$1.00

the University Technilog on Loudspeakers

THE SOUND PLANNING HANDBOOK FOR ARCHITECTS AND ENGINEERS

SOUND SYSTEM DESIGN CHART

The Speaker System Design Chart is based on the use of University high efficiency loudspeakers. To determine audio power, select required application and draw pencil line horizontally to proper room volume diagonal and continue pencil line down vertically to first adjustment line. Make adjustments as follows:

ADJUSTMENT FOR SOUND ABSORPTION

For acoustically treated locations, INCREASE adjustment reading 1-2 db by drawing line towards RIGHT 1-2 spaces. In location containing more than average reflecting surfaces, DECREASE adjustment reading 1-3 db by drawing line towards LEFT 1-3 spaces. Where acoustic conditions are normal (no acoustic treatment or highly reflective surfaces), no adjustments are required. Continue line vertically to voice-music adjustment.

ADJUSTMENT FOR VOICE OR MUSIC

For speech reproduction only, DECREASE adjustment reading 1-4 db by drawing line towards LEFT 1-4 spaces. For wider dynamic range in music, INCREASE adjustment reading 1-4 db by drawing line towards RIGHT 1-4 spaces. For speech reproduction and some incidental music, no adjustments are required.

After these two adjustments have been made, continue pencil line vertically down to the center of the horizontal bar in line with the speaker type selected for use. After this point has been reached, continue in a diagonal line to bottom scale which indicates the total operating power required for the system. The amount of power to each speaker is determined by the number of speakers used to provide adequate coverage.

AVERAGE SOUND LEVEL IN DB DELIVERED BY SOUND SYSTEM

100 95 90 85 80 75 70 65 60

1000 CU. FT. 3000 CU. FT. 10,000 CU. FT. 30,000 CU. FT. 100,000 CU. FT. 300,000 CU. FT. 1,000,000 CU. FT. 3,000,000 CU. FT. 10,000,000 CU. FT.

Average Typical Application	Background Noise Level in db	Background Noise Characteristic
FACTORY (Very Noisy)	90	HIGH NOISE LEVEL — CONVERSATION DIFFICULT
MACHINE SHOP (Average)		
PRINTING PRESS	80	MEDIUM NOISE LEVEL — VOICE MUST BE RAISED TO BE UNDERSTOOD
BALLROOMS		
RESTAURANT (Noisy)		
NOISY ASSEMBLY DEPT		
FACTORY (Average)		
R.R. WAITING ROOM	75	
AUDITORIUM (Average)		
ASSEMBLY PLANT (Quiet)		
SHIPPING-REC. (Average)	70	
OFFICE (Busy)		
DEPT STORE (Average)	65	QUIET BACKGROUND — NORMAL CONVERSATION POSSIBLE
AUDITORIUM (Quiet)		
RESTAURANT (Average)	60	
STORE (Quiet)		
OFFICE (Quiet)		
GARAGE		
HOTEL LOBBY—HOSPITALS		
CHURCH—FUNERAL PARLOR	55	

10 DBM* 20 30 40 50

EACH SPACE EQUALS 1 db

REFLECTION-ABSORPTION ADJUSTMENT

VOICE-MUSIC ADJUSTMENT

.01 .02 .03 .06 .1 .2 .3 .6 1. 2 3 4 6 8 10 12 16 20 24 30 40 48 60 80 100 120 160 200 240 300

READ WATTS OPPOSITE DESIRED SPEAKER

MIS, MM-2, HIGH EFFICIENCY CONES
MIL, CMIL, IBR, MM-2L
CIB, MA-25/RSH, MA-25/2WP
IB, CR, MA-25/SMH or COBREFLEX, SA-HF/2WP
MA-25/PH or CLH, SA-HF/RPH, SMH, COBREFLEX
SA-HF/PH or RLH or CLH, MA-25/LH or GH
SA-HF/LH or GH, PA-HF/PH or CLH
PA-HF/LH or GH

Note: SA-30 may be substituted for the SA-HF
PA-50 may be substituted for the PA-HF

*DBM ZERO LEVEL .001 watt

RATED AMPLIFIER POWER REQUIRED FOR UNIVERSITY SPEAKERS SHOWN AT RIGHT

the University Technilog on Loudspeakers

The TECHNILOG is a compilation of technical and product information in factual and concise form—representing the experience of many years of research and progress in the design and manufacture of loudspeakers which has made the University brand world famous. The staff of our Technical Service Department is ready to serve you in any technical, maintenance or procurement problem you may encounter.

SELECTING THE PROPER LOUDSPEAKER SYSTEM

This is not too difficult if a problem is approached in logical, step-by-step order. The Speaker System Design Chart will enable you to estimate the approximate power required for a given location, considering noise level, reverberation, speaker efficiency, and program. Treat individual rooms, alcoves, partitioned areas, and any other areas cut off acoustically from sound sources as separate problems. Based upon initial cost, convenience of installation and servicing, disturbance considerations, if any, and architectural dictates (reverberation, sound absorption, etc.) it is then decided whether a "high level" or "low level" speaker system shall be laid out for the specific location in question. If high level, the larger trumpets and radial projectors with heavy duty driver units should be used, either singly at key points, or in a cluster at a central location. If a low level system is decided upon, the smaller paging and intercom type speakers will serve admirably.

Knowing the power required to cover a given location, and the sound dispersion characteristics of the speakers being considered, the most suitable speaker and the number to be used is easily determined. Bear in mind that sound pressure is reduced approximately 6 db, or 75% below the previous level, each time the distance from the speaker is doubled. By laying out the speaker placement on a floor plan and tracing dispersion angles, the power at which each speaker must be operated, in order to cover the extremes at a desired minimum level, can be estimated.

Where music is involved, speakers capable of lower cut-off frequencies should be used to retain fidelity, irrespective of power considerations. On the other hand, where a reverberation is particularly severe, fidelity may have to be compromised at the expense of the low frequency response.

CONTENTS

HEAVY DUTY DRIVER UNITS

THESE DRIVERS MEET EVERY SOUNDCASTING REQUIREMENT

Model MA-25

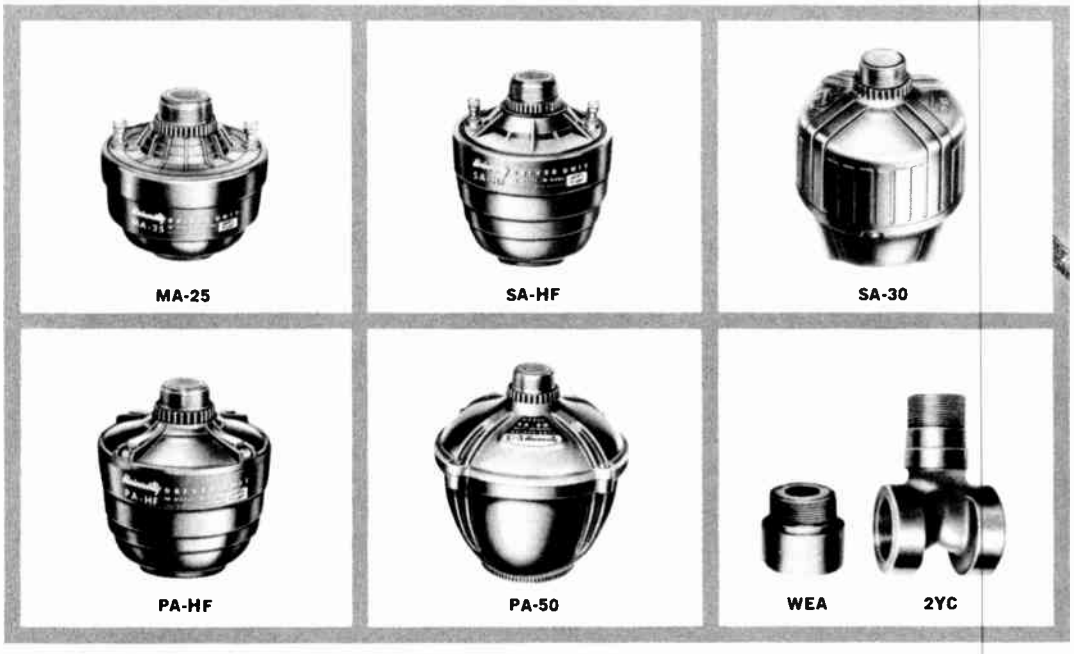
This rugged, weatherproof driver unit will find widest application where response to 6500 cycles is adequate... to preserve "balance" when used with high cut-off frequency trumpets in areas with moderate ambient noise... or in systems where great distance of penetration is not essential. The MA-25 has a highly efficient magnet structure, tropicalized full-sized 2″ voice coil, and "rim-centered" breakdown-proof linen base phenolic diaphragm. These are but a few important features which make the MA-25 a typical University top value... designed to meet low cost requirements, but with uncompromised quality.

Model SA-HF

Often referred to as the "workhorse" of the sound industry, the University Model SA-HF will meet most P.A. and industrial requirements. With high frequency response to 10,000 cycles and greater efficiency than the popular MA-25, this unit will deliver that extra "punch" needed to cut through heavy noise. It can be used with equal facility in speech or high quality music; uses audio energy efficiently and economically. Tropicalized and hermetically sealed, the SA-HF can be relied upon to give continuous top-flight performance under adverse weather conditions.

Model SA-30

With the same efficiency and response as the SA-HF, the SA-30 includes a built-in line matching transformer. The driver housing contains the transformer and bakelite screw-terminal plate. Entrance is made through an exclusive water-tight dural "gland nut" assuring positive weather-proofing after connections have been made. Terminals are labelled in impedances, as well as wattage consumed on "constant voltage" lines. The SA-30 employs a completely die-cast aluminum housing, making its use imperative whenever durability must be ensured in the face of unusually hazardous environment or accidental abuse. The shockproof bi-sectional construction of the speaker mechanism is an admirable match for the SA-30's exterior design. Here is veritable "battleship" construction combined with "plus" performance.



Model PA-HF

Ideally suited to applications requiring the *greatest* power handling capacity, *maximum* sensitivity, *widest* range frequency response *and* construction that will withstand a lifetime of hard use, the PA-HF is without question the very finest driver unit ever offered. It includes bi-sectional construction, super-efficient all-Alnico 5 *W* magnet and a *completely die-cast* aluminum housing. For added convenience, watertight voice coil terminals are located at the base of the housing.

Model PA-50

A truly "deluxe" unit, the PA-50 incorporates every advance design feature: extended high and low frequency range, highest continuous duty power capacity, super-power all-Alnico 5 *W* magnet and bi-sectional mechanism, husky, built-in transformer—plus special extra features such as transformer terminals immediately available at the base of the driver housing and superior conversion efficiency. The PA-50 is especially recommended for reproduction of church chimes, carillons and organ music. It is ideal for both rental work requiring repeated set-up and dismantling of equipment, and for semi-permanent systems where changes in location or the number of speakers are likely to affect line impedance requirements. The PA-50 should be specified whenever the ultimate in efficiency and distance penetration is required, because it will deliver *maximum* acoustic energy for a given amount of electrical input.

Accessories

WEA Adapter Advantage of the superior performance of University driver units can be taken by use of this thread adapter which fits University drivers to Western Electric and RCA trumpets employing $1\frac{7}{16}$"—16 thread.

Double power with standard drivers *Any* two University driver units can be used with the 2YC connector to double input power to any radial, directional, or wide-angle trumpet. Eliminates need for a *special* high wattage driver; enables you to select the model drivers that best suit response, efficiency and budget requirements. Screw the 2YC into the trumpet. The drivers of your choice are then screwed into the 2YC... that's all there is to it. Fits standard $1\frac{3}{8}$"—18 thread.

Specifications

MODEL	MA-25	SA-HF	SA-30	PA-HF	PA-50
FREQUENCY RESPONSE	85 to 6500 cps	80 to 10,000 cps	80 to 10,000 cps	70 to 10,000 cps	70 to 10,000 cps
POWER CAPACITY (Cont. Duty) FULL RANGE *ADJUSTED RANGE	25 watts 50 watts	30 watts 60 watts	30 watts 60 watts	50 watts 100 watts	50 watts 100 watts
VOICE COIL IMPEDANCE	16 ohms	16 ohms	16 ohms	16 ohms	16 ohms
TRANSFORMER IMPEDANCES	----	----	16/45/165/250/500/ 1000/2000 ohms	----	16/100/165/250/500/ 1000/2000 ohms
70 V. LINE POWER TAPS	----	----	30/20/10/5/ 2.5 watts	----	50/30/20/10/ 5/2.5 watts
‡SOUND PRESSURE LEVEL	127 db	130 db	130 db	134 db	134 db
DIMENSIONS (OVER-ALL)	$4\frac{1}{8}$" dia. $3\frac{3}{4}$" deep	$4\frac{1}{2}$" dia. $4\frac{7}{8}$" deep	5" dia. $6\frac{1}{4}$" deep	4 11/16" dia. 5" deep	$6\frac{3}{4}$" dia. $6\frac{3}{4}$" deep
SHIPPING WEIGHT	$3\frac{3}{4}$ lbs.	$4\frac{1}{2}$ lbs.	$5\frac{1}{4}$ lbs.	$5\frac{3}{4}$ lbs.	$6\frac{1}{4}$ lbs.

*When input program response is limited to above low frequency cut-off of trumpet used for sound pressure reduction of 6 db at this frequency.

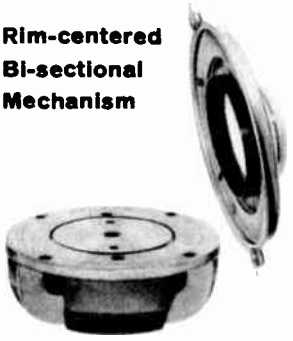
‡Sound Pressure readings taken at 4 ft. on $6\frac{1}{2}$' horn, with rated Full Range power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; add 3 db when power input is doubled. Drivers resistant to 9 lbs. per sq. inch Class 3 blast pressure can be furnished upon special request at extra cost.

Only University breakdown-proof driver units have these exclusive built-in features...

Rim-centered Bi-sectional Mechanism

In University wide-range driver units, specially tapered, one-piece linen base phenolic diaphragms are set in an exclusive aluminum acoustical "palate" which ensures correct phasing at the upper register of the sound spectrum. This results in exceptionally *uniform* over-all frequency response.

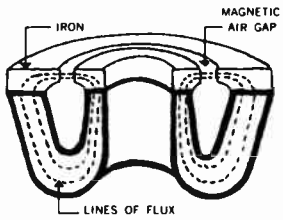
The precision assembly of the palate (comprising voice coil, diaphragm and acoustical equalizer) enables it to center *automatically* in the voice coil gap of the magnet top plate. The inner rim of the palate coincides with the outer edge of the magnet top plate. Thus, the palate falls into position, automatically self-centering in the magnetic air gap. This unique "rim-centering" technique results in a shockproof and vibration-proof assembly and also makes possible a precision magnetic gap of smaller width for high flux density and greater conversion efficiency. It permits field replacement of the palate (in models SA-30, PA-HF, PA-50) in a matter of minutes, without need for any centering devices, should it ever be necessary.



W-shaped Magnet

The exclusive University *W* magnet assembly, used in the PA-HF and PA-50, is a substantial improvement over other designs in conventional use. Except for the prime grade Armco top plate, the *entire* assembly consists of Gold Dot Alnico 5. This eliminates fully *50%* of reluctance losses normally present in other designs where the magnetic path must be completed through soft iron

bottom plate "keepers" and "U" structures. The all-Alnico 5 *W* shape also helps contain the magnetic energy *within* the magnet, thereby avoiding losses due to surface leakage. The pull of the *W* magnet is so powerful that no bolts or welded joints are required to secure it to the top plate!



W-shaped Magnet

Built-in Transformer

Built-in Transformers

Originally introduced by University, greater economy can be effected by using the Models SA-30 and PA-50, wherever a reliable weatherproof, multi-impedance line matching transformer is required. Suited to both "constant impedance" and "constant voltage" amplifying systems, these drivers provide the highest degree of versatility of application and greatest flexibility of operation.

Custom-built, Tropicalized and Blast-proof

University voice coils are individually precision-wound with meticulous care to ensure uniform response and impedance. Voice coil is wound on a special form designed to achieve life-long perfect concentricity, permitting close coil-to-gap design, resulting in greater heat dissipation. Thermosetting bonding cements are prepared according to an exclusive time-tested University formula. Voice coil/diaphragm assemblies are slowly cured and aged to ensure continuous trouble-free operation. Diaphragms are individually checked for correct taper, dimensions and weight distribution. *All* voice coil/diaphragm assemblies are treated with a special antifungicidal solution, so that wherever a University speaker may be used, its built-in superiority will remain impervious to the elements. Civil Defense and most military requirements will be met by the inherent blast-resistance of University drivers.

PLUS Performance

Extended range drivers, another first by University, set new standards and create new fields of application. "High fidelity" program material can be reproduced with life-like brilliance—making possible truly effective penetration of refractory industrial noises. Speech comes through clearly, crisply and highly intelligible. Church chimes, carillons and organ music exhibit a new, almost startling realism. High, but *conservatively rated,* continuous-duty power handling capacity at maximum conversion efficiencies means lowest dollar-per-watt costs. Rugged design and painstaking fabrication ensure longer life and greatest investment protection. University driver units give *plus* performance—result in *plus* value.

About Driver Units Generally

Power Ratings

Absence of industry-wide standards for evaluating the performance of loudspeakers makes the comparison of driver unit specifications difficult for the uninitiated. Power handling capacity is an indication of the ability of a driver to withstand an amount of electrical input power, *of a certain nature,* for some length of time, without danger of driver breakdown. But, the power handling capacity is not necessarily an indication of sound output. It is possible, for example, to design a driver rated at 40 or 50 watts input which would produce no more sound output than a more *efficient* driver rated at 25 or 30 watts.

Driver Efficiency

"Gauss", a measure of flux density existing in the voice coil gap, is sometimes used by implication to indicate the efficiency of the driver unit. This is misleading, because the magnet is only a part of the motor mechanism, while the *conversion* efficiency is dependent upon the manner in which the magnet energy is employed. The weight, shape, size and mounting of the diaphragm, design of voice coil and suspension, as well as heat dissipation, are other less obvious but still significant factors. Sound pressure measurements presumably would be the answer, if there were a common basis of

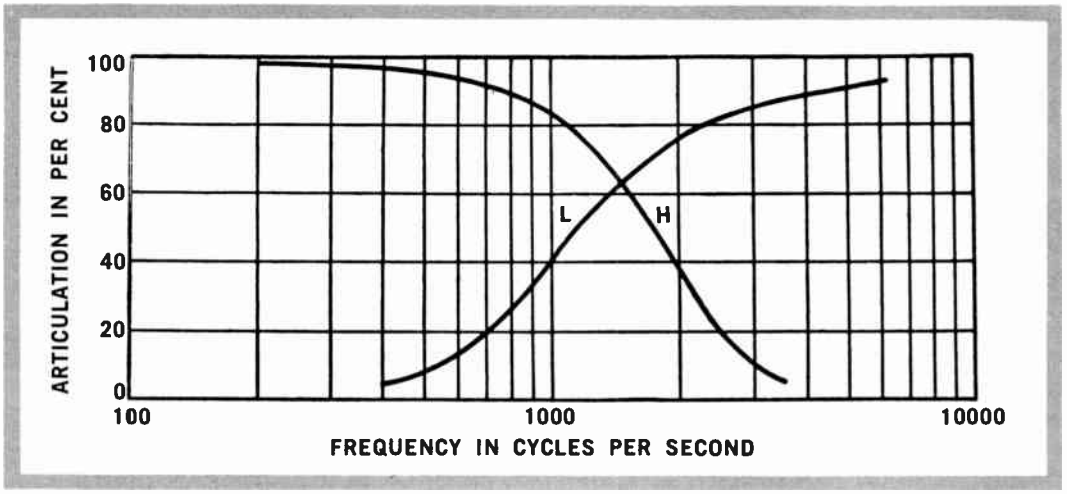


Fig. 1

The effect of the frequency range upon the articulation of speech. H. High-pass filter removes all frequencies below the frequency given by the abscissa. L. Low-pass filter removes all frequencies above the frequency given by the abscissa. (After Fletcher, "Speech and Hearing," D. Van Nostrand Company.)

From: G. L. Bonvallet in THE JOURNAL of the Acoustical Society of America, July, 1951

measurement. But apart from the differences in laboratory constants, some of the factors which would affect the sound pressure measurements also include distance from the sound pickup device, type of pickup and frequency at which the measurement is taken.

Frequency Response

The frequency response of a driver unit is another important consideration in evaluation. Studies in the composition of ambient noises reveal that over-all low frequency noise encountered under average industrial conditions has a tendency to mask intelligibility. Fortunately, it has been found that the higher frequencies are of major importance for articulation in speech. Thus, even if a driver were to reproduce very low frequencies, in a particularly noisy location those tones would probably be masked by the general level of noise. On the other hand, if the same driver were incapable of extended range response, the "highs" which are so sorely needed under such conditions would be lacking, and intelligibility would suffer. For this reason University introduced the extended range driver units which have now become standard in the industry for most applications.

A speaker or a trumpet/driver combination selected for its specific ability to work efficiently in high ambient noise and designed to penetrate noise with maximum intelligibility should be judged for tonal "quality" only under *operating conditions.* When listened to in relative quiet, the speaker will naturally have a rather high pitched quality.

For music reproduction, good low frequency response (barring reverberation problems) is usually desirable along with the highs. Of particular importance is the ability of the driver to withstand extreme excursions of the diaphragm when reproducing high-level, low frequency passages. In such cases protection of the driver unit by adequate horn loading is important. Fractured diaphragms, broken voice coil leads and excessive distortion can result from improper selection of horn and driver unit, especially when working with church chimes, carillons and organ music.

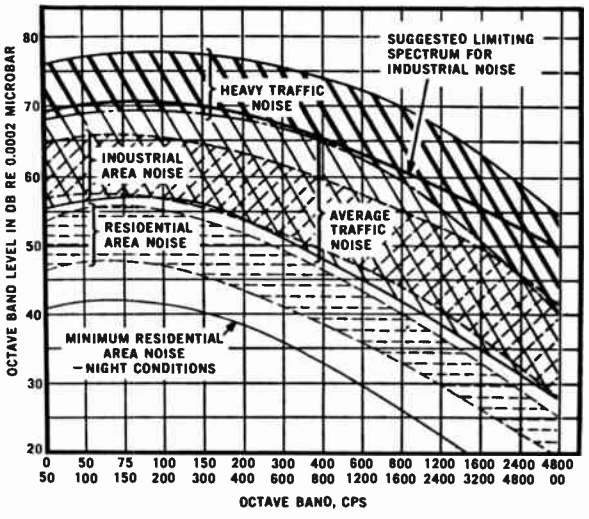


Fig. 2

Average levels of traffic, industrial and residential area noise. The data for industrial area and residential area noise are shown as a range including 50 percent of the measurements. The curves for traffic conditions are those of average and heavy traffic. The suggested limiting spectrum for industrial noise and the curve of minimum levels in quiet residential areas for night conditions also are indicated.

From: ACOUSTICAL ENGINEERING, 3rd Edition, H. F. Olson, Copyright 1957, D. Van Nostrand Company, Inc., Princeton, N. J.

For these and other reasons, when judging specifications of competitive driver units, it is extremely important to take note of how the manufacturer qualifies the power capacity rating.

About University Driver Units

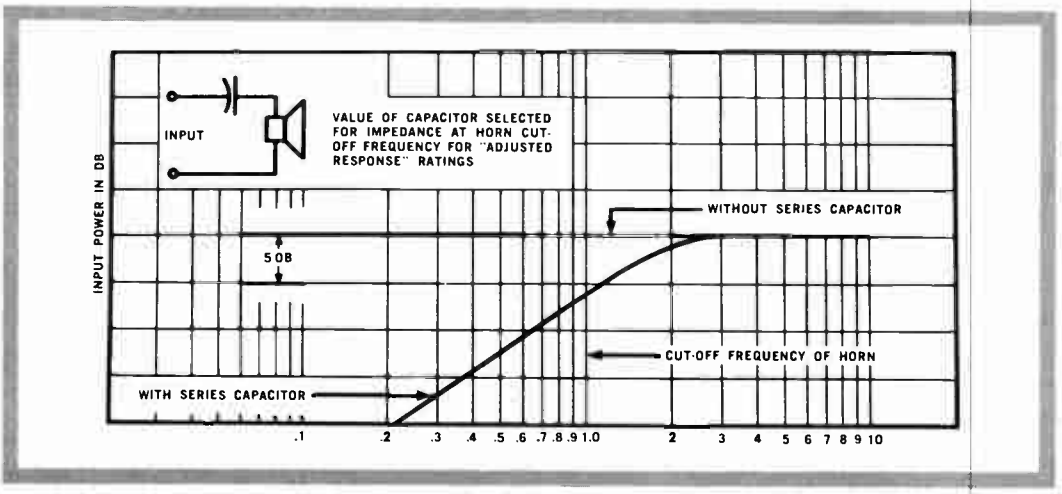
POWER RATINGS

The new line of University drivers has been designed and rated for use under two different operating conditions:

"Full Range" Power Capacity

"Full range" power capacity is by far the most common method of operation in the field. Although a driver itself may be capable of full frequency response, the actual acoustical output of the driver and trumpet combination will be considerably influenced by the low frequency limit of the *horn* used, below which the output drops drastically. With an amplifier operating for wide-range response, substantial low frequency energy *enters* the driver unit, but very little of it may end up as sound energy, due to the horn's limiting or "cut-off" characteristic, as it is commonly referred to in manufacturers' specs. The cut-off of a horn is determined by the flare design and air column length. Thus the larger, longer trumpets will baffle a driver to lower frequencies more efficiently than smaller models. At best, the biggest horns for use in P.A. have an air column length of 6½ feet and are capable of response down to 85-100 cps. With a driver mounted to a more popularly used horn with, for example, a 150 or 200 cycle cut-off, and thus operating without much loading at the lower frequencies, the driver mechanism endures relatively severe electrical and mechanical punishment which could lead to eventual breakdown... *unless* the driver is designed to take a given amount of input power under such conditions. An expression such as "full range" continuous duty power capacity can be used to denote application of a given driver to horns without regard to cut-off. University actually life tests drivers on this basis and accordingly, rates its drivers for continuous duty. (See Section T-2 for guidance on selection of proper driver/horn combination.)

Fig. 3



"Adjusted Range" Power Capacity

Obviously, then, if the low frequency energy *below* the cut-off of the horn used could be eliminated from the program signal source or from the driver input, the low frequency overloading condition is eliminated too, and the driver may be rated for substantially greater input. In such case the power rating is *doubled*. If wide-range frequency response is not required elsewhere in the speaker distribution lines, the amplifier bass tone control (or low frequency filter, if any) can be adjusted to eliminate some desired amount of lows. However, it is a good idea to make certain of the actual attenuation by testing amplifier output with an audio signal generator and output meter. If the amplifier cannot be adjusted or altered, or if wide-range program is also required elsewhere in the distributing system, a *non-polarized* capacitor of proper value can be inserted in series with the driver of the P.A. speaker not requiring hi-fi performance, to attenuate *input* low frequency energy, thereby achieving higher power capacity.

The graph in Fig. 3 shows what generally takes place. Note that while the series capacitor produces a steady roll-off below the established cut-off frequency, the roll-off actually begins to occur *above* the cut-off point, resulting in a loss of 6 db *at* the cut-off point fixed by the value of capacitor.

To find the value of capacitor:

$$\text{Capacitor in microfarads} = \frac{1{,}000{,}000}{3 \times 6.28 \times \text{desired cut-off frequency} \times \text{driver impedance}}$$

The scale at the bottom of the graph in Fig. 3 represents:

$$\frac{\text{attenuation at any frequency}}{\text{established cut-off frequency}}$$

For example, assuming that we have already calculated a value of capacitor to provide cut-off at 200 cycles, and we want to know from the graph what the attenuation will be at 600 cycles, we divide 600 by 200 and get the answer of 3, which the graph shows will not be affected at all. If we want to know what happens at 40 cycles, we divide 40 by 200 and get .2 for an answer. The graph shows that at .2 there will be an attenuation of about 14 db below the established cut-off frequency and 20 db below the point where roll-off actually begins.

While limiting amplifier response or applying a series capacitor will increase the power handling capacity of a driver, it should be borne in mind that there will often be discernible aural differences compared to operating without the limiters. This is due to the roll-off rather than sharp cut-off characteristics. Therefore it is preferable to restrict these methods to *voice* reproduction. If the stated power rating or warranty of a driver unit other than the University brand is qualified in specifications with respect to horn size, or if input response is restricted to horn cut-off, you may be certain that such rating is actually the "adjusted range" capacity. To find the "full range" power rating it would be safest to divide the given rating by two.

FREQUENCY RESPONSE RATINGS

Rating Driver Response

In the absence of industry-wide standards, ratings are an indication of driver response capability. Naturally, *horn* characteristics influence acoustic response, especially near and below horn cut-off. Sound obeys the laws of physics, so that even a trumpet with an air column of 6½ feet (Model GH) exhibits a good deal of attenuation at the low frequency, compared, for example, with the response at 1000 cycles. Fortunately, the energy in the fast roll-off region at the low end is quite usable and therefore is considered when rating the response range of horns. Though University drivers are capable of high frequency energy beyond the ratings applied, the high frequency limit is established at a point of high sound output level, in order to compensate for the program and for the higher projection attenuation rate encountered in practice in that portion of the spectrum.

Figures 4, 5, and 6 depict the frequency response of University drivers, all taken on the same size trumpet (GH), in order that effects due to differences in *driver* response may be clearly seen. The curves at the low end, say from 200 cycles and down, bear a family resemblance. This is because the horn cut-off characteristic is the predominant factor. However, the differences in *driver* characteristics do show up in a graphically small but aurally discernible way. Note degree to which each driver unit fills in the area between 70 and 100 cycles differently. The response envelope is also

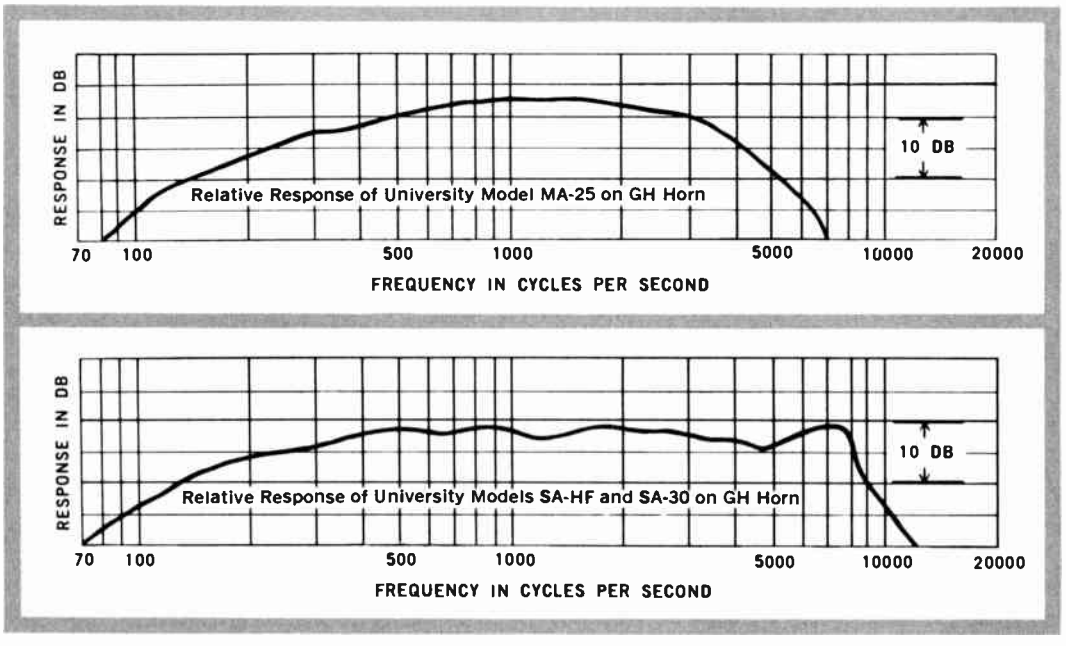
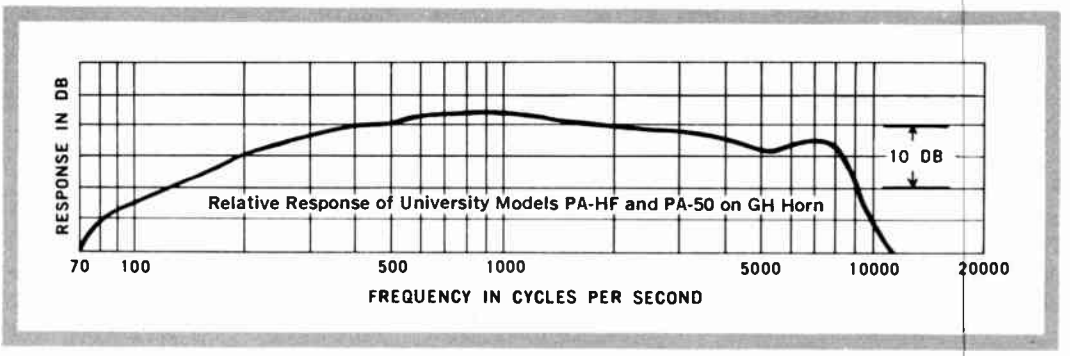


Fig. 4

Fig. 5

Fig. 6



different with each driver... for good reason. The MA-25, with limited frequency response and least efficiency, bears a "humped" envelope, with most of the energy concentrated in the 200 to 5000 cycle range. This gives the MA-25, in actual field operation, a noise penetrating wallop and apparent musical balance that would hardly be expected of an "economy" unit. The SA-HF (and SA-30), with better lows, highs and efficiency, was designed to provide essentially "flat" response. It can be used with equal success in any application requiring voice, music, or noise penetration. In fact, the SA-HF is widely used as well by high fidelity manufacturers and hobbyists. The PA-HF (and PA-50), on the other hand, combines the best features of the MA-25 and SA-HF, having both extended range frequency response and a small hump in the mid-range, plus still greater efficiency. These drivers, each in their class, are unexcelled in modern loudspeaker design.

