Bulletin No. 11

CONDENSER MICROPHONES

Announce Type 4-AA-1 Suspension Type 4-AS-1 Program Type 4-AP-1

PHIL COOK

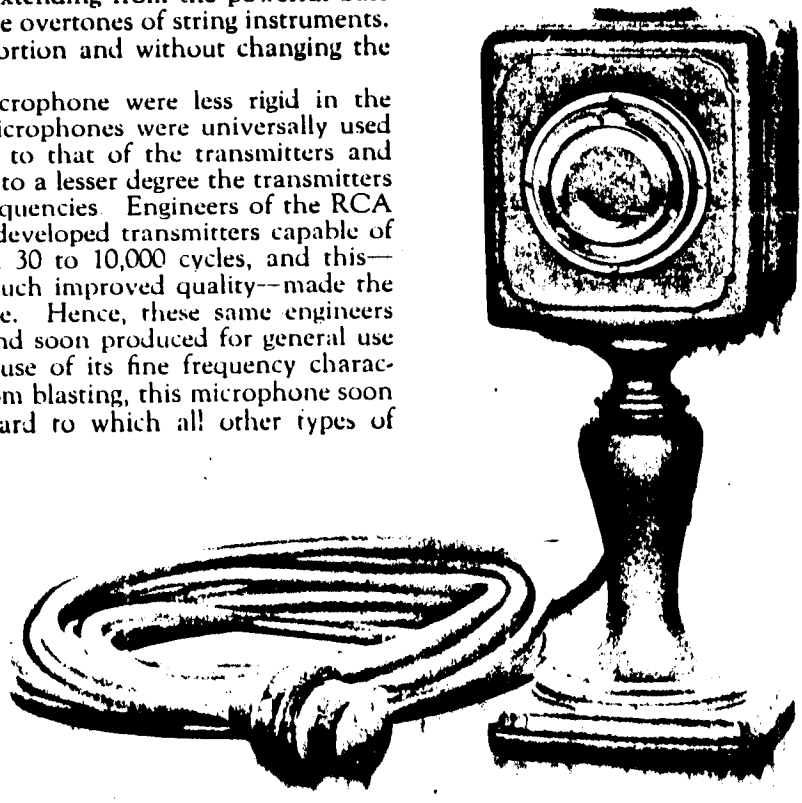
The RCA Victor Company, Inc., offers in the Type 4-A-1 Microphones a series of improved condenser microphones for use in broadcast studios where fidelity of transmission and reliability of performance are primary requisites. Discriminating program directors specify these microphones because:

1. They feature high quality reproduction—transmitting with substantial uniformity frequencies from 30 to 10,000 cycles.
2. They have an extremely low noise level and a consequent high sensitivity—making crowding of artists close about them unnecessary.
3. They incorporate constructional improvements which increase their ruggedness—insure against their becoming inoperative at extremes of temperature or humidity.
4. They include a built-in, three-stage amplifier—providing a minus 32 db. output and obviating the necessity of additional fixed-gain amplifiers.
5. They are designed for interchangeable mounting—facilitating their use with program stand, announce stand or suspension mounting as desired.
6. They may—as their ruggedness and sensitivity exceeds that of carbon microphones—be used at outside pickup points as well as in the studio.

IMPORTANCE

Conversion of studio sounds into electrical impulses and transmission of these impulses to the transmitter are the functions of the speech input equipment of a broadcasting station. Singly most important unit of this equipment is the studio microphone. On the fidelity with which it converts into electrical vibrations all the musical frequencies which go to make up a program depends directly the naturalness with which that program will be reproduced at a distant point. It must, therefore, be capable of reproducing electrically a range extending from the powerful bass notes of an organ to the whispering treble overtones of string instruments. Moreover, it must do this without distortion and without changing the natural ratio of tonal amplitude.

Requirements of a satisfactory microphone were less rigid in the early days of broadcasting. Carbon microphones were universally used and in general their quality was equal to that of the transmitters and receivers in use, as these receivers—and to a lesser degree the transmitters --were limited to a narrow range of frequencies. Engineers of the RCA Victor Company, Inc., however, soon developed transmitters capable of faithfully transmitting frequencies from 30 to 10,000 cycles, and this—with the introduction of receivers of much improved quality--made the need for better microphones imperative. Hence, these same engineers directed their efforts toward this goal and soon produced for general use the condenser type microphone. Because of its fine frequency characteristic, low noise level, and freedom from blasting, this microphone soon became, and has remained, the standard to which all other types of microphones are compared.



