

LESSON
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PUBLIC ADDRESS AND SOUND SYSTEMS



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PUBLIC ADDRESS AND SOUND SYSTEMS

Public address or sound systems are employed when a large group of people are to be served or entertained with a single program that in itself could not be heard intelligibly over the same large area. Such sound systems are applicable both for outdoor and indoor use. For example, in churches and lodge rooms a microphone can be placed conveniently on the rostrum and a number of loudspeakers distributed through the room so that all persons can hear the speaker equally well. Similarly, in a large convention hall or stadium a sound system can be used to distribute the announcer's voice uniformly through the entire auditorium. Additional speakers can also be installed outdoors or in adjoining rooms to carry the messages to any overflow crowds. In school buildings sound systems are used extensively for announcing messages from the principal in the main office to the various classes and assembly rooms. And in the home a small sound system serves excellently for furnishing music for dancing, etc.

Outdoors the applications of sound systems are just as numerous. At race tracks, athletic meets, baseball and football games, etc., those attending are accurately informed of the progress of events through a series of loudspeakers connected to a central microphone in the announcer's cage or on the observation platform. Another important application of outdoor sound systems is as mobile equipment on sound trucks, by means of which advertising announcements, political speeches, etc., can be broadcast through the streets.

A COMPLETE P. A. OR SOUND SYSTEM CONSISTS OF -

A complete public address or sound system consists essentially of the sound sources or input devices that pick up the signals to be amplified, the power amplifier, and the reproducer system or speaker installation. In addi-

tion there is the auxiliary equipment such as the connecting cables, the coupling units, the mixing and gain controls, etc.

The commonly used sources in public address work are microphones, phonograph pick-ups, and radio receivers (tuner and detector). Either one or several of these sound sources can be connected to the same amplifier for reproduction; but since the signal voltage output of a radio receiver is many times as great as that of a phonograph pick-up, and the pick-up signal in turn is very much stronger than the signal output of a microphone, special coupling transformers and mixing or blending controls must be provided to bring the various signals to nearly the same level. In the case of microphones special pre-amplifiers are often employed to bring up the signal strength to the value needed for the input of the amplifier.

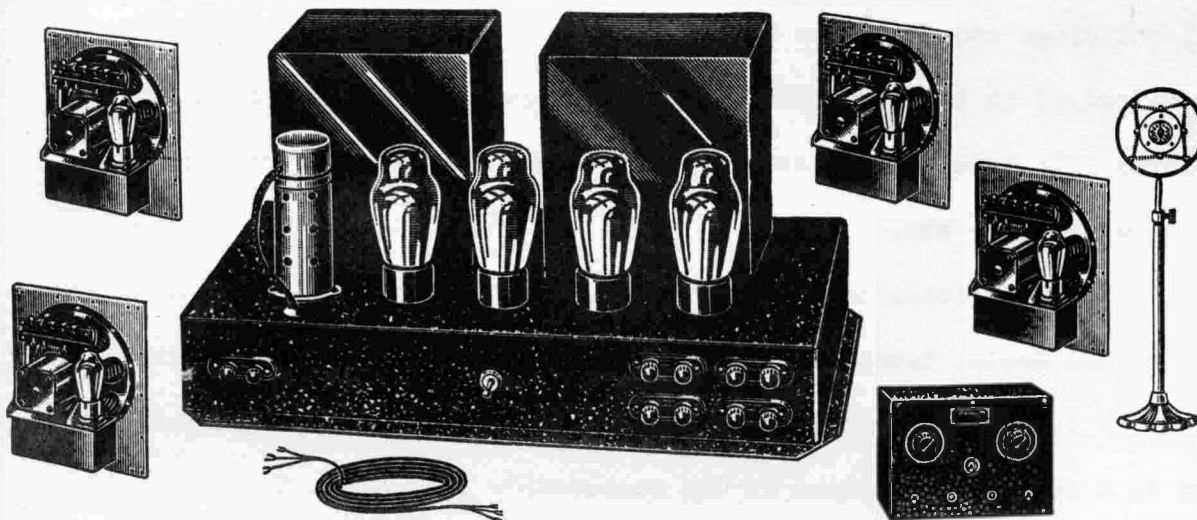


Fig. 1. A complete public address system consisting of a microphone, input control and fader housed in rectangular box, connecting cords, power amplifier, and four dynamic speakers.

