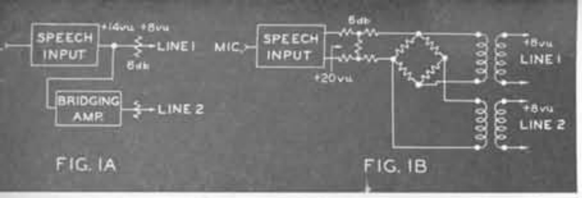


FIG. 1A FIG. 1B

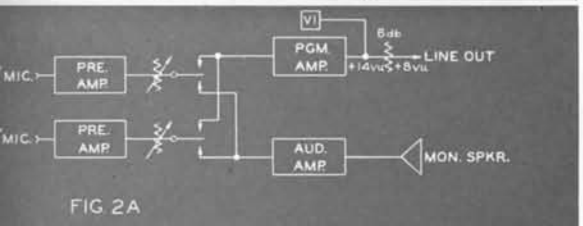


FIG. 2A

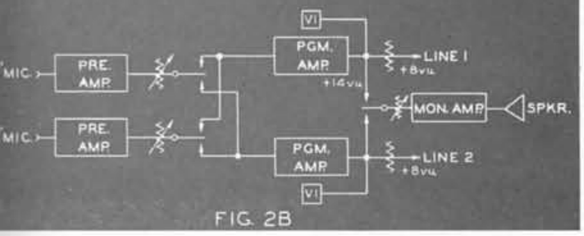


FIG. 2B

SPEECH INPUT SYSTEMS

A Thorough Discussion of the Practical and Theoretical Aspects of Various Systems

By

C. M. LEWIS, Speech Input Sales Manager

J. D. COLVIN, Design Engineer

Presented Before the Fourth Annual Broadcast Engineering Conference, Ohio State University, Columbus, Ohio.

BROADCAST engineers, like the proverbial postman who takes a long walk on his day off, are often found visiting other broadcast stations. We are all interested in knowing how our colleagues meet their particular problems because we learn unusual methods which can benefit our own stations. It is practically impossible for an operating engineer to visit every new installation. For this reason we have prepared an outline describing the major type of speech input systems in use today. Few speech input systems are alike in every respect. Each varies in the number of studios, network connections and programming requirements.

This paper is divided into two parts. The first describes practical schemes for switching output channels, remote inputs and monitoring systems. The second part deals with actual installations which are successfully performing their required functions. In order to make the paper as comprehensive as possible, systems are described which vary from the relatively simple one transmitter installation to the comparatively complex multiple studio and multiple output layout.

PART I

Multiple Output Systems

The simplest system is the one consisting of an assembly of amplifiers and mixers by means of which one or more microphones are fed to one transmitter or outgoing line. An expansion of this circuit is required whenever it becomes necessary to feed more than one output as, for example, the transmitter and a network or two transmitters. The two outputs should not be multiplied directly or connected together in a simple mixer because insufficient isolation is obtained with the result that any objectionable noise originating on either of the lines will also interfere with the other. Two successful methods are used, and are shown in Fig. 1. The first employs a bridging line amplifier (Fig. 1A). The input of the amplifier has a high impedance (usually 20,000 ohms) and may be connected across the main program bus without affecting its level or characteristics. Sufficient gain is provided in the amplifier to overcome the bridging loss and to furnish an output level which is the same or greater than the input. Since the amplifier is a one-way device, perfect protection is afforded the main bus. If two amplifiers are used, one in each output, complete isolation is obtained between the two lines. The second method utilizes a bridge circuit and is less expensive but has a few disadvantages. As shown in Fig. 1B, the output of the program amplifier is fed into one leg of a Wheatstone bridge and the two output lines are connected across opposite corners of the bridge. Any undesirable voltage generated on either line will be attenuated approximately 40 db before getting on the other line, but the program is attenuated only 6 db to each line. In actual practice, we have found that high quality line coils are usually required between the bridge and the lines to insure correct balance. A 6 db impedance isolation pad is also desirable between the amplifier and the bridge. The disadvantages of the bridge circuit are the high loss of 12 db in the amplifier's output, the limited attenuation between lines and the fact that both outputs must be operated at the same level.