TYPE 4-AA-1
ANNOUNCE MICROPHONE

CONDENSER UNIT

The microphone itself—as used in broadcasting—is a device which converts sound waves into electrical currents having a direct amplitude relation to, and approximately the same wave form as, these sound waves. Usually this device forms an element of the circuit into which the sound currents are to be introduced, and is so connected that a direct voltage is constantly impressed on it. Transfer of energy is accomplished by having the impinging sound waves vary one of its electrical parameters. Types of microphones are generally differentiated by that parameter—resistance, inductance or capacitance—which is varied.

The condenser microphone depends for its operation on the variation of capacitance between two closely spaced metallic plates. One of these plates is heavy and is firmly fixed. The other is a disc of thin metal which, although tightly stretched, moves perceptibly in response to sound waves striking it. A constant voltage is impressed on this condenser and when its capacitance is varied by movement of one of the plates, a voltage difference is set up which causes a current to flow in the circuit of which the condenser is a part. As the external resistance of this circuit is large, the amplitude of the alternating voltage across the condenser is directly proportional to the amplitude of the sound waves.

Simplicity of construction is the most prominent feature of the condenser unit incorporated in the Type 4-A-1 Microphones. Essentially, this unit consists of a thin diaphragm, a protective front screen, an outer mounting ring, and a heavy back plate. The only moving part—the diaphragm—is tightly stretched and

firmly fixed in the outer ring. This construction is obviously stronger and more rugged than that of other types of microphones in which the diaphragm must support a moving coil. It is also simpler in that complicated air chambers to correct the frequency response of the moving parts are not necessary.

The most critical part of the condenser is the air space between the diaphragm and the back plate. The actual separation between these two is only a few thousandths of an inch and it is, therefore, essential that no moisture or dust enter this air chamber if leakage is to be avoided. To insure this, the chamber is sealed by a new equalizing system which compensates for ambient temperature and pressure changes.

As a further precaution, the component parts of the condenser are assembled in an air-conditioned room from which dust and moisture are carefully excluded. As the first step of this assembly, the diaphragm and back plate are examined under a microscope to make sure that no dust particles are lodged on them. After the units are completed, they are aged for a month before shipment. During this time they are subjected to conditions simulating those to be expected in the field and are tested at intervals for leakage. As a result of these precautions, the Type 4-A-1 microphones are entirely free from noises and uncertainties caused by leaky condenser units.

WHILE WE DO NOT RECOMMEND THIS SORT OF TREATMENT, THIS IS AN ASTOUNDING AND INTERESTING STATEMENT

"It might be intereresting to you to know that the RCA Condenser Microphone unit that was in the fire in our studios on January 20th was burned black by the flames, was knocked over by firemen and lay in about two feet of water for a half an hour or more. It was removed then from the amplifier and tried in another amplifier and found to be working perfectly."

T. A. McCLELLAND,
Chief Engineer of WDAF, Kansas City, Mo.

AMPLIFIER UNIT

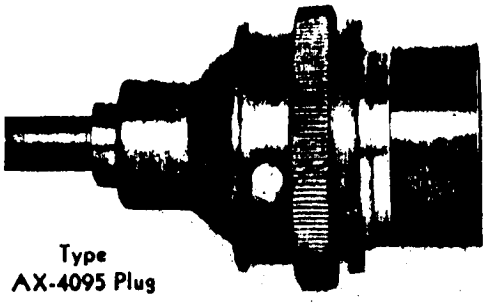
A low noise level—and a consequent high sensitivity—is the most important characteristic of condenser microphones. In order to fully realize the advantages of this low level the microphone amplifier is located in close proximity to the condenser unit. Operation with the amplifier at a distance is entirely possible—but at a sacrifice, as noises picked up by the connecting cable are intensified by the following amplifier and the noise level thereby raised. The practice is not recommended, either for condenser or other types of microphones.