SOUND PRESSURE LEVEL

Importance of Sound Pressure Data

One of the most revealing measurements of a speaker is its output on some *specific* basis. A driver that withstands greater input power is of no general value if it does not produce more sound for a given input. It takes a change of about 3 db in sound for the difference to become useful. But to get 3 db more output, power to a given speaker must be doubled! Obviously then, in enlightened and practical design, higher power capacity should be coupled with greater efficiency as well, so that the resultant gain in output will be a combination of *both* the increased input power and the increased efficiency. The chart in Fig. 7 shows the relationship between increases and decreases in power input to a speaker vs. sound output in db.

As a practical example, let us take a good but modestly priced driver unit, the University MA-25, which produces 127 db on a 6½ foot air column reflex trumpet with 25 watts input. If we were to use a series capacitor and double the input power to 50 watts, sound output would rise to 130 db. Yet, a University SA-HF driver, at 30 watts input, yields the same 130 db, of which only a small portion (.8 db) is due to the five extra watts input, the greatest increase being due to its higher *efficiency*. Now if we were to apply the "adjusted-range power" input of 60 watts to the SA-HF, the sound pressure would go from 130 db to 133 db. It becomes obvious that driver units designed to complement higher input power with increased efficiency increase sound output more economically than by merely increasing power alone.

A 25 watt P.A. amplifier might price around $50, while a 50 watt amplifier with comparable features would cost about $90. The difference between the two drivers mentioned is only $8.50 list!

Fig. 7

Table of various power ratios as related to decibels gain or loss.

POWER RATIO	± DB	POWER RATIO	± DB	POWER RATIO	± DB
1.000	0	0.562	2.5	0.126	9.0
0.977	0.1	0.501	3.0	0.112	9.5
0.955	0.2	0.447	3.5	0.100	10
0.933	0.3	0.398	4.0	0.0794	11
0.912	0.4	0.355	4.5	0.0631	12
0.891	0.5	0.316	5.0	0.0501	13
0.871	0.6	0.282	5.5	0.0398	14
0.851	0.7	0.251	6.0	0.0316	15
0.832	0.8	0.224	6.5	0.0251	16
0.813	0.9	0.200	7.0	0.0200	17
0.794	1.0	0.178	7.5	0.0159	18
0.708	1.5	0.159	8.0	0.0126	19
0.631	2.0	0.141	8.5	0.0100	20

$$\text{db gain} = 10 \log \frac{\text{higher power}}{\text{lower power}}$$

FOR MODEL	DEDUCT
LH	1.0 db
PH	2.0 db
SMH	3.0 db
CLH	4.0 db
Cobreflex	5.0 db

Adjusting Sound Pressure Ratings

All measurements discussed and shown in the specifications are taken on a GH horn, on axis, at a distance of 4 ft. Input frequency is 750-1250 cps in a 1 cycle repetitive sweep. Db reference is relative to .0002 dynes/cm^2. To determine the sound pressure of the drivers on horns other than the GH, apply the correction index at left.

Note that the wide-angle horns require the greatest adjustment. Since measurements are taken on horn axis, the spreading of available energy in a wider horizontal pattern by wide-angle trumpets thereby reduces relative on-axis sound pressure. More on wide-angle trumpets in Section T-3.

Phasing Driver Units

"Phasing" is concerned with the utilization of two or more loudspeakers in such a way that the sound from any one speaker does not cancel out with the sound from other speakers and thus create a dead area between both. This is an important consideration where speakers face in the same direction. The connections to the voice coil or matching transformers, whether in series or parallel, must be made so that in any one instant all diaphragms will move in unison outward or in.

Two Drivers on a Single Trumpet

If two driver units were connected to a single horn, through say, the Model 2YC connector, it can be clearly seen that if they were out of phase, the resultant pressure where the sound of the two units meet in the connector would be completely cancelled out, resulting in no sound at all. They must be connected so that both diaphragms are working in the same direction together. For parallel impedance operation, the like terminals of each unit must be connected together. If the speakers are wired in series, two unlike terminals must be used as a junction. See Fig. 8.

Phasing Separate Speakers

Phasing is of least importance where two separate loudspeakers are a good distance apart or pointing in opposite directions. However, as the two speakers are brought closer together in a smaller angular relationship, the necessity for *in-phase* operation becomes increasingly important. Sometimes out-of-phase connections are tried to overcome reverberation and echo problems, using the sound-cancelling effects as a means of setting up an acoustical barrier. Best phasing is generally determined by experimentation.

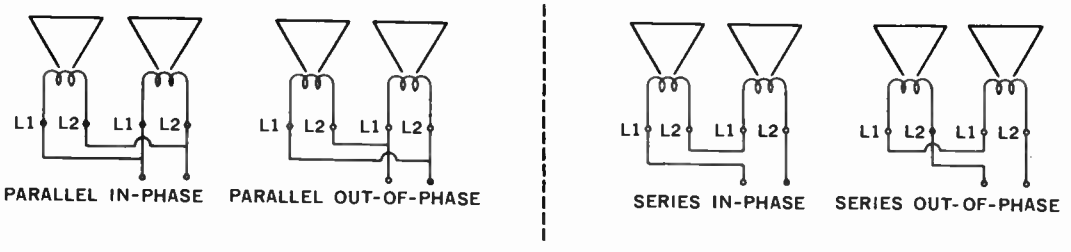


Fig. 8

Overload Protection of Driver Units

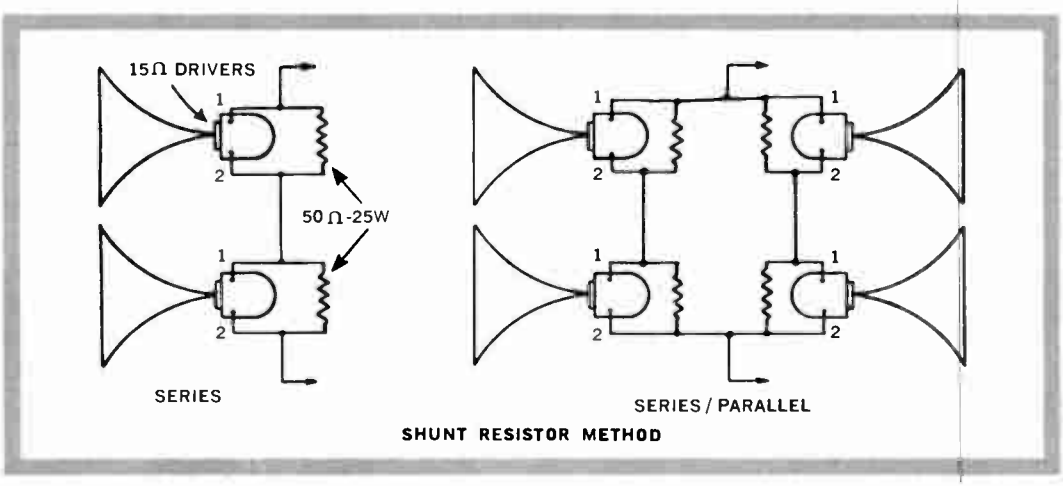
In elaborate installations involving hundreds of watts of audio power, there is the danger of *accidental* or *excessive* peak surges. This is quite aside from low frequency overload protection of drivers through the use of a series capacitor. Sometimes "ground loops" (voltages established by equipment and lines considerably above so-called ground potential) will find a circuit to the speaker lines. There is always the possibility of amplifier output transformer breakdown, resulting in high

D.C. voltage applied to drivers. It is also surprising how often raw powerline A.C. finds a way to the speaker lines, or drivers are burned out by voltages induced in speaker transmission lines by lightning. All of which dictates consideration of one of the following methods suggested to protect speakers in installations of a relatively involved nature, and to minimize the possibility and inconvenience of a complete system breakdown.

Shunt Resistor Method

This method is for use where driver units are connected in series or series/parallel. Shunt each driver unit with a fixed resistance of approximately three times the impedance of the unit. For instance, 8 ohm units would be shunted with a 25-ohm resistor; a 16-ohm driver unit, with a 50-ohm resistor. These shunt resistors will cause a loss in sound pressure of about 1½ db, a loss that may be overlooked when safety is more important than loss in efficiency. The wattage dissipation capabilities of the resistor should be equal to the maximum handling capacity of the driver unit. This method prevents failure of the entire system should a single driver unit open, as would be the case in a series arrangement installed without shunt resistors. Should a unit of 16 ohms break down and become open-circuited, a 50-ohm resistor takes its place, thus considerably lowering the energy in the remaining speakers. This results in a reduced sound output which may alert the operator without impairing the service for a temporary period.

Fig. 9



SHUNT RESISTOR METHOD

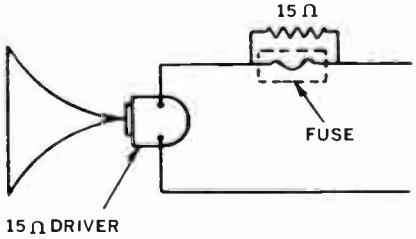
Littelfuse Method

This method uses ordinary fuses to protect against breakdown whenever the current becomes excessive—the speaker remaining in operation. When the fuse blows, the power to the driver unit is automatically reduced, and the amplifier power is divided equally between the loudspeaker and a fixed resistance. The speaker continues to function at a 3 db lower sound level. This method utilizes low current "Littelfuses" placed in series with each driver unit. Across each fuse is shunted a fixed resistor equal in resistance and power to that of the loudspeaker. The current rating of the fuse is selected on the basis of the peak current encountered in the average musical or speech output, where the averaged level is equivalent to the loudspeaker rating. In the case of a 25 watt loudspeaker, the current rating of the fuse should be approximately .75 ampere when shunted with a 15-ohm resistor.

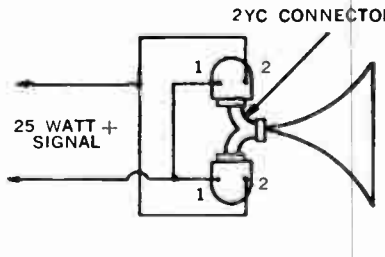
Double Driver Method

This is a practically foolproof method that involves additional driver units, each operating at 50% capacity. Where a certain amount of power must be supplied to a single horn, positive protection against breakdown is achieved by equipping each horn with two driver units, using a 2YC connector. Thus, each driver unit receives approximately one half the electrical power, while the acoustic energy at the horn mouth is equivalent to that furnished by a single unit operating at full power input. The safety factor is increased by many times in this type of installation.

Fig. 10, 11



LITTELFUSE METHOD



DOUBLE DRIVER METHOD

Architects' and Engineers' Specs

Model MA-25

Driver unit shall have a full range power capacity of 25 watts continuous duty, and a power capacity rating of 50 watts when program frequencies below cut-off of horn used are eliminated, and sound pressure reduced 6 db at this frequency. Rated response of driver shall be 85 to 6500 cps; voice coil impedance 16 ohms at 1000 cycles. Driver shall deliver a sound pressure of at least 127 db on a 6½ ft. re-entrant horn, on axis at 4 feet, with 25 watts 1 cps sweep 750-1250 cps input. Rim-centered mechanism in a die-cast aluminum head shall contain at least 6.5 oz. Alnico 5 magnet. Voice coil shall be 2" diameter; diaphragm, linen base molded phenolic. Driver unit shall have 1⅜"—18 threads for screw-in attachment to horn. Spun over aluminum housing shall be hermetically sealed; vise-like grip type binding posts used to make electrical connection to the driver. Unit diameter shall not exceed 4⅛" nor its length 3¾" without horn. University Model MA-25 is specified.

Model SA-HF

Driver unit shall have a full range power capacity of 30 watts continuous duty, and a power capacity rating of 60 watts when program frequencies below cut-off of horn used are eliminated, and sound pressure reduced 6 db at this frequency. Rated response of driver shall be 80 to 10,000 cps; voice coil impedance 16 ohms at 1000 cycles. Driver shall deliver a sound pressure of at least 130 db on a 6½ ft. re-entrant horn, on axis at 4 ft., with 30 watts 1 cps sweep 750-1250 cps input. Rim-centered mechanism with split path die-cast aluminum head shall contain at least 10¼ oz. Alnico 5 magnet. Voice coil shall be 2" diameter; diaphragm, linen base molded phenolic. Driver unit shall have 1⅜"—18 threads for screw-in attachment to horn. Spun over aluminum housing shall be hermetically sealed; vise-like grip type binding posts used to make electrical connection to the driver. Unit diameter shall not exceed 4½" nor its length 4⅞" without horn. University Model SA-HF is specified.

Model SA-30

Driver unit shall have a full range power capacity of 30 watts continuous duty, and a power capacity rating of 60 watts when program frequencies below cut-off of horn used are eliminated, and sound pressure reduced 6 db at this frequency. Rated response of driver shall be 80 to 10,000 cps; voice coil impedance 16 ohms at 1000 cycles. Driver shall deliver a sound pressure of at least 130 db on a 6½ ft. re-entrant horn, on axis at 4 ft., with 30 watts 1 cps sweep 750-1250 cps input. Rim-centered mechanism with separate, replaceable, split path palate voice coil/diaphragm assembly shall contain at least 10¼ oz. of Alnico 5 magnet. Voice coil shall be 2" diameter; diaphragm, linen base molded phenolic. Driver unit shall have 1⅜"— 18 threads for screw-in attachment to horn. Entire driver mechanism, complete with line matching transformer shall be contained within an all die-cast aluminum head and housing, with weatherproof gland nut for a cable entrance. Transformer shall provide following impedances: 45, 165, 250, 500, 1000, 2000 ohms and following power taps on 70-volt line: 30, 20, 10, 5, 2.5 watts. Impedances and power taps shall be clearly marked on transformer screw-type terminal board. Unit diameter shall not exceed 5" nor its length 6¼" without horn. University Model SA-30 is specified.

Model PA-HF

Driver unit shall have a full range power capacity of 50 watts continuous duty, and a power capacity rating of 100 watts when program frequencies below cut-off of horn used are eliminated, and sound pressure reduced 6 db at this frequency. Rated response of driver shall be 70 to 10,000 cps. Driver shall deliver a sound pressure of at least 134 db on a 6½ ft. re-entrant horn, on axis at 4 ft., with 50 watts 1 cps sweep 750-1250 cps input. Unit diameter shall not exceed 4$^{11}/_{16}$" nor its length 5" without horn. Rim-centered mechanism, with separate, replaceable, split palate voice/coil diaphragm assembly shall contain at least 24 oz. of all-Alnico 5 *W* shape magnet. Voice coil shall be 2" diameter; diaphragm, linen base molded phenolic. Driver unit shall have 1⅜"—18 threads for screw-in attachment to horn. Entire driver-mechanism shall be contained within die-cast aluminum head and housing, with water-tight screw terminals located at base of housing for making electrical connection to the driver. University Model PA-HF is specified.

Model PA-50

Driver unit shall have a full range power capacity of 50 watts continuous duty, and a power capacity rating of 100 watts when program frequencies below cut-off of horn used are eliminated, and sound pressure reduced 6 db at this frequency. Rated response of driver shall be 70 to 10,000 cps. Driver shall deliver a sound pressure of at least 134 db on a 6½ ft. re-entrant horn, on axis at 4 ft., with 50 watts 1 cps sweep 750-1250 cps input. Unit diameter shall not exceed 6¾" nor its length 6¾" without horn. Rim-centered mechanism, with separate replaceable split path palate voice coil/diaphragm assembly, shall contain at least 24 oz. of all-Alnico 5 *W* shape magnet. Voice coil shall be 2" diameter; diaphragm, linen base molded phenolic. Driver unit shall have 1⅜"—18 threads for screw-in attachment to horn. A line matching transformer shall be contained within the driver housing with water-tight screw terminals at base of the housing for making electrical connections. Transformer shall provide following impedances: 16, 100, 165, 250, 500, 1000, 2000 ohms; and power taps on 70-volt line of: 50, 30, 20, 10, 5, 2.5 watts. University Model PA-50 is specified.

DIRECTIONAL REFLEX TRUMPETS

Reflex trumpets, pioneered by University, helped develop and expand the usefulness of amplified sound to its present important position. They represent the most efficient modern method of converting electrical power into acoustic energy. Conversion efficiencies as high as 40% are achieved, compared with 2-5% ordinarily obtained with cone speakers. This results in remarkable amplifier economy, cutting amplifier power requirements by several times. Reflex construction assures maximum compactness and weather protection, making possible performance of the highest order.

Meticulous Design

- All University horns receive meticulous attention during fabrication, right down to the rust-proofed hardware. Select materials must meet University's rigid quality standards. All castings and exponentially spun air column members must conform, uniformly, to the time-tested, performance-proven University formula of flare rate.
- Scientifically exponentially expanded and reflexed air column and bell—for utmost conversion efficiency.
- Heaviest gauge metals plus rubbber rim damping for positive elimination of acoustic resonance.
- Exclusive rib-reinforced heavy gauge steel "U" mounting bracket. New, serrated, fully adjustable swivel joints with self-locking nut for positive grip. Strongest, surest mounting ever made.

Complete Weatherproofing

There is more to University quality than meets the eye *and* ear. All metals used in the manufacture of University equipment are given a number of special treatments before and during fabrication to insure life-long protection against destructive elements which may be present in the environment, as well as to maintain the physical and acoustical properties for which these metals were originally selected. These treatments—plus the hard finish paint—serve as further protection against corrosion, and as further proof of University superiority.

Degreasing

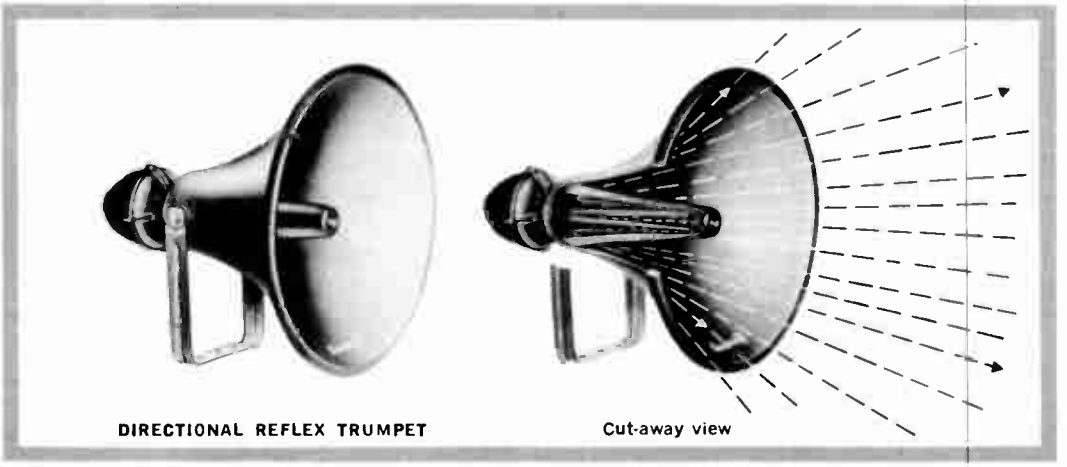
All University metals go thru a thorough "degreasing" operation to remove all foreign particles, such as dirt, filings, grease, etc., usually found imbedded in raw stock. Attention to such details assures lasting adhesion of subsequent anti-rust treatments.

Inhibiting Corrosion

Every iron and steel part used in a University product is electro-chemically plated with cadmium to virtually seal the metal surfaces against rust. As a further precautionary measure, phosphate treatment is then applied to those parts which are to be painted.

Finishing The Product

University goes beyond the generally considered adequate "finish," starting with an electrolytically deposited plating on all aluminum parts to give their surfaces a fine etch for superior adhesion. This is followed by a thick coat of the finest outdoor lacquer, sprayed and then *baked* to a hard peel-proof enameled finish.



DIRECTIONAL REFLEX TRUMPET — Cut-away view

PMA

2YC

RTA

Accessories

PMA Adapter—Fits standard ½" dia. threaded pipe to any University "U" mounting bracket—for special applications requiring pipe mounting from ceiling, on stands, etc.

2YC Connector—Enables two driver units to be used on a single trumpet where unusually high power is required and high efficiency must be maintained.

RTA Adapter—Advantage of the superior performance of University projectors can be taken by use of this thread adapter which fits University trumpets to Western Electric and RCA drivers employing 1 7/16"—16 threads.

Specifications

MODEL	GH	LH	PH	SMH
LOW FREQUENCY CUT-OFF	85 cps	120 cps	150 cps	200 cps
SOUND DISTRIBUTION	65°	75°	85°	95°
AIR COLUMN LENGTH	6½ ft.	4½ ft.	3½ ft.	2½ ft.
*SERIES CAPACITOR FOR HORN CUT-OFF	40 mfd.	28 mfd.	22 mfd.	16 mfd.
HORN LENGTH	28"	19"	15¾"	12"
BELL DIAMETER	31"	25¾"	20⅜"	16¼"
SHIPPING WEIGHT	22 lbs.	16½ lbs.	11¾ lbs.	8 lbs.

*For doubling "Full Range" driver power capacity. Assumes 16 ohms driver. If two drivers with 2YC connector are used, halve the value shown if drivers are wired in series; double it if drivers are wired in parallel. See Fig. 19, p. 18 for chart on other impedances.

Trumpet Characteristics

All too often the selection of a loudspeaker is predicated on habit, price and insufficient understanding of loudspeaker characteristics. Understanding these characteristics is of inestimable value in planning a successful and economical system.

Effect of Size on Dispersion

For example, it has been common practice to select heavy duty trumpets primarily on the basis of initial cost, usually with the assumption that only low frequency response is being compromised. A second glance at trumpet specifications, however, will reveal a relationship between trumpet size (air column length and horn mouth diameter) and the angle at which the sound is dispersed. Note that the dispersion angle *decreases* as the horn size increases. Thus a gain in fidelity is accompanied by a loss of coverage off speaker axis. On the other hand, if the sound is required to penetrate to as great a distance as possible, or override high ambient noise, the larger trumpets with their sharper distribution pattern will provide more sound intensity along the speaker axis than the smaller horns. The larger horns, in addition to affording greater protection to the driver unit against low frequency overload, distribute the load on the driver diaphragm more uniformly, thereby producing smoother over-all response as well. Obviously, then, there are three essentials to be considered when selecting a trumpet; fidelity, distribution angle and penetration of distance or noise.

Effect of Size on Response

Four trumpet sizes with different low frequency cut-offs are available for applications where such directional projection characteristics are desired. University Model GH has a very low frequency cut-off especially suited for reproduction of musical programs. Model LH is excellent for general applications requiring good music and speech characteristics. The PH, with slightly higher cut-off than that of the LH, is suggested where economy is an important factor in the planning of a music and speech system. Model SMH is designed primarily for voice reproduction where a heavy duty speaker must be relied on for continuous, highly intelligible speech reinforcement. Models SMH

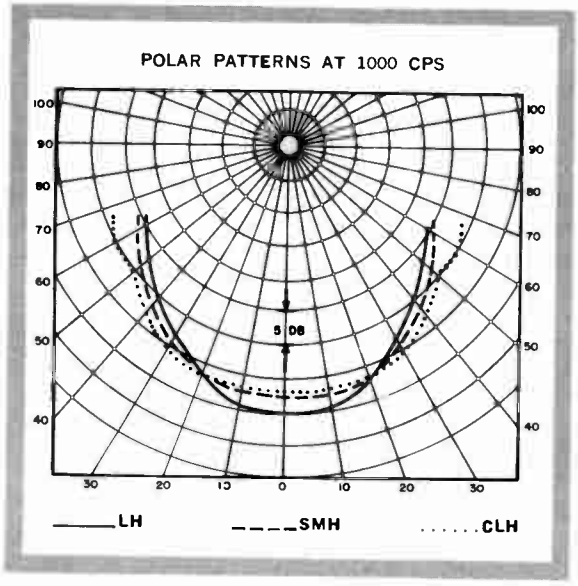
FOR MODEL	DEDUCT
LH	1 db
PH	2 db
SMH	3 db

and PH will also provide excellent coverage of wide angled areas. Models LH and GH with their sharper dispersion characteristics will deliver *more* sound intensity on axis, and may therefore be used to greater advantages in covering longer distances or beaming sound to where it is particularly required. For determining sound pressure corrections relative to a given driver unit on the GH, refer to the table at left.

Directional vs. Wide-Angle Trumpets

Since the advent of "wide-angle" projection (University pioneered with the Cobra-12 paging speaker and the Cobreflex trumpet), there appears to be considerable misunderstanding in the field regarding the relative merits of directional vs. wide-angle horns. Properly applied, the wide-angle horn is another contribution in solving certain sound problems, but by no means do such horns replace the round "directional" trumpet for general utility or in specific instances. Wide-angle projectors are discussed in greater detail in Section T-3; but note in Fig. 12 the comparison of the polar patterns (horizontal plane) of the wide angle CLH projector vs. the LH round horn with equivalent 4½ ft. air column (taken at 1000 cps). The SMH with only 2½ ft. air column is also included to show what this smaller horn with a less narrow dispersion rating than the LH will do. The CLH provides a much wider pattern than the LH, but at a *loss* of 3 db in the horn axis region, and a similar *gain* off speaker axis.

Fig. 12



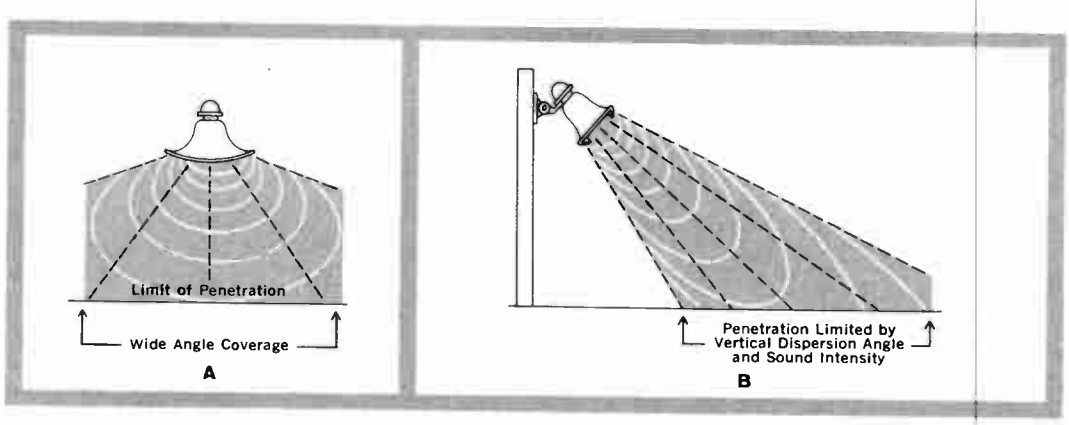
If we were to attempt to make up for that loss in order to penetrate to the same *distance* of projection, the power input to the driver on the CLH would have to be *doubled*. If it were not a matter of distance, but the need to overcome particularly troublesome noise conditions, again that loss of 3 db in a wide-angle projector could make a big difference in intelligibility. On the other hand, notice how more closely the SMH follows the wide CLH pattern. Though 2 db below the LH in the axis region, it is 1 db better than the CLH near the axis. Then it, too, falls off below the CLH in the farther off-axis regions. Bear in mind, however, that the small SMH would not have the low frequency characteristics of either the LH or CLH near or below the SMH 200 cycle cut-off.

Dispersion vs. Coverage... of Wide-Angle Trumpets

Clearly then, what the wide-angle projector has to offer is *uniformity* of wide-angle response, falling off less rapidly, off speaker axis, than the *equivalent* directional horn. But, does "wide angle" mean *more coverage?* Not necessarily; it all depends upon the configuration of the area to be covered. If the area is very *wide* but not too deep, the "wide angle" horn with a 120° horizontal x 60° vertical projection pattern would probably do a good job. See Fig. 13A and B. On the other hand, supposing the area to be covered was *very* narrow and *very* deep. In this case the wide angle horn could be mounted and used in a manner opposite to normal, with the horizontal dispersion of the horn operating physically in the vertical plane. Fig. 14A and B shows what would happen. Used in this

Fig. 13

Wide Angle Horn Used Normally



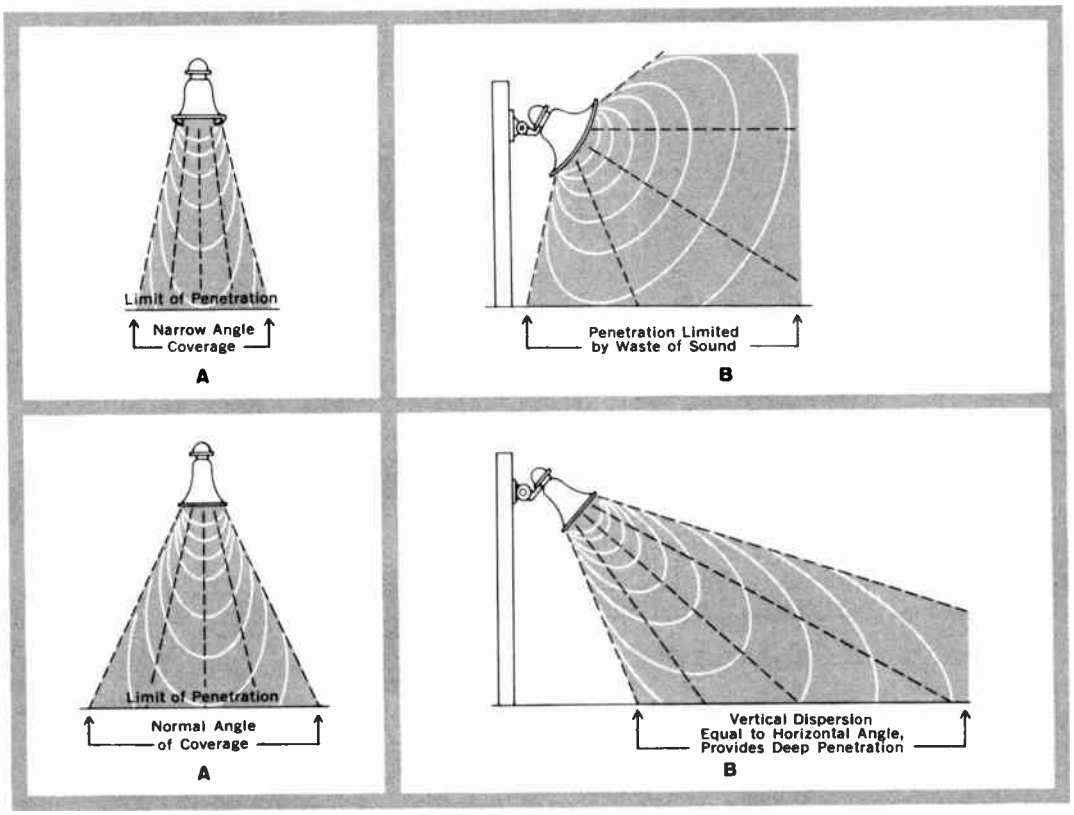


Fig. 14
Wide Angle Horn Used In Reverse Plane

Fig. 15
Round Horn

manner, a wide angle horn is satisfactory, *provided* the distance of depth is not greater than can be penetrated with the sound output of the horn. Note how in Fig. 14B much of the sound energy is wasted in space. Mounting angles are obviously very important, especially in applications just discussed.