When more than one studio is involved, some arrangement for selection of the proper studio is required. Simultaneous broadcasting and auditioning is of great importance to the programming and sales departments. When only two studios are to be fed to one output and a minimum of equipment is desired, the simple arrangement shown in Fig 2A may be employed. By inserting key switches in the outputs of the respective mixers, each studio

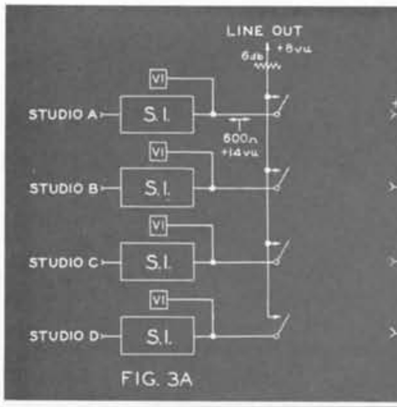


FIG. 3A

FIG. 3B

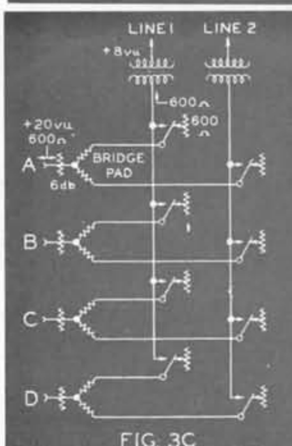


FIG. 3C

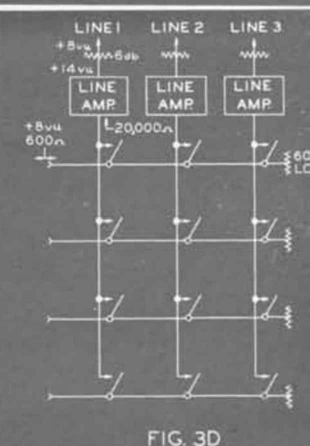


FIG. 3D

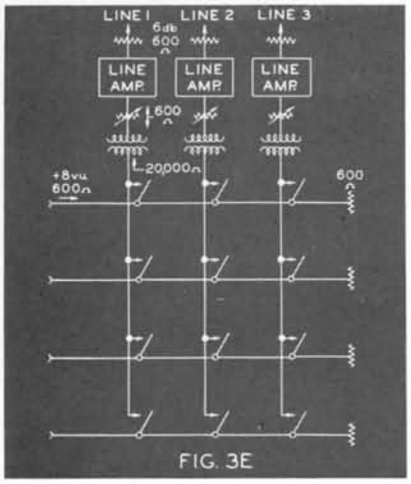


FIG. 3E

can be connected to either the program amplifier or the audition amplifier. Thus it is possible to be broadcasting from one studio while auditioning from the other. An alternative and more flexible version of this arrangement is indicated in Fig. 2B. By making the audition amplifier a duplicate of the program amplifier, it can be used to feed a second output. A separate monitoring amplifier with a selector switch will then be required.

As the number of studios is increased, it becomes desirable to have separate and independent amplifiers and controls for each studio. With independent systems for each studio, it is possible to use more than one operator at a time which permits simultaneous broadcasting or rehearsing from any combination of studios. Fig. 3A shows a basic circuit for connecting one output to any one of several studios. Some means should be provided to interlock the studio outputs so only one can be fed to the output at a time. If it were possible to connect two or more studios to the output, a serious impedance mismatch and possibility of accidently interfering with the program would result. If the output switching can always be done from the same location, as in the case of a central control room operating several studios from one control desk, the output selector may be a mechanically interlocked pushbutton switch. However, if the switching is to be operated from various locations, relays should be used for the master selectors. The relays can be made to operate from output keys at each studio control and interlocked so that only one relay will close at a time. A convenient interlocking system is one in which the circuit is so connected that, if all the studio keys are "off," any one key can close its respective relay. The succeeding studio operator would then close his key when ready but would not get the output line until the preceding studio's key had been released. Suitable indicating lamps, operated from contacts on the relays, may be used to inform each operator when the output line has been transferred to him.