The amplifier incorporated in the Type 4-A-1 Microphones has been especially designed for this use. Its input impedance correctly matches the impedance of the condenser unit. It employs three stages of resistance-coupled amplification—utilizes non-microphonic Type UX-864 Radiotrons developed especially for the purpose. A tapped output transformer provides choice of 70, 250 or 500 ohms output impedance. The output of this amplifier, when the pressure on the condenser diaphragm is 10 dynes per sq. cm. (average studio condition), is —32.5 db. As this is somewhat above the output of other types of microphones (including carbon), the Type 4-A-1 Microphones may be substituted anywhere without adding fixed-gain amplifiers to the existing speech input racks.

No possibility which might increase the dependability of this amplifier was overlooked in its design and construction. In the choice of the component parts, for instance, the engineers of the RCA Victor Company, Inc.,

—not satisfied to rest on past experience—spent nearly a year. Every available make and type of each new item was carefully tested and rated. Capacitors and resistors were particularly scrutinized and subjected exhaustive life tests. Those finally chosen are unquestionably the finest available. Their use guarantee to the broadcaster that his microphones will be as free from troubles due to defective parts as it is possible to make them.

Assembled on a moulded bakelite chassis, the amplifier forms a compact unit rugged enough to withstand shocks much in excess of those to be expected in general use. For additional protection it is floated on sponge rubber in the microphone case. The rear of this case is removable—facilitating access to the amplifier tubes. The condenser unit locks firmly in a receptacle in the front of this case. A short lead connects the back plate of the unit with the amplifier. The connection from the diaphragm is made through the frame and the case—all three being at ground potential.



Type AX-4095 Plug

MOUNTINGS

The condenser unit, amplifier chassis and microphone case proper are common to all three of the Type 4-A-1 Microphones—the program, announce and suspension types differing only in type of mounting supplied. As all three mountings are available separately, this interchangeability greatly increases the usefulness of these microphones. A station owning four microphones, for instance, will find it desirable to have at hand two or three of each type of mounting. These mountings, as well as the microphone case, were designed by a well-known artist. With their deep bronze finish, they add to rather than subtract from the beauty of the studios in which they are used.

The Type 4-AP-1 Program Microphone is furnished with a Type AZ-4090 Program Stand. The height of this stand is adjustable—the microphone may be placed from 50" to 75" above the floor by pressing the handy release button and raising or lowering as desired. A new device—a pneumatic plunger built into the stand—prevents the microphone from crashing down when the release button is pressed. If it is found desirable to maintain the microphone at a fixed height it may be locked there with the locking screw provided. The weight of the heavy tripod base of this stand insures that it will not be knocked over by accidental contact.

The Type 4-AA-1 Announce Microphone is furnished with a Type AZ-4091 Announce Stand. This short fixed stand (shown in illustration) is particularly convenient for the announcer at the control desk—or for the speaker who prefers to sit at a table.

The Type 4-AS-1 Suspension Microphone is furnished with a Type UP-4092 Suspension Mounting. This mounting makes possible overhead suspension of the microphone. Such an arrangement is most deirable for certain pickups.

CABLE AND PLUG

The Type 4-A-1 Microphones are equipped with a 30 ft. specially-shielded rubber-covered cable and a new locking-type plug. Both the cable and the plug are of much heavier construction than that of former models. The thick rubber outer coating of the cable insures that it will be "squeak-proof" under the severest conditions of twisting, bending or rubbing. The improved plug is designed to lock securely into a Type UP-4089-A wall receptacle—thus eliminating the danger of program interruption from the plug being accidentally pulled out of the receptacle. Locking is effected by a partial turn of the collar of the plug.