The transformers serve not only to couple the various circuits, but also to match or balance the circuit impedances of the sound source and the amplifier input so that maximum transference of signal energy is obtained. The mixing controls consist of a network of fixed and variable resistors for varying the signal voltage without introducing distortion by changing the frequency characteristics. They are generally referred to as pads, L pads or T pads, depending

upon the number and the arrangement of the resistors. Special preliminary amplifiers are also used when the sound source is at a great distance from the main power amplifier to boost the signal voltage and compensate for the losses that occur in the line.

MUSIC, NOISES AND SPEECH

Sounds, it will be remembered, reach our ears in the form of a wave motion through the surrounding air, and this wave motion is merely a disturbance set up in the air by some vibrating object. The manner in which the object vibrates determines the kind of air waves (sound waves) that are sent out, and the nature of the sound sensation produced in the ears. If the object vibrates in a regular and uniform manner, the sound waves created are also of a uniform nature, and a pleasing or musical sound sensation is produced. But if the object vibrates in an irregular and erratic manner, correspondingly irregular waves are sent out, and an unpleasant sound sensation is produced called noise. Thus the only difference between a musical sound and a noise is the regularity and shape of the wave motion.

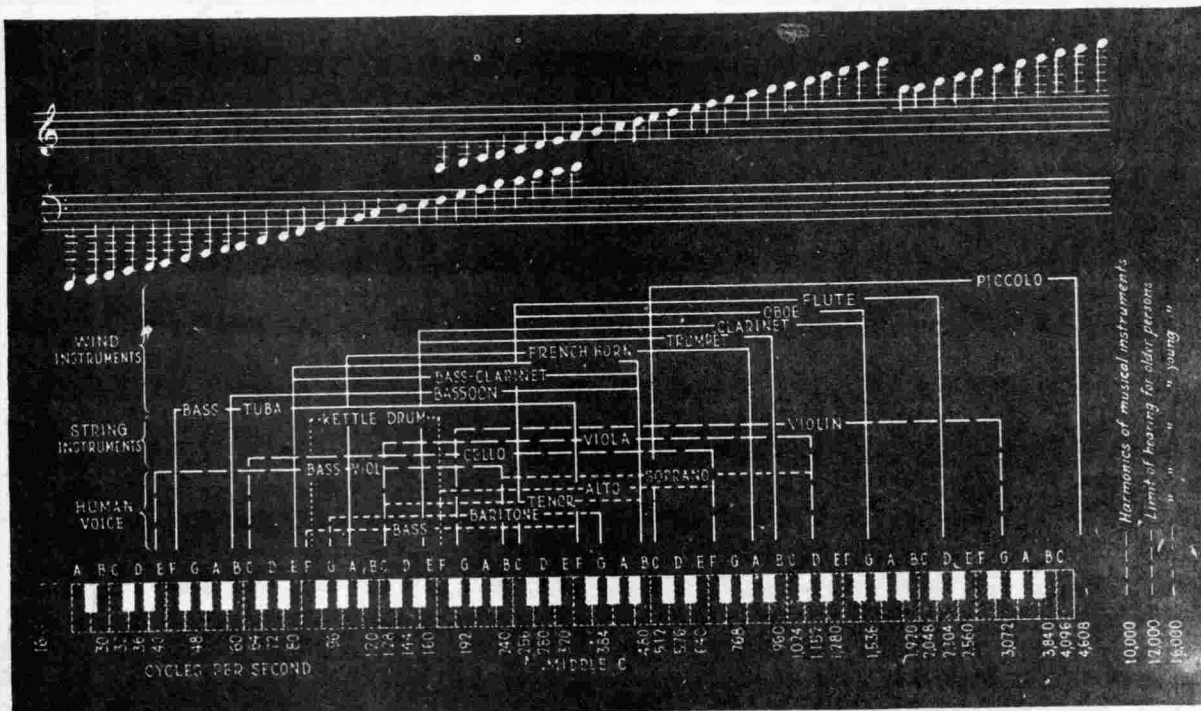


Fig. 2. Audio frequency chart showing the range of the various musical instruments and of the human voice.