Should it become necessary to simultaneously feed the outputs of two or more studios into one outgoing line, one of the studio controls should be designated as the master. The outputs from the other studios should then be routed through the master in the same manner as for remote pickups. This is the only sure method of insuring correct output level and proper balance.

Fig. 3B is a simple arrangement for selecting between two outgoing lines. Double rows of pushkeys or relays are provided and connect to loading resistors, when normal. Since the selectors are interlocked only in the vertical rows, it is possible to feed any one studio to either or both of the outgoing lines. Like Fig. 3A, these selectors can be pushkeys or relays. Although inexpensive, this system has the disadvantage of practically no attenuation between outgoing lines when they are being fed from the same studio. Also, the mixer loss must be overridden by operating the studio equipment at a higher output level. Considerable improvement in line isolation may be obtained by using the Wheatstone bridge circuit as shown in Fig. 3C. The isolation between outputs is greatly improved over the arrangement in Fig. 3B but the disadvantages of program level attenuation and the necessity of operating both outputs at the same level are still present.

A worthwhile improvement in operating performance is obtained with the arrangement shown in Fig. 3D. Here only a +8 vu output level is necessary for each studio. The studio's output is loaded with a 600 ohm resistor. Line amplifiers with high impedance (bridging) inputs are used in each outgoing line. This method has the advantage that either one or all of the outgoing lines are fed from any studio without affecting the program level or characteristics. Complete isolation is obtained between channels and different levels may be fed to each outgoing line if necessary.

Relays may be used instead of pushbuttons to permit operating the master selectors from any desired remote position. Each studio control can be provided with a remote control station from which

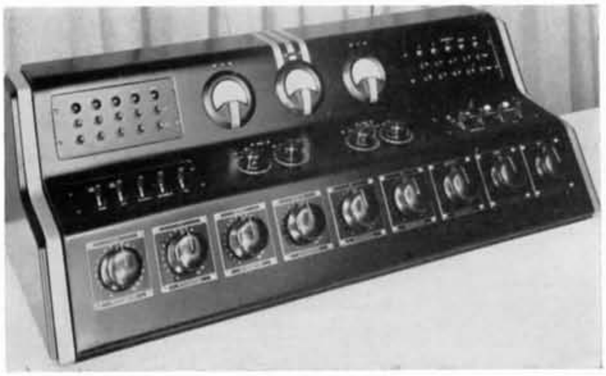
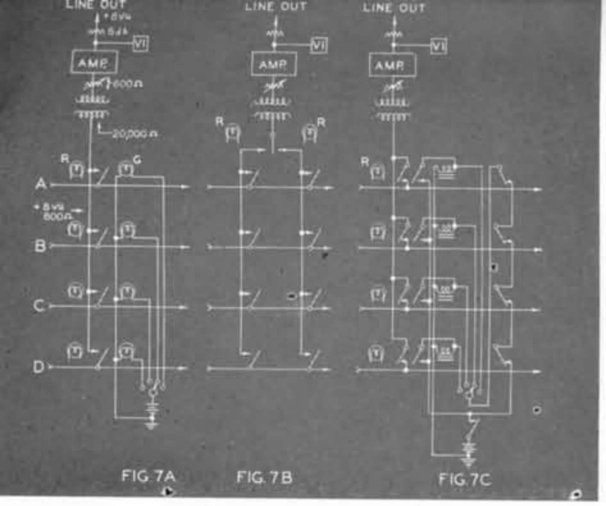


Fig. 4—Master Control Console at WHBC, Canton, Ohio.

Fig. 5—Master Switching at WOV, New York.

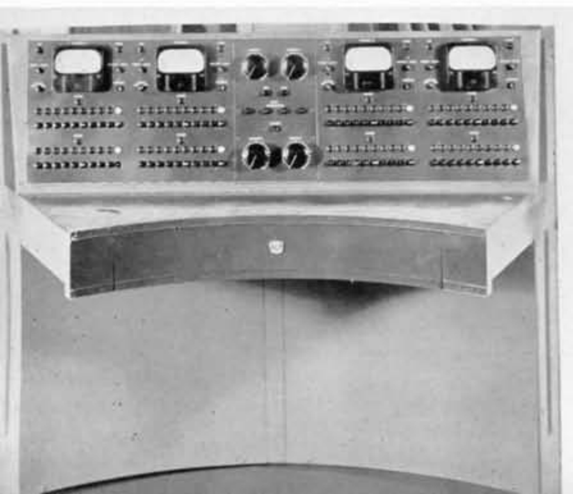
Fig. 6—Master Control Panel at WIRE, Indianapolis.