Dispersion vs. Coverage... of Directional Trumpets

Now let's take a look at the round "directional" horn. From Fig. 15A and B we see that the area covered by a round horn with moderate dispersion angle (neither wide nor too narrow) resembles something like a teardrop. Because the vertical dispersion and sound energy is the same as that of the horizontal plane, considerable distance of penetration results. The actual configuration of sound on the ground surface would be a circle, becoming more of an ellipse as greater distance penetration is attempted. In fact, the pattern of Fig. 13A can often be duplicated by the round trumpet angularly mounted for distance, without as much loss in sound pressure. Considering the wide selection of University round trumpets available, it is easy to see why the majority of applications and many special requirements will be satisfactorily met by these "directional" types.

Selecting the Driver

With the variety of University driver units available, many with valuable exclusive features, full consideration can be given to over-all response, required sound pressure, versatility and cost. Section T-1 describes the individual features of each model driver. Once the differences between drivers are understood, it is easy to see how various combinations provide tremendous flexibility.

Line Matching

Sound system installations—whether involving only a single amplifier delivering its entire power output to a single loudspeaker, or a group of amplifiers feeding varying amounts of power to numerous speakers—depend primarily for satisfactory operation on an *efficient* transfer of power from the amplifier to the speaker. The wires connecting an amplifier to its respective speakers are known as speaker transmission lines. In planning interconnection of loudspeakers, it must be determined if these lines are to be of low or high impedance for proper match to the amplifier output transformer; and if the connection of the loudspeaker should be in *series*, *parallel*, or *series/parallel* for proper match to speaker transmission lines.

When Low Impedance Lines Are Used

When the transmission lines are connected *directly* to one or more speaker voice coils, they are referred to as low impedance lines. In general, where the distance between the amplifier and speakers is less than 200 feet, lines run at voice coil impedances are satisfactory. Fig. 16 below indicates maximum practical distances.

Fig. 16

MAXIMUM LENGTH OF LINE FOR 15% POWER LOSS—LOW IMPEDANCE LINES			
WIRE SIZE (B & S)	LOAD IMPEDANCE		
	4 OHMS	8 OHMS	16 OHMS
14	125′	250′	450′
16	75′	150′	300′
18	50′	100′	200′
20	25′	50′	100′

When High Impedance Lines Are Used

High impedance lines are used 1) when the distance between the amplifier and the load is greater than that indicated for a given wire size in the low impedance table, 2) a power loss in the transmission line of less than 15% is required, or 3) where the number of speakers used is so large that low impedance connections would be impractical. High impedance lines also facilitate connection of speakers to operate at individually different power levels and make it easier to carry out future changes in the loudspeaker system. Fig. 17 below indicates the proper size wire to be used at common impedances for various line lengths.

Fig. 17

MAXIMUM LENGTH OF LINE FOR 5% POWER LOSS—HIGH IMPEDANCE LINES			
WIRE SIZE (B & S)	LOAD IMPEDANCE		
	100 OHMS	250 OHMS	500 OHMS
14	1000′	2500′	5000′
16	750′	1500′	3000′
18	400′	1000′	2000′
20	250′	750′	1500′

Series vs. Parallel Operation

The operation of a large cluster of loudspeakers with *series* connection is not recommended. High total transient voltages which may result can be great enough to cause arc-over in the voice coil air gap of some of the speaker mechanisms. For this reason, it is desirable that all units which are grouped at one location be placed in parallel or series/parallel arrangement, and then by means of a suitable transformer matched to the line impedance.

Sometimes, transformer matching problems make it difficult to utilize parallel connection. Series operation may then be used, provided each speaker is electrically insulated from the adjoining speaker. This can be achieved by installing the speaker cluster on a 2" x 4" base, or other wood support, so that there is no metallic connection (electrical continuity) between each loudspeaker mounting bracket. The reason for insulating speakers in series circuits is not often appreciated. The voltage across a driver unit may suddenly rise to many times the normal rated value. For example, during a transient period lasting for only a few milliseconds, a 25 watt unit (which should have a maximum of only 20 volts across it) may experience a momentary surge of 75 or more volts. Thus when four or six driver units are wired in series, the total surge voltage may be *several hundred,* causing breakdown across the magnetic gap between voice coil winding and the magnet structure of the units at the "hot" end of the series circuit. However, if the precautions recommended are taken, this possibility will be reduced appreciably.

Drivers with Built-in Transformers

It is obvious from the foregoing, therefore, that where very long speaker lines are necessary, or the installation involves too many speakers to handle at voice coil impedances, drivers with built-in line matching transformers such as Models SA-30 and PA-50 are the logical solution. In cases where a constant voltage 70v. amplifying system is used, these same drivers will provide the proper power taps. If low impedance operation is satisfactory, the MA-25, SA-HF or PA-HF units can be used. If at a later date, it is decided to convert to high impedance operation, transformers can be procured to make the change. See Section T-10 for matching transformer equipment.

Judging Efficiency and Power Requirements

There are many ways to approach this question in connection with selection of a companion driver unit. We suggest you first establish the horn on the basis of function. For example, supposing the GH is selected for greatest *distance* coverage. If program is to consist mostly of speech, the MA-25 would be adequate, providing 127 db with 25 watts. See Fig. 18. By using a series capacitor, sound pressure would be 130 db at 50 watts. Supposing, however, the area to be penetrated is quite noisy. The SA-HF could provide 130 db at 30 watts, and 133 db at 60 watts. Need more? The PA-HF will produce 134 db at 50 watts, 137 db at 100 watts with series capacitor. The influencing factors determining the selection of driver, *other* than sound pressure requirements, are amplifier power available and the cost of more amplifier power.

It's easy to see that on a watts-per-dollar basis, you can get more *sound* by using a more efficient driver than by pouring on more amplifier watts. For example, supposing you selected the PH trumpet because it offers the desired dispersion characteristics and meets frequency response requirements. The MA-25 will yield 125 db on the PH with 25 watts input. You need more? You can get a 50 watt amplifier instead, and obtain 128 db by using a capacitor in series with the MA-25. Or, the SA-HF at only a few dollars more than the MA-25 can be used with a PH to provide the same 128 db at only 30 watts! If speech were still the only consideration and high sound pressure desired at a minimum cost, you might even consider the SMH with PA-HF driver. That combination will produce 131 db at 50 watts as against 130 db using the MA-25/GH combination at the same 50 watts (with series capacitor).

Obviously, University horn/driver combinations can be adapted to yield desired sound pressures. Once the *horn* has been selected on the basis of dispersion and frequency response characteristics, the driver should be selected to provide the sound pressure required. Bear in mind that as the smaller horns are used, dispersion increases and the available sound energy is more spread out. When exceptionally high powers are required, the University Super-Power speakers should be used. See Section T-7.

Judging Frequency Response Requirements

Naturally, if the program is to be both voice and music, any of the University drivers other than the MA-25 may be used for greater range. However, in the event the SMH trumpet has been selected, perhaps for reasons of dispersion, cost, or physical requirements, the MA-25 can be successfully used, because its limited high frequency response (6500 cps) will balance well with the high cut-off (200 cps) of the horn. If music is an important consideration, and for other good reasons an LH or even a PH is to be used, use of the PA-HF (or PA-50) will produce an aurally discernible improvement over the SA-HF because of its greater efficiency. Where the need is for the very finest musical reproduction, either the GH with SA-HF or PA-HF (SA-30 or PA-50), or one of the University Weatherproof High Fidelity Coaxial LC series speaker systems should be used. See Section T-6.

Fig. 18

DRIVER	INPUT POWER	GH	LH	PH	SMH
MA-25	25 watts *50 watts	127 db 130 db	126 db 129 db	125 db 128 db	124 db 127 db
SA-HF & SA-30	30 watts *60 watts	130 db 133 db	129 db 132 db	128 db 131 db	127 db 130 db
PA-HF & PA-50	50 watts *100 watts	134 db 137 db	133 db 136 db	132 db 135 db	131 db 134 db

*With capacitor in series with driver. See trumpet specifications or Fig. 19 for finding proper value of capacitor.
Note: Sound pressure readings taken at 4 ft. on 6½ ft. horn, with rated "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; add 3 db when power input is doubled.

Adjusting Power Capacity and Cut-off

Chart for Finding Series Capacitor

When the low frequency response of the input program to a loudspeaker is limited to essentially the operating range of the speaker, as established by the horn cut-off, the "adjusted" power capacity becomes twice its rated "full range" response. Chart Fig. 19 provides the value of the non-polarized capacitor to be placed *in series* with the speaker in order to cause a rate of loss of about 3 db at the point of horn cut-off. See Fig. 3, p. 6, for curve of the action that occurs.

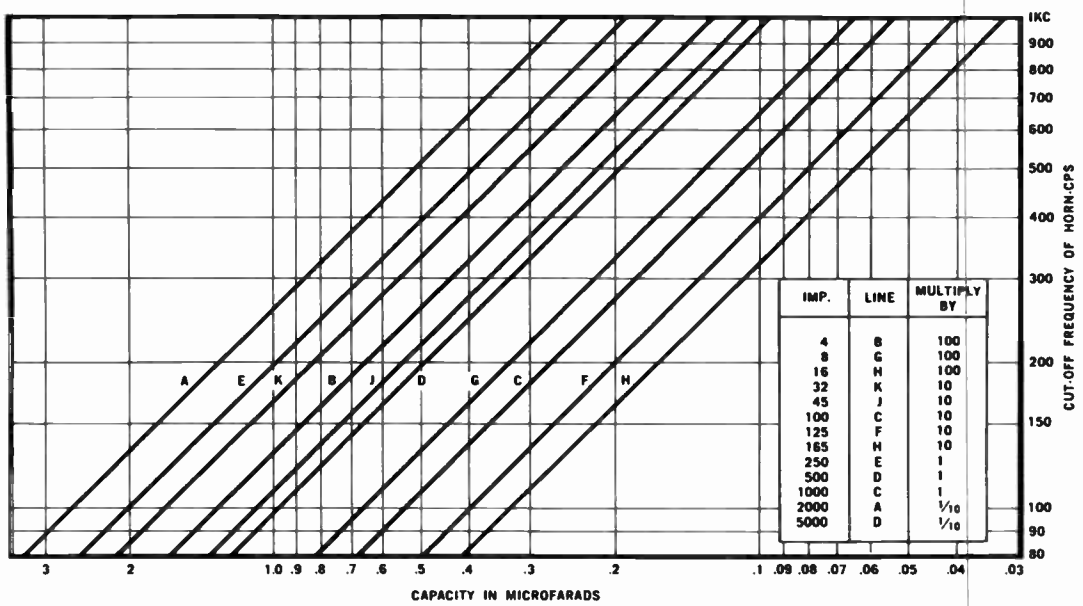
Capacitors for operation up to 25-watts input should have a "working voltage" rating of no less than 50; up to 50 watts input, 75 to 100; and up to 100 watts input or better, 150 to 175 volts.

Using the Chart

1. To determine the capacitor for a 70-volt (or 25-volt) "constant voltage" system, first determine the value of impedance which corresponds to the power tap *being used:*

$$\text{Impedance} = \frac{\text{Voltage of system} \times 2}{\text{Wattage to speaker}}$$

Fig. 19



2. If the impedance is known (or calculated according to the formula), find the correct level line on the chart by referring to the table which identifies the impedance being used.
3. Find the horn cut-off on the horizontal scale of the chart, and intersect the selected level line at that point.
4. Follow that point horizontally to the vertical scale and note the number thus indicated.
5. Finally, multiply that number by the factor alongside the impedance level line in the table. The resulting answer is the value of capacitor in *microfarads*. Because of commercial availability, values within 10% will suffice.

Note: Odd capacitor values can be achieved by paralleling capacitors to *add* value; or placing capacitors in series to *reduce* values.

When they are in series, the resulting value $= \dfrac{1}{\frac{1}{C_a} + \frac{1}{C_b}}$

Architects' and Engineers' Specs

Horn shall be reflexed, with reflector and bell of spun aluminum, and shall have air column length of (d) feet. A rib-reinforced steel "U" mounting bracket shall be affixed to the horn bell with fully serrated, adjustable joints, and bracket position secured by self-locking nuts. All parts other than hardware, but including mounting bracket, shall be finished in steel-gray baked enamel. Mounting bracket shall have three holes at base for mounting to a pipe fixture. Threaded throat area to accommodate screw-in driver unit shall have 1⅜"—18 thread. Over-all horn length shall not exceed (c) inches, less mounting bracket and driver unit. Bell mouth diameter shall not exceed (b) inches and shall have a rubber damping rim. University Model (a) is specified.

(a)	(b)	(c)	(d)
SMH	16¾"	12½"	2½'
PH	21"	16¼"	3½'
LH	26½"	19¾"	4½'
GH	32"	29"	6½'

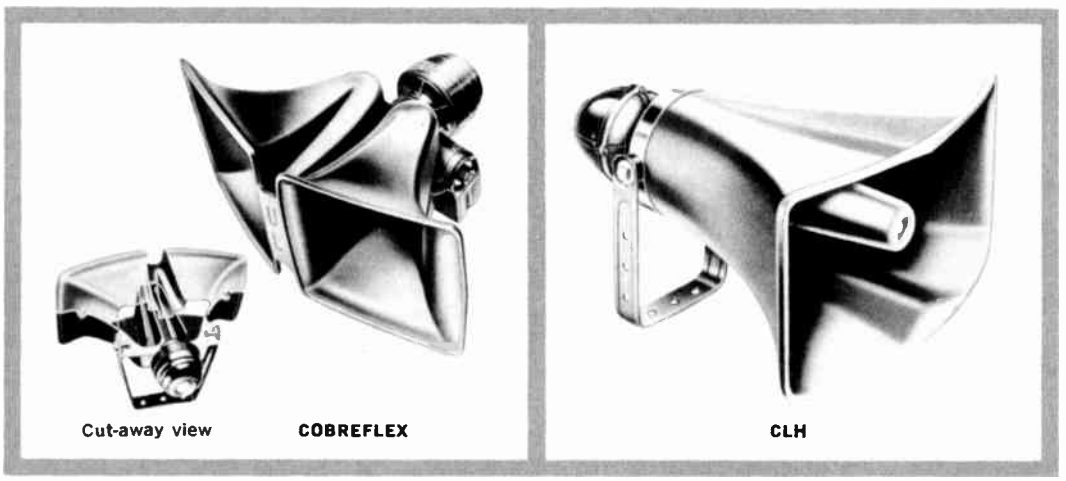
HEAVY DUTY WIDE-ANGLE REFLEX TRUMPETS

Types and Purposes

Two wide-angle reflex trumpets intended for operation at moderate to high power are included in this series. One, the unique Cobreflex, is unexcelled in ruggedness of construction and exceptionally high articulation of speech—ideal for the most gruelling applications. The other, the CLH, provides a wider response range making it particularly suited to reproduction of both voice and music. A new omni-directional mounting also adapts the CLH admirably to those particularly troublesome installations requiring odd-angle coverage.

Design criteria are predicated on a 120° horizontal dispersion angle as the best for achieving "wide-angle" coverage with retention of reasonable distance penetration, and 60° as the optimum vertical dispersion to avoid waste of sound energy and "bounce-back" echo. In "directional" trumpets, such as described in Section T-2, the angle of dispersion changes with the low frequency cut-off of the horn. Hence the need in that case to provide at least four models in order to present a choice in response, dispersion and distance penetration qualities. Since both the Cobreflex and CLH result in wide-angle projection, only the two sizes are necessary in meeting any field requirement.

Sound pressure levels from the Cobreflex and CLH will bear a general difference of about only 1 db with a given driver. There will be some exchange of levels at different frequencies and at different angles, due to the difference in designs, but these are not sufficient to warrant presentation as field data. Where power inputs need not be high but wide-angle dispersion is desirable, the smaller CIB and CMIL *paging* speakers should be considered. These are described in Section T-5.



Model Cobreflex

The outstanding feature of the Cobreflex is the pair of folded exponential horns having twin air columns in a *single* assembly. An exclusive University development, the perfection of a "dual exponential flare" design, makes this possible for the first time, resulting in a very smooth radiation pattern and high efficiency.

Simplified, rugged construction includes two identical one-piece heavy aluminum die castings with *integral* tone arm and reflectors. There are no separate parts to loosen or vibrate and the heavy gauge die castings assure elimination of resonant vibration. The Cobreflex offers the unique com-

bination of battleship construction and Swiss watch precision. A serrated rib-reinforced "U" bracket provides an adjustable mounting.

Low frequency cut-off of the trumpet is 200 cycles, the ideal for maximum penetration of high noise levels without low frequency masking effects. This acoustic low end cut-off also aids in combating reverberation effects in locations having hard reflecting surfaces. High frequency response depends on the driver used.

Now, with the availability of Models SA-30 and PA-HF drivers in all die-cast housings, literally indestructible speaker combinations are possible, suiting any power and impedance requirement.

Model CLH

A 4½ foot reflex air column gives the general purpose CLH wide-angle trumpet sufficient low frequency response for good reproduction of music as well as voice. An exclusive University horizontal bell design results in a truly well-proportioned, *compact* assembly that can be placed atop sound trucks and left there without worrying about low hanging trees and other road hazards.

But, that isn't all. The bell also swivels a full 360° (another University exclusive), so that working together with its serrated positive-lock "U" bracket, the CLH may be placed *anywhere* necessary to achieve just the right coverage. No need to worry about which direction the speaker ends up facing, or having to build a platform or other structure to accommodate the speaker... just fasten the "U" bracket to the most convenient surface—adjust the bracket swivel for speaker direction—then rotate the bell for the angle to be covered... and you're finished! See Fig. 20.

It's also a wonderful device for getting sound into alcoves and other "dead" areas. And, when it comes to licking reverberation problems, here's the long-awaited solution. Position the trumpet and angle the bell to get sound to precisely the point of reception, yet avoid echoing surfaces. You practically *tune* the speaker during installation by angling it for best anti-reverberant reception during the initial tests.

The CLH can also be *stacked* to provide any multiple speaker array desired. However, unlike rigid multi-cellular and other "wide-angle" type speakers, the omni-directional feature of the CLH permits each speaker or group of the cluster array to be angled to avoid reverberant "hot spots" and can also be positioned to eliminate equally frustrating "dead spots." The special CLH "U" mounting brackets can be bolted together at the base and/or sides to form any desired configuration.

Model L30-1 Horn Stacking Kit is available (optional) for clamping CLH bell rims together, whenever high velocity winds may cause excessive vibration of stacked projectors.

Specifications and Sound Pressure Chart

Specifications		
MODEL	COBREFLEX	CLH
LOW FREQUENCY CUT-OFF	200 cps	120 cps
SOUND DISTRIBUTION	120° x 60°	120° x 60°
AIR COLUMN LENGTH	2½ ft.	4½ ft.
*SERIES CAPACITOR FOR HORN CUT-OFF	16 mfd.	28 mfd.
BELL MOUTH SIZE	18½" x 9¼"	21½" x 11½"
DEPTH (less driver)	10¼"	20"
SHIPPING WEIGHT	10¼ lbs.	15 lbs.

*See Section T-1, p. 6, for explanation.

Sound Pressure Chart			
DRIVER	WATTS	CLH	COBREFLEX
MA-25	25	123 db	122 db
SA-HF	30	126 db	125 db
SA-30	30	126 db	125 db
PA-HF	50	130 db	129 db
PA-50	50	130 db	129 db

Sound pressure readings taken at 4 ft. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time input power is halved; increase by 3 db when input power is doubled.

Accessories

PMA Adapter—For mounting University "U" bracket speakers on standard ½" pipe.

2YC Connector—Used with two driver units, provides double wattage for any trumpet or projector.

RTA Adapter—Adapts WE and RCA drivers with 1 7/16"—16 thread for use with any University trumpet, including the CLH and Cobreflex.

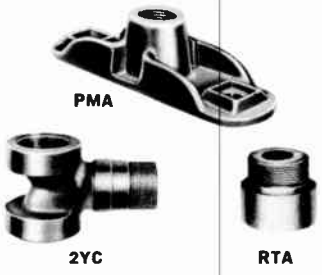
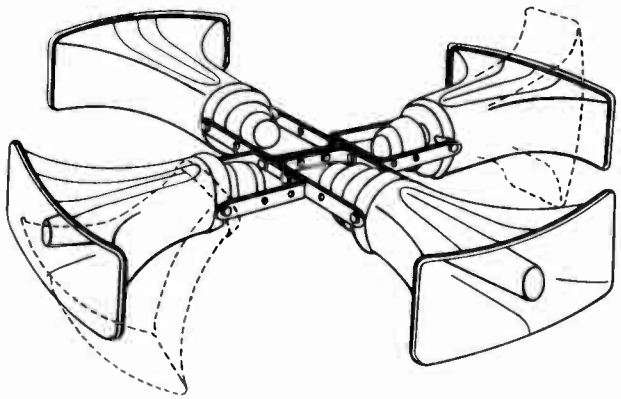
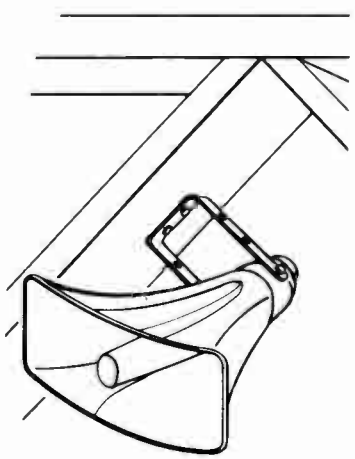


Fig. 20

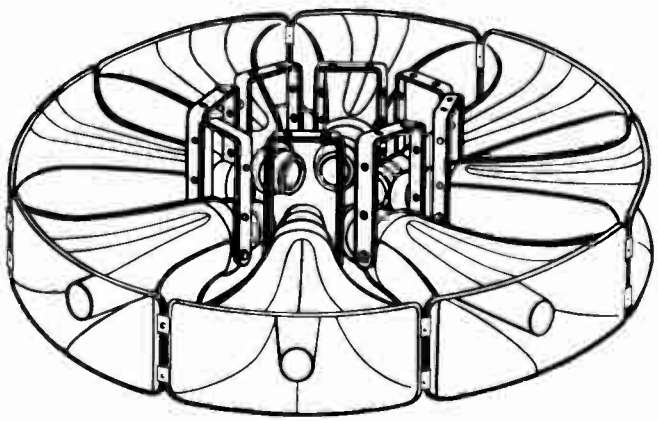
Typical CLH Installations



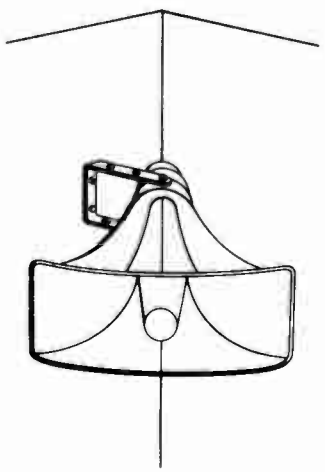
Four CLH in cluster



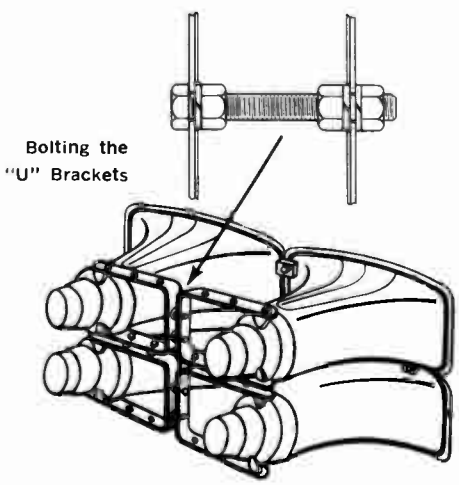
CLH on a 45° beam



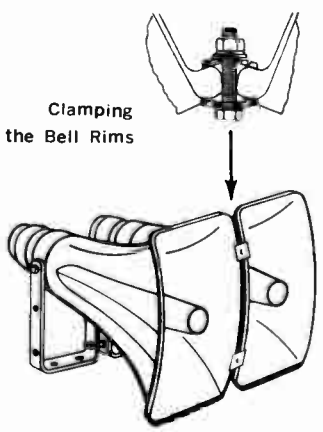
Eight CLH in cluster



CLH in a corner



Four CLH stacked
(horizontal emphasis)



Two CLH stacked
(vertical emphasis)

Multiple Speaker Arrays

Adding Up Sound

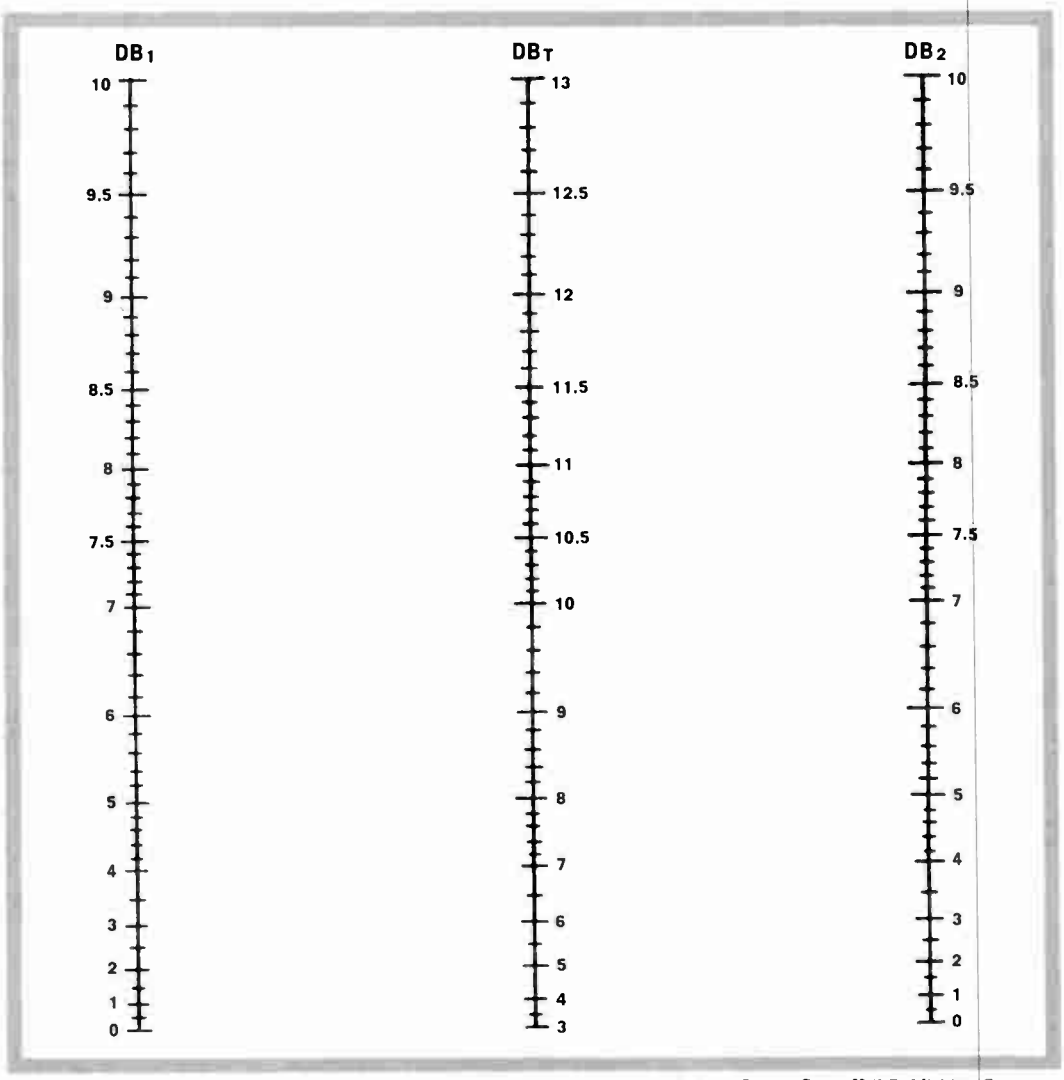
Since the CLH and the Cobreflex lend themselves readily to multiple speaker arrays, an understanding of what occurs when sound outputs from several speakers are combined will be helpful. While use of multiple speakers is generally precipitated by need for *angular* coverage, acoustically the combined sound generated will increase according to the configuration of array used. Circular arrays indoors can be considered to have a somewhat cumulative effect due to the retention of sound by the edifice. Outdoors, a circular array might best be considered as a single speaker with strong overlap and therefore having rather consistent sound pressure uniformity.

Acoustical addition becomes more pronounced with *directional* arrays. With this arrangement, two or more sounds combine to give a total sound whose acoustical power is the sum of the powers involved in the individual components. Since sound levels are expressed in decibels, the sound level of each component must be reduced to terms of power. These powers are then added, and finally the ratio of the new power is converted to decibels.

The nomogram, Fig. 21, makes it possible to read total sound levels without converting to acoustical powers, adding and reconverting. A straightedge intersecting the outer scales of the nomogram at positions corresponding to the individual sound levels db_1 and db_2 intersects the center scale at db_T, which is the total sound level. For example, individual sound levels of 8 and 10 decibels will be found to give a total of 12.1 decibels.

Fig. 21

Nomogram For Reading Sound Levels



From: "Electronics," December 1950, McGraw-Hill Publishing Company

It is necessary to choose a convenient base reference level so that the individual components are within 10 db of it. Thus, for the total of 62 db and 67 db, a reference level of 60 db is chosen. Since the components are 2 and 7 db above this reference, the resultant 8.2 db given by the nomogram is added to the base reference, resulting in a total of 68.2 db.

When a difference of more than 10 db exists between two sound levels, the contribution of the smaller may for practical purposes be ignored.

Any two equal sound levels combine to produce a sound which is 3 decibels higher than either of them separately. Thus 7.5 db and 7.5 db combine to yield 10.5 db; 0 db and 0 db gives 3 db.

Other Uses for the Nomogram

One component of noise can be found when the other component and the total noise are known. This is useful in correcting sound-level meter readings for ambient noise. For example, a sound-level meter shows 64.5 db in the neighborhood of a certain machine when it is operating, and an ambient noise reading of 60 db when the machine is turned off. What is the noise level at the same location due to the machine alone? Choosing 60 db as the reference level, a straightedge is aligned with 0 db (60-60) on the db_1 scale, and 4.5 db (64.5-60) on the db_2 scale, giving a reading of 2.6 db on the db_2 scale. Adding this to the reference level of 60 db results in a noise level of 62.6 db for the machine alone.

When more than two sound levels are to be combined, the total of two components is determined and combined with a third component, the new total combined with a fourth component, and so on.

Reverberation

The total sound arriving at any one point in the average auditorium, ballroom, indoor studio, etc., comprises the original sound directly from the source, and successive sound waves arriving at the same point due to reflection from the walls, ceiling and other surfaces capable of such reflection. "Reverberation" is the term applied to the continuation or persistence of sound after its source has ceased to emit the original impulse. Reverberation *time* is the measurement of the duration of this sound.

Advantage and Disadvantage of Reverberation

A slight amount of reverberation is sometimes desirable in the upper frequencies because this may enhance "intelligibility". However, if the original sound is sustained for too long a period by reverberation, successive impulses will tend to clash, resulting in a loss of over-all clarity and intelligibility. Where the distance covered by the reflected sound wave is substantially greater than the

Fig. 22

Acceptable Reverberation Time Limits

ROOM VOLUME IN CUBIC FEET	ACCEPTABLE LIMITS IN SECONDS	
	HALF AUDIENCE	FULL AUDIENCE
10,000	0.9–1.2	0.6–0.8
25,000	1.0–1.3	0.8–1.1
50,000	1.2–1.5	0.9–1.3
100,000	1.5–1.8	1.2–1.5
200,000	1.8–2.0	1.4–1.7
400,000	2.1–2.3	1.7–2.0
600,000	2.3–2.6	1.8–2.2
800,000	2.5–2.8	1.9–2.3
1,000,000	2.6–2.9	2.1–2.5

Calculation of Reverberation Time:

$$\text{Time in Sec.} = \frac{0.05 \times \text{volume of room in cu. ft.}}{\text{Total absorption}^*}$$

*Where total absorption is obtained by adding up all the individual areas, each area multiplied by its own absorption coefficient.

path of the direct wave, an "echo" is heard. That is to say, the reflected wave repeats all or part of what the listener has already clearly heard. Of course, such conditions are highly detrimental to good reproduction. See Fig. 22 for acceptable limits.

