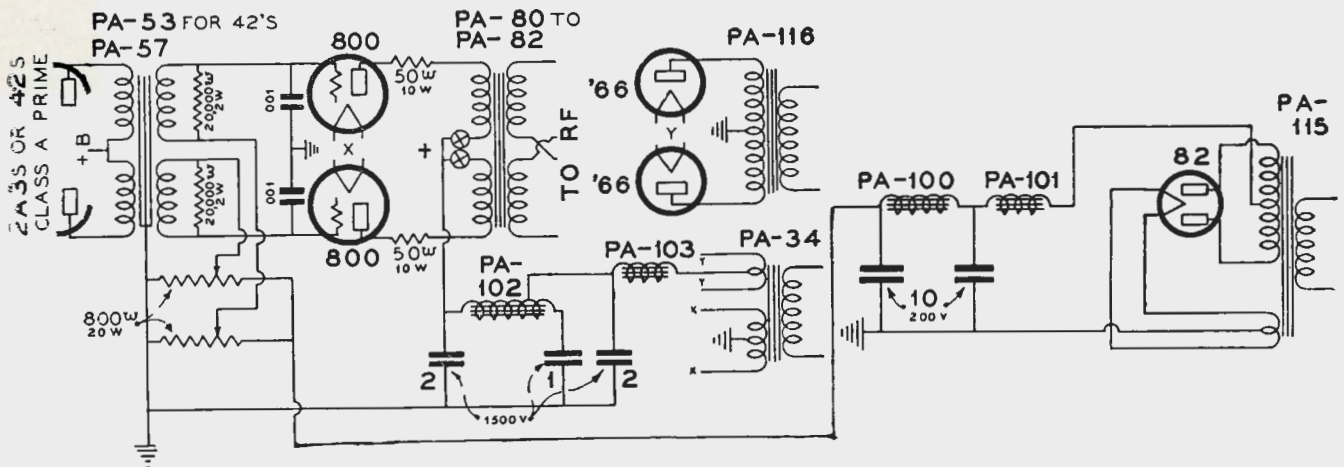
Two stage battery microphone or photo electric cell pre-amplifier using 864 tubes.



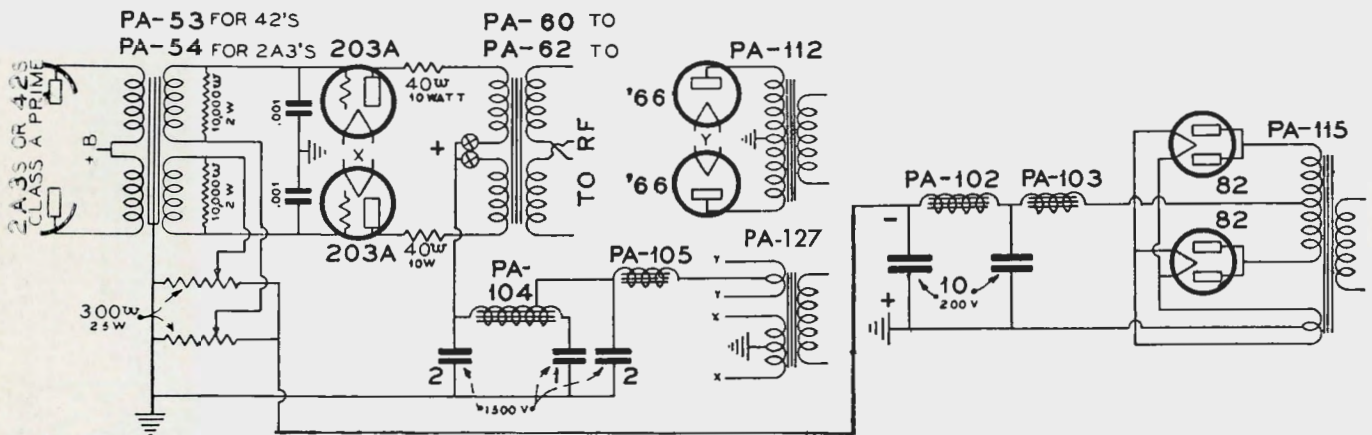
Push pull parallel 2A3 output power stage with fixed C bias and separate bias adjustment to balance plate current of output tubes. Shunt resonant rectifier filter used for highest filtering efficiency.