the complete master control can be operated. A typical control of this type is shown in Fig. 4. The studio mixer console is equipped with two panels of master control selector keys. A panel is used for each of the two outgoing channels. From this console, any of the three studios, the remote pickup input, and the incoming network may be dispatched to either outgoing channel. Another example is shown in Fig. 5 which consists of a remote master control console. One of these consoles is located in each studio control room and provides switching facilities for five studios and three outgoing channels. Indicator lamps show the circuits in use and a standard vu meter may be switched across the output of each of the three channels. The "READY" lamps and keys are for simplified "present" as described in Figure 7A.

Whenever a master control position is utilized, it is desirable to have master gain controls in each outgoing line. These controls are usually operated at a normal attenuation of 10 or 15 db and can be increased or decreased as required. They also permit the operator to fade an outgoing channel and thereby avoid a sudden break. The master gain control should not be connected in the output of the line amplifier because its attenuation will necessitate the operation of the amplifier at a high output level resulting in increased distortion. The preferred method is to connect the master gain control in the input to the line amplifier and use bridging coils between the selectors and the variable attenuators as shown in Fig. 3E. This system is ideal because it has advantages of all the others. The program may be easily and quickly dispatched to six or more outgoing lines from any number of studios. The actual switching is accomplished without affecting the level or load impedance of the circuits involved. A typical panel layout of a system of this type is shown in Fig. 6.

Fig. 8—Master Control Panel at WFBR, Baltimore.



Pre-set Systems

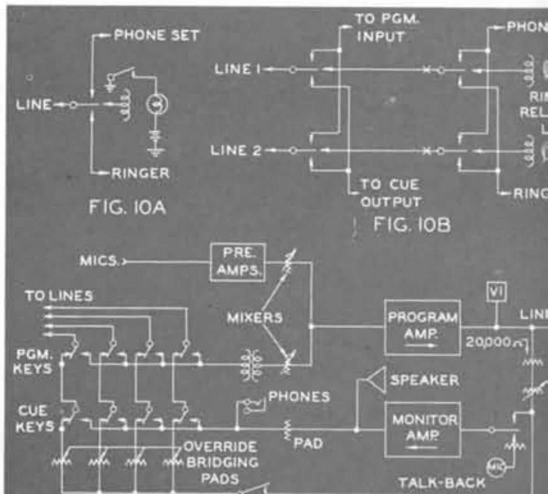
The primary purpose of a master control selector system is to permit the operator to execute comparatively complicated dispatching with a minimum of mistakes and time. In the average installation utilizing a number of studios it is usually necessary to switch several studios in the space of a few seconds at the quarter-hour station break interval. It would be impossible for a single operator to attempt to make the required switching with patch cords and the possibilities of making mistakes would be numerous. With convenient switching arrangements such as those described above, the dispatching operation is greatly expedited but the chance for errors has not been eliminated. It is difficult for the operator to refer to his schedule sheet and operate the many switching functions in the alloted time. A reduction of errors and an increase in efficiency result when a "pre-set" arrangement is used. A "pre-set" system permits the operator to set up the succeding dispatching circuits ahead of time, thus simplifying the actual selector switching. A number of "preset" circuits have been devised and they all have certain advantages.

One of the simplest "preset" circuits is that shown in Fig. 7A. Pushbutton selector switches are used in the audio circuits and only the indicator lamps are utilized in the presetting arrangement. The operator can rotate the preset switch and light a green lamp located next to the pushbutton associated with the studio in which the succeeding broadcast is to originate. This procedure is followed for each of the outgoing channels and, at the time of making the actual switch, it is only necessary for the operator to push the buttons beside the green lights. As an added convenience, red lamps are lighted through contacts on the selector switches and give a quick indication of the studio in use. Although simple, this circuit has one disadvantage. The particular studio pushkey associated with each channel must be depressed at the time of actual transfer because the audio circuit has not been preset. Also, its use is restricted to the master control room and the switching operation cannot be made from the studio nor can all channels be operated simultaneously.