Control of Reverberation

A common but usually expensive method used to cope with reverberation problems is simply to absorb the wave at the point of each reflection by the use of absorbent acoustical materials placed on walls, ceiling, etc. There is a wide variety of such materials available, made from such ingredients as cork, celotex, rockwool, fiberglas, asbestos, etc. Each material is rated in its ability to absorb sound. This is expressed as the "absorption co-efficient" of the material. See Fig. 23.

Fig. 23

Absorption Co-efficients of Commonly Used Acoustical and Building Materials

Cushions:	
Cotton under canvas, 2¾ sq. ft., short nap, plush	2.8
Canvas and plush	1.7
Vegetable fibre under canvas and damask	1.6
Hair under canvas, thin leatherette	1.3
Rock Wool 1"	.80
Balsam Wood, soft wood fibre, paper backing, screen facing 1" thick, .254 lbs. per sq. inch	.68
Felt, standard 1" thick, all hair	.66
Drapery, velour, 18 oz. per sq. yard, hung 4" from wall	.50
Drapery, velour, 18 oz. per sq. yard	.45
Drapery, cotton fabric, 14 oz. per sq. yard	.22
Carpet, 4" pile, on concrete	.26
Acousti-Celotex:	
Type A, perforated fibre board, 13/16" thick, 441 holes per sq. ft. 3/16" dia., ½" deep, plain side exposed	.19
Type B, same as above but with perforations exposed	.46
Masonite, standard ½" board, laid on 1" furring, 18" o.c.	.32
Sheathing, 8" pine	.081
Plaster, Lime on wood lath on wood studs, rough finish	.085
Plaster, same as above but smoothly finished	.037
Brick wall, 18", unpainted	.042
Brick wall, 18", painted	.020
Cork, ¾" floor slabs, waxed and polished	.11
Average ceiling, plaster on wire lath	.033
Plain wood seat	.1
Audience, per person	4.7

Unless one wishes to install tens of thousands of square feet of sound absorbing material (often the only adequate solution) there are four reasonably good methods of dealing with such a situation which may prove reasonably successful.

The first method calls for the installation of many loudspeakers, each spaced approximately 20 to 40 feet apart and each operating with low power, just sufficient to serve the immediate area in front of the loudspeaker. The thought to observe in this type of installation is that no one loudspeaker shall develop enough sound to reach an opposite wall to cause reflections. However, in the larger areas, as in large railroad depots and armories, this may call for a great many loudspeakers, and the installation becomes expensive.

The second but less certain method is to hang a cluster of loudspeakers from the ceiling at the center of the space, at a considerable height above the floor. Each loudspeaker is generally pointed to the junction between floor and wall. This allows the sound to hit two surfaces, wall and floor, at such an angle as to send the reflected sound in a direction where it causes the least interference. Also, by pointing a speaker in this direction, it will receive considerable absorption due to the presence of absorptive elements. An additional low level speaker can be pointed directly at the floor center to cover this area if need be. Of course, the Model CLH with its omni-directional features facilitates "tuning" the projection pattern of the speaker to compensate for odd acoustical patterns often encountered in sound installations.

Some improvement can also be obtained by eliminating some low frequencies from the amplifying system. Low notes will travel farther and rebound from walls more readily; hence the technician should take measures to suppress them in the interest of intelligibility, though fidelity may suffer in the process. This may be done by using the amplifier tone controls; or by employing a suitable capacitor in series with the speakers. The normal 200 cycle horn cut-off of the Cobreflex makes that trumpet a widely used candidate for this type solution.

Speakers with wide, uniform dispersion characteristics such as the Cobreflex, CLH, and the LC High Fidelity series, described in Section T-6, also help to avoid agitating those areas that are highly reflective or resonant. The characteristics of these speakers are such that in terms of both frequency response and projection pattern "hot spots" are avoided. The architecturally troublesome areas are thus inhibited from influencing acoustics.

Architects' and Engineers' Specs

Model Cobreflex

Horn shall be reflexed wide-angle trumpet with tone arm, reflector and twin-mouthed bell integral in a two-section one-piece all die-cast aluminum assembly. Bell mouth shall not exceed 18½" x 9¼" nor depth 10¼" less driver. Serrated, rib-reinforced "U" bracket shall provide for adjustable mounting of the horn. Air column length shall be 2½ ft., and depth (less driver) shall be not more than 10¼". Dispersion shall be rated as 120° horizontally in the plane of widest dimension and 60° vertically. Horn shall have a rated cut-off of 200 cycles and shall accommodate driver units with standard 1⅜"—18 thread. Finish shall be in gun-metal gray baked enamel. University Model Cobreflex is specified.

Model CLH

Horn shall be reflexed wide-angle trumpet with spun aluminum reflector and a bell of one-piece fiberglas reinforced polyester resin mold with mouth dimensions of 21½" x 11½". Bell depth shall be not more than 20" without driver. Air column length shall be 4½ ft. and not reflexed more than twice. Rated cut-off shall be 120 cps and horizontal dispersion shall be rated 120° in the plane of widest dimension, 60° vertically. Horn shall accommodate driver units with standard 1⅜" —18 thread. Serrated, rib-reinforced "U" bracket shall provide means of mounting, and the bell directional orientation shall be continuously adjustable through a 360° rotation by means of 3 adjusting bolts on a die-cast aluminum flange. University Model CLH is specified.

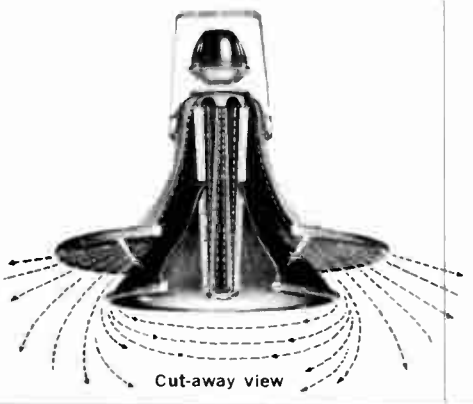
RADIAL REFLEX PROJECTORS

UNIFORM DISPERSION IN ALL DIRECTIONS... from a Single Projector

University radial reflex projectors are the answer for those applications requiring uniform 360° horizontal dispersion and where ambient noise levels are moderate. The considerably higher efficiency of reflex radial projectors using driver unit mechanisms for sound energy is responsible for the increasing popularity of this type speaker over radial and wall baffles employing cone speakers, especially in commercial and light industry applications. The sturdy, weather-resistant construction of reflex trumpets makes them ideal, as well, in installations subject to high humidity and dirt or dust-laden atmosphere.

Model RLH has the longest air column and is suggested where maximum low frequency response is desired. Reproduction of chimes and liturgical music in church towers is another natural application of the RLH, especially if it is desired to keep equipment costs and space requirements to a minimum. The RPH, with higher cut-off, is designed for both music and speech; the RSH is most suited where high clarity of speech is more essential than high fidelity of music reproduction. There is also a difference in sound pressure output between the three model sizes; the RPH being 1 db lower than the RLH, and the RSH 2 db lower than the RLH.

RADIAL REFLEX PROJECTOR



Cut-away view

MODEL	RLH	RPH	RSH
LOW FREQUENCY CUT-OFF	120 cps	140 cps	180 cps
SOUND DISTRIBUTION	360°	360°	360°
AIR COLUMN LENGTH	5 ft.	4 ft.	3 ft.
*SERIES CAPACITOR FOR HORN CUT-OFF	28 mfd.	23 mfd.	18 mfd.
OVER-ALL HEIGHT (Horn Only)	18½"	13¾"	11"
BELL DIAMETER	28⅛"	25⅛"	19"
SHIPPING WEIGHT	25 lbs.	19 lbs.	13 lbs.

*Capacitor is used only when desiring to double the "full range" power capacity of driver units. Assumes 16 ohm driver. If two drivers with 2YC connector are used, halve the value shown if drivers are wired in series; double if drivers are used in parallel. See Fig. 19, p. 18, for chart on other impedances.

When to Use a Radial Projector

To achieve a 360° dispersion pattern would require at least three 120° "wide-angle" projectors or four 90° "directional" horns. But, the angle of projection is not equal for *all* frequencies, being wider for the lower frequencies and sharper for the higher frequencies. Therefore the use of either the wide-angle or directional horns will not provide *uniform* 360° dispersion, *unless* more than the minimum number of horns are used, to provide sufficient overlapping. Since the design of University reflex radial trumpets is such that all the sound energy, regardless of frequency, emanates from a single center assembly and empties into a bell and deflector arrangement common to all frequencies, all the sound output spreads uniformly in a 360° horizontal pattern, projecting downward at the same time. Thus, if a reflex radial is suspended, centrally, *above* the area to be covered, it would do the work of several other type horns.

While it is obviously economical to install and use a reflex radial projector, sound pressure level at any one point will be considerably less than would be obtained from a circular cluster of *directional* reflex projectors. To begin with, a single driver (or *two*, when using the 2YC connector) is called upon to supply all the sound energy. That available sound is spread throughout a ground area as a circle, the diameter of which is determined by the *height* at which the horn is suspended. Sound pressure levels from a radial may be from 10 to 17 db lower (depending upon models compared) than from a cluster. Therefore, a radial may be used, if sufficient height is available for suspension, in order that the desired area of coverage be achieved economically and the resulting sound pressure level at the points of reception be adequate. As a rule, the greatest advantage of the projection characteristics of a reflex radial is achieved in cube-like rooms (warehouses, aircraft hangars, gymnasiums, high-ceilinged factories, etc.) where suspension heights are not only possible, but a problem for other types.

The special chart, Fig. 24, provides just about all the practical data you will need to use University radials properly. In preparing the chart, a desirable amount of overlap has been introduced in determining the span of coverage, in order that sound pressure level will remain fairly constant between adjacent horns in multiple speaker installations. The first step in using the chart is to survey the installation locale and determine the maximum and minimum suspension heights possible, since these are the factors that will determine the range of sound pressure levels you can achieve and hence the number of radials you will require to cover a given area.

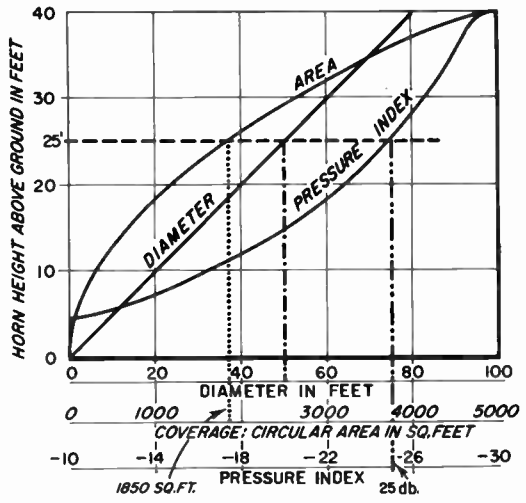


Fig. 24

How to Use a Radial Projector

For example, let us assume that the highest we can mount an RLH in a certain location is 25 feet (height of the bell mouth above ground). By coming across the chart from the vertical scale (see line ---) at the 25 ft. line, we first strike the curve for "area" coverage. By following the point of intersection downward (line ...) to the area scale at the bottom, we find that at 25 ft. height we will cover a circular area of 1850 sq. ft. By continuing across the chart, we next intersect the "diameter" curve; and if we follow that point down to the scale at the bottom showing distance diameter (line .....) we find that the diameter of the circular coverage is 50 feet. This also means that if more than one radial is to be used because of the length and breadth of the locale, each horn should be 50 ft. apart for uniform sound pressure level. Now then, to determine what the sound pressure level would be with a given driver, continue following the broken line across the chart to where it hits the "index" curve. At this point, follow the chart down (line _. _. _.) to the pressure index scale at the bottom. This is the figure in db (in this case about 25 db) which should be *deducted* from the pressures given in Fig. 25 for the particular driver unit selected.

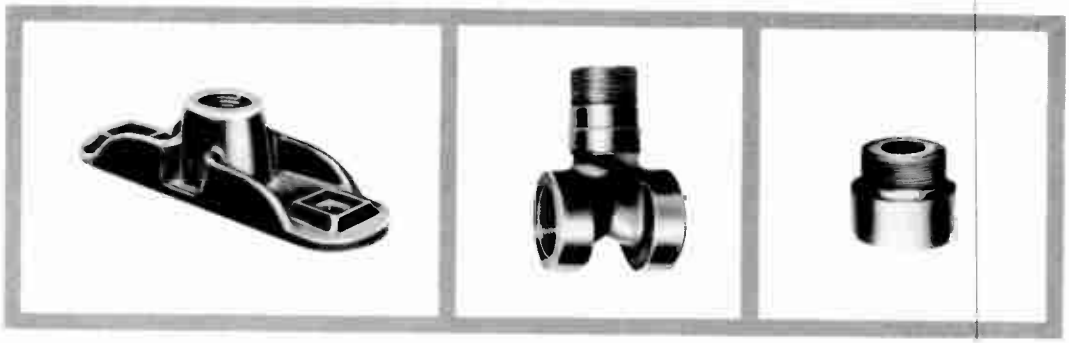
DRIVER MODEL	WATTS INPUT	PRESSURE (10 FT)
MA-25	25	119 db
SA-HF	30	122 db
SA-30	30	122 db
PA-HF	50	126 db
PA-50	50	126 db

Fig. 25

How Choice of Drivers Aids Results

Let's assume we had selected the SA-HF. Fig. 25 shows 122 db, from which we deduct 25 db according to our findings on the chart when the horn is 25 feet in the air. This gives us 97 db for use at the ground surface. The RPH provides 1 db less than the RLH, in which case the pressure would be 96 db were we to use that model instead. In the case of the RSH, the pressure would be 95 db, being 2 db less in output than from the RLH. Of course, by putting the proper value of capacitor in series with the SA-HF and operating at 60 watts, we could increase the sound pressure level by 3 db. However, we can get 4 extra db at *50* watts by using the PA-HF or PA-50. Another approach would be to use two drivers with a 2YC connector, in which case power handling capacities are further and substantially increased. If we need more sound level and want to stay with the one SA-HF, we could, of course, lower the height of the speaker, say to 15 feet, in which case we would have a sound pressure of 102 db instead of the 97 db we had at 25 ft. However, at the same time we would be able to cover a lesser circular area (about a third) and the distance between speakers would have to be shortened.

Accessories



PMA Adapter
Fits standard ½" dia. threaded pipe to any University "U" mounting bracket—for special applications requiring pipe mounting from ceiling, on stands, etc.

2YC Connector
Permits use of two University driver units on a single radial projector for double power output.

RTA Adapter
Fits University trumpets to Western Electric and RCA drivers employing $1\frac{7}{16}$"—16 thread.

Architects' and Engineers' Specs

Radial Reflex Projectors

Horn shall be reflexed radial, with reflector bell and deflector of spun aluminum, and shall have an air column length of (d) feet. A rib-reinforced steel "U" mounting bracket shall be affixed to the horn bell with fully serrated adjustable joints, and bracket position secured by self-locking nuts. All parts other than hardware, but including mounting bracket, shall be finished in gun-metal gray baked enamel. Mounting bracket shall have three holes at base for mounting to pipe fixture. Threaded throat area to accommodate screw-in driver unit shall have $1\frac{3}{8}$"-18 thread. Over-all horn length shall not exceed (c) inches less mounting bracket and driver unit. Bell mouth diameter shall not exceed (b) inches and both bell and deflector shall have a rubber damping rim. University Model (a) is specified.

(a)	(b)	(c)	(d)
RSH	19½"	11½"	3'
RPH	25¾"	14½"	4'
RLH	29"	19¼"	5'

PAGING AND TALK-BACK SPEAKERS FOR GENERAL APPLICATIONS

University offers a greater variety of paging loudspeakers than any other brand. The growing importance of sound to industry and communications, plus the increasing complexity of such installations, demand continuous research. New product designs aim at simplifying their use, improving efficiency, and reducing over-all cost.

As a consequence, many University types are now available, including compact low wattage units—ideal for spot coverage; medium and high power directional types—for penetrating high noise levels; bi-directional speakers—that reduce over-all cost when their use is feasible; and adjustable swivel mounting types, and flange- or bulkhead-mounted models, to suit any specific need.

All incorporate compact *reflex* horns and rugged waterproof construction, providing maximum immunity to destructive corrosive agents such as humidity, salt spray, wind, rain and sleet, etc. Models CR, IBR, and the IB, CIB series have integral, hermetically-sealed driver units. Models MIS and MIL, CMIL series employ screw-in type sealed drivers for immediate interchangeability when desired. The MIL, CMIL, IB and CIB series are equipped with the new positive-lock omni-directional mounting bracket. Frequency response of all these speakers is carefully controlled to conform with findings resulting from extensive research in University's laboratories involving innate characteristics of human hearing as regards intelligibility of reproduced sound. Complete compatibility is achieved in University paging speakers between smallest possible physical dimensions, optimum power handling capacity, and perfect clarity and noise penetrative qualities.

Features That Make University Paging Speakers Great Value and Outstanding Performers

Tropicalized

Tropicalizing voice coil/diaphragm assemblies is standard University procedure. Application of an anti-fungicidal solution is merely the finishing touch to customized assembly of the voice coils which are individually precision-wound on a special form designed to achieve life-long perfect concentricity, permitting close coil-to-gap design, resulting in greater heat dissipation.

Hermetically Sealed

Driver mechanisms in all University paging speakers are hermetically sealed in airtight, weather-proof housing to further safeguard valuable "built-in" performance qualities.

Highest Quality Finishing

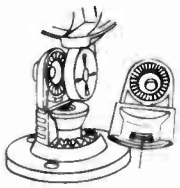
No raw metal is ever used. Everything is thoroughly degreased to remove foreign matter that may cause trouble later. Then, the metals are irridited, cadmium plated or anodized, to give University speakers through-and-through protection. Finally, all exposed parts (*and* even most parts that aren't) are given a heavy coat of hard-*baked* marine enamel that defies the elements. All hardware is made of the choicest anti-corrosion metal and then plated for added protection.

High Power with High Efficiency

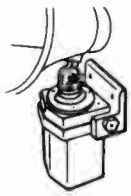
When power ratings are increased at the expense of sound output, the loss is far greater than the gain. University speakers provide the highest reliable power capacity ratings without compromising efficiency, and are offered in great variety, with a choice in dispersion, response and power capacity consistent with actual field requirements. The first design criterion is maximum *efficiency*, once frequency response requirements have been established. Only then is power capacity developed to meet application needs.

New Positive-Lock Omni-Directional Mounting

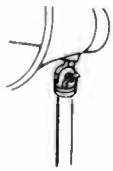
Exclusive swivel mounting, all die-cast aluminum bracket, is used on the MIL, CMIL, IB and CIB series speakers. A new ingenious design provides a positive-lock *geared* arrangement in *two* planes, with a specially contoured universal joint that can't pull loose. What's more, *no* additional fixtures are needed to mount directly to ½" I.P.S. threaded pipe. The base will also fit directly on the CTR Weatherproof Transformer Housing (see Section T-10), to result in a versatile, compact assembly.



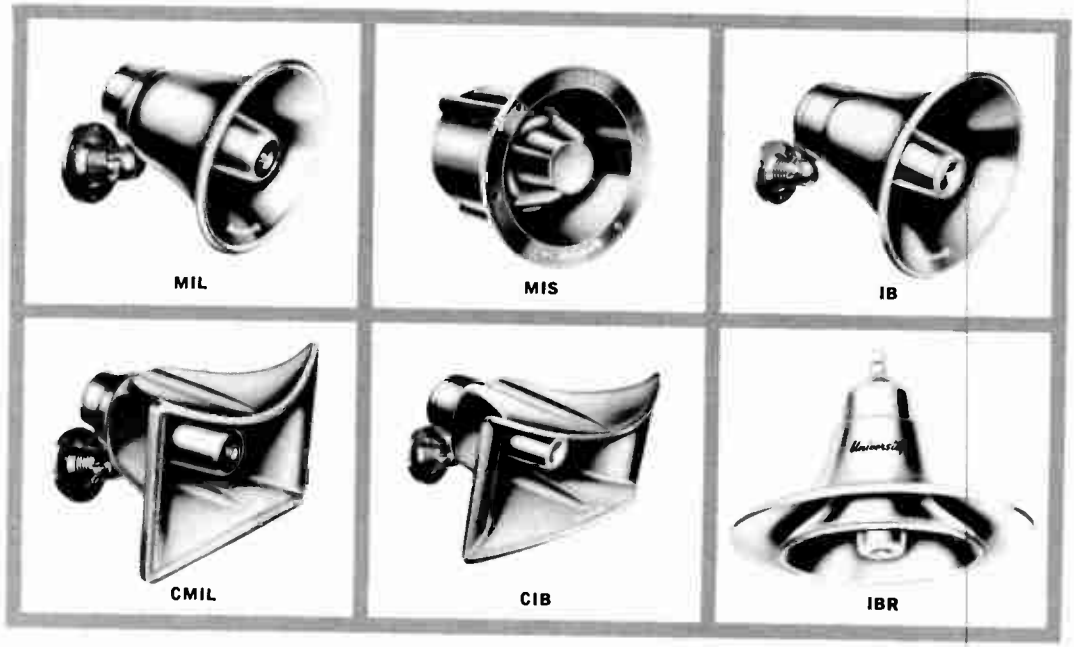
With base flange



On CTR housing



For pipe



Model MIL

Model MIL is a very small, compact speaker designed for those installations requiring concentrated power to cover small areas. Its high conversion efficiency makes it perfect for paging and talk-back operation in relatively low power systems. Also ideal for "filling in" areas the regular sound systems may not reach.

Model MIS

Model MIS is similar to the MIL except that it is intended for flange or flush mounting such as in cabinets, walls, or ceilings, bulkheads, dashboards, etc. MIS is ideal for replacing the less efficient cone-type speakers and will result in considerable gain in output. Die-cast bell housing will withstand hard use.

IB Series

The IB series was the sound industry's first modern, self-contained, compact paging speaker. High efficiency, wide frequency range, small size, high power handling capacity, and waterproof breakdown-proof construction make it the most widely used medium power speaker in the world.

Built to typical University standards, it employs the famous University reflex design, and incorporates a built-in, hermetically sealed driver unit conservatively rated and capable of lifetime, trouble-free operation. A specially controlled rising frequency characteristic and 90° projection angle result in exceptional penetration of high ambient noise levels to provide an unusually high degree of intelligibility. Used as a microphone, its remarkable sensitivity makes this speaker ideal for "talk-back" purposes and provides a most effective way to convert simple intercom sets into a surprisingly good paging and talk-back system.

CMIL and CIB Series

The CMIL and CIB series speakers are the natural outgrowth of a pressing need for a high efficiency paging and talk-back loudspeaker capable of high articulation and intelligibility, but with a dispersion pattern expressly designed for greatest sound distribution in the horizontal plane.

These speakers incorporate for the first time, all the proven advantages of the University reflex design, plus the superiority of the University "cobra" shaped horn. It provides a substantially uniform sound pattern with respect to both frequency and amplitude over a horizontal arc of 120°, and an optimum vertical dispersion for public address work of 60°. Wasteful "up in the air" sound is thus eliminated, and is instead directed, by means of the speaker's adjustable swivel-mounting bracket, to exactly where it is needed most. The result is truly effective coverage over wide areas. These unique characteristics will often make these speakers the practical answer to difficult reverberation problems where feedback "howl" and echo effects limit sound volume to inadequate levels.

The round horn shown at left provides greater distance and noise penetration, but over a smaller horizontal arc. The wide-angle horn shown at right provides a greater horizontal dispersion, and is suitable for general applications where the ambient noise level is not too severe.

Fig. 26

Dispersion Characteristics

Model IBR

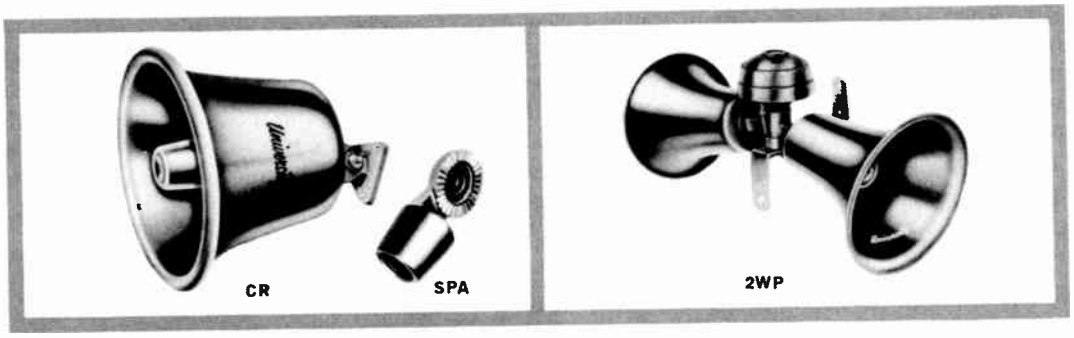
Model IBR is a small radial speaker, giving uniform 360° horizontal dispersion of sound. It offers an economical solution to installations where the total number of speakers must be kept to a minimum but where wide coverage is required. Application is same as discussed in Section T-4.

Model CR

Model CR is a relatively powerful reflex speaker in a small package, conservatively rated at 20 watts full range continuous duty. It has a built-in driver unit using a full-sized 2" diameter voice coil and is particularly suited for speech systems requiring high efficiency, with maximum "punch" and intelligibility. The lower cut-off of the CR horn results in low frequency response best suited to medium power paging/talk-back systems also required to reproduce music with good quality.

SPA Adapter

SPA Adapter replaces standard triangular base used on CR in order to mount to threaded ½" I.P.S. pipe. Order separately.



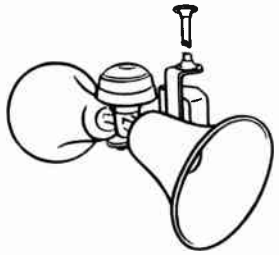
Model 2WP Bi-Directional Paging Projector

The new Model 2WP Bi-Directional Paging Projector is designed to provide an economical and practical means of covering two oppositely located areas effectively and efficiently. A single driver unit (see Section T-1) serves both reflexed horns through a carefully designed "T" acoustic coupler. Can be used with Models MA-25, SA-HF, SA-30 or PA-HF.

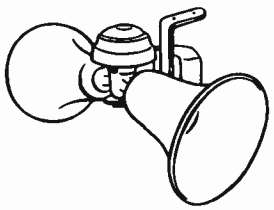
Each horn has a wide 120° sound projection pattern. A unique mounting bracket arrangement permits the sound to be projected either 10° downward or 10° outward, so that no energy will be lost in unoccupied space. The bracket itself can be mounted on any vertical surface, such as a wall or pillar, or may be pipe-supported from a ceiling or convenient superstructure.

Ruggedly constructed and built to usual high quality University standards, Model 2WP is recommended for all bi-directional applications requiring perfect clarity and dependable functioning under all conditions indoor or out. Typical uses include paging as well as "talk-back" in school and hospital corridors, railroad stations, warehouse loading ramps, airlines, passenger gateways, etc.

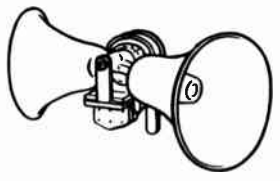
Model 2WP shown above with MA-25 driver and universal mounting bracket arranged for wall mounting with 10° downward tilt of horn. Illustrated below with CTR Transformer Housing.



Bracket permits pipe-supported mounting from ceiling or superstructure. Horns may be angled either horizontally or vertically, according to requirements.



Same bracket arranged for ceiling mounting with horns directed 10° **downward** for good coverage at all distances. Transformer also shown.



Mounting bracket shown arranged for wall mounting with horns angled 10° **outward** from wall. Note line matching transformer (University Model CTR) which mounts on same bracket, when required.

Selecting the Right Paging Speaker

For this purpose the SOUND SYSTEM DESIGN CHART (inside front cover) is as good a place as any to start. Obviously, ambient noise conditions, the size of the area to be covered, the acoustical properties of the environment and type of program will establish the basic amount of amplifier power needed. However, before you can determine the actual wattage, you will have to decide upon the specific speakers, since the *efficiency* of the particular models selected will be the ultimate determining factor.

"High Level" vs. "Low Level" Systems

Is the distribution of sound to be "high level"?—that is to say, is a rather large area to be covered from relatively distant points so that high output speakers are needed? This might be necessary where facilities for mounting speakers are limited, or because there are no particularly desired fixed points of reception. Since in such cases the speakers are to have high sound output, there will be high power input; so it is likely that we would consider the heavy duty trumpet and driver unit type speakers described in the previous sections. This is fine, provided, of course, the increasingly higher sound pressure nearer the location of the speaker does not create an annoying "blasting" effect for the persons closest to the speakers. Of course, if ambient noise is extremely high, this "brute force" method would not create such a condition since the speakers would presumably only be heard just above the din of the noise.

However, we could in many instances plan a "low level" speaker system whereby a larger number of smaller speakers, operating at moderate power levels, are used. If general noise conditions are not too bad, speakers could be spaced to provide intelligible sound as a background. If the area is very noisy, speakers could be placed at discrete locations, varying the sound output of each to conform with the situation in the immediate locale. In either of these two situations, the use of a low level speaker system will help avoid contributing to the general level of the ambient noise.

Quantity of Speakers Needed

The *number* of speakers required, therefore, is a matter of *angular coverage, consistent with the dispersion ratings of the speakers selected.* The amplifier wattage indicated as being needed for specific speakers on the Design Chart is *total* power, based on a sound pressure of about 5 db above ambient noise. As this power is divided by the number of speakers needed to obtain the necessary angular coverage, the *speaker* power capacity requirements are established. Plenty of *reserve* amplifier power and speaker power capacity should be planned in order to cope with unforeseen or varying operating conditions.

Specifications

It is evident that speaker characteristics and ratings cannot always coincide with a given requirement, but tremendous flexibility and versatility is provided to cope with any budget or technical requirement. For example, if the low frequency characteristic of the CR is desired, the fact that

MODEL	IB	CIB	MIL	CMIL	MIS	CR	IBR	2WP
FREQUENCY RESPONSE	300-13,000 cps	300-13,000 cps	400-13,000 cps	400-13,000 cps	500-13,000 cps	250-8000 cps	300-10,000 cps	350 cps horn cut-off
POWER CAPACITY (Cont. Duty) FULL RANGE *ADJUSTED RANGE	15 watts 30 watts	15 watts 30 watts	5 watts 10 watts	5 watts 10 watts	5 watts 10 watts	20 watts 40 watts	15 watts 30 watts	Depends upon driver used
IMPEDANCE	4,8,45 ohms	4,8,45 ohms	4,8,45 ohms	4,8,45 ohms	4,8,45 ohms	16 ohms	4,8,45 ohms	Depends upon driver used
DISPERSION	90°	120° x 60°	120°	120° x 60°	150°	90°	360°	120° each horn
**SOUND PRESSURE LEVEL	120 db	118 db	113 db	113 db	111 db	119 db	†106 db	***Depends upon driver used
‡SENSITIVITY AS MICROPHONE	−26 DBM	−22 DBM	−23 DBM	−20 DBM	−22 DBM	−22 DBM	−32 DBM	Depends upon driver used
VALUE SERIES CAPACITOR	See Fig. 19, P. 18							
DIMENSIONS	8½" dia. 9" deep	7⅜" hi. 14" wide 12" deep	6⅜" dia. 7" deep	6¼" hi. 9½" wide 8½" deep	5½" o.d. 4-7/16" deep 6 holes on 4⅞" mtg. dia.	11½" dia. 11½" deep	13" dia. 10¼" high	8½" dia. each bell 20½" long
SHIPPING WEIGHT	4 lbs.	5½ lbs.	3¼ lbs.	4 lbs.	3½ lbs.	8¾ lbs.	5¼ lbs.	4 lbs.