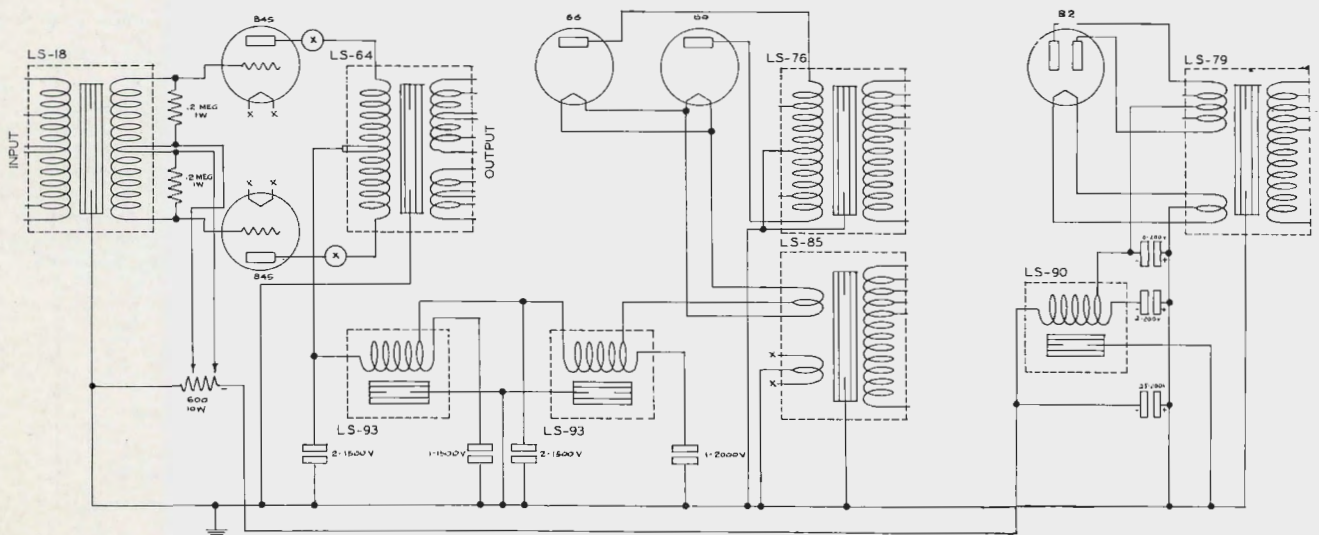
Class B 203 output stage. If graphite or carbon plate power tubes are used the maximum power output available is 200 watts. Fixed C bias is used with separate bias adjustment to balance plate current of output tubes.



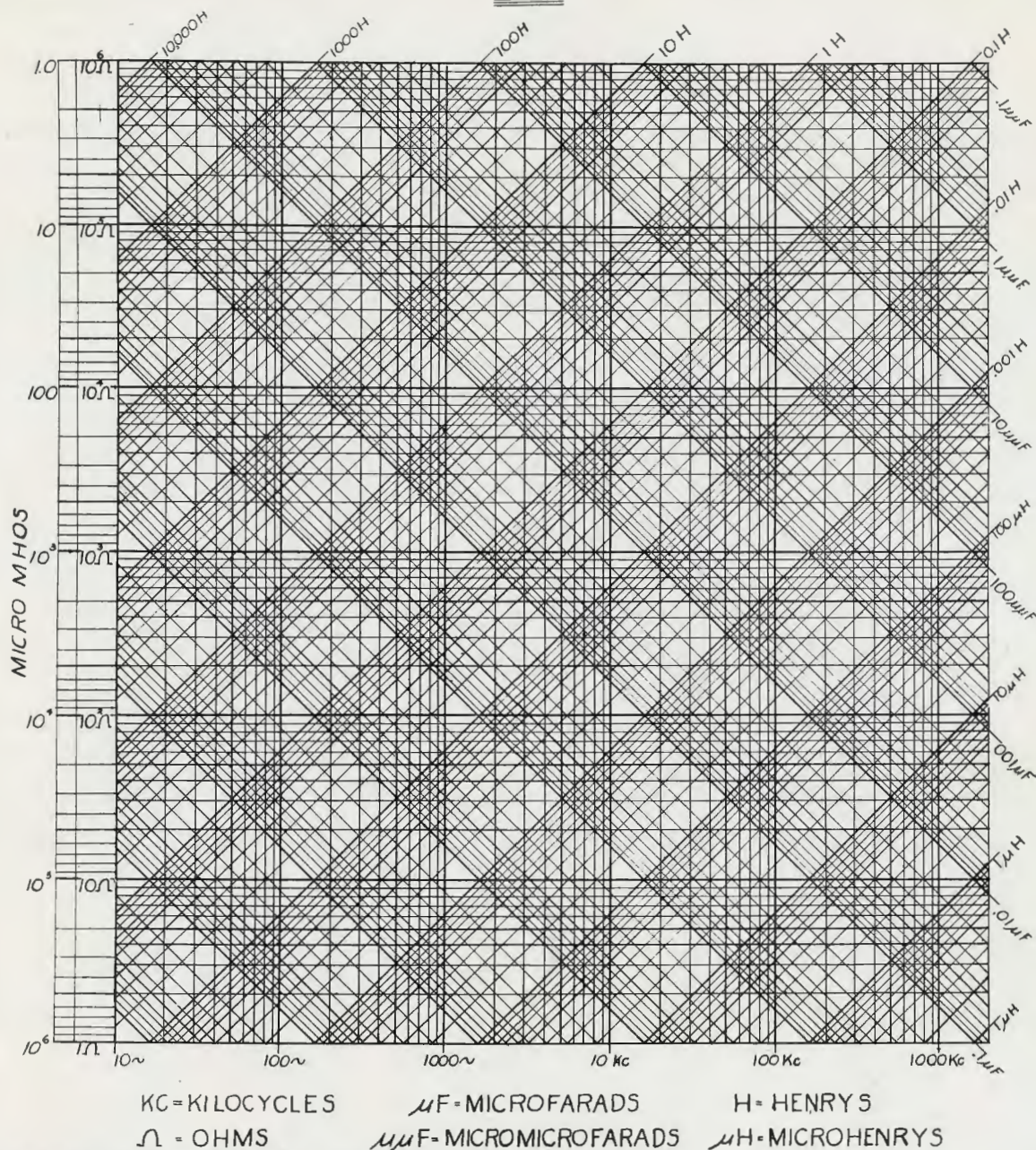
Class B 800, 100 watt output stage for transmitter applications. Fixed C bias is used for Class B 800's. Note the individual bias adjustment controls for each 800 tube.