Fig. 9—Master Control Panel at WFAA, Dalla

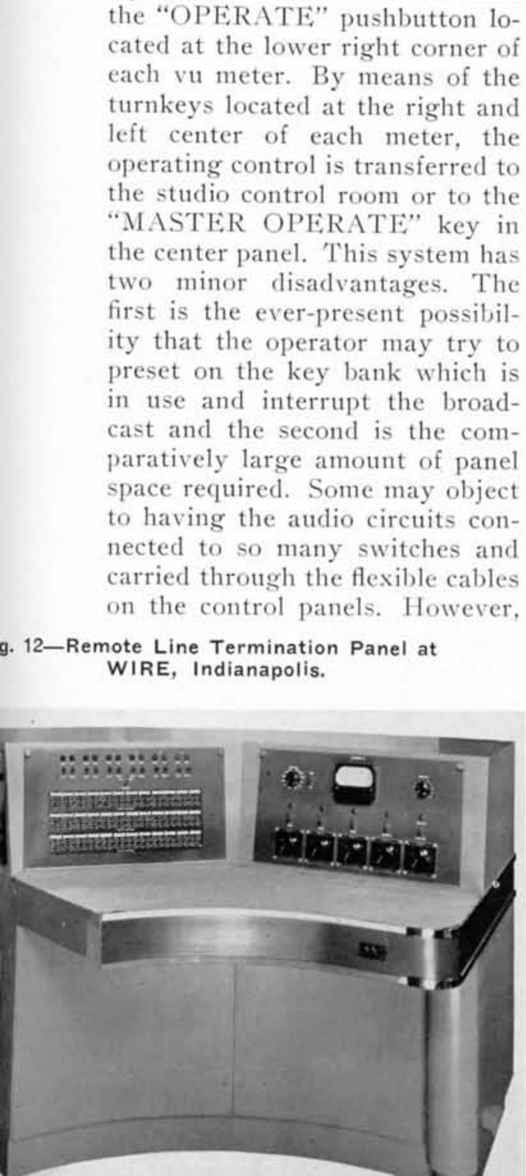
Another version of pushbutton selector switching systems with "preset" is shown in Fig. 7B. In this circuit two rows of pushbuttons are used for each outgoing channel.* Only one row is

* Mechanically interlocked push keys must be used with the interlocking arranged vertically in Fig. 7B. This is necessary to prevent cross connecting the "on-air" and "pre-set" studios in the key banks should two keys be accidentally depressed.



used at a time thereby leaving the other row free for the "preset." Red indicator lamps show which row of pushbuttons is in use. The outgoing line is switched between the two rows of pushbuttons by means of a key-switch on relays. The use of relays is preferred because they can be operated from a single non-locking pushkey and, since the same key is pressed every time, the operating routine is easily maintained. Relays also permit ganged operation from a single "MASTER OPERATE" pushkey so that all the channels can be switched simultaneously from a single key. A typical master control panel of this type is shown in Fig. 8. A total of nine studios may be dispatched to four outgoing channels. Two rows of pushbuttons are provided for each channel as is a vu meter and a master gain control. Lamps associated with each row of pushkeys give ready indication of the circuits in use. The transfer between key banks is made by relays which are controlled from the "OPERATE" pushbutton located at the lower right corner of each vu meter. By means of the turnkeys located at the right and left center of each meter, the operating control is transferred to the studio control room or to the "MASTER OPERATE" key in the center panel. This system has two minor disadvantages. The first is the ever-present possibility that the operator may try to preset on the key bank which is in use and interrupt the broadcast and the second is the comparatively large amount of panel space required. Some may object to having the audio circuits connected to so many switches and carried through the flexible cables on the control panels. However, stations using this system over a considerable length of time report very satisfactory service.

Fig. 7C shows a basic circuit for the ultimate in master control switching systems. It is the type used by most of the larger stations and network control rooms.



g. 12—Remote Line Termination Panel at WIRE, Indianapolis.