The rate at which the object vibrates regulates the number of sound waves that are sent out and that strike the ear drum, and this frequency determines the pitch of the sound, that is, its degree of highness or lowness. One complete back and forth vibration creates one sound wave, and this operation is called a cycle. The pitch of a sound or frequency is therefore expressed in cycles per second. The chart shown in Fig. 2 illustrates the frequency range of the different types of musical instruments and of the human voice.

The intensity with which the object is struck and set into vibration governs the strength of the sound waves and the power with which they strike the ear drum. This determines the degree of loudness of the sound. The louder the sound the greater the dissipation of energy do the waves represent. This means that the larger the volume output needed from a P.A. system, the larger and greater in number must be the power tubes used in the last stage of the power amplifier, so that sufficient energy can be imparted to the speaker system.

HARMONICS AND TONE QUALITY

When a sound producing object is in vibration, it generally not only vibrates as a whole unit, but also vibrates additionally in sections, and as a result the vibratory motion is often very complex in nature. The frequency of the object when vibrating as a whole unit is known as its fundamental or basic frequency, but the sectional vibrations are higher in frequency and are called overtones or harmonics. When the object vibrates in two sections, the frequency is twice that of the fundamental and is called the second harmonic. When the frequency is three times that of the fundamental, it is known as the third harmonic, etc. The 2nd, 4th, 6th, etc. harmonics are often referred to as the even harmonics and the 3rd, 5th, 7th, etc. as the odd harmonics.

It is evident that more or less of these sectional vibrations will materially affect the vibrating nature of the whole object; in other words, the presence of harmonics or overtones will mould the shape of the sound waves produced and determine the quality of the sound heard. This quality of a sound as determined by the presence of various harmonics or overtones is spoken of as its timbre. It is the number and kind of harmonics present that impart individuality to a tone and that enable one to recognize the tone and distinguish its source. For example, the note A struck on the piano and played on the violin will each have the same fundamental frequency, but they will sound entirely different due to the presence of different harmonics or overtones. Similarly, it is the harmonics in a spoken sound that enable one to recognize the person speaking. The mellow and pleasing tone delivered by high grade musical instruments is due to certain harmonics that are the result of special constructional features.

DISTORTION IN P.A. SYSTEMS

When sounds are put through several transformations, as when they are sent through a complete P.A. system, it is very important that they be ultimately reproduced in their true nature, that is, the output must in all respects except intensity duplicate the input. For example, after sounds enter the microphone and are changed to electrical impulses, these impulses pass through the mixing controls consisting of a network of resistors and then enter the amplifier. Here they travel through a series of amplifying tubes, transformers, resistors, condensers, etc., and finally reach the loudspeaker where they are changed back to sound. And after passing through all these stages, every frequency present in the original sounds must reappear, and each must have received the same treatment. None of the harmonics originally present may be lost or destroyed, and no others may be added. The loss or addition

of any harmonics changes the shape of the sound waves and alters the quality or timbre of the sound, and the reproduction will differ from the original. Such deformation is called distortion.

If some frequencies are amplified more than others, due perhaps to the amplifier being resonant to some frequencies within the working range, the shape of the waves will be changed. Such a condition is referred to as frequency distortion. Also, if the output signals are not directly proportional to the input, non-linear amplification results, and the effect is known as amplitude distortion. For example, if an audio amplifier tube is overloaded, that is, the grid permitted to swing positive, the plate circuit output is deformed due to the appearance of 2nd and other even harmonics. Such distortion is also frequently referred to as harmonic distortion.

All this means that for best results from a P.A. system, only the highest grade component parts should be employed, and the circuits should be designed to permit the amplifying tubes to perform under optimum conditions.

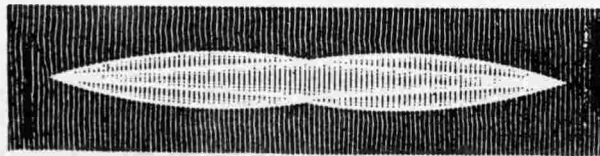


Fig. 3. A piano string vibrating both as a whole and in two sections. It is these sectional vibrations that produce the harmonics and determine the quality of the tone that enables one to recognize its source.