Class B 203A, 225 watt output stage for transmitter applications. Fixed C bias is used for Class B 203A's. Note the individual bias adjustment controls for each 203A tube.



Class A 845 output power stage. Fixed C bias is used with separate bias adjustment, to balance plate current of output tubes. Shunt resonant rectifier used for highest filtering efficiency. If utilized to drive Class B 204 power stage, substitute LS-48 for LS-64 output unit.



The construction and use of this chart is as follows:

The sloping lines from lower left to upper right represent inductances and those from lower right to upper left, capacitances. The main divisions are subdivided on a logarithmic scale, each line being an even multiple of the first. For example, the light line immediately following the dark 1 Henry line represents two times 1 Henry; the next line represents 3 Henrys; etc. It should be noted that when interpolating between minor divisions, the same logarithmic gradation should be used as in the major divisions. To obtain the reactance or admittance of a capacitance or inductance, the sloping line should be followed to the point where it intersects with the vertical line corresponding to the frequency at which the value is desired. The horizontal line which corresponds with this intersection when carried to the left gives the value of reactance or admittance. In a similar manner, if reactance and frequency are known, the inductance or capacitance can be determined by a reverse process.

EXAMPLE TO DETERMINE REACTANCES.

To find the reactance of a coil having an inductance of 1 Henry at a frequency of 1000 cycles, we follow the sloping 1 Henry line until it meets the vertical 1000 cycle line. At the point of intersection, a horizontal line to the left edge of the chart indicates a reactance of 6200 ohms. Similarly, the sloping .1 mfd. line can be followed to the point where it intersects with the vertical 1000 cycle line and a horizontal line from the point of intersection to the left side of the chart indicates a reactance of 1600 ohms.