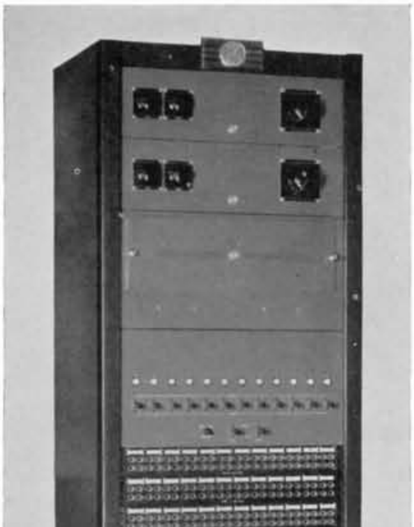


Fig. 11—Remote Line Termination Rack at WHBC, Canton, Ohio.

Fig. 13—RCA Type 76B-2 Consolette.

The audio switching is handled by relays which can be "preset" and operated from the control desk. The operation can also be made from the studio control rooms and the "MASTER OPERATE" key can be made to trip any combination or all of the channels. The circuit is particularly fool-proof because the same rotary switch is always used for presetting and no interruptions can result from turning it during a broadcast. As soon as each relay has operated, its self-locking contacts hold it in place and additional contacts prevent the other relays from closing. The transfer is made by operating a non-locking, normally closed push or lever key. When the relay power is momentarily broken, all relays drop open. The instant the "OPERATE" key is released to normal, the relay, whose coil circuit has been completed through the "preset" switch, immediately closes and locks in. The "preset" switch is then free and can be set for the next transfer. A typical master control board using this circuit is shown in Fig. 9. Ten studios may be dispatched to six outgoing channels. Two rows of lamps are provided for each channel, one to indicate the studio feeding the channel and the other to indicate the studio that has been preset. The "OPERATE" lever-key is located in the center below the "PRESET" and "MASTER" gain control knobs. This key is non-locking in the right "OPERATE" position and locking in the left "MASTER" position. The "MASTER OPERATE" key in the center of the entire panel will trip all channels having keys thrown to "MASTER." Each channel is equipped with a power "OFF-ON" switch located in the lower left corner of each panel. A "STUDIO ON AIR" lamp under each vu meter indicates when the studio operator has thrown his output key. Many of these installations have been in continuous use for several years and relay troubles have been negligible. Although the original cost is higher than the other systems we have described, the improved performance and lessened possibility for operating mistakes make it a sound investment.

Remote Pickup Circuits

The handling of incoming circuits from remote pickups involves two considerations. The

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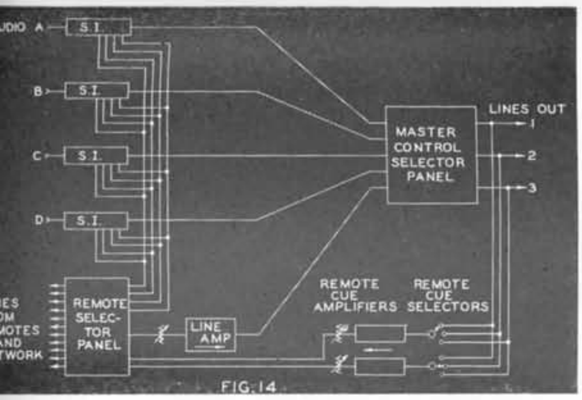

FIG. 14

SPEECH INPUT SYSTEMS

(Continued from Page 11)

first is the method of routing the incoming program and the second is the method of maintaining communication with the operator or announcer at remote locations. The safest system and the one used by networks and most stations for important programs is the use of two lines; one for the program and the other for the talking circuit. The order wire (talking circuit) is usually terminated on a ringdown panel at the studios. A lever key, in its normal position, connects the line to a relay which closes, locks in and lights an indictaing lamp when ringing current is sent in. As shown in Fig. 10A, the two operating positions of the leverkey connect the line to a telephone hand-set or to the source of ringing current for calling out. A typical rack-mounted ringdown panel is shown in Fig. 11.