*Input program response above speaker low frequency cut-off for sound pressure reduction of 6 db at this frequency. **Sound pressure readings taken at 4 ft. with "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; increase by 3 db when input is doubled. †Use 98 db when using Installation Design Chart, Fig. 24, p. 27 (basic reading taken at 10' instead of 4') ‡DBM re 10 dynes/cm²

***DRIVER	PER HORN	DRIVER	PER HORN
MA-25	119 db	PA-HF	126 db
SA-HF	122 db	PA-50	126 db
SA-30	122 db		

the speaker also has a rather high power capacity can be ignored. On the other hand, the MIL is a wise choice where very little power is needed and the speaker can be installed relatively close to the target; but low frequency response will not be as good as the CR. Yet, with a given amount of input power, the IB-8 will yield about 3 db more than the MIL. Thus, it may be an equally wise selection, since it will provide more sound with less amplifier power. Power capacity requirements can then be reduced. The IB bridges the small and larger paging speakers and is a very popular selection because of its general utility. We can further reduce the number of IB speakers, however, by employing the CIB *wide-angle* speaker, ambient conditions permitting; or we can use the IBR radial for the reasons described in Section T-4 on Reflex Radials. The chart in Fig. 24, p. 27, in Section T-4 applies to the IBR as well. Another approach is to use the 2WP Bi-Directional Projector with a driver unit, if the shape of the area permits. That combination produces from each horn about the same sound pressure as an IB and can therefore be used in place of two IB speakers.

Choosing the Type Speaker

Where the widest possible frequency response range is required for "high fidelity" installations requiring moderate power paging speakers, the Model MLC Weatherproof Dual Range High Fidelity Speaker should be considered. (See Section T-6.)

Paging Speakers for Talk-Back

In a great many installations where intercom facilities are incorporated, considerable economy can be effected by using high efficiency speakers as microphones. All University speakers and driver units are suitable for such application. In fact, they are far more *sensitive* as microphones, than actual microphones designed and intended for the purpose. The response and pick-up characteristics, however, will be similar to that of a speaker and will therefore vary depending upon the speaker dispersion angle and frequency response ratings. Since in "talk-back" work the operating range is required for voice only, these factors are of relative unimportance. Refer to specification tables on p. 32 for ratings of the speakers as microphones.

Architects' and Engineers' Specs

Model MIL

Speaker shall be twice reflexed with reflector of high impact Butyrate and bell of spun aluminum. Driver shall be separate, with ⅞"—18 thread, screwing into a one-piece die-cast aluminum tone arm. Driver mechanism shall contain at least 4 oz. of Alnico 5 ring magnet, be tropicalized and hermetically sealed, and have a full range power capacity rating of 5 watts; 10 watts with suitable series capacitor. Head shall be of the split path design. Response shall be rated as 400 to 13,000 cps and dispersion as 120°. Speaker shall be no greater than 6½" in diameter and 7" in depth. Bell clamp connecting horn to mounting bracket shall be die-cast aluminum; mounting bracket shall be omni-directional type with geared design in two planes for positive lock. Mounting bracket shall be capable of mounting to a threaded ½" pipe without additional fixture. Finish of metal surfaces shall be gun-metal gray baked enamel. University Model MIL is specified.

Model CMIL

Speaker shall be twice reflexed, with reflector of high impact Butyrate and the bell a one-piece mold of fiberglas reinforced polyester resin with widest dimension in the horizontal plane. Driver unit shall be separate, with ⅞"—18 thread, screwing into a one-piece die-cast aluminum tone arm. Driver mechanism shall contain at least 4 oz. of Alnico 5 ring magnet, be tropicalized and hermetically sealed, and have a full range power capacity rating of 5 watts; 10 watts with suitable series capacitor, and shall be of the split path design. Diaphragm shall be of linen base molded phenolic. Response shall be rated as 400 to 13,000 cps, and dispersion 120° horizontally, 60° vertically. Speaker shall be no greater than 6¼" high, 9½" wide and 8½" deep. Bell clamp connecting horn to mounting bracket shall be stamped heavy gauge steel; mounting bracket shall be omni-directional type with geared design in two planes for positive lock. Mounting bracket shall be capable of mounting to a threaded ½" pipe without additional fixture. University Model CMIL is specified.

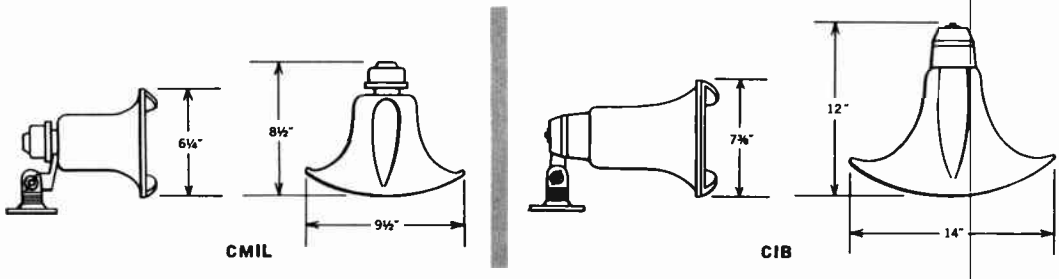
Model IB

Speaker shall be twice reflexed, with reflector and tone arm of high impact Butyrate and bell of spun aluminum. Driver mechanism shall be integral with the tone arm, tropicalized and hermetically sealed, and shall contain at least 7 oz. of Alnico 5 slug magnet. The diaphragm assembly shall be of the integral palate type with split path design and have a voice coil of at least 1½" diameter. Speaker shall have a full range power capacity rating of 15 watts; 30 watts with proper series capacitor. Response shall be rated as 300 to 13,000 cps; dispersion 90°. Speaker shall be no greater than 8⅝" in diameter and 9" in depth. A die-cast aluminum bell clamp shall connect the speaker to an omni-directional type mounting bracket with geared design in two planes for positive lock. Mounting

bracket shall be capable of mounting to a threaded ½" pipe without additional fixture. Speaker metal surfaces shall be finished in gun-metal gray baked enamel. University Model IB is specified.

Model CIB

Speaker shall be twice reflexed, with reflector and tone arm of high impact Butyrate, and the bell a one-piece mold of fiberglas reinforced polyester resin with widest dimension in the horizontal plane. Driver mechanism shall be integral with the tone arm, tropicalized and hermetically sealed, and shall contain at least 7 oz. of Alnico 5 slug magnet. The diaphragm assembly shall be of the integral palate type with split path design and shall have a voice coil of at least 1½" diameter. Speaker shall have a full range power capacity rating of 15 watts; 30 watts with proper series capacitor. Speaker shall be no greater than 7⅜" high, 14" wide and 12" deep. Response shall be rated as 300 to 13,000 cps and dispersion 120° horizontally, 60° vertically. A die-cast aluminum bell clamp shall connect the speaker to an omni-directional type mounting bracket with geared design in two planes for positive lock. Mounting bracket shall be capable of mounting to a threaded ½" pipe without additional fixture. University Model CIB is specified.



Model CR

Speaker shall be twice reflexed, with reflector and bell of spun aluminum. Bell mouth shall have a rubber damping rim. Driver mechanism shall be integral with tone arm, tropicalized and hermetically sealed; shall have a 2" voice coil and contain at least 6½ oz. of Alnico 5 slug magnet. Speaker shall be no greater than 11¾" in diameter, or 11½" in depth. Speaker shall have a full range power capacity rating of 20 watts; 40 watts with proper series capacitor. Response shall be rated as 250 to 8000 cps, dispersion 90°. A cast aluminum bell clamp shall connect the speaker to a die-cast aluminum swivel mounting bracket having serrated gear design for positive lock. Speaker shall be finished in gun-metal gray baked enamel. University Model CR is specified.

Model MIS

Speaker shall be twice reflexed with reflector of high impact Butyrate and bell and tone arm of die-cast aluminum. Driver mechanism shall be integral with tone arm, tropicalized and sealed and contain at least 4 oz. of Alnico 5 magnet. Diaphragm shall be of linen base molded phenolic. Head shall be of split path design. Speaker shall have a full range power capacity rating of 5 watts; 10 watts with suitable series capacitor. Response shall be rated as 500 to 13,000 cps and dispersion 150°. Speaker shall be no more than 4⁷⁄₁₆" deep; be suitable for flange mounting, having a flange no greater than necessary to keep the over-all diameter of the speaker to 5½". Cork neoprene rim gasket shall be provided. Mounting circle diameter shall be 4⅞", with 6 equally spaced holes to clear #10 mounting bolt. Connections shall be made to screw terminals at rear of speaker, protected by plastic cover. Speaker shall be finished in gun-metal gray baked enamel. University Model MIS is specified.

Model IBR

Speaker shall be a twice reflexed radial, with reflector and tone arm of high impact Butyrate, and bell and deflector of spun aluminum. Driver mechanism shall be tropicalized and hermetically sealed, and shall contain at least 7 oz. of Alnico 5 slug magnet. The diaphragm assembly shall be of the integral palate type with split path design and have a voice coil of at least 1½" diameter. Speaker shall have a full range power capacity rating of 15 watts; 30 watts with proper series capacitor. Response shall be rated as 300 to 10,000 cps; horizontal dispersion 360°. Over-all height of speaker shall be no greater than 10½", diameter 13¼". No support studs shall be used at the mouth ends of the deflector and bell. Driver unit end of horn shall be provided with integral hanger bracket. Speaker shall be finished in gun-metal gray baked enamel. University Model IBR is specified.

Model 2WP

Projector shall have two doubly reflexed horns, with reflectors of high impact Butyrate, bells of spun aluminum and tone arms of die-cast aluminum. The horns shall face in opposite directions and be joined by a cast aluminum "T" acoustic coupler. It shall be possible to use a driver unit up to 5" diameter having 1⅜"–18 thread, screwed directly into the acoustic coupler. Each bell mouth diameter shall not exceed 8⅝" and shall have a dispersion rating of 120°. Low frequency cut-off shall be rated as 350 cycles. Heavy gauge stamped steel "S" shaped mounting bracket shall connect directly to the acoustic coupler in such ways as to permit variation in projection angle approximately 10° downward or 10° outward both horns. Projector shall be finished in gun-metal gray baked enamel. University Model 2WP is specified.

'LC' SERIES WEATHERPROOF DUAL RANGE HIGH FIDELITY SPEAKERS

Designed to simplify indoor and outdoor "high fidelity" sound installations, the LC series speakers are *complete* systems, comprising a heavy duty low frequency driver, separate compression high frequency reproducer coaxially assembled and electrical frequency divider . . . all completely wired and housed in a compact dual horn projector. The low frequency driver is arranged in a rear baffle chamber which works in conjunction with a properly designed front-folded horn to provide optimum loading. The result is clean, highly efficient bass. The wide-angle dispersion characteristic of the tweeter horn is, in the case of each model speaker, designed to complement the response of the woofer with which it is operating . . . hence the difference in the specific appearance of each of the three models. Though following the same basic design principles, each model was developed to perform *its* intended application *without compromise*.

Corrosion-resistant construction permits constant exposure even in unusually humid locations or in abnormal temperatures. The re-entrant designs provide further maximum protection to the speaker mechanisms against rain, snow, wind, etc. The sturdy serrated "U" bracket enables the entire assembly to be set quickly and easily in any vertical or horizontal position. Weatherproof marine paint, hard-baked to a smooth, protective peel-proof finish gives further assurance of a beautiful, long-lasting appearance for exposed metal parts.

Many Ways Better

1. Better Lows: Balanced "compression" folded horn, starting with large throat and energized by top quality woofer drivers provides more lows than other designs.

2. Better Highs: Driver unit tweeters with exclusive patented wide-angle horn designs transmit more highs with greater uniformity . . . high frequency response that you can hear!

3. Better Efficiency: Dual range theater-type system permits uncompromising design of the woofer and tweeter sections for greatest efficiency. These speakers penetrate noise with remarkable fidelity and intelligibility.

4. Less Distortion: Separate low and high frequency driver systems with electrical crossover reduce intermodulation and acoustic phase distortion found in other systems which use two different horns on a single diaphragm.

5. Better Acoustics: Smooth projection characteristics, devoid of excessive peaks or "hot spots," help prevent echo and combat reverberation effects . . . every installation is a successful one.

6. More Dependable: Experienced mechanical engineering and careful electrical design meet the challenge of diversified application and environmental hazards. Rugged and conservatively rated—you can rely on the LC series speakers.

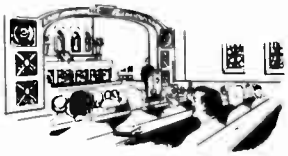
Use The LC Series Anywhere

On Sound and Amusement Trucks—Diversified programs demand a versatile speaker, efficient at varying output levels. Many towns have ordinances prohibiting speakers that blare harshly. The LC series speaker is a high fidelity instrument—and does the job right, at comfortable, annoyance-free level.

In Rinks, Armories, Auditoriums—Full fidelity is needed in such applications but is rarely achieved because of reverberation and echo. The design of these speakers permits exceptional uniformity of response and dispersion of sound, avoids "hot spots," and results in full-bodied reproduction at higher output.

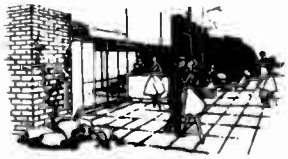
In Factories, Institutions, Office Buildings—LC series speakers have the built-in ability to penetrate ambient noise with high intelligibility, to cope with the problem of hard-surfaced walls, ceilings and floors. There is no need to provide excessive audio reserve. These speakers remain pleasing to the ear for all types of program material.

In Restaurants, Night Clubs, Church Interiors – A good-looking instrument, and unobtrusive, an LC series speaker is ideal for sound reinforcement where space and noise must be overcome—not people. High quality at low level is a spec any of these speakers can easily meet.



In Stadiums, Fairs, Steeples, Concert Malls—Specify "rugged, efficient, weatherproof and full range reproduction" and you have called for an LC series speaker. Because it is easier to understand, it is easier to hear. This intelligibility together with its high conversion efficiency requires less audio operating power. Install it and forget it—dependability is the keynote of this design.

In Country Clubs, Bazaars, Swimming Pool Areas—As an outdoor extension speaker to existing public address and music systems, an LC speaker will accomplish wonders. Dancing under the stars becomes a new experience for your guests and customers.



On Patios, Lawns, Terraces—LC series speakers are the only speakers for extending a high fidelity music system to lawn, terrace, porches, gardens. No other speaker offers such fidelity of response as well as weatherproof construction—all at a low price you can afford.

Model WLC

The largest of the series, the WLC has been in use in auditoriums, concert malls and stadiums throughout the world. The original prototype goes back well over a decade . . . a time-tested testimonial to the performance capabilities and hardiness of its basic design. The present production of this model embodies all the refinements and innovations that come of field experience by the originators—University. Though rated at only a few more watts power capacity than the next smaller model, the WLC produces substantially more low frequency response and generally higher output, equal to double the power on a relative basis. The WLC uses a 1000 cycle crossover network. The curve in Fig. 27 shows a useful relationship in the response of the three LC series speakers. For the very finest in full range response . . . for ease of installation . . . and for a high fidelity speaker system with which you can ignore the weather, call for the very finest—the WLC.

Model BLC

A sensation the moment it was introduced, the BLC put a *new high in P.A.* It set new standards for general application in high quality public address work . . . a new standard for voice and music reproduction, both indoors and out. Relatively light in weight, it is easy to transport. Shallow in depth it will fit anywhere, whether the emphasis is on decor or physical limitations. The BLC uses a 2000 cycle crossover network. As a complete system, the price compares very favorably with trumpet/driver unit combinations and may be used in their place, except under *exceptionally* noisy conditions or where *maximum* distance penetration is required.

Model MLC

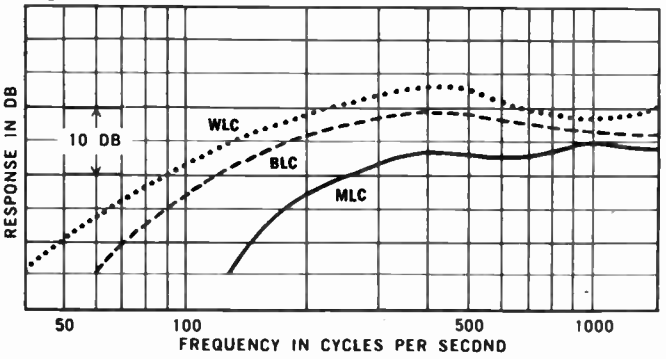
Now, for "low level" speaker distribution systems or where moderate-sized crowds or areas are to be covered . . . there is the new MLC. A compact, midget-sized version of the time-tested LC design, the MLC incorporates design changes making it most suited to paging speaker applications. It may be used with equal success for reproduction of music or voice. The MLC uses a 2000 cycle crossover network. Articulation is exceptionally good and musical balance is so well preserved that in many applications the superior frequency response of the BLC may not be missed. The MLC is the ideal speaker for sound "reinforcement" systems where sound must be carried to points that cannot be reached unaided, yet it is desired to retain naturalness and avoid the presence of a loudspeaker being felt.

SPECIFICATIONS

MODEL	WLC	BLC	MLC
POWER CAPACITY	30 watts	25 watts	15 watts
FREQUENCY RESPONSE	50-15,000 cps	70-15,000 cps	150-15,000 cps
IMPEDANCE	8 ohms	8 ohms	8 ohms
DISPERSION	90°	120°	120°
*SOUND PRESSURE LEVEL	120 db	119 db	117 db
DIMENSIONS DIAMETER (over-all) DEPTH (over-all)	 33½" 20"	 22¾" 9¼"	 12¾" W x 9⅛" H 10⅝"
SHIPPING WEIGHT	72 lbs.	21 lbs.	10 lbs.

*Sound Pressure taken at 4 ft., 750-1250 cps with 1 cps sweep. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved.

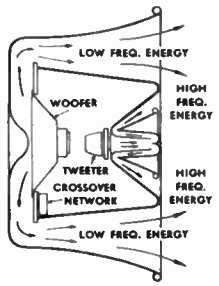
Fig. 27 RELATIVE RESPONSE DIFFERENCES BELOW 1000 CPS



Architects' and Engineers' Specs

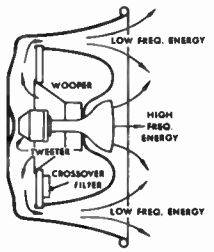
Speaker shall comprise heavy duty weather-resistant 12" woofer in a totally rear-sealed infinite type compression chamber with woofer diaphragm driving a folded front-loaded horn. A coaxially mounted reflexed radial high frequency horn shall be integral with the woofer chamber and energized by a separate heavy duty replaceable hermetically-sealed split path type driver unit with 1⅜"—18 throat thread. Woofer, tweeter driver and 1000 cycle electrical crossover shall be contained within the spun aluminum compression chamber. Speaker bell shall be of heavy gauge spun aluminum with rubber damping rim, and shall not exceed 34½" in over-all diameter, 21" over-all depth. Response shall be rated as 50 to 15,000 cps, power capacity 30 watts, impedance 8 ohms. Woofer shall contain at least 24 oz. of Alnico 5 *W* magnet, tweeter driver at least 7 oz. Alnico 5 slug magnet. Serrated, rib-reinforced steel "U" mounting bracket shall be affixed to the bell of the speaker and position secured with self-locking nuts. Finish shall be gun-metal gray baked enamel. University Model WLC is specified.

Model WLC



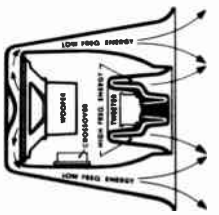
Speaker shall comprise a weather-resistant 8" woofer in a balanced vent compensated rear chamber with woofer diaphragm driving a folded front-loaded horn. A coaxially mounted "reciprocating-flare" high frequency horn shall be integrally assembled through the woofer magnet assembly and energized by a separate replaceable split path type hermetically-sealed driver unit with ⅞"—18 throat thread. Woofer, tweeter driver and 2000 cycle electrical crossover shall be contained within the spun aluminum compression chamber. Speaker bell shall be of spun aluminum with rubber damping rim and shall not exceed 23" in over-all diameter, 9½" in over-all depth. Response shall be rated as 70 to 15,000 cps, power capacity 25 watts, impedance 8 ohms. Woofer shall contain at least 16 oz. of Alnico 5 *W* magnet, tweeter driver at least 4 oz. of Alnico 5 slug magnet. Serrated rib-reinforced steel "U" mounting bracket shall be affixed to the bell of the speaker and position secured with self-locking nuts. University Model BLC is specified.

Model BLC



Speaker shall comprise a weather-resistant 6" woofer in a totally sealed, infinite type, compression chamber with woofer diaphragm driving a one-piece, fiberglas reinforced Polyester, folded, front-loaded horn. There shall be mounted coaxially in the compression chamber a doubly reflexed high frequency projector with the reflector made from high impact Cycolac. The woofer compression chamber shall be all die-cast aluminum in two pieces, the back section supporting the woofer and the front section containing integral with it the split path acoustic head, tone arm and wide-angle radiation bell sections for the high frequency projector. The tweeter-driver mechanism shall contain 4 oz. of Alnico 5 magnet and the diaphragm shall be of linen base molded phenolic. The speaker shall employ a 2000 cycle electrical crossover network between the woofer and the tweeter-driver mechanisms. The front half of the compression chamber shall be secured to the rear half by means of four (4) #1024 machine bolts, and may be oriented in either plane for altering dispersion characteristics by rotating front section in relation to rear section of compression chamber. Response shall be rated at 150 to 15,000 cps and a horizontal dispersion of 120°. Power capacity shall be rated at 15 watts. Speaker shall be secured to reinforced steel "U" mounting bracket. Mounting bracket shall have holes at base for mounting to pipe fixture. Dimensions shall not exceed 12¾" wide by 9⅛" high by 10⅝" deep. University Model MLC is specified.

Model MLC

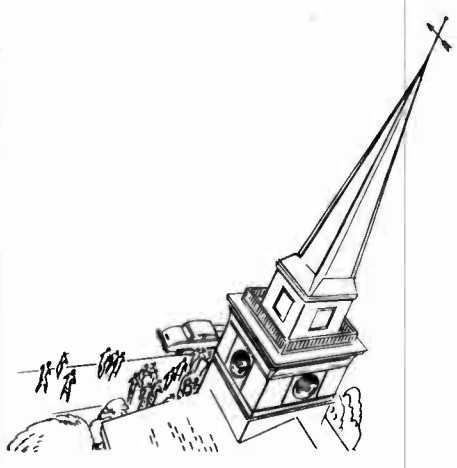


SUPER-POWER PROJECTORS

LONG RANGE, ALL-WEATHER, DEPENDABLE

Developed in World War II

The need for this type of speaker first became apparent during the early part of World War II. Before then, high powered systems generally consisted of large multi-cellulars or clusters of lesser powered trumpets. Military necessity, however, dictated the need for an extremely compact, light-weight high power unit which could concentrate the acoustic energy developed into a powerful force capable of penetrating the terrific noise levels found under combat conditions. In addition, the speakers had to be exceptionally rugged in construction, simple to install, foolproof in operation, and immune to weather conditions of every kind. These speakers are the results of that challenge, and have since found extensive successful application in all branches of the armed forces up to the present day. Driver units for withstanding 9 lbs. per square inch, Class 3 military blastproofing can be supplied upon request at extra cost.

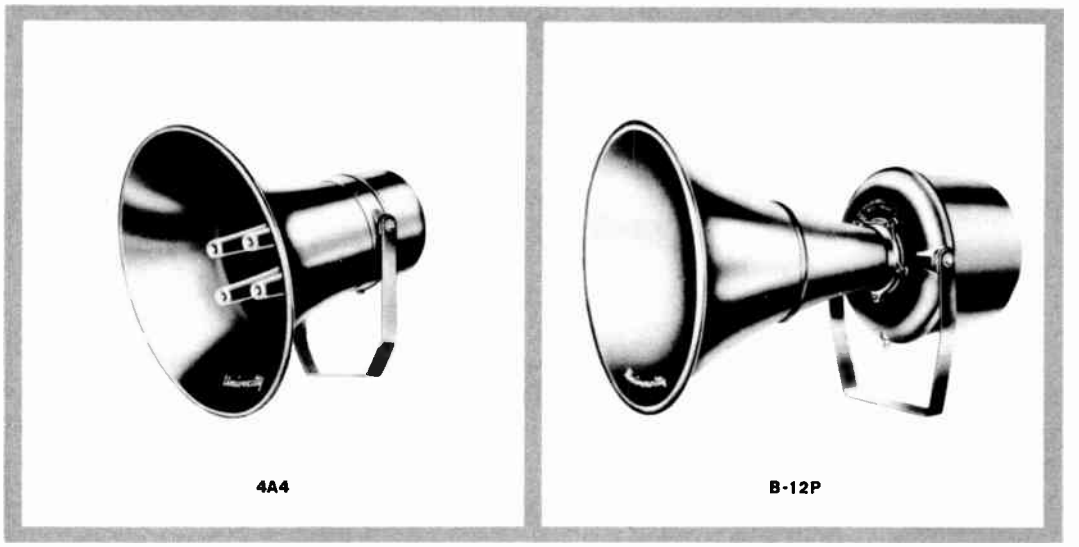


Now Widely Used In Everyday Applications

Commercial applications were not long in suggesting themselves, and all these speakers are now being used in stadiums, race tracks and airplane soundcasting, and have become very popular for use in the transmission of chime and organ music from church towers. They are the perfect answer for present civil defense preparations in connection with air raid alert and "panic control" systems.

Model 4A4 Super-Power Reflex Projector

Exceptionally versatile, the 4A4 is available as a projector, for use with Models MA-25, SA-HF, SA-30 or PA-HF drivers, depending upon the response, efficiency and impedance requirements. Four individually reflexed center assemblies are united in an acoustically correct, cast aluminum sound mixing chamber and the combined outputs concentrated in a single bell for maximum sound level and penetration of distance. This also makes possible, in a single compact assembly, power capacity ranging from 100 to 400 watts, permitting an extremely wide safety margin and ample reserve power for changing and unforeseen operating conditions. The drivers selected are simply screwed directly into the mixing chamber casting. The drivers and interconnecting wires are further shielded by a heavy gauge spun aluminum rear coverall. The technique of using multiple drivers to achieve specific power ratings is the preferred engineering practice where uninterrupted service is essential. (See Section T-1 for methods of protecting drivers against overloads). An adjustable, extra-heavy, serrated "U" bracket is used for complete mounting flexibility.

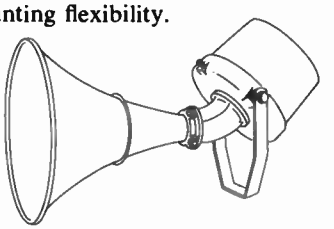


4A4 B-12P

Model B-12P Super-Power Straight Projector

The B-12P accommodates twelve driver units of the MA-25, SA-HF, or PA-HF type, achieving an almost fantastic range of input powers—300 to 1200 watts! Here's reserve power that will meet every conceivable challenge. A heavy gauge straight horn with rubber damping rim is used to help prevent bell resonance at these remarkable input powers. Choice of driver depends upon response, efficiency and impedance desired. Drivers screw directly into a patented, acoustically correct mixing chamber of heavy cast aluminum construction. The bell is a separate assembly with a slotted flange casting which easily and quickly attaches to the mixing chamber. A large spun aluminum rear coverall protects the drivers and interconnections. A weatherproof cable entrance is provided, and an adjustable, extra-heavy "U" bracket is used for complete mounting flexibility.

Optional accessory for the Model B-12P is a 45° elbow coupling which fits between the horn and the driver unit housing assembly. Where the B-12P is used at exceptional heights (top of buildings, towers, etc.), offsetting the driver housing ensures proper drainage of rain, sleet and snow that may be carried into the horn by high wind velocities.



Specifications

4A4 WHEN USED WITH FOUR OF FOLLOWING DRIVERS				
MODEL DRIVER	MA-25	SA-HF	PA-HF	SA-30
FREQUENCY RESPONSE	120-6500 cps	120-10,000 cps	120-10,000 cps	120-10,000 cps
POWER CAPACITY (Cont. duty)				
FULL RANGE	100 watts	120 watts	200 watts	120 watts
*ADJUSTED RANGE	200 watts	240 watts	400 watts	240 watts
**IMPEDANCE	4, 16, 64 ohms	4, 16, 64 ohms	4, 16, 64 ohms	4, 12, 16, 45, 60, 65, 125, 165, 180, 250, 500, 660, 1000, 2000, 4000, 8000 ohms
DISPERSION	80°			
***SOUND PRESSURE LEVEL	128 db	131 db	135 db	131 db
DIMENSIONS				
BELL DIAMETER	30¾"			
LENGTH OVER-ALL	28⅞"			
SHIPPING WEIGHT	49 lbs. (projector only)			

*Input program response limited to above 120 cps.
**Complete wiring diagrams supplied in instructions with speakers.
***Sound Pressure readings taken at 4 ft. with "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; increase by 3 db when power input is doubled.

Specifications

B-12P WHEN USED WITH 12 DRIVERS OF FOLLOWING TYPES			
MODEL DRIVER	MA-25	SA-HF	PA-HF
FREQUENCY RESPONSE	100-6500 cps	100-10,000 cps	100-10,000 cps
POWER CAPACITY (Cont. duty)			
FULL RANGE	300 watts	360 watts	600 watts
*ADJUSTED RANGE	600 watts	720 watts	1200 watts
**IMPEDANCE	By connecting individual driver units in various series/parallel combinations the following total impedances are available: 192/48/21.3/12/5.3/1.3 ohms		
DISPERSION	80°		
***SOUND PRESSURE LEVEL	136 db	139 db	143 db
DIMENSIONS			
BELL DIAMETER	31½"		
LENGTH OVER-ALL	47"		
SHIPPING WEIGHT	60 lbs. (projector only)		

*Input program response limited to above 120 cps.
**Complete wiring diagrams supplied in instructions with speakers.
***Sound Pressure readings taken at 4 ft. with "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; increase by 3 db when power input is doubled.

Architects' and Engineers' Specs

Model 4A4

Projector shall have four doubly reflexed center assemblies in a cast aluminum sound mixing chamber and terminate in a single round bell to combine the outputs. Reflectors and bell shall be of spun aluminum, and bell shall have a rubber damping rim. Projector shall have a rated dispersion of 80°. Projector shall accommodate four screw-in type driver units having 1⅜"–18 thread with a full range power capacity of ___ watts each, ___ watts each when used with proper series capacitor; and in combination with the projector shall have a rated response of 100 to ___ cycles. Each driver unit coupler shall be insulated electrically from the sound mixing chamber. Spun aluminum rear coverall shall protect the drivers and interconnections. Bell diameter not to exceed 30¾", over-all length not to exceed 28⅞". A heavy duty serrated, adjustable "U" bracket shall be included for mounting. Finish shall be gun-metal gray baked enamel. University Model 4A4 projector with four Model ___ driver units specified.

NOTE: See Specifications Chart for driver data to be used in completing these specs.

Model B-12P

Projector shall accommodate twelve driver units screwed into a cast aluminum sound mixing chamber, each having a full range power capacity rating of ___ watts, ___ watts each when used with proper series capacitor; and in combination with the projector shall have a rated response of 100 to ___ cycles. Each driver unit coupler shall be insulated electrically from the sound mixing chamber. Spun aluminum rear coverall shall protect the driver and interconnections. Bell shall be a separate straight horn assembly with cast flange for mounting to the chamber casting. Over-all length of projector is not to exceed 47", bell diameter 31½". Rated dispersion shall be 80°. Heavy duty adjustable "U" bracket shall be included for mounting. Finish shall be gun-metal gray baked enamel. University Model B-12P with twelve Model ___ driver units is specified.

NOTE: See Specifications Chart for driver data to be used in completing these specs.

EXPLOSION-PROOF SPEAKERS

Introduction of the new University Models 7101 and 7102 Explosion-Proof Speakers now makes it possible for industries previously denied the advantages of sound paging to install 100% safe loudspeaker systems in locations where flammable liquids, gases, dust and other combustibles are present. Approved by the Underwriters' Laboratories Inc. for Class I and Class II locations, Models 7101 and 7102 represent the last word in rugged design and are complete with built-in line matching transformer. The entire speaker is shipped fully assembled, carefully checked out at the factory . . . your assurance that the stringent government safety regulations *will* be met and the installation approved.

Approved by Underwriters' Laboratories, Inc.

The required conduit entrance is provided as a part of the driver housing casting. Within the cast driver housing is a special, highly efficient heavy-duty driver, itself in a casting. High input power is a necessity in installations of this kind because of a loss in sound pressure incurred by the explosion barrier needed as a part of the design. The sound engineer is well advised to be wary in reviewing sound pressure requirements and specification claims of equipment being offered for this application. The University series Explosion-Proof speakers employ the most efficient, sound-conserving technique known, and will perform as expected.