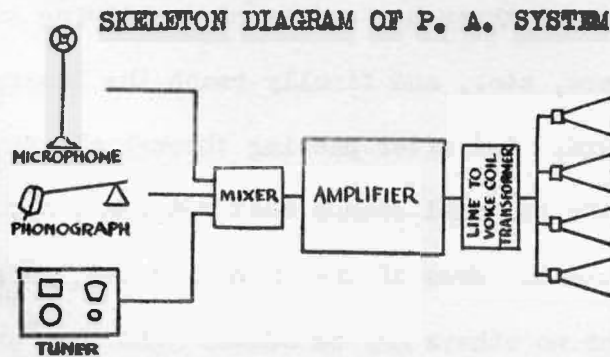


Fig. 4. A skeleton diagram of a sound system showing the different kinds of input devices or sound sources. Page 6

A typical public address or sound system is illustrated diagrammatically in Fig. 4. The input may consist either of a microphone, a phonograph pick-up or a radio tuner and detector. Either one, two, or three of these input units can be used in a single installation. A very common combination is a microphone for making the announcements and a phonograph pick-up for furnishing the music. These units are tied together through a mixer or fading control by means of which the input to the amplifier can be shifted or blended from one unit to the other. The mixers also serve to some extent as volume controls.

The signal next enters the main amplifier, which is merely an expanded form of audio amplifier to yield greater amplification, the number and types of tubes used depending upon the gain in signal strength needed and the amount of power that is required to operate the speaker or reproducing system. The amplifier is equipped with a gain control (sometimes also called the volume control) which regulates the gain in signal voltage as the signal passes through the amplifier. Some form of volume or level indicator is employed for indicating to the operator the strength of the signal that is being put out and supplied to the distribution lines. A monitor loudspeaker is also used at the output of the amplifier as a means for the operator to listen in and check the quality of the reproduction and observe if any corrections are necessary.

If long lines are used between the amplifier and the speakers, so-called line equalizers are used to compensate for the detrimental effects that the inductance and capacity of the lines may have. With long lines small local amplifiers may also be necessary to make up for the line losses that occur. The number and kinds of loudspeakers used will depend upon the nature of the installation, the area to be covered, and the volume that is desired.

With the various parts described and illustrated previously, numerous combinations can be built together to meet the requirements of any particular sound system.

RADIO TUNERS

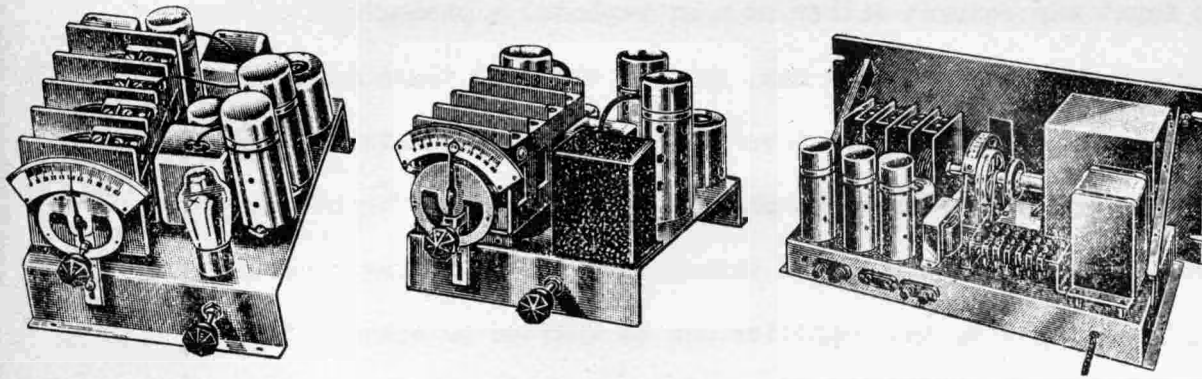


Fig. 5. Several types of radio tuners for sound systems.
Made by Lafayette Radio Mfg. Co., New York.

Radio tuners that are employed to be used in connection with power amplifier systems consist of a high grade frequency amplifier, either of the tuned radio frequency or superheterodyne type, and demodulating detector, but without the customary audio amplifier used in the regular radio receiver. The output of the detector is coupled through a suitable transformer to the main amplifier and then distributed to the various speakers connected into the system.