For reasons of economy, many stations desire to use just one line on less important pickups. Successful operation can be accomplished with one line by utilizing the line for communication until the actual broadcasting begins. Once the program is on the air, however, no communication facilities are available which may prove embarrassing in case of trouble on important pickups. The scheme shown in Fig. 10B provides an installaiton which is readily adapted to both one and two line remote. If only one line is to be used, it is connected to a lever-key which connects the line to the input of the speech input equipment or to the "cue" output. When the first lever-key is in its normal position, the line is connected through a second lever-key which is in the usual order-wire ringdown circuit. This arrangement permits the remote operator to ring-in and talk with the studio upon arrival at location. The studio operator can then feed the cueing program to the line until the remote is to go on the air, at which time the lever-key is thrown to the program position. Attention is called to the fact that when the circuit is set up for broadcasting, it is impossible for the cueing and talking circuits to interfere with the program. By inserting jacks or accessible terminals into the circuit between the two keys (as indicated by "x" in Fig. 10B) the arrangement is readily converted to a two-line system for commercial and more important pickups. A remote switching panel utilizing this system is shown in Fig. 12. Switching facilities are provided for six remote lines.

Another one-line circuit which has become popular in the lower-powered stations, is shown in Fig. 10C. Two banks of pushkeys are used. The first bank permits the incoming remote lines to be switched into the speech input equipment. When the keys of the first bank are normal, the line is connected through to the second bank. The keys of the second bank are normal, the line is connected to "override bridging pads" the combined outputs of which are connected to the input of the monitoring amplifier through an off-on switch. When this switch is on, a remote operator can talk into his microphone and be heard by the studio operator over the program being monitored on the control room loudspeaker. The studio operator can then talk to the remote operator by closing the proper "cue" key and speaking into the talkback microphone. After the "cue" key has been closed, it becomes necessary for the studio operator to listen to the remotes by means of headphones plugged into the jack shown on Fig. 10C. Sufficient attenuation is provided in the monitor bridging pad to keep the override signal from cross-talking onto the program line above a level equivalent to that of the hum and noise in the system. Thus it is possible to handle the program, "cue" and two-way communication over one line without the use of hand-sets or ringers. A commercial speech input equipment successfully utilizing this type of circuit is shown in Fig. 13. Switching facilites are provded for six remote lines. Two banks of program keys are used to permit the handling of two pickups simultaneously. One pickup can be on the air while "cue" or two-way communication is being conducted on another.

The larger multi-studio installations require special consideration with regard to remote input switching. Because it is often necessary to mix a studio announcement or another program with the incoming remote program, special facilities must be provided to permit the master operator to route the remote through a studio control. This is usually accomplished by having one or two mixers reserved for outside programs in each studio control equipment. Lines connect these mixers to jacks in the master control room and the master operator can patch the remote into the studio. For those cases where no mixing is necessary in a studio control, the master operator may wish to route the remote directly into the master selector system. Facilities for both methods are usually included. Fig. 15 shows the circuit of a typical installation. The remote lines and incoming networks terminate in the master control room from which they are dispatched to the studio controls or directly into the master selectors. An amplifier is provided in the direct circuit to bring the remote program to the same level as the studio outputs. The lines to the studio controls are shown multipled. Such an arrangement is often used, especially for the incoming networks, because it permits the outside programs to be taken in any or all of the studios. The multipled lines are bridged in the studio controls. Cueing amplifiers,

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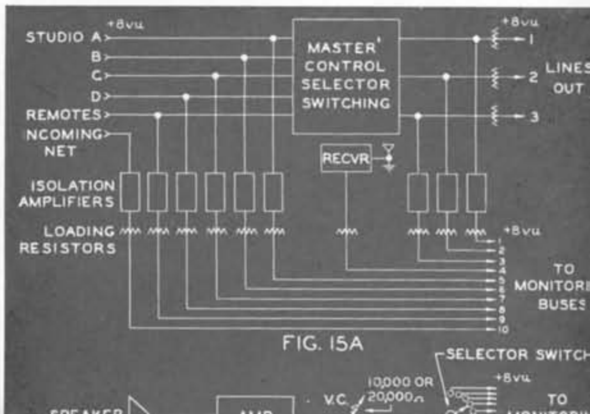

FIG. 15A

SPEECH INPUT SYSTEMS

(Continued from Page 12)

switching facilities, gain controls and communication circuits are located in the master control room. The selection of the incoming lines made with patch cords and switches or, if the number of lines is large and the personnel is limited, automatic dial selector systems may be employed.