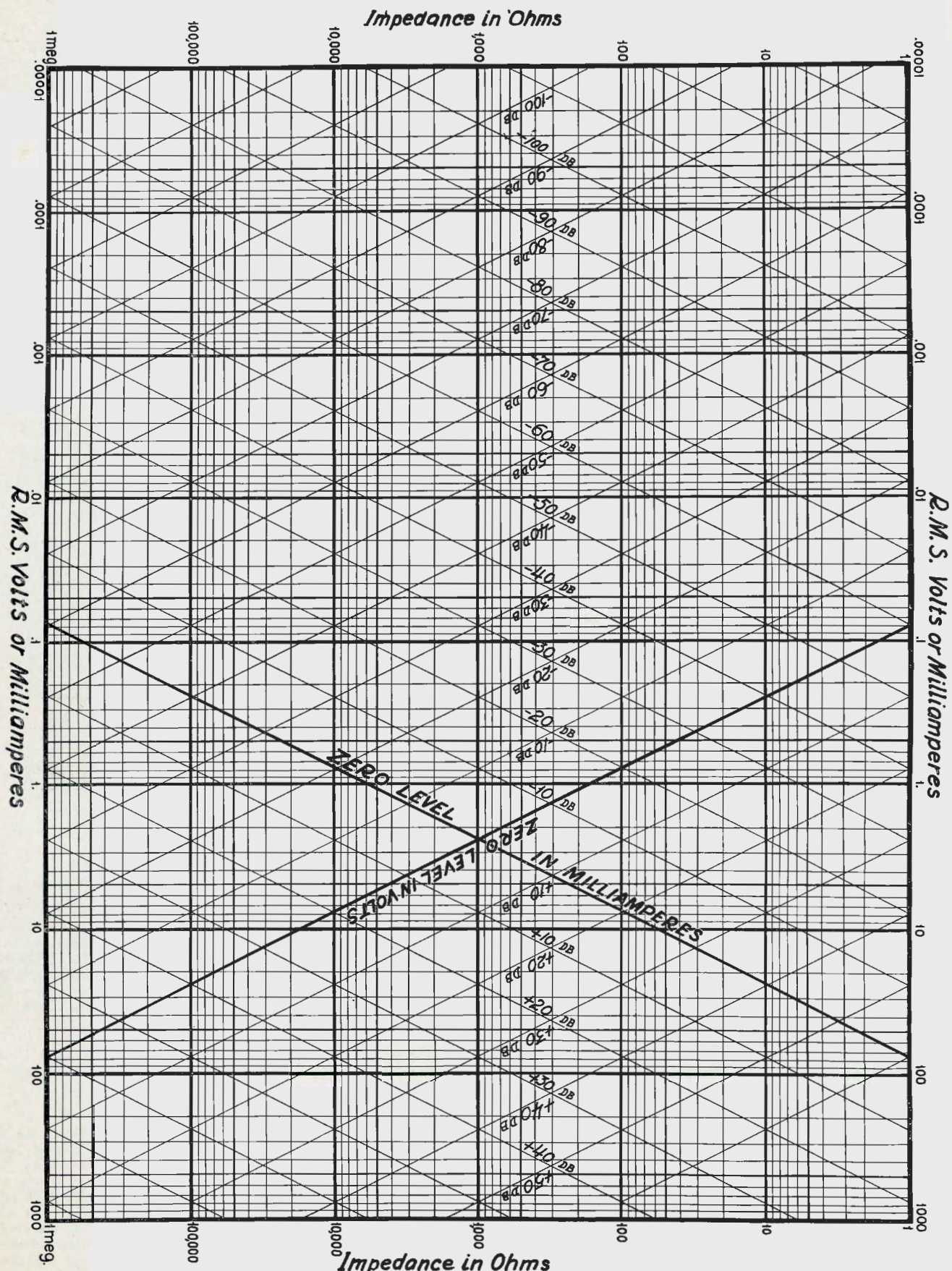
EXAMPLE TO DETERMINE RESONANCE.

To determine the point of resonance, let us consider the values of inductance and capacitance chosen in the previous example. We follow the sloping 1 Henry line to the point where it intersects with the .1 mfd. line. The vertical line through the point of intersection indicates a resonance frequency of 500 cycles.

EXAMPLE OF PARALLEL CIRCUIT CALCULATIONS.

The mho scale is primarily useful in the solution of parallel circuits. Consider an inductance of 1 Henry in parallel with .1 mfd. at 1000 cycles. The admittance of 1 Henry is found by the chart to be 161 micromhos at 1000 cycles, and the admittance of a .1 mfd. condenser 625 micromhos at the same frequency. In adding admittances of inductances in parallel or condensers in parallel, the admittances are simply added without regard to sign. However, the sign of capacitance and inductance are opposite when used in parallel. Therefore, in this example, the total admittance is 161 minus 625, or minus 464 micromhos. Glancing at the left side of the chart, this is found to correspond to 2160 ohms, which is the total reactance of the combination.

To use this chart, the measured value of volts or milliamperes is located at the bottom of the chart. This is extended vertically to the position where it intersects the correct horizontal impedance line. The sloping line corresponding to this point of intersection is the DB level. As an example, let us take a case where 8 volts is measured across 10 ohms. Extending the 8 volts line vertically to the point where it intersects the 10 ohm horizontal line, we coincide with the sloping voltage line of plus 30 DB.





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