In every respect—construction, compact size and approved safe design—Models 7101 and 7102 are the answer to long-felt needs and the key to many new applications.

The difference between Explosion-Proof and Blast-Proof speakers is often confused. The Explosion-Proof speaker is intended for service where volatile or flammable gases, dusts or other foreign particles are present in the air which may be ignited by a spark from the speaker mechanism. Such speakers must be able to prevent the entry of such substances beyond the horn air column to the driver; and in the event of entry, construction must be such that should the substance within the

Specifications

SPECIFICATIONS—7101 AND 7102

FREQUENCY RESPONSE	200-10,000 cps
POWER CAPACITY (Cont. Duty) FULL RANGE *ADJUSTED RANGE	 30 watts 60 watts
DISPERSION	95°
**SOUND PRESSURE LEVEL	7101 122 db 7102 110 db
†SENSITIVITY AS MICROPHONE	7101 −23 DBM 7102 −32 DBM
‡SERIES CAPACITOR FOR HORN CUT-OFF	16 mfd
VOICE COIL IMPEDANCE	16 ohms
TRANSFORMER IMPEDANCES	45, 165, 200, 250, 500, 1000, 2000 ohms
70 V. LINE POWER TAPS	30/25/20/10/5/2.5 watts
DIMENSIONS BELL DIAMETER LENGTH OVER-ALL	 15¾" 19"
SHIPPING WEIGHT	23¾ lbs.

*Input program response limited to above 200 cps.

**Sound Pressure readings taken at 4 ft. with "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db each time power input is halved; increase by 3 db when power input is doubled.

†DBM re 10 dynes/cm²

‡Assumes 16 ohms voice coil connection. See Fig. 19, p. 18, for other impedances.

speaker become ignited, that explosion cannot spread to the outer atmosphere but must be contained within the speaker. A Blast-Proof speaker is designed to withstand tremendous instantaneous peak air pressures which would otherwise destroy the voice coil/diaphragm assembly of the speaker. An example of such service would be military where a loudspeaker is likely to be used in close proximity to artillery, or in an area under bombardment. Standard University speakers are constructed to withstand considerable blast pressure without additional devices. However, under the most *severe* blast conditions, referred to in the military as "Class 3" (9 lbs per square inch pressure), it is best to request that speakers be especially prepared for such application. University can furnish such types in both driver unit and communications-type cone speakers.

So that you will better appreciate the use of Explosion-Proof Speakers, the following explains the specific categories encountered in sound work.

MODEL 7101 is Underwriters' Laboratories Inc. approved for Class I, Groups C and D.
MODEL 7102 is similarly approved for Class I, Groups C and D and Class II, Groups E, F and G.

Class I Locations

Class I locations are those in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are manufactured, used, handled, or stored. This class includes such industries as dry cleaning, dyeing plants, plastic manufacturing plants, varnish and paint manufacturers, distilleries, rectifying and blending plants producing whiskey and other alcoholic beverages and plants or locations involving similar hazardous processes or conditions.

GROUP C—locations where ether, cyclopropane, ethylene and anaesthetic gases are present.

GROUP D—locations where gasoline and oil vapors are present. Also alcohol, naphtha, acetone, propane, methane, natural gases, lacquer, solvent vapors, etc.

Class II Locations

Class II locations are those in which combustible dust is thrown or held in suspension in the air in sufficient quantities to produce explosive mixtures, also those locations where combustible dust may collect or settle on motors, lamps, or other electrical devices. This class includes such locations as flour mills, feed mills, grain elevators, starch plants, sugar, cocoa and coal pulverizing plants, coal mines, etc.

GROUP E—refers to atmospheres containing metallic dust, such as magnesium.

GROUP F—refers to atmosphere or gases containing carbon dust, such as fine coal dust.

GROUP G—refers to atmospheres containing grain, flour or sugar dust, such as found in flour mills, grain elevators and starch plants, etc.

Architects' and Engineers' Specs

Models 7101, 7102

The loudspeaker shall comprise a reflex trumpet with 2½ foot air column with a spun steel bell and spun aluminum reflector; and 30 watt driver unit with 16 oz. *W* shape Alnico 5 magnet, 16 ohms 2" diameter voice coil and line matching transformer with primary impedances of 45/165/200/250/500/1000/2000 ohms within an explosion-proof housing. Rated dispersion angle of this speaker shall be 95°. Transformer shall withstand 1000 volt breakdown test between all windings and iron core. Cable entrance shall be provided in the base of the explosion proof housing, threaded for standard ½" conduit. Speaker shall be mounted by means of a rib-reinforced, fully serrated steel "U" bracket affixed to the trumpet bell. Over-all length shall not exceed 19", bell diameter shall not exceed 15¾". Speaker shall be supplied fully assembled, and the entire speaker comprising trumpet, driver and matching transformer shall be covered by an approval by Underwriters' Laboratories Inc. for the Class I, groups C and D (7101) and Class II, groups E, F and G (7102). Speaker shall be finished in gun-metal gray baked enamel. University Model 7101 (7102) is specified.

SUBMERGENCE-PROOF SPEAKERS

University "submergence-proof" speakers perform beyond the normal requirements of commercial and industrial speakers. They are built for applications demanding the utmost ruggedness, and immunity to salt spray, gases, live steam and especially harmful dusts and fungus. Designed originally to U.S. Navy "submergence" specs, these speakers will drain automatically, and will provide reliable, uninterrupted service with little or no maintenance under the most gruelling conditions. Long in the service of the U.S. and foreign navies, Coast Guard, and other military branches, they also have numerous commercial and industrial applications—docks, bridges, boiler rooms, laundries, dye houses, mines, railroads, fire and police department vehicles, and other locations where severe climatic conditions or heat and humidity combine to cause eventual failure of standard type speakers.

Rugged, Dependable Beyond the Call of Duty

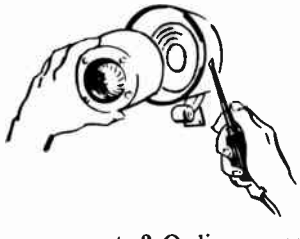
Only University Submergence-Proof Speakers Offer These Exclusive Features

Built to withstand submersion in water, these drivers have been operated even while under water. Dampness, humidity, salt spray, dirt-laden atmosphere are all taken in easy stride. The voice/coil diaphragm assembly is further protected by a treatment of special anti-fungicidal solution. Performance will not deteriorate... for with these speakers, time stands still.

Tropicalized, Hermetically-Sealed Driver

A big heavy duty Alnico 5 magnet structure and exclusive "rim-centered" voice coil/diaphragm construction provide *big speaker* performance, for those especially noisy industrial applications. Rim-centering design eliminates concern over shock or vibration that may be transmitted to the speaker by environmental or accidental abuse. These are speakers you don't have to baby!

Super-Efficient, Shock and Vibration-Proof Driver Mechanisms



Is the atmosphere thick with dirt, dust, particles, sticky fumes, gas, etc.? Ordinary speakers will clog up, reducing response and output until they are practically inoperative. The diaphragms of University submergence-speakers can be cleaned in a few minutes... *without* removing the speaker from its original mounting. Just remove the four screws that hold the die-cast reflector at the front of the speaker—and there is the diaphragm ready to be wiped clean. So sturdy is this assembly that it may even be sprayed with live steam! Replace the reflector and you're back in operation at once.

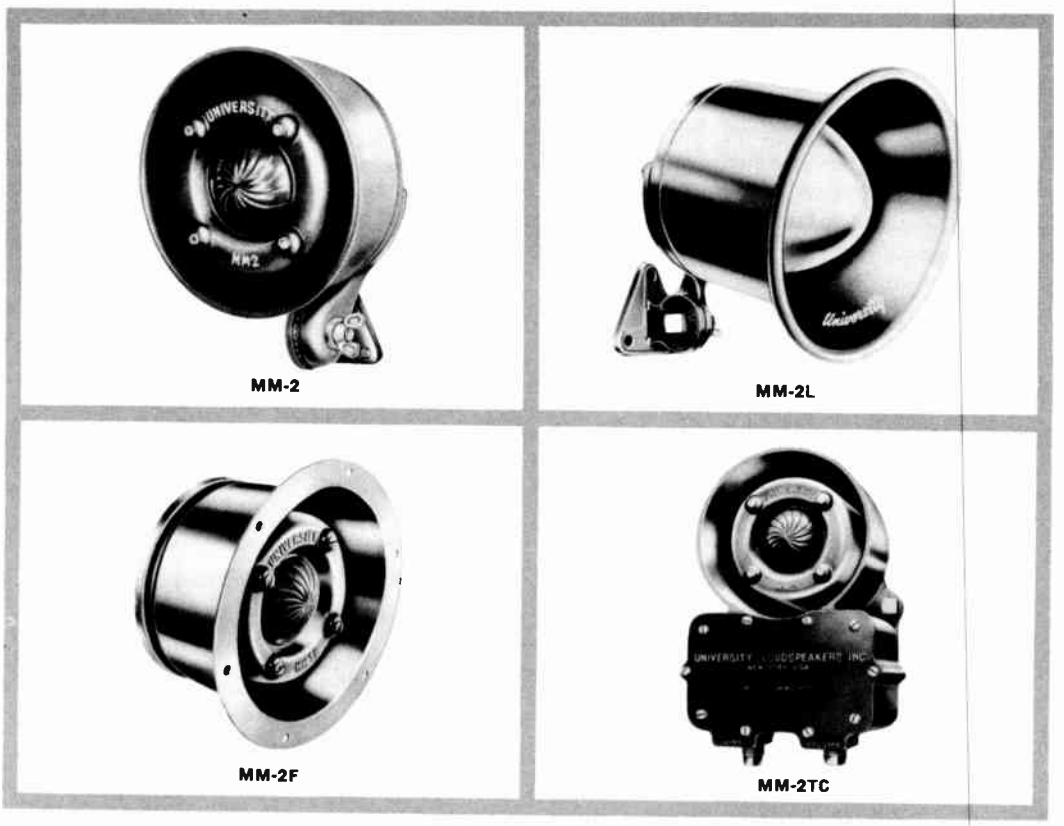
Easily, Quickly Cleaned

Whatever the application or mounting requirements, there is a model or adapter in this series which will be just the right answer.

Model MM-2 Very compact and furnished with serrated, swivel mounting bracket. Power capacity and frequency response are perfect for clear, noise-cutting reception.

Model MM-2L Similar to the MM-2 except for higher power capacity and extended low frequency response. For use where some music as well as speech is to be reproduced, or when higher power capacity and sound output are desired.

Model MM-2F Same characteristics as the MM-2 but designed for recessed, flush mounting in walls, ceilings, bulkheads, vehicle dashboards and similar applications where appearance is a consideration, or mechanical damage is likely to occur to projecting objects. Supplied with cork-neoprene flange gasket for weatherproofing. Mounting hole circle diameter is 6⅝". Six 7/32" mounting holes are provided in the flange.

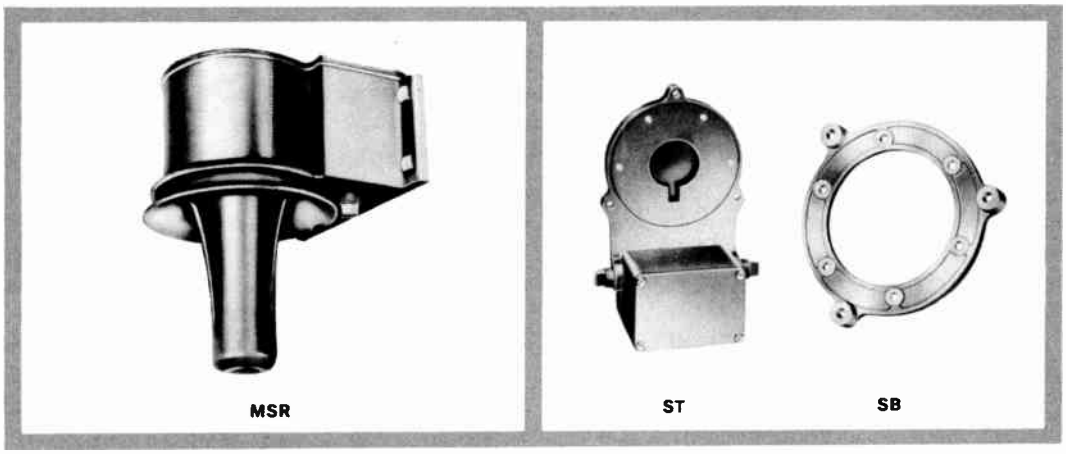


Model MM-2TC This model has an integral, cast aluminum combination bell and weatherproof housing for a line matching transformer and/or volume control. Transformer may be up to 2¼" x 2¼" x 2¾" in dimension, with 2" or 2⅜" mounting center. The control can be mounted directly into position at the bottom of the casting. Cable entrance is threaded for ½"—14 I.P.S. pipe or rigid conduit, if desired. The housing front plate includes a cork-neoprene gasket. The MM-2TC is intended for bulkhead, wall, or ceiling mounting.

Model MM-2TC-T Same as MM-2TC except that the speaker is supplied completely wired with multi-impedance line matching transformer and pad attenuator. Transformer primary impedances: 45/325/500/1000/2000/4000/8000 ohms.

Model MSR Special reflexed air column speaker with radial deflector for 360° horizontal dispersion. For wall or bulkhead mounting. Features completely die-cast aluminum housing and horn, and hermetically sealed but easily removed built-in driver unit. Has provisions for both line matching transformer (with 2⅜" mounting center), and volume control within the housing with access to the control (when used) at the base. All internal components and wiring can be reached through the watertight top coverplate, without need to remove the speaker housing from its mounting. Cable entrance threaded for ½"—14 I.P.S. pipe or rigid conduit.

Model MSR-T Same as MSR except that speaker is furnished completely wired with line matching transformer and pad attenuator. Transformer primary impedances: 45/500/1000/1500/2000 ohms.



Model SB Bulkhead Adapter

May be used with Models MM-2, MM-2L, or MM-2F when it is desired to mount speakers to a bulkhead, wall, or ceiling without provision for adjusting angle of projection. The adapter, a casting, is mounted directly to rear of speaker (with original swivel bracket removed) and is fixed to a flat surface by means of screws through three ¼" holes 120° apart in the casting. Mounting hole circle diameter is 5.81".

Model ST Transformer/ Junction Box Adapter

This adapter casting may be used with either the MM-2 or MM-2L (original swivel bracket removed) to provide bulkhead, wall, or ceiling mounting complete with transformer or terminal junction box facilities. Housing cover plate has cork-neoprene gasket for weatherproofing. It will house a transformer up to 2¼" x 2¼" x 2¾" in dimensions, and mounting centers of 2" and 2⅜". Housing can be used as a junction or terminal box. Cable entrance and exit is threaded for ½" pipe, and comes complete with weatherproof gland nuts.

Models MM-2 and MM-2L can be furnished with either adapter SB or adapter ST factory-mounted, in production quantities. Please inquire, stating details.

The MM-2 Series center assembly (including driver) is readily adapted to special housings required for specific industrial applications in volume. Resistance to 9 lbs. per sq. inch Class 3 blast pressure on special order. Please inquire, providing full specifications and quantity.

Specifications

MODEL	MM-2	MM-2L	MM-2F	MM-2TC	MSR
FREQUENCY RESPONSE	350-10,000 cps	250-10,000 cps	350-10,000 cps	350-10,000 cps	250-10,000 cps
POWER CAPACITY (Cont. Duty) FULL RANGE *ADJUSTED RANGE	 15 watts 30 watts	 25 watts 50 watts	 15 watts 30 watts	 15 watts 30 watts	 15 watts 30 watts
DISPERSION	150°	120°	150°	120°	360°
**SOUND PRESSURE LEVEL	117 db	120 db	117 db	117 db	114 db
IMPEDANCE	16 ohms	16 ohms	16 ohms	16 ohm	16 ohms
†SERIES CAPACITOR FOR ADJUSTED RANGE	11 mfd	14 mfd	11 mfd	11 mfd	14 mfd
DIMENSIONS (over-all)	6" O.D. 5" deep	7¼" O.D. 5" deep	7¼" O.D. 3¾" deep	10" high 6 7/16" w. 4 7/16" deep	10¾" high 7¾" w. 8¼" deep
SHIPPING WEIGHT	5¼ lbs.	6¾ lbs.	5¼ lbs.	MM-2TC—8½ lbs. MM-2TC-T—10¼ lbs.	MSR—10 lbs. MSR-T—10½ lbs.

*Input program response above low frequency cut-off.

**Sound Pressure reading taken at 4 ft. with "Full Range" power input. Reduce by 6 db each time distance is doubled. Reduce by 3 db when power input is halved; increase by 3 db when power input is doubled.

†Assumes use of 16 ohm input.

Architects' and Engineers' Specs

Model MM-2

Speaker shall be submergence-proof reflex with a die-cast aluminum reflector that can be removed from the front with four screws to expose the diaphragm for cleaning. Bell shall be spun aluminum and mounting bracket die-cast swivel, serrated for positive lock. Diaphragm shall be linen base phenolic with 2" tropicalized voice coil, and speaker shall have 10¼ oz. Alnico 5 slug magnet in a rim-centered assembly. Speaker shall have a full range power capacity of 15 watts, 30 watts with proper series capacitor, rated response of 350 to 10,000 cycles and rated dispersion of 150°. Over-all O.D. to be no greater than 6¼" and depth 5". Finish shall be gun-metal gray baked enamel. University Model MM-2 is specified.

Model MM-2F

Speaker shall be submergence-proof reflex with a die-cast aluminum reflector that can be removed from the front with four screws to expose the diaphragm for cleaning. Bell shall be spun aluminum and have a flange with 6 holes in a mounting circle diameter of 6⅝" and a cork-neoprene rim gasket, for recessed mounting. Diaphragm shall be linen base phenolic with 2" tropicalized voice coil, and shall have at least 10¼ oz. of Alnico 5 slug magnet in a rim-centered assembly. Speaker shall have a full range power capacity of 15 watts, 30 watts with proper series capacitor, rated response of 350 to 10,000 cycles and rated dispersion of 150°. Over-all O.D. not to exceed 7¼" and depth 3¾". Finish shall be gun-metal gray baked enamel. University Model MM-2F is specified.

Model MM-2L

Speaker shall be submergence-proof reflex with an aluminum reflector that can be removed from the front to expose the diaphragm for cleaning. Bell shall be spun aluminum and mounting bracket die-cast swivel, serrated for positive lock. Diaphragm shall be linen base phenolic with 2" tropicalized voice coil, and shall have at least 10¼" oz. of Alnico 5 slug magnet in a rim-centered assembly. Speaker shall have a rated response of 250 to 10,000 cycles and rated dispersion of 120°. Full range power capacity shall be 25 watts, 50 watts with proper series capacitor. Bell diameter shall not exceed 7½", over-all depth 5". Finish shall be gun-metal gray baked enamel. University Model MM-2L is specified.

Model MM-2TC

Speaker shall be submergence-proof reflex with a die-cast aluminum reflector that can be removed from the front with four screws to expose diaphragm for cleaning. Bell shall be integral with transformer housing in a weatherproof one-piece aluminum casting. Speaker shall be designed expressly for bulkhead mounting to wall or ceiling, having two holes in the casting. Cable entrance shall be provided in the casting and shall be threaded for ½" pipe. There shall be provision in the casting for a variable attenuator control. Front of transformer housing section shall be removable for transformer adjustment without removing speaker from mounting position. Diaphragm shall be linen base phenolic with 2" tropicalized voice coil, and shall have at least 10¼ oz. of Alnico 5 slug magnet in a rim-centered assembly. Speaker shall have a full-range power capacity of 15 watts, 30 watts with proper series capacitor, and a rated response of 350 to 10,000 cycles and rated dispersion of 150°. Speaker shall have maximum over-all dimensions of 10" x 6 7/16" x 4 7/16". Finish shall be gun-metal gray baked enamel. University Model MM-2TC is specified.

Model MSR

Speaker shall be submergence-proof reflexed radial in a weatherproof completely die-cast aluminum reflector and housing designed for bulkhead mounting to wall or ceiling, with 4 holes provided in the casting for mounting. Diaphragm shall be linen base phenolic with 2" tropicalized voice coil. Speaker shall have at least 10¼ oz. of Alnico 5 slug magnet in a removable rim-centered assembly. Speaker shall have a full range power capacity of 15 watts; 30 watts with proper series capacitor and rated response of 250 to 10,000 cycles. Maximum over-all dimensions shall be 10¾" x 7¾" x 8¼", and there shall be space within the housing for transformer and variable attenuator control. University Model MSR is specified.

Model SB

Adapter shall be one-piece casting with three mounting holes 120° apart on a 5.81" mounting circle diameter for mounting to walls, ceilings, or bulkheads. Adapter shall attach to the rear of the speaker in place of original mounting bracket. University Model SB is specified.

Model ST

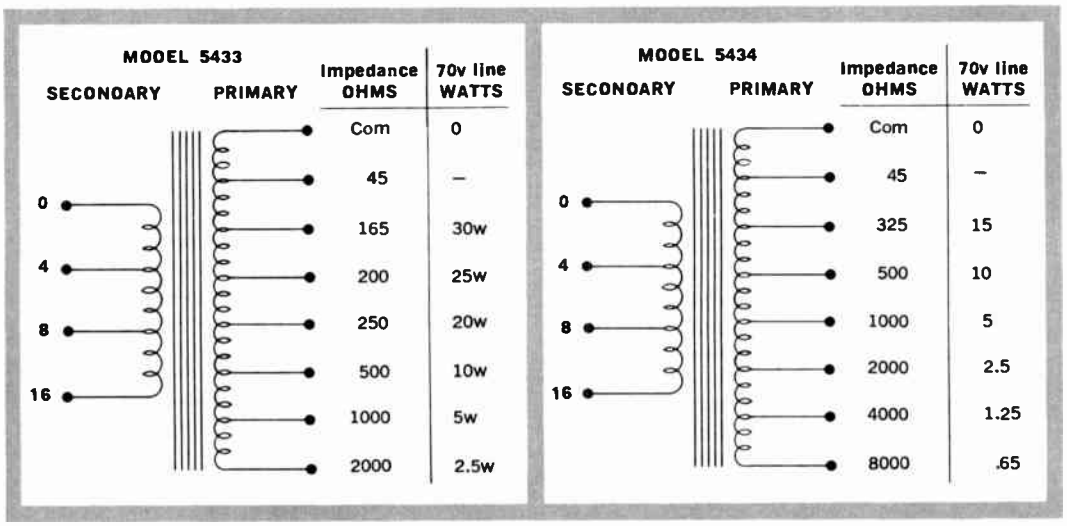
Adapter shall be one-piece casting with three ¼" mounting holes 120° apart on a 5.81" mounting circle diameter for mounting to walls, ceilings, or bulkheads. Integral cast housing shall accommodate a transformer up to 2¼" x 2¼" x 2¾" in dimensions, and shall have transformer mounting centers of 2" and 2⅜". Cable entrance and exit shall be threaded for ½" pipe. Adapter shall attach to the rear of the speaker in place of original mounting bracket. University Model ST is specified.

LINE MATCHING TRANSFORMERS

This new series of speaker-matching transformers and weatherproof housings has been designed to complement the University speakers offered, avoid needless duplications and to afford maximum utility and convenience of installation. Since most University speakers and drivers are capable of response to 10,000 cycles and beyond, these transformers have been specially designed to assure highly efficient performance. Only the highest grade audio "A" annealed or orientated cores are used; insulation and windings are completely varnished, *vacuum* impregnated and must withstand 1000 volt RMS breakdown tests. The impedance range available will meet all practical requirements of constant impedance and constant voltage (70.7 volt) systems.

Model 5433 Transformer

Model 5433 has a 30 watt capacity and may be used with the MA-25 and SA-HF driver units, or can be used in a speaker transmission line feeding a number of smaller paging speakers like the IB, MIL, or CR, etc. The universal secondary impedances permit matching to any series, parallel, or series/parallel combination of speakers, as well as obtaining unlisted impedance ratios. Over-all dimensions: 1 15/16" x 2 5/16" x 1 3/4". Mounting hole centers: 2 3/8". The 5433 will fit the CTR Weatherproof Housing.




MODEL 5433


MODEL 5434

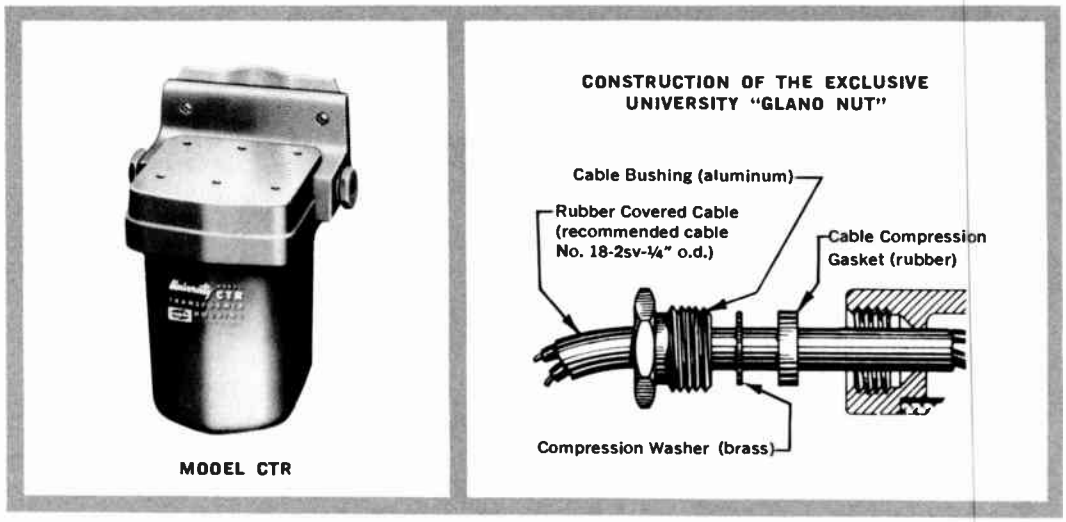
Model 5434 Transformer

Model 5434 has a 15 watt power capacity suiting it to paging speakers or lines carrying a number of the smaller types. Primary impedance ratios have been selected to provide the most practical range; while the multi-tap secondary permits obtaining other unlisted impedances that may be desired. Over-all dimensions: 1 5/8" x 1 15/16" x 1 5/8". Mounting hole centers: 2". The 5434 will fit the CTR and PB-1 Weatherproof Housings.

Model CTR Weatherproof Transformer/ Junction Housing

The new, all die-cast aluminum housing is the last word in versatility and quality construction. Exclusive University gland nut cable entrance and exit go way beyond the rubber grommeted hole techniques – affording *complete* and assured weather protection. The gland nuts can be easily removed to provide still larger diameter openings. Use it to house the 5433, 5434 transformers, or any other transformer having maximum dimensions of 4" x 4 15/16" x 3 3/4". Comes complete with

adjustable slotted adapter strap for mounting transformers with mounting hole centers of 1½" to 2¾". The CTR also makes a wonderful junction box for terminating and tying speaker transmission lines.

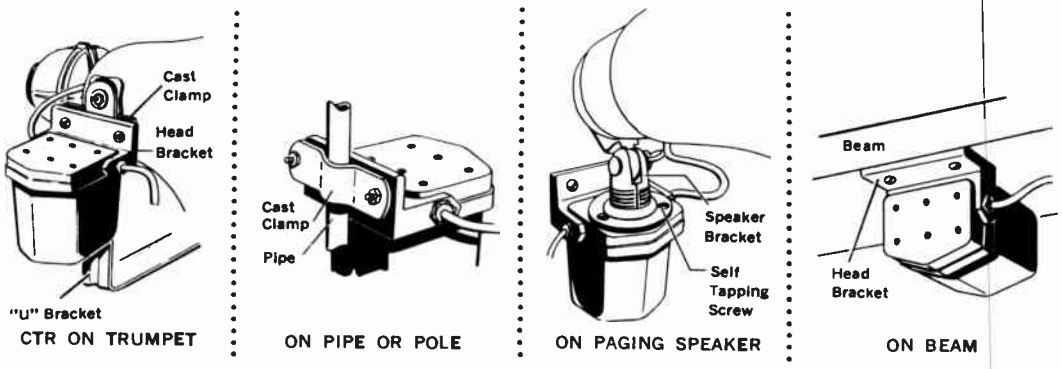


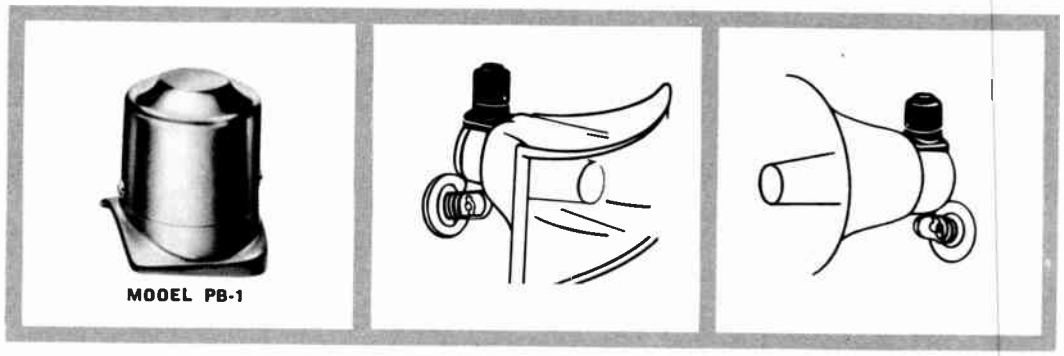
CTR Versatility

The CTR may be clamped to the "U" type mounting bracket used on trumpets and radial projectors, or a small pipe, beam, etc. The clamp bar is supplied with the CTR.

For mounting to University paging speakers, the base of the speaker is fastened to the top of the CTR with screws provided for this purpose. The CTR mounting bracket then supports both the transformer and speaker.

The CTR may be mounted to wall, ceiling, or any other flat surface by means of screws, using the heavy bracket which is an integral part of the one-piece casting.





Model PB-1 Weatherproof Housing

Designed specifically for use with University MIL, CMIL, IB and CIB series paging talk-back speakers, the PB-1 provides a high quality, low cost housing for transformers with maximum dimensions of 1⅝" x 1 15/16" x 1⅝" and 2" mounting center. The Model 5433 transformer is ideal. Watershedding weather-resistant design atop speaker avoids adding to over-all dimensions, thus does not restrict original mounting variation or flexibility.

Impedance Matching

Typical Low Impedance Speaker Circuits

The following are typical speaker connections used when matching to a low impedance tap of the amplifier output transformer.

Fig. 28 represents a typical simple paging system—The 16 ohm source impedance is properly matched by the 16 ohm load impedance presented by the speaker.

Fig. 29 represents two or more speakers in parallel—When the individual impedances of all speakers connected in parallel are the same, the resulting impedance is equal to the impedance of any one speaker divided by the number of the speakers. In Fig. 29 the load impedance equals:

$$\frac{16}{2} = 8 \text{ ohms}$$

Fig. 30 represents two or more speakers in series—The total load impedance presented by several speakers in series is obtained by simply adding the individual impedances. In Fig. 30 the load equals 8 ohms + 8 ohms = 16 ohms. In most installations, series connection should be avoided since an open circuit in any one speaker will cause the entire system to become inoperative.

Fig. 31 represents four or more speakers in series/parallel—In many cases, it may not be possible to satisfactorily match a group of speakers in parallel connection to available output transformer taps. In this event, series/parallel operation of speakers may be employed to obtain the proper match.