Monitoring Systems

The monitoring facilities present a minor problem in the smaller installations. In the larger systems, however, special precautions must be taken to provide adequate monitoring facilities with protection against program interference. Such installations usually require monitoring speakers in the offices as well as the studios and control rooms. Also, it is generally necessary to provide a means of selecting the source of the program to be monitored. A typical monitoring circuit is shown in Fig. 15A. Monitoring circuits are provded for the outputs of each studio, the outgoing channels, the incoming network and the output of a receiver. Single or double-stage isolation amplifiers are used between the program lines and the monitoring buses. These amplifiers prevent impedance variations and monitoring bus circuit noises from feeding back into the program lines. The outputs of the isolation amplifiers are loaded with resistors and the monitoring stations are bridged across the low impedance buses.

Two methods of distributing the monitoring circuits are used. A multiple pair telephone cable may be run to every monitoring station where a simple rotary switch can be used as the selector as shown in Fig. 15B. Another method utilizes an automatic dial selector system which requires only two two-wire lines to each station.

(To be concluded in the next issue.)

NOISE REDUCTION

(Continued from Page 29)

conditions caused varying rates of decay of this charge. On one particular day a clear vinyl disc dropped from 11,600 volts to 6,000 in a two-hour period, while the same disc on another day dropped from 11,400 volts to 3,000 volts in the same time period. It was found that V-257, subjected to the same tests, could not be made to exceed a maximum potential estimated at 1,000 volts. The sensitivity of the meter was such that no further data can be presented at this time on the rate of decay of V-257. Sufficient evidence is displayed, however, to show the appreciable superiority of V-257 over clear vinyl from the standpoint of the susceptibility to electrostatic charge.

In the foregoing paragraphs mention has been made of "clear vinyl." To avoid confusion it is perhaps advisable to point out that the terminology "clear vinyl" is used for all vinyl compounds free from filler. However, various dyes are used to attain any desired color of disc, which dyes have no effect on the electrostatic characteristics. In some instances heavy concentrations of dark colored dyes are used which make the discs opaque and consequently similar in appearance to V-257 which is opaque due to the filler used. The susceptibility to electrostatic charging is a reliable test to differentiate the two classes of vinyl discs.

In concluding it is pointed out that the signal to scratch ratio of present day transcriptions is in the vicinity of 45 db to 50 db. With the applicaton of Orthacoustic a further reduction to the vicinity of 55 db is realized. Present day developments in the recording and processing techniques gives promise of attaining, within the very near future, transcription reproduction with a signal to scratch ratio in the order of 60 db or better. Experience has demonstrated that this figure is entirely satisfactory for all broadcast requirements.

S.S. AMERICA

(Continued from Page 25)

just as readily to determine the position of other ships at sea.

Lifeboats Radio-Equipped

The direction finder uses a highly sensitive and selective superheterodyne receiver, and is designed with an automatic compensator so that deviations in the radio bearings are automatically corrected. The unit is also used in conjunction with the ship's gyro repeater system, thereby enabling radio bearings to be taken with reference to true North at all times.

Permanently installed in each of two motor-driven lifeboats of the *America* are complete radiotelegraph transmitters and receivers. Designed to withstand the weather conditions encountered by a lifeboat, this equipment permits communication on the distress frequency of 500 kilocycles. Power is derived from storage batteries.

Thirteen antennas are used in the *America's* radio communication system. Including the two life boat antennas, they are the radio direction finder loop antenna, the direction finder sense antenna, the harbor telephone antenna, the five doublet receiving antennas, the main flat-top, the horizontal V and the forward inverted L antennas.

Power Generators

Power for operating the ship's radio equipment is derived from four motor generators located in a room just forward of the radio quarters. Unit No. 1 supplies 2500 volts for operation of either the intermediate or low frequency transmitters. Unit No. 2 is similar to No. 1 and powers the high frequency transmitter. A switching panel is provided so that, in event of failure of one unit, either of the other units may be quickly connected to the desired transmitter.