Some manufacturers and designers prefer a radio tuner of the tuned radio frequency type and others the superheterodyne type. Although the superheterodyne tuner is superior in many respects, it lacks the fidelity and tone quality that are available with a T.R.F. tuner. In metropolitan districts where good selectivity is essential the superheterodyne tuner would be chosen, but if tone quality is more desired and selectivity is not such an important factor, the tuned radio frequency receiver is preferable. However, for the average installation a superheterodyne tuner is used, for it really takes well trained ears to distinguish the difference. Also, the superheterodyne tuner lends itself more readily to automatic volume control action, which is a desirable feature, especially since the installations in many cases are not always under

the constant observation of an operator.

In installations employing several different sound sources, the different units are generally mounted on uniform steel panels and supported on a vertical angle-iron rack. The various controls are then mounted on one special panel, so that the entire installation can be conveniently controlled and operation shifted at will from one sound source to another. Any of the various speakers can also be cut in or out as desired. In some installations the radio tuner has its own power supply unit and in others the high voltage power is supplied by the main amplifier. But a separate filament supply transformer is used for the tuner.

SOUND AMPLIFIER SYSTEMS

Sound amplifier systems serve to amplify the electrical output of the sound sources described previously so that the programs can be reproduced with much greater power and distributed through a group of loudspeakers, whereas otherwise the original reproductions would be audible only with the normal volume and intelligible to only a relatively small group of people.

The signal output voltages of the different kinds of pickups, microphones and radio tuners it was stated, vary widely, and if two or three such sources are to be operated through a single amplifier, provision must be made at the input to the amplifier that all source voltages will be brought up to or reduced to approximately a common level near the input voltage required by the amplifier. Also, means must be provided for shifting operation from one source to the other smoothly and without any abrupt break in the continuity. These adjusting and program shifting or transfer operations are performed by a special section of a public address system known as the mixer. In a small simple installation such a mixer may consist merely of a plain center-tapped variable resistor similar to an ordinary volume control, but in a larger installation it will consist of a rather complex network of fixed and variable resistors so that the proper signal voltage relations in the various circuits can be established.

The amplifiers used in public address and sound systems vary greatly in circuit design and construction, and range from simple 2-stage audio amplifiers employing power tubes of medium power output, to large 3 and 4-stage amplifiers equipped with tubes of great power handling capacity. Some of these amplifiers are built on steel chassis for resting on a shelf or table as shown in Fig. 12, while others are built on steel panels and supported on angle-iron or pipe uprights.



Fig. 12

TYPICAL RACK AND PANEL ASSEMBLY

A typical rack and panel assembly as used in a modern central distribution sound system is shown in Fig. 13. Here all the various component parts are mounted on steel panels that in turn are supported on two vertical angle iron uprights. Different combinations of units can be assembled in this manner to meet the requirements of any particular installation.

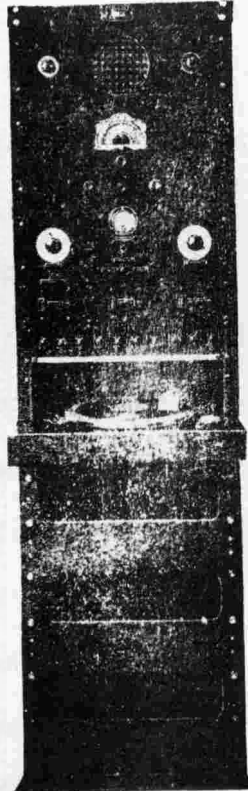


Fig. 13. A system illustration rack and panel type of construction.

In the illustration shown, the uppermost panel contains a monitor speaker with a constant impedance volume control and a selector switch through which the speaker can be cut into any of the various distribution channels so that the operator can listen in to observe if the sound output is satisfactory. The second panel is a radio tuner and detector chassis of the superheterodyne type. The third panel is a program control panel and contains a master volume control, microphone current control, program selector switch and microphone current meter with cut-in jacks. The fourth is the power control panel and contains three master A.C. switches and pilot lights to indicate which circuits are on or off.

The next is a narrow panel called the speaker selector panel with ten selector switches for controlling speakers at various locations. Double-pole double throw switches are used so that when the speaker is cut out, a load impedance is switched in. This arrangement maintains a constant load on the output system. The sixth panel is a phonograph panel and contains a phonograph motor with 12-inch turntable; also a volume control and the necessary A.C. control switches. The lower three panels contain the various sections of the main power amplifier that amplifies the output of the different sound sources for distribution through the various speaker channels.

- END OF LESSON -

EXAMINATION QUESTIONS ON FOLLOWING PAGES