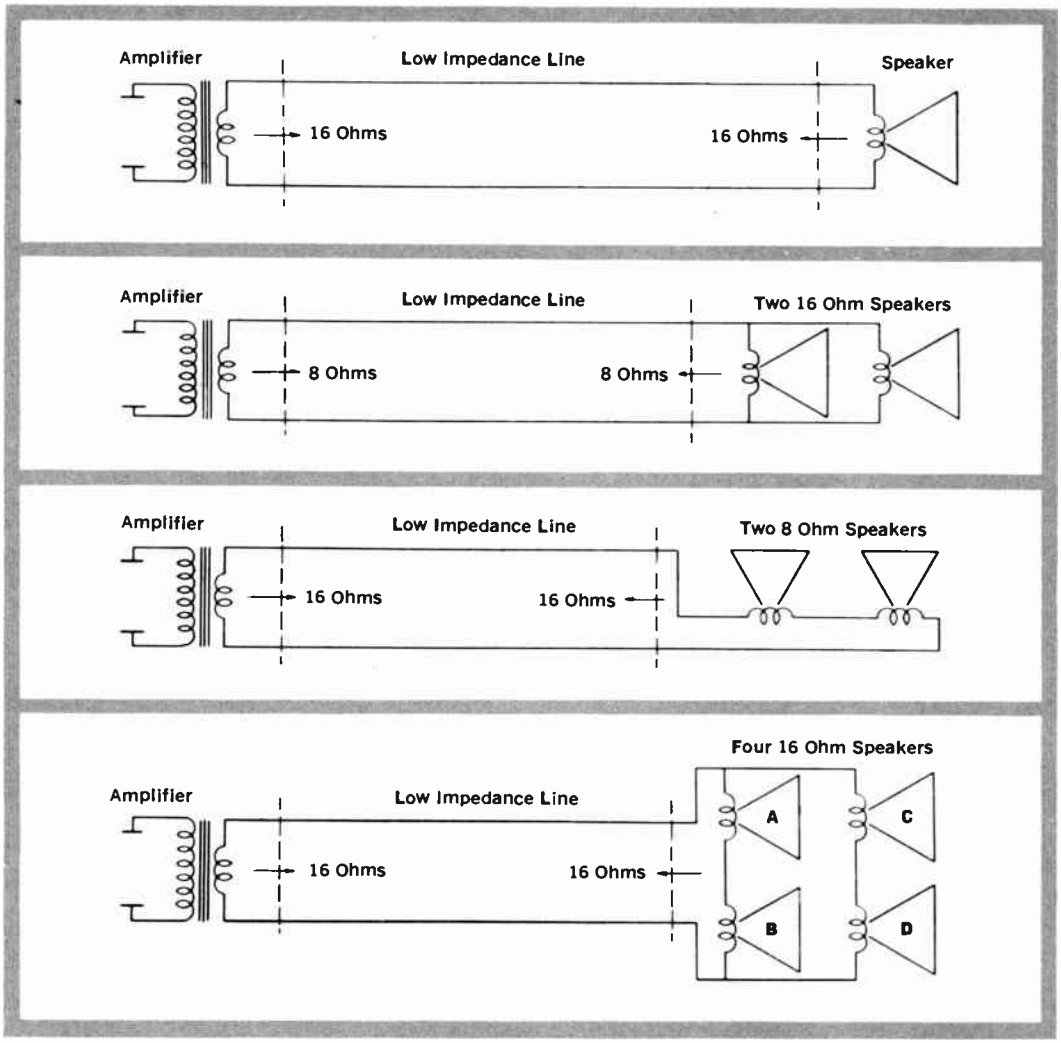


Fig. 28

Fig. 29

Fig. 30

Fig. 31

The 32 ohm load, resulting from speakers A and B in series, is in parallel with the resulting 32 ohm load of speakers C and D in series. The over-all load, therefore, equals 16 ohms and properly matches the 16 ohm secondary of the output transformer.

Calculation of Parallel Impedance Systems

When *two* parallel connected speakers are *not* of equal impedance, divide the product of their impedances by the sum of their impedances. The impedance of a 4 and 16 ohm speaker in parallel would be:

$$\frac{4 \times 16}{4 + 16} = 3.2 \text{ ohms (use 4 ohm taps)}$$

When more than two different impedance speakers are connected in parallel, add the reciprocals of the individual impedances and then take the reciprocal of their sum. The impedance of a 4, 8 and 16 ohm speaker would be:

$$\frac{1}{\frac{1}{4} + \frac{1}{8} + \frac{1}{16}} = \frac{1}{\frac{7}{16}} = 2.2 \text{ ohms}$$

Division of Power in Series and Parallel Systems

When the voice coil impedances of speakers in *series* are alike, equal distribution of power will occur. However, if one speaker is 8 ohms and the other 16 ohms, the 16 ohm speaker will receive *twice* as much power as the 8 ohm speaker.

In circuits employing a number of similar impedance speakers in *parallel*, each will receive the same amount of power. When a number of speakers of different impedances are paralleled, the lower impedance speakers will receive the greater amounts of power. If one speaker is 8 ohms and the other 4 ohms, twice the power will be consumed by the 4 ohm speaker.

Typical High Impedance Speaker Circuits

In many installations the loudspeaker must of necessity be distant from the amplifier. In these cases, the use of low impedance lines (running directly from amplifier to speaker voice coils) would result in comparatively large power losses. High impedance lines of the order of 125 to 600 ohms are therefore employed, fed at one end by the high impedance tap of the amplifier output transformer

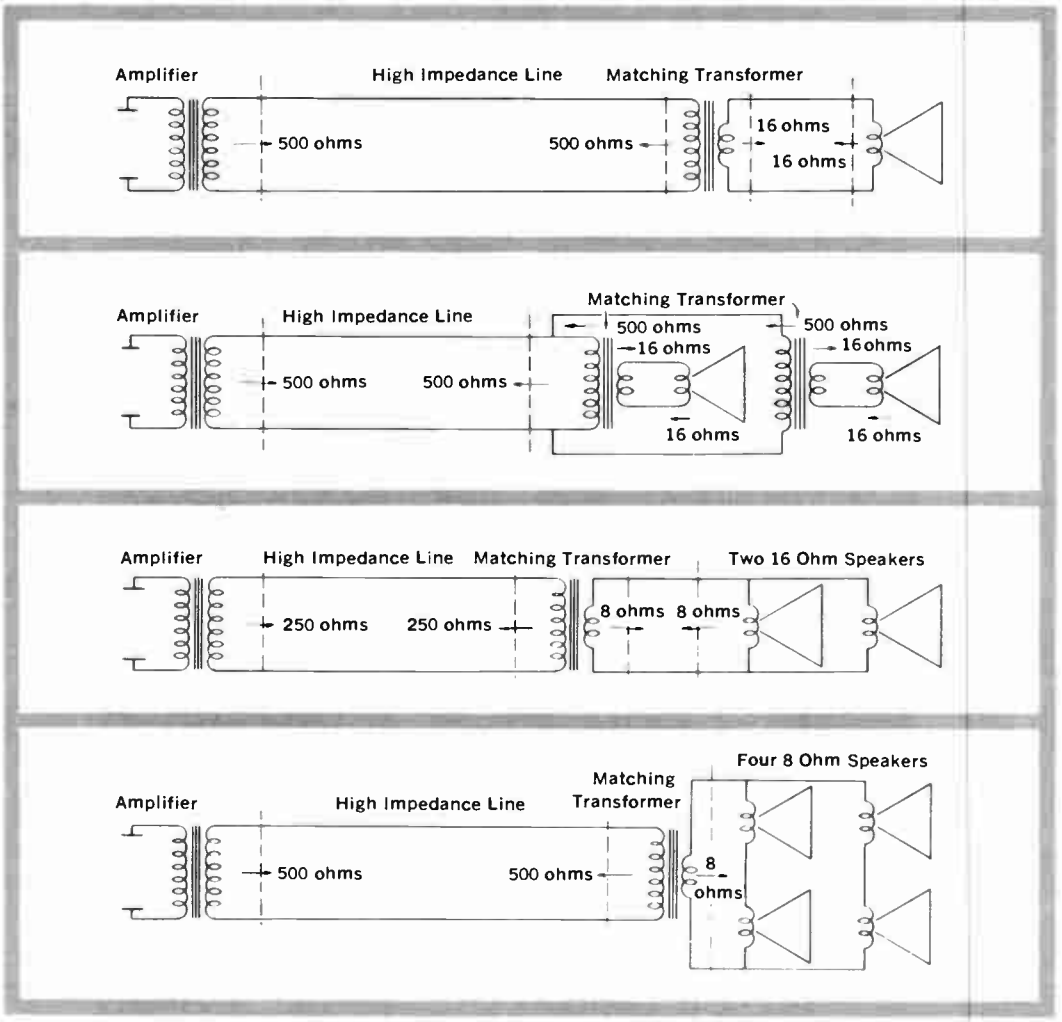


Fig. 32

Fig. 33

Fig. 34

Fig. 35

secondary and terminated at the speaker end by a "matching transformer" with an equivalent primary impedance. It is to be observed in Fig. 32 that, unlike Fig. 28, connection is not made directly from the amplifier to the speaker voice coil. Instead, a suitable high impedance "matching" transformer is selected, matching its 16 ohm secondary to the 16 ohm speaker. The operation of this system will be identical to that of the low impedance line example in Fig. 28, and can be considered a properly matched system.

Fig. 33 represents two or more speakers in parallel—In installations where speakers are at a considerable distance from each other, individual speaker matching transformers are required. If equal power distribution is desired, simply multiply the line impedance by the number of speakers in the circuit. The result will be the required primary impedance of each line matching transformer.

In systems requiring speakers close to one another, the voice coils may be paralleled and connected to a common transformer as shown in Fig. 34. The power handling capacity of the line matching transformer must be sufficient for this particular application.

Fig. 35 represents four or more speakers in series/parallel—In this case, the 8 ohm load resulting from the four 8 ohm speakers in series/parallel is matched to the 8 ohm secondary of an impedance matching transformer. The 500 ohm primary of the impedance matching transformer is in turn properly matched to the 500 ohm secondary of the amplifier output transformer. As outlined previously, care must be observed in selecting a transformer capable of handling the total required power.

Speaker Matching with Unequal Power Distribution

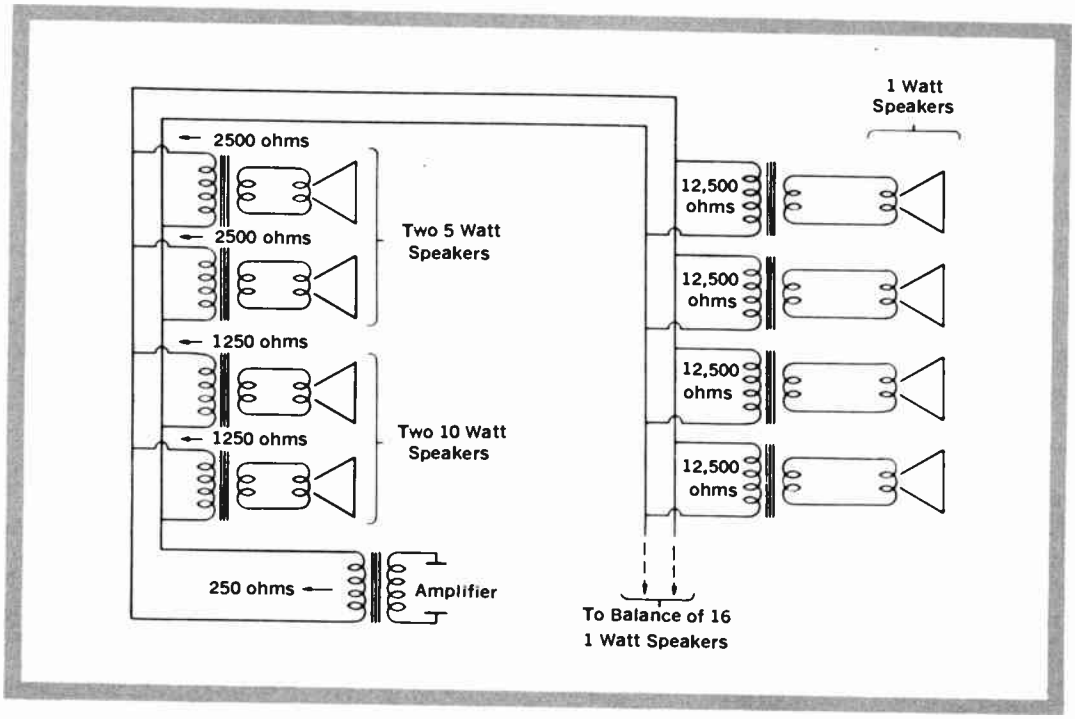
In the various speaker arrangements discussed thus far, it has been assumed that all speakers of a multiple speaker system are to receive equal power. It is frequently required, however, to connect a group of speakers to a given amplifier in such a manner that the various speakers operate at different power levels. This problem is most often encountered in industrial installations where several speakers may be required to operate at power levels sufficient for very noisy areas, whereas other speakers are to be placed in more quiet locations and may therefore operate at lower levels. Unequal power distribution may be accomplished by arranging the impedances of individual loads in such a manner that their total impedance properly matches the source impedance. The method outlined below is accurate and simple. A typical installation involving a number of speakers operating at different power levels is used as an example. See Fig. 36 below.

Typical Industrial Speaker Installation

To connect 24 speakers to an amplifier so that two speakers in the factory receive 10 watts each, two in the cafeteria receive 5 watts each and twenty stockroom speakers receive 1 watt each:

1. Since the areas to be covered are distant from the amplifier, the use of a high impedance transmission line is indicated. Assume amplifier output impedance is 250 ohms.
2. Total power requirements are 50 watts $(2 \times 10) + (2 \times 5) + (20 \times 1)$.

Fig. 36



3. Obtain the ratio between the total power required and the power required for the 10 watt speakers, i.e:

$$\frac{50}{10} = 5:1$$

4. Obtain the ratio between the total power required and the power required for the 5 watt speakers, i.e:

$$\frac{50}{5} = 10:1$$

5. Obtain the ratio between the total power required and the power required for the 1 watt speakers, i.e:

$$\frac{50}{1} = 50:1$$

6. Since the derived ratios indicate the relationship between required impedance and line impedance to effect the necessary transfer of power, multiplying 250 ohms (line impedance) x 5 will give us the primary impedance for each of the matching transformers for the 10 watt speakers, i.e. 1250 ohms. Similarly, the 5 watt speakers would each require an impedance of 2500 ohms (250 ohms x 10) and the 1 watt speakers, 12,500 ohms (250 ohms x 50).

Although a line impedance of 250 ohms was chosen in the above example, in practice, any appropriate high impedance may be utilized. Since the selected line impedance will bear a direct relation to the final calculations, the choice should be based on the types of transformers available. If in the above problem a 500 ohm line was used, all derived values would have been doubled and the 1 watt speakers would have required 25,000 ohm transformers—a size difficult to obtain. Of course, while we have considered only the problem of matching the speaker transmission line to the speaker matching transformer, it is understood that the secondary impedance of the matching transformer used should in turn match the voice coil impedance of the speaker used. For example, an 8 ohm speaker will require a transformer secondary of 8 ohms, etc.

Deriving Other Than Rated Impedances From a Transformer

How to Select a Transformer

Impedance matching transformers are commercially available in a wide variety of impedance ratios. Four factors must be considered in the selection of the proper transformer:

1. Primary impedance (determined by the load impedance of the output of the amplifier).
2. Secondary impedance (to match the load impedance presented by the speaker or speakers connected to the transformer secondary).
3. The transformer must be capable of handling and transmitting an amount of power at least equal to the power consumed by its associated speakers.
4. The transformer must not discriminate unduly against any of the audio frequencies which are to be transmitted. The ability of the transformer in this respect is usually reflected in the price. A poor or improperly selected transformer may result in loss of tone quality, loss of power and an increase in distortion.

How to Make Substitutes Work

It is not always possible to secure impedance matching transformers with the exact primary and secondary impedances required in a given sound installation. In such cases we may substitute other transformers having different primary and secondary impedance ratings, but with the same primary to secondary impedance *ratio*. Let us assume, for example, that a given installation requires an impedance matching transformer with a 1000 ohm primary and a 4 ohm secondary. The impedance ratio is then:

$$\frac{1000}{4} \text{ or } 250:1$$

We can make use in this instance of an available transformer with a 2000 ohm primary and an 8 ohm secondary since the impedance ratio will be:

$$\frac{2000}{8} \text{ or } 250:1$$

When the 8 ohm secondary of this transformer is terminated in a 4 ohm speaker load, the primary will act as though it were of 1000 ohm impedance. While this will provide a proper impedance match, it may result in some change in the frequency response characteristics of the transformer. It is therefore desirable, where high fidelity response is essential, to use impedance matching transformers with primary and secondary impedances rated for the specific requirements of an installation. In normal P.A. work, however, especially where speech rather than music is predominant, the effects of possible changes in frequency response are not always of prime importance, and the above suggestions may prove expedient.

Constant Voltage Distribution Systems

How to Use the Constant Voltage System

This method is based on the "Constant Voltage" amplifier, and simplifies to a great degree the computation of the proper transformer taps when varying sound levels are required. It also permits the addition of speakers to an existing system, without the recalculation of the load and source impedances. As long as the total power consumed by the loudspeakers is less than or equal to the amplifier power rating, a favorable load condition will always exist. It permits loudspeakers to be connected across a transmission line with the same ease that electric lights are loaded on a power line up to the capacity of that circuit. To use this method requires that a power amplifier incorporate an output transformer tap which will deliver 70.7 volts at the rated output of the amplifier. Amplifiers over 100 watts power capacity employ a 141 volt tap under this system.

The choice of 70.7 volts (referred to hereafter as 70 volts) took into consideration Underwriters' requirements which in many locations limit loudspeaker circuit voltage to a specified maximum unless wiring is run in conduit or BX. There is now some activity toward use of 25-volt systems.

Reference to a "70 volt loudspeaker distribution line" does not mean that the voltage on this circuit will always be 70 volts. It may be less when the system is operated at levels well below the rating of the amplifier. The 70 volts is the *maximum* voltage on a sine wave test signal for a given amount of distortion. This expresses the standard for rating amplifier power. Standardizing this voltage means that the voltage is the same for a low power amplifier as for a high power amplifier if rated under 100 watts.

When transformer taps are marked directly in "watts," no mathematics is required. Simply choose a transformer with the correct power tap and connect to the desired terminals. For transformers marked in impedance, follow the procedure below. Actual calculations are simple. One basic formula is used:

$$Z = \frac{E^2}{P} \text{ of required impedance } = \frac{(\text{Output voltage})^2}{\text{desired power}}$$

so that for an amplifier employing a 70 volt output tap, the formula is reduced to:

$$\text{required impedance } = \frac{5000}{\text{desired power}}$$

For a system that may already be using a 25 volt constant wattage line, the formula would be:

$$\text{required impedance } = \frac{625}{\text{desired power}}$$

The figures to bear in mind are 5000 (roughly the square of 70.7), 20,000 (square of 141) and 625 (square of 25). In actual practice, wiring for a quantity of loudspeakers becomes very simple. First, decide on the power required for each loudspeaker. Add up the power required for all the speakers and choose an amplifier capable of supplying at least this much power. Using the formula above, choose a transformer which will give this power on a 70 volt line. All transformer primaries may then be connected in parallel across the 70 volt line without any further consideration of impedance. Amplifier power does not enter into any of the calculations.

For example, the typical industrial sound installation discussed under "Impedance Matching" may be laid out on a 70 volt constant voltage basis (assuming the amplifier incorporated a 70.7 volt output tap on the transformer). Using the basic formula, primary speaker transformer impedance values are:

For each 10 watt speaker: $Z = \frac{E^2}{P} = \frac{5000}{10} = 500$ ohms

For each 5 watt speaker: $Z = \frac{E^2}{P} = \frac{5000}{5} = 1000$ ohms

For each 1 watt speaker: $Z = \frac{E^2}{P} = \frac{5000}{1} = 5000$ ohms

From the above, it may be readily seen that many conventional line matching transformers may be used with equal effect on constant voltage as well as constant impedance systems. Where the derived values differ slightly from the actual transformer taps, it should be remembered that mismatches up to 25% are permissible. However, the following conditions must be observed:

1. The total power to be supplied to all speakers in the system must not exceed the amplifier rating.
2. The power rating of the matching transformer must be adequate for the power consumed by its associated speaker load.
3. Matching transformer secondaries must be terminated by an equivalent speaker load.

Typical of speakers readily adaptable to either constant voltage or constant impedance systems are the University Models PA-50 and SA-30 heavy duty driver units which incorporate a built-in line matching transformer marked both in watts consumed on a 70 volt line and in various useful impedances.

Effects of Mismatch Upon Power Transfer

While every reasonable effort should be made to match the speaker load properly to the amplifier output, generally speaking, a load impedance which is within 25% of the rated amplifier impedance may be considered a satisfactory match.

The extent of permissible mismatch does depend, however, upon two important factors:

1. Fraction of the maximum available amplifier power that will actually be used.
2. Load characteristics of the amplifier.

Figure 37 illustrates the performance of typical present-day amplifiers of both the slightly or non-regulated variety, and the "constant voltage" type amplifier. Note that for the same degree of mismatch, the power loss is greater for the amplifier which is required to deliver full output (curve B) than for the amplifier being run at reduced power (curve A). If 100% of an amplifier's power capacity must be utilized, a very close match would seem imperative.

Measurements recently made on a number of popularly priced amplifiers indicated a power loss, at full output, of approximately 25% for a 1 to 2 upward mismatch. For example, this means that with the 8 ohm output tap of a ten watt amplifier working into a 16 ohm loudspeaker, the actual power delivered to the speaker will be 7.5 watts. Of course, under practical circumstances, as in home systems, this amount of power loss can be tolerated.

Examining curve B once again, an upward mismatch of four times produces a power loss of 50%, or 3 db. *But a mismatch of four times on a well regulated amplifier (curve C) results in a power loss of 75% or 6 db.* The former while not particularly desirable, is tolerable if sufficient power is available to perform to requirements, but the latter would be a serious condition indeed. Thus it may be clearly seen, forgetting for the moment all other relative advantages and disadvantages of the two types of amplifiers, that amplifiers of more or less conventional design, with perhaps only small amounts of negative feedback on the output stage, may be mismatched to a greater extent than amplifiers of the "constant voltage" or high damping factor type.

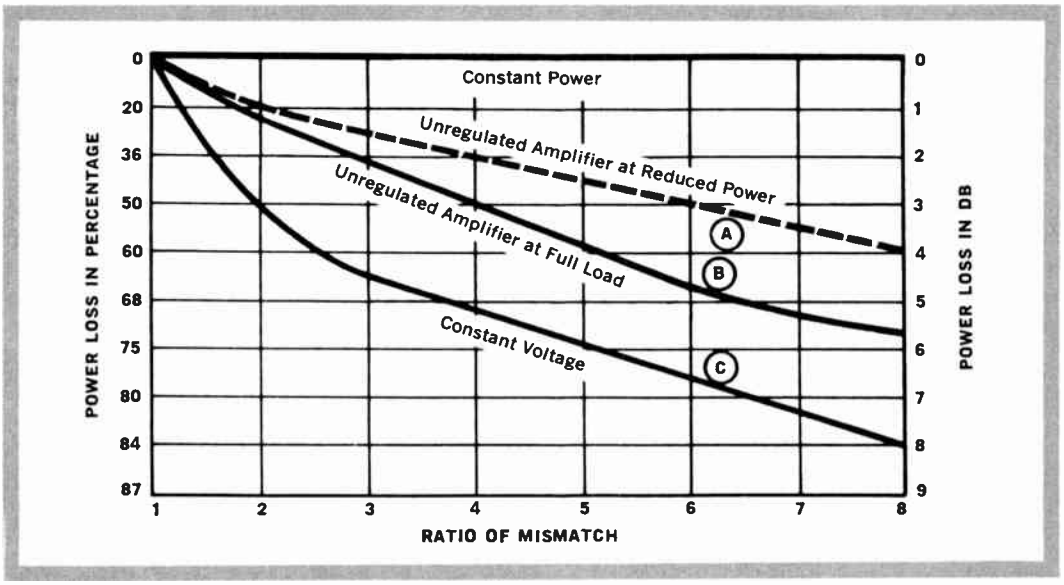


Fig. 37

If the output regulation of the amplifier is unknown, but some negative feedback is known to be employed in the circuit, it might be well to assume a curve that slopes between curves B and C. Constant voltage amplifiers, although somewhat more expensive than the conventional types, offer a number of fidelity and system installation advantages which are making them more and more popular. The manufacturers of these type units will often supply detailed information concerning application advantages of their product, and in most cases a curve of the regulation characteristics is available. However, if such data is unavailable, an indication of the curve may be determined as follows:

1. Feed a constant level, single frequency audio signal to the input of the amplifier.
2. Connect a resistance to the output which is equal to the rated impedance of the amplifier and of suitable power capacity.
3. Measure the voltage reading across this resistor.
4. Replace the load with a resistor equal to the impedance of the intended mismatch, and read the voltage again without changing any of the original amplifier control settings.

If the two readings are practically the same, the amplifier is considered to be well regulated. If the readings are different, the power loss may be determined. Knowing the value of the load resistances and voltages read in each case, the formula:

$$\text{Watts in load} = \frac{\text{Volts}^2}{\text{Resistance of load}}$$

is used for each load situation, and the two results subtracted to find the *actual power lost*. A curve may be drawn by taking readings of subsequent steps of mismatch and plotting them as ratio of mismatch versus power loss in percentage.

This discussion assumes that all mismatching is in an upward direction. This is recommended in order to help preserve optimum frequency response. Downward mismatch should be religiously avoided as it will cause excessive power loss and will affect low frequency response.

Controlling Loudspeaker Volume

In many loudspeaker installations it is often required that the volume level of individual speakers be made adjustable. This condition is best met by the use of the "constant impedance" type attenuator.

Constant impedance volume level controls do not change their input impedance. Consequently, changing the volume level setting on a given speaker in a group will not affect the volume level of

the other speakers. These constant impedance volume level controls differ from the usual controls in that they may have as many as three variable elements to attain their characteristics. The most common controls supplied for this purpose are known as the unbalanced "T" pad, (Fig. 38A), and the "L" pad, (Fig. 38B). While the "L" pad is not rigorously a constant impedance type, the variation in impedance is small enough to make its use suitable for most practical purposes. The expense of "T" pads is not always warranted.

In this type of volume control the dissipation rating of the unit is very important since the power that is not used by the speaker must be dissipated by the control: In choosing a volume control for a loudspeaker, it is necessary that the impedance and the power rating of the control equal the impedance and the maximum power rating of the speaker or the matching transformer into which it works.

Controls illustrated in Fig. 38A and 38B are available from P.R. Mallory Company as type number T-15 and L-15 respectively; from Clarostat as type number CIT-15 and CIL-15 respectively. (In both cases, the number indicates the impedance of the pad. Other impedances are available.)

When it is desired to handle an emergency situation where the output of a particular low power speaker must be reduced, a simple 15-50 ohm wire-wound potentiometer handling 10 watts can be used as shown in Fig. 38C.

Another means of controlling loudspeaker output is the simple expedient of creating an impedance mismatch. The graph, Fig. 39, can be used to calculate the power loss, expressed either in db or percentage, for various degrees of mismatch. All mismatches are assumed to be upward from source-to-load. This method is easily accomplished by means of a multi-tap line matching transformer. This principle can be employed in either the primary or secondary circuits, depending upon requirements and convenience. It must be borne in mind, however, that this method will function properly only when amplifiers with excellent regulation characteristics are used as the power source. The previous discussion on effects of mismatch on power transfer clearly shows how poorly or non-regulated amplifiers have a tendency to vary their output voltage with mismatch thus partially nullifying the anticipated loss.

Fig. 38

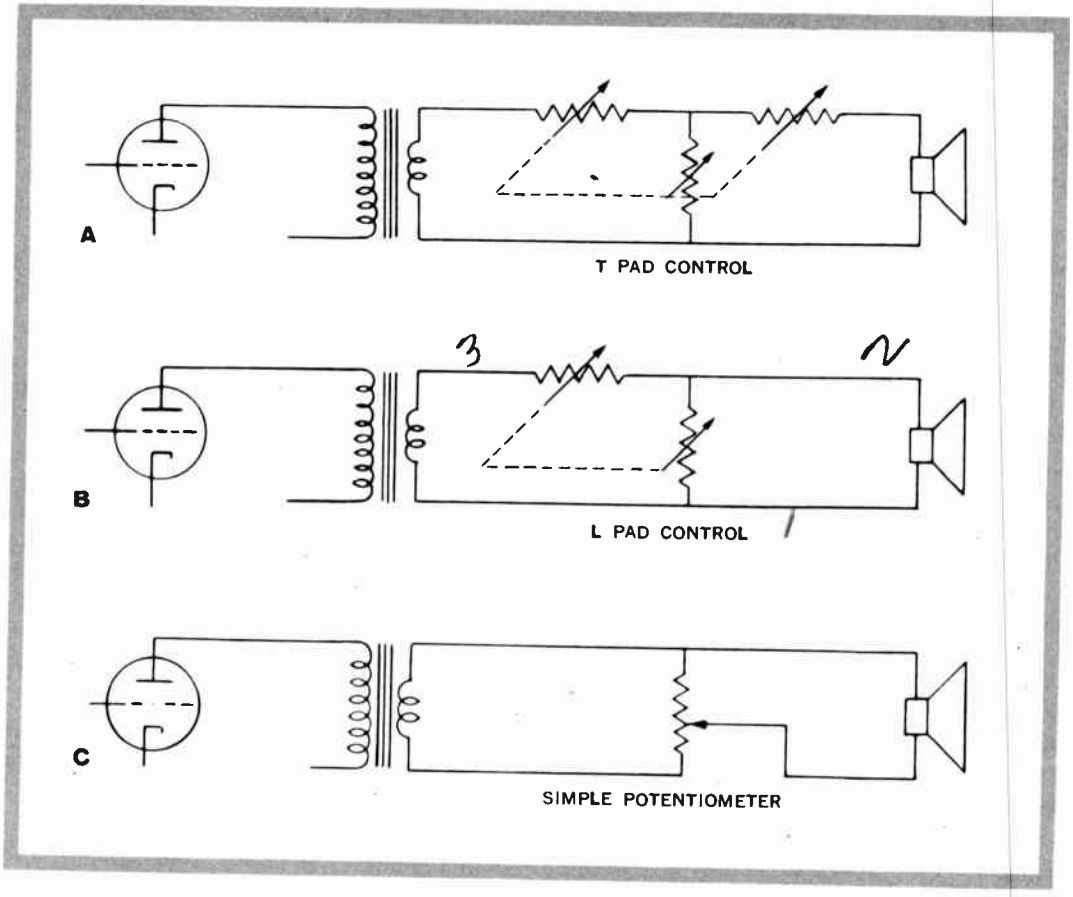
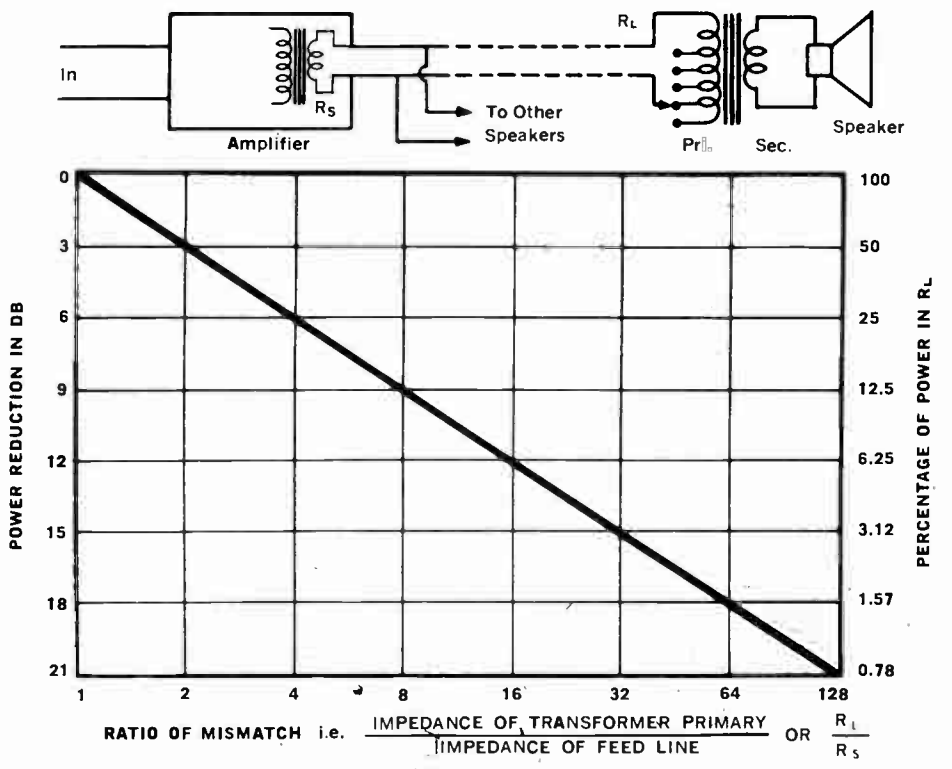


Fig. 39



Architects' and Engineers' Specs

Model 5433

Transformer shall have a 30 watt full-range power capacity, primary impedances of 45/165/200/250/500/1000/2000 ohms, secondary impedance of 4/8/16 ohms. Terminals shall be marked in both impedance and equivalent 70.7 v. constant voltage power. Over-all dimensions shall not exceed 1 15/16" x 2 5/16" x 1 3/4". Mounting center shall be 2 3/8", transformer shall be varnished, vacuum impregnated to withstand 1000 v. RMS breakdown test. University Model 5433 is specified.

Model 5434

Transformer shall have a 15 watt full range power capacity, primary impedances of 45/325/500/1000/2000/4000/8000 ohms, secondary impedance of 4/8/16 ohms. Terminals shall be marked in both impedance and equivalent 70.7 v. constant voltage power. Over-all dimensions shall not exceed 1 5/8" x 1 15/16" x 1 5/8". Mounting center shall be 2 3/8", transformer shall be varnished, vacuum impregnated to withstand 1000 v. RMS breakdown test. University Model 5434 is specified.

Model CTR

Transformer housing shall be of all die-cast two-piece construction with a threaded cable entrance and similar exit supplied complete with weatherproofing gland nut assemblies. Slotted adapter plate shall permit housing to be used with transformer up to 4" x 4 15/16" x 3 3/4" in dimension and with mounting centers up to 2 3/4". V-notched clamp shall be provided for mounting housing to trumpet "U" bracket or pipe. Housing shall be finished in gun-metal baked enamel. University Model CTR is specified.

Model PB-1

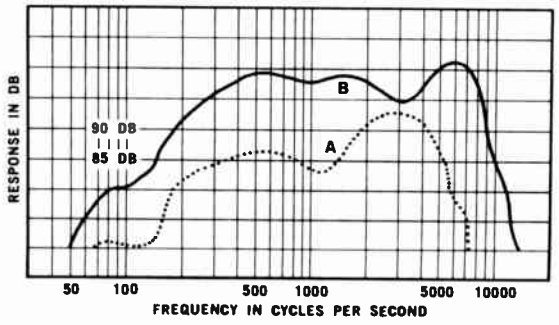
Transformer housing shall be comprised of die-cast mounting plate and water-shedding spun aluminum dust cover. Housing shall accommodate transformer with up to 2" mounting center and 1 15/16" x 1 5/8" maximum dimensions. Design shall not restrict original speaker installation flexibility; mounting directly atop the speaker bell and driver at the bell clamp is recommended. Housing shall be finished in gun-metal baked enamel. University Model PB-1 is specified.

CONE TYPE SPEAKERS AND BAFFLES FOR P. A.

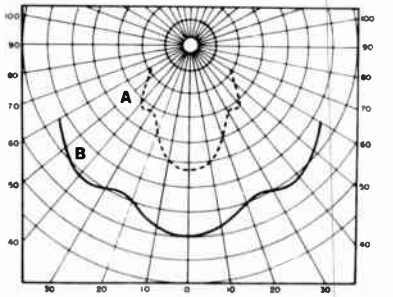
University offers a very wide selection of 8" and 12" high efficiency, high fidelity, cone-type speakers for use in high quality sound reinforcement applications. "Low level" installations are all too often compromised into *low quality*, in the belief that economies effected by use of inferior equipment and imperfect techniques will be justified by the limited expectations. Field results and the public's growing awareness of high fidelity reproduction have enabled the users of such installations (restaurants, night clubs, supermarkets, lounges, hotels, etc.) to employ high quality equipment to greatest commercial advantage, with cost thus becoming a lesser obstacle.

Technically speaking, the unique performance qualities and advantages of University high fidelity speakers help to further reduce initial cost. Fig. 40 shows the frequency response of a commonly used 12" speaker of the ordinary variety vs. the University Diffusicone-12, in the *same* baffle. Note the substantial loss of lows below 200 cycles. There is a still more appreciable over-all loss throughout the rest of the range above 200 cycles, and then a final drop-out after 5000 cycles. Fig. 41 shows the polar response of both speakers at 5000 cycles. The losses off-axis of the middle and high frequencies will make an already inferior speaker sound still worse in positions not directly in line with it.

Fig. 40, 41



COMPARISON OF FREQUENCY RESPONSE OF 12" "REPLACEMENT" SPEAKER (A) AND UNIVERSITY DIFFUSICONE-12 (B) IN SAME SMALL ENCLOSURE



COMPARISON OF POLAR RESPONSE OF 12" "REPLACEMENT" SPEAKER (A) AND DIFFUSICONE-12 (B) AT 5000 CPS

Problems with Poor Speakers

What then do these measurements add up to? Sound reinforcement is supposed to sound *natural*; certainly high distortion and poor response on-axis plus drooping response off-axis do not contribute to that. Low level sound should be *background* sound, unobtrusive yet highly articulate. Since frequency and polar response is poor in the conventional speaker, the sound cannot be very articulate (tests show that good high frequency response is important), and because the efficiency of the speaker is equally poor, it must be pushed with more power. Distortion from *both* the speaker and amplifier increases with power output, with the result that the already inherently distorted output of the speaker is further compounded to a substantial amount. Obviously, highly distorted sound cannot long remain *unobtrusive* to the listener for longer than a few minutes. In addition, since the low frequency end of the speaker output is also poor (and rarely are cone speakers operated in such applications with acoustically optimum-sized baffles), the sound from the conventional speaker will be unbalanced. If the amplifier tone control is used to beef up the sagging low end response of the speaker, further distortion results, *and* the power output capability of the amplifier is further reduced.

Better Speakers Cheaper In the Long Run

Some of these deficiencies may be partially overcome by the use of additional speakers and baffles. But since this will call for additional installations of conventionally constructed speakers that can give trouble, one wonders whether it's so economical to use the garden variety speaker at that! No wonder, then, that more and more sound engineers are recommending and pointing out the advantages of quality speakers to the end user. Sound should not distract from the decor environment, comfort and wares of the establishment; rather it should complement them by adding to the atmosphere and pleasantness of the surroundings; put the customer and employee in a receptive, congenial frame of mind. In such applications sound should be *effective* in its particular intent, more sensed than heard. Experiments show that clean, balanced, natural sound can be operated at lower levels... more effectively.

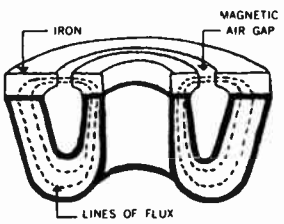
All University Cone Speakers Have These Exclusive Features

All Alnico 5 W Magnet

The exclusive University *W* magnet assembly is a substantial improvement over other designs in conventional use. Except for the prime grade Armco top plate, the *entire* assembly consists of Gold Dot Alnico 5. This eliminates fully 50% of reluctance losses normally present in other designs where the magnetic path must be completed through soft iron bottom plate "keepers" and "U" structures. The all-Alnico *W* shape also helps contain the magnetic energy *within* the magnet, thereby avoiding losses due to surface leakage. The pull of the *W* magnet is so powerful that no bolts or welded joints are required to secure it to the top plate!

Rim-Centered Bi-Sectional Construction

Only University loudspeakers are constructed in two complete subassemblies entirely independent of each other for structural support of integral components. The unique rim-centering design and closely controlled fabrication of these assemblies result in a precision product—vibration-proof and shockproof in operation, built for trouble-free long life. Either section is immediately interchangeable with a replacement subassembly. No special tools, shims, etc., required. Here is truly skilled engineering, second to none.



W-shaped Magnet


Rim-centered Bi-sectional mechanism

Custom-Built, Tropicalized Voice Coil Assemblies

University voice coils are individually precision-wound with meticulous care to ensure uniform response and impedance. Voice coil is wound on a special form designed to achieve life-long perfect concentricity, permitting close coil-to-gap design resulting in greater heat dissipation. Thermo-setting bonding cements are prepared according to an exclusive time-tested University formula. Voice coil/diaphragm assemblies are slowly cured and aged to ensure continuous trouble-free operation. Diaphragms are individually checked for correct taper, dimensions and weight distribution. *All* voice coil/diaphragm assemblies are treated with a special antifungicidal solution, so that wherever a University speaker is used, its built-in superiority remains impervious to the elements.

Permanent Finishes

Commercial and industrial applications are punishing to the finish of any piece of equipment. An enduring finish is important protection to the lasting qualities of speaker performance. *All* raw metals used in University speakers are thoroughly degreased to remove all foreign particles that may give trouble later on. Then, depending on the metal, all parts are irridited, cadmium plated, or anodized. Finally, all surfaces are given a heavy coat of the finest *outdoor enamel,* which is then *baked* to a hard impervious finish. This is the same treatment given our industrial drivers and projectors!

Individually Checked

Every University loudspeaker is carefully followed and checked throughout the manufacturing process; but the final test is the toughest and most revealing...and must be *exceeded* by each speaker before it can be passed through for packing. Speakers are individually operated and test curves run, checked both aurally and visually on a spectrum analyzer. Frequency response, distortion, efficiency and cone resonance are just some of the major check points which must be satisfied before a speaker is released.

University High Fidelity Speakers Popular for Commercial Application

Model 6200 — A very shallow 12" extended-range speaker that will fit into those tight places. Response range will cover general purpose applications.

Model UXC-122 — A 12" 2-way Diffaxial, similar to the Model 6200, except that it includes the exclusive uni-sectional Diffusicone device at the apex to diffuse the middle and high frequencies.

Diffusicone-8 and Diffusicone-12 — Available in both 8" and 12" sizes, these 2-way Diffaxial speakers have high output, extended response and the deluxe multi-section Diffusicone device for superior dispersion characteristics.

Model 308 8" 3-Way Diffaxial — An 8" 3-way powerhouse, capable of filling space with truly clean natural sound. High efficiency and high power further help to make this the most unusual 8" speaker on the market. The deluxe multi-section Diffusicone crossing over mechanically at 1000 cycles provides the mid-range, while a separate driver-driven tweeter with patented "reciprocating flare" wide angle horn takes over at 5000 cps to produce crisp, clean high frequencies.

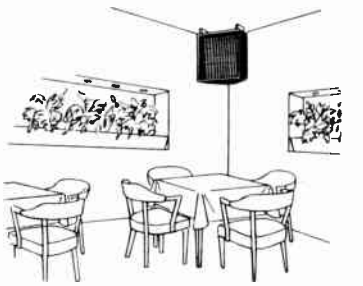
Model 6201 12" Dual Range Coaxial — Where the ultimate in sound is required for use in particularly fine commercial and executive suite installations, the 6201 will have no peer. This speaker comprises a heavy duty woofer and driver-driven tweeter with "reciprocating flare" wide angle horn, crossover at 2000 cycles through a built-in inductive/capacitance network. A high frequency control is provided already wired in, for adjustment to room acoustics.

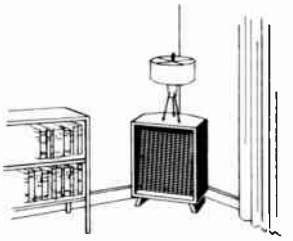
Specifications

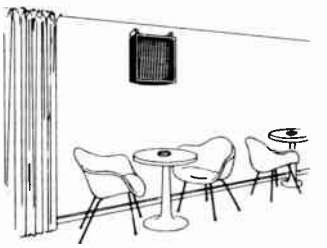
MODEL	DIFFUSICONE-8	308	6200	UXC-122	DIFFUSICONE-12	6201
FREQUENCY RESPONSE	70-13,000 cps	50-15,000 cps	45-10,000 cps	45-13,000 cps	40-14,000 cps	45-15,000 cps
POWER CAPACITY	25 watts	25 watts	30 watts	25 watts	30 watts	25 watts
IMPEDANCE	8-16 ohms	8-16 ohms	8-16 ohms	8-16 ohms	8-16 ohms	8-16 ohms
TOTAL ALNICO-5 WEIGHT	16 oz.	20 oz.	16 oz.	16 oz.	24 oz.	28 oz.
OVER-ALL DEPTH	3⅜"	6¼"	4"	4⅜"	4¼"	8¼"
SHIPPING WEIGHT	3¼ lbs.	5 lbs.	5¼ lbs.	5¼ lbs.	6 lbs.	10¼ lbs.

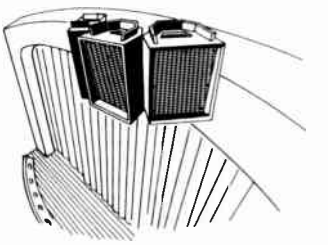
Model TM-812 Enclosure for 8″ or 12″ Speakers

This very unusual, highly versatile enclosure is capable of exceptional performance when employed with *any* of the 8″ or 12″ University high fidelity cone speakers. Its unusually diminutive size and exceptional performance is achieved by a judicious combination of rear wave horn and phase inversion loading for extension of clean fundamental bass and direct radiation for smooth, brilliant treble response. It is suited to installation against a flat wall, in a corner, on the floor or ceiling, on walls, and in clusters. The acoustic design used is not dependent upon external room configurations. The baffle board is tilted, so that when used on the floor, sound is directed upwards, and when used on a wall, the sound is projected downwards. The baffle board is removable from the front; the back of the enclosure is permanently fixed to the rest of the cabinet. Thus, the TM-812 can be easily mounted and secured *directly* to any convenient surface, the speaker conveniently mounted first to the removed baffle board, and then the baffle board replaced onto the already mounted enclosure. Heavy ¾″ wood is used *throughout*, for real ruggedness and best performance. Available in blond as TM-812B, mahogany as TM-812M, walnut as TM-812W and unfinished as TM-812U for easy finishing to any other desired finish. Baffle board is cut out for 12″ speakers. If the enclosure is to be used for 8″ speaker, order 8″ adapter panel at the same time at no extra cost.









Baffling A Cone Speaker

The word "baffle" is commonly used today to describe any kind of an enclosure, either open or closed, in which a loudspeaker is mounted. It is intended to provide a means of loading the loudspeaker in such a manner that the low bass frequencies are adequately reproduced.

Need for a Baffle

The primary purpose of any baffle is either to isolate infinitely the airwaves produced by the rear of the speaker diaphragm, or to extend considerably the distance they must travel to reach the airwaves produced by the front of the diaphragm. Therefore, the size of a baffle (or its resultant air column length in the case of a horn-type baffle), bears a relationship to the lower limit, amplitude and fidelity of the low frequencies it is desired to reproduce, within the capabilities of the speaker used.

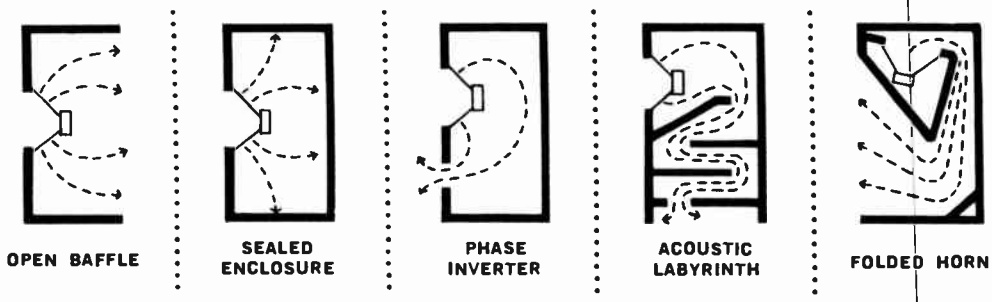
Basic Types of Baffles

Many variations of basic types of baffles exist. However, the following represent the better known and most often used principles:

THE OPEN BAFFLE—May be simply a flat board or open back cabinet, lengthening the distance traveled by the sound waves from front to rear of speaker. This is the simplest to construct but also the least effective. Low frequency response depends upon baffle size. To reproduce 50 cycles at full output would require a baffle *diameter* of nearly 11 feet in this case!

THE INFINITE BAFFLE—An infinite partition that completely prevents any return acoustical path, but of such great proportions that the diaphragm is only slightly loaded, the major load being simply the air load upon it, which affects the resonance characteristics only slightly with minimum damping effects, but does permit low frequency reproduction down to the resonant frequency. A wall between rooms of a house is perhaps the only practical application. An objection to the *true* infinite baffle is its severely peaked response at the speaker resonant frequency.

THE SEALED ENCLOSURE—This is commonly but erroneously called an "infinite baffle." Totally enclosed, it completely prevents the possibility of acoustic return path, but the limited volume of air which is held captive within the enclosure stiffens the speaker cone, raising the system resonance considerably, and sometimes damps the cone beyond a desirable degree. To overcome these faults, baffle size must be large, about 10 cu. ft. of volume being preferable.



THE PHASE INVERTER—Better known as the "bass reflex". Practically a sealed enclosure, but with an opening ("port") in the front so that cabinet resonance works with speaker resonance to produce a wider range of equalized bass response while extending the low frequency limit. The air vent also provides a desirable degree of damping relief. Cabinet dimensions can be kept to a practical limit, generally 4-6 cu. ft.

THE ACOUSTIC LABYRINTH—Similar to the Phase Inverter type baffle, except that "tuning" is accomplished by adjustment of the integral air column length. Advantages are about the same as for the bass reflex baffle, with claims having been made for superior performance, especially with regard to the ability of this type to lower bass response of loudspeaker by a full octave. Major disadvantage is the difficulty for the average home craftsman to design and construct.

THE FOLDED EXPONENTIAL HORN—The exponentially expanded horn is actually an acoustic transformer which, because of its continually expanding cross section, provides an improved mechanical impedance match between the vibrating diaphragm at the small throat of the horn and the large radiating area at the mouth of the horn. This improved mechanical impedance match between the vibrating diaphragm and the surrounding air makes for a high efficiency system.

Factors Affecting Reproduction

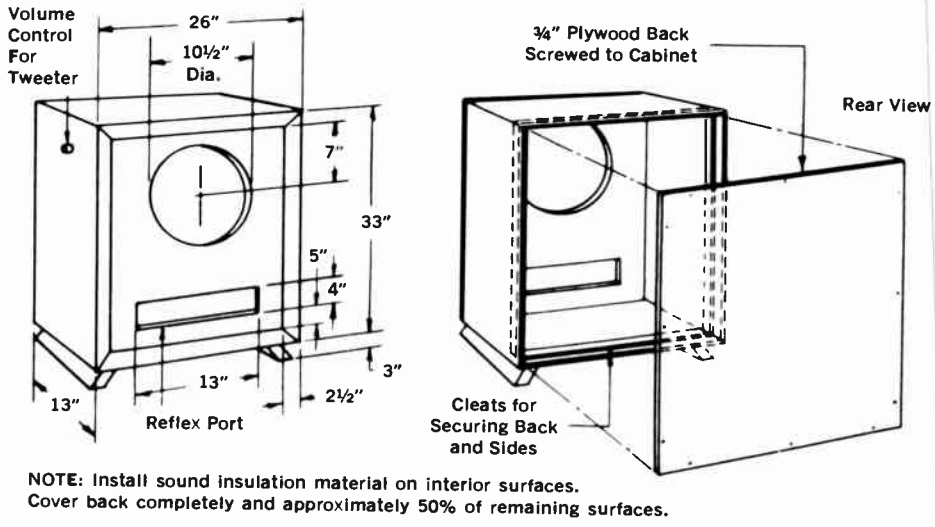
There are essentially four terms requiring a brief definition, each affecting baffle construction and consequent results:

CONE, SPEAKER, BAFFLE, OR SYSTEM RESONANCE—The resonance of a particular speaker cone in free air (the complete speaker, or the baffle with which it is used, or the resonance of the combined system comprising the speaker in its baffle) is that frequency at which the acoustic output is at a maximum amplitude for a given excitation.

DAMPING—Damping expresses the degree to which the excursion of the diaphragm (amplitude of the speaker, or its baffling system) is reduced at resonance, below the free unrestricted level.

TRANSIENT RESPONSE—The transient response of a speaker, or its complete system, is the ability, acoustically, to faithfully follow sudden changes in amplitude of a complex electrical wave shape without sluggishness or "hangover" effects.

Fig. 42



RADIATION RESISTANCE—Radiation resistance is the measure of effective air load into which the speaker system dissipates its acoustic power, thus producing usable sound.

Constructing a Base Reflex Cabinet

Popularity of the bass reflex type baffle is due to its relative ease of construction, small space requirements and satisfactory over-all performance. As a general rule, speakers of 12" size and up should be installed in a cabinet of not less than approximately 4 cubic feet volume. However, by proper proportioning of the port, smaller-sized baffles can be used with gratifying results. Decide upon the dimensions of the baffle to be built, in accordance with physical requirements, but try to keep the inside depth of the cabinet to not less than 12". All sides should be made of heavy, seasoned wood (preferably ¾" plywood). All corners must be thoroughly braced to prevent buzz noises at cabinet resonance. The removable side (usually the back) should be secured at the corners, as well as approximately every 4" along the edges. Unless the front panel is absolutely flat and free from warping, a mounted speaker might undergo physical stresses which will affect reproduction. Inner surfaces of the cabinet should be lined with a sound absorptive material, such as celotex, rockwool, etc. It is usually a good idea to line all of the backside and about 50% of the remaining surfaces. So as not to attenuate the high frequencies, the grille cloth should be an open mesh material consistent with good appearance. Holding selected materials up to a source of light will give you some idea of their absorptive qualities by their ability to pass light.

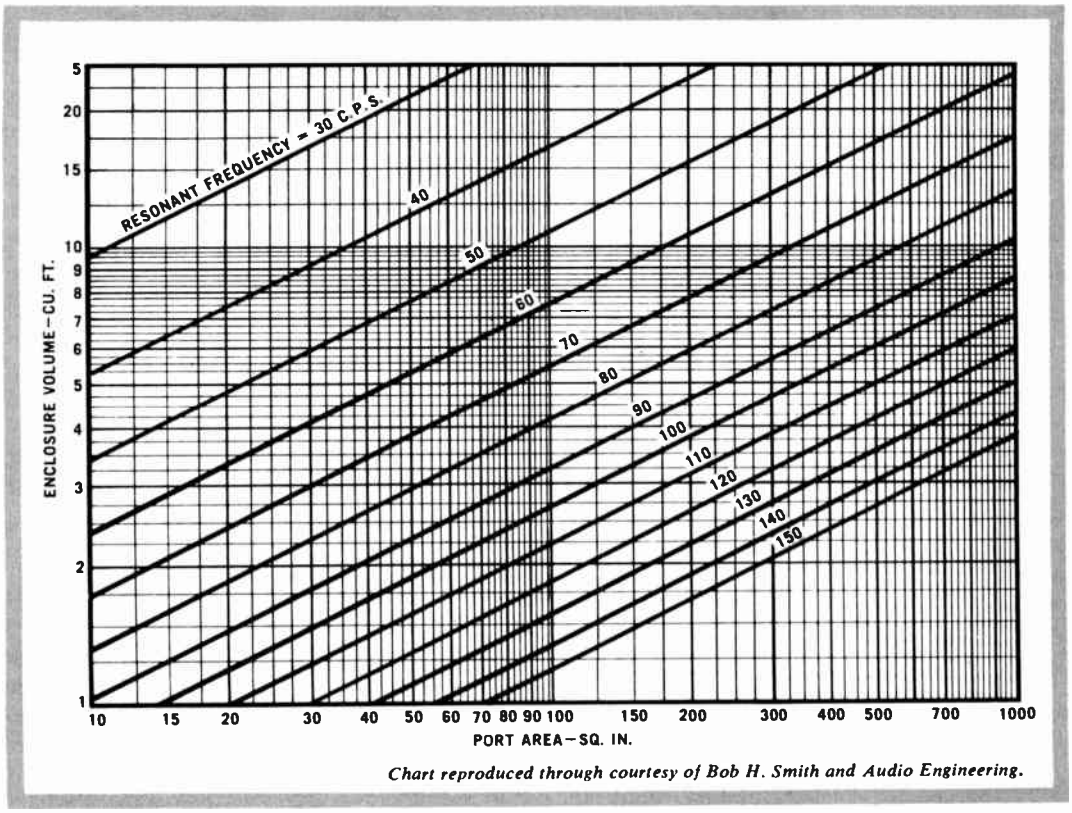


Chart reproduced through courtesy of Bob H. Smith and Audio Engineering.

Fig. 43

OPTIMUM PORT AREA FOR BASS REFLEX ENCLOSURE

Tuning the Port

The port of a bass reflex baffle is considered properly tuned for best low frequency response of the speaker system when the bass response has been equalized and spread out over as wide a range as possible. Peaking or excessive boominess is an indication of an improperly dimensioned port. It is possible to plot a curve for each change in port area to determine the correct size. An audio signal generator, used as a variable signal source, is connected to the input of the amplifier (all tone controls set at normal), and voltage readings taken at the voice coil of the speaker with an A.C. voltmeter or output meter (at least 1000 ohms-per-volt).

To simplify this one critical factor in constructing a bass reflex cabinet, Fig. 43 provides optimum port area for given cabinet volumes and loudspeaker free air resonances. A simple method of determining the *speaker resonance* is to place the speaker on a table in open air and apply single sine wave frequencies directly to the voice coil terminals or through the amplifier to be used. Starting at about 200 cycles, slowly decrease the frequency until the point is found where the cone excursions are most severe. Once the port area is determined, the actual dimensions will not be found to be critical. The port opening is generally placed as close to the speaker as possible.

Architects' and Engineers' Specs

Diffusicone-8

Speaker shall be 8" high fidelity extended range cone type with a rated frequency response of 70 to 13,000 cycles and a power capacity of 25 watts integrated program. At least 16 oz. of Alnico 5 *W* magnet shall be used in a rim-centered bi-sectional assembly. A 2" voice coil shall be tropicalized and be rated for use with 8 to 16 ohms input. Diaphragm shall be a one-piece mold with plasticized rim-edge treatment and a multi-section Diffusicone at its apex. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 3⅜". University Diffusicone-8 is specified.

Model 308

Speaker shall be a high fidelity integrated 3-way Diffaxial with an 8" cone woofer, multi-section Diffusicone and driver-driven tweeter with "reciprocating flare" wide-angle horn, all true coaxially assembled. Frequency response shall be rated as 50 to 15,000 cycles and have a power capacity of 25 watts integrated program. The woofer shall have at least 20 oz. of Alnico 5 *W* magnet in a rim-centered bi-sectional assembly. A 2" woofer voice coil shall be tropicalized and the speaker shall be rated for use with 8 to 16 ohms input. Tweeter driver shall be hermetically sealed in a spun-over aluminum housing and shall have a threaded head casting in order to unscrew from the horn. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 6¼". University Model 308 is specified.

Model 6200

Speaker shall be 12" high fidelity extended range cone type with rated frequency response of 45 to 10,000 cycles and a power capacity of 30 watts integrated program. At least 16 oz. of Alnico 5 *W* magnet shall be used in a rim-centered bi-sectional assembly. A 2" voice coil shall be tropicalized and be rated for use with 8 to 16 ohms input. Diaphragm shall be a one-piece mold with plasticized rim-edge treatment and a dural dome at its apex. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 4". University Model 6200 is specified.

Model UXC-122

Speaker shall be 12" high fidelity extended range cone type with a rated frequency response of 45 to 13,000 cycles and a power capacity of 25 watts integrated program. At least 16 oz. of Alnico 5*W* magnet shall be used in a rim-centered bi-sectional assembly. A 2" voice coil shall be tropicalized and be rated for use with 8 to 16 ohms input. Diaphragm shall be a one-piece mold with plasticized rim-edge treatment and a uni-sectional Diffusicone element at its apex. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 4⅜". University Model UXC-122 is specified.

Diffusicone-12

Speaker shall be 12" high fidelity extended range cone type with a rated frequency response of 40 to 14,000 cycles and a power capacity of 30 watts integrated program. At least 24 oz. of Alnico 5 *W* magnet shall be used in a rim-centered bi-sectional assembly. A 2" voice coil shall be tropicalized and be rated for use with 8 to 16 ohms input. Diaphragm shall be a one-piece mold with plasticized rim-edge treatment and a multi-section Diffusicone at its apex. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 4½". University Diffusicone-12 is specified.

Model 6201

Speaker shall be a high fidelity dual range 2-way coaxial with 12" cone woofer and driver-driven tweeter with "reciprocating flare" wide-angle horn through-axially assembled. Frequency response shall be rated as 45 to 15,000 cycles; power capacity 25 watts integrated program. The woofer shall have at least 24 oz. of Alnico 5 *W* magnet in a rim-centered bi-sectional assembly. A 2" woofer voice coil shall be tropicalized. Tweeter shall be hermetically sealed in a spun-over aluminum housing and shall have a threaded head casting in order to unscrew from the horn. An inductance/capacitance 2000 cycle crossover network shall be mounted inside the speaker under a spun aluminum coverall and completely wired to the woofer and tweeter together with a high frequency control. Speaker shall be rated for use with 8 to 16 ohms input. Speaker shall be finished in baked enamel. Depth of speaker shall not exceed 8⅜". University Model 6201 is specified.

Model TM-812

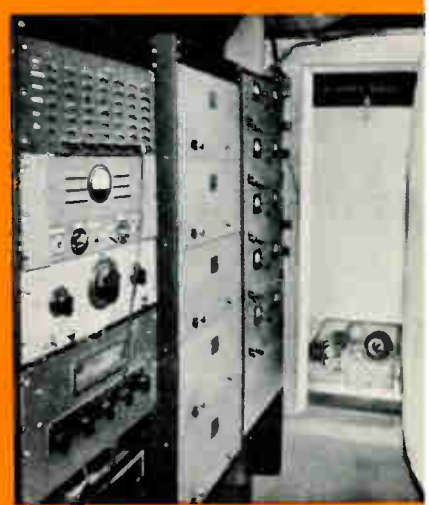
Enclosure shall be "cornerless-corner" design using direct radiation and phase inversion loading of the rear sound waves emanating from a horn vent at the base of the enclosure. 3/4¼ thick wood construction shall be used throughout, with back of enclosure permanently secured, and tilted speaker baffle board removable from the front. Baffle board shall be cut out for 12" cone speaker and be capable of taking 8" speaker with suitable adapter board. Over-all dimensions shall not exceed 21¼" height, 15½" width and 12½" depth. University Model TM-812 is specified.

BEHIND THE UNIVERSITY TRADITION OF "BETTER PRODUCTS AT LOWEST POSSIBLE COST"

NEW IDEAS, born in the imaginative minds of experienced acoustical engineers, take practical form on the crafting boards of skillful mechanical engineers. University's pace-setting leadership is the result of its ability to carry through a constant program of research and production improvements, facilitated by a magnificently equipped, completely self-sufficient modern plant.

SELF-SUFFICIENCY in every production stage contributes to University's superior quality. Casting, spinning and stamping are all performed under one roof. Anti-corrosion conditioning of raw and finished metal is done in our own degreasing and plating department. For utmost protection, the finest all-weather enamel is generously applied and oven-baked to a durable, peel-proof finish.

SKILLED TECHNICIANS meticulously fabricate the diaphragm and voice coil assembly ...heart of a speaker system...with every step closely supervised to guarantee the perfection demanded by University standards. This highly developed art allows extremely sensitive speaker driving units to withstand the tremendous concussion waves from a 5" high-explosive cannon as simulated by the testing device shown here...an exact replica of the one used by the National Bureau of Standards.



GUESSWORK IS ELIMINATED at University. Actual performance testing in anechoic chambers determines conformity to theory. Elaborate inspection techniques assure the adherence of each and every speaker produced to rigid standards. In addition, a torture chamber subjects samples from every run to life-tests under the most grueling conditions to make doubly certain that University products are durable and will always represent the very finest in performance, quality and value.

Products described in the Technilog are protected by one or more of the following U. S. Patent numbers: 163,616; 2,494,134; 2,532,413; 2,532,414; 2,538,026; 2,545,961; 2,546,343; 2,546,344; 2,550,359; 2,641,329; 2,690,231; 2,746,558; 2,751,996; 2,755,343; and other patents pending

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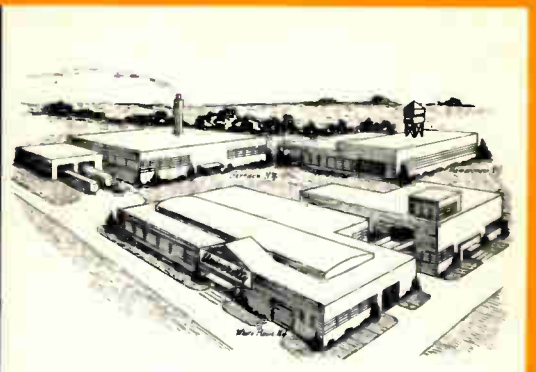

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