WALL RECEPTACLES

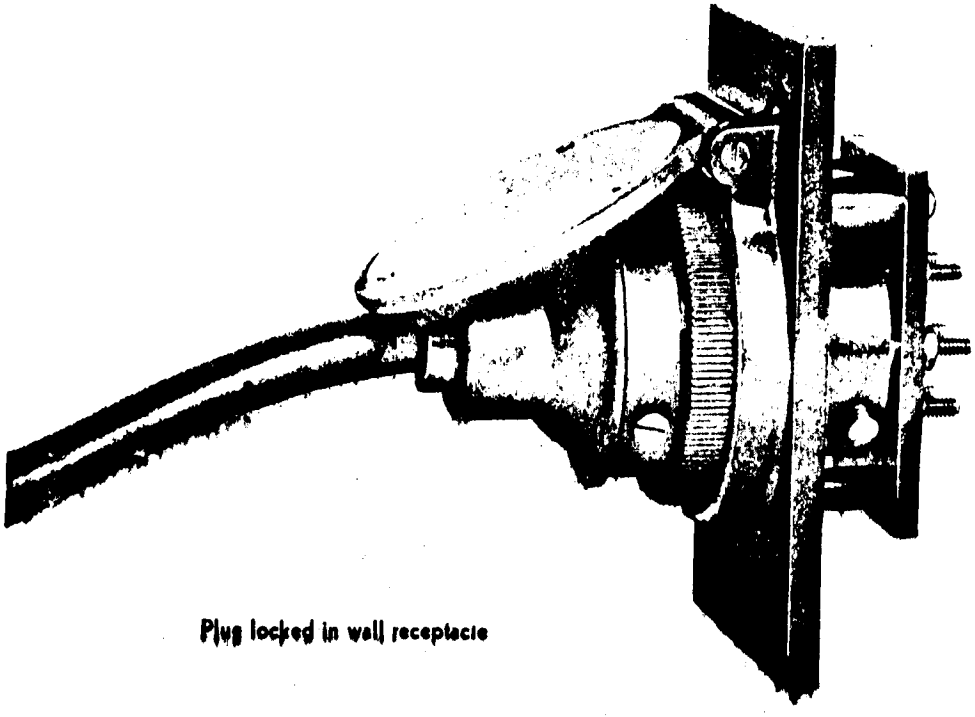
Although not furnished with the Type 4-A-1 Microphones—as many studios are already equipped with them—Type UP-4089-A Wall Receptacles are strongly recommended for use with these microphones. Only by so doing is full advantage of the locking feature taken. The sturdy construction and neat appearance of these receptacles is evident in the illustration.

Type UP-4089A Wall Receptacle

POWER SUPPLY

Power supply for these microphones is furnished through the cable. Battery connections are permanently made to the wall receptacles. A six volt source capable of supplying .25 amperes for each microphone is necessary for lighting the Radiotron filaments. A 180 volt plate supply is also required. It furnishes in addition the polarizing potential for the condenser. No bias voltage supply is needed.

Either batteries or rectifier may be employed as "B" supply. If a rectifier is used a good filter is necessary. The RCA Victor Type SIR-1 Rectifier with a Type 39-A Filter is recommended for this purpose.



Plug locked in wall receptacle

CHARACTERISTICS

Dependability is the first requirement of a studio microphone. For, regardless of how fine its other qualities, a microphone which fails frequently in service cannot be considered. Realizing this, engineers of the RCA Victor Company, Inc., in writing specifications for the Type 4-A-1 Microphones, laid particular stress on the necessity that they must be absolutely reliable. In fact, they started the development of these new microphones with an assumption that former models were not in this respect good enough. The care exercised in the choice of component parts and the precautions taken in assembling these parts have been detailed. When the first sample units were completed, they were set aside to age under conditions simulating those of actual use. In addition they were subjected to extreme tests—sub-zero temperatures—temperatures near the boiling point—and finally complete submersion under water. When these microphones would undergo these tests without impairment of their characteristics—and not before—they were offered to broadcast stations.

Ruggedness was the second quality stressed in the development of these microphones. Reason for this the fact that, although early condenser microphones were fairly satisfactory for studio use, their delicate construction prohibited use of them at outside pickup points. Engineers of the RCA Victor Company, Inc. succeeded in overcoming this drawback. Because of the simple construction of the new condenser unit—and the fact that its vibrating diaphragm does not have to support additional moving parts—it was found possible to make it rugged enough to withstand the severest shocks. In fact, it can only be injured by forcing a sharp instrument through the protective front screen. The compact assembly of the microphone amplifier, plus its use of sturdy, non-microphonic UX-864 Radiotrons, plus its sponge rubber protection insures that it also will be able to withstand the roughest usage. As a check, two of the first microphones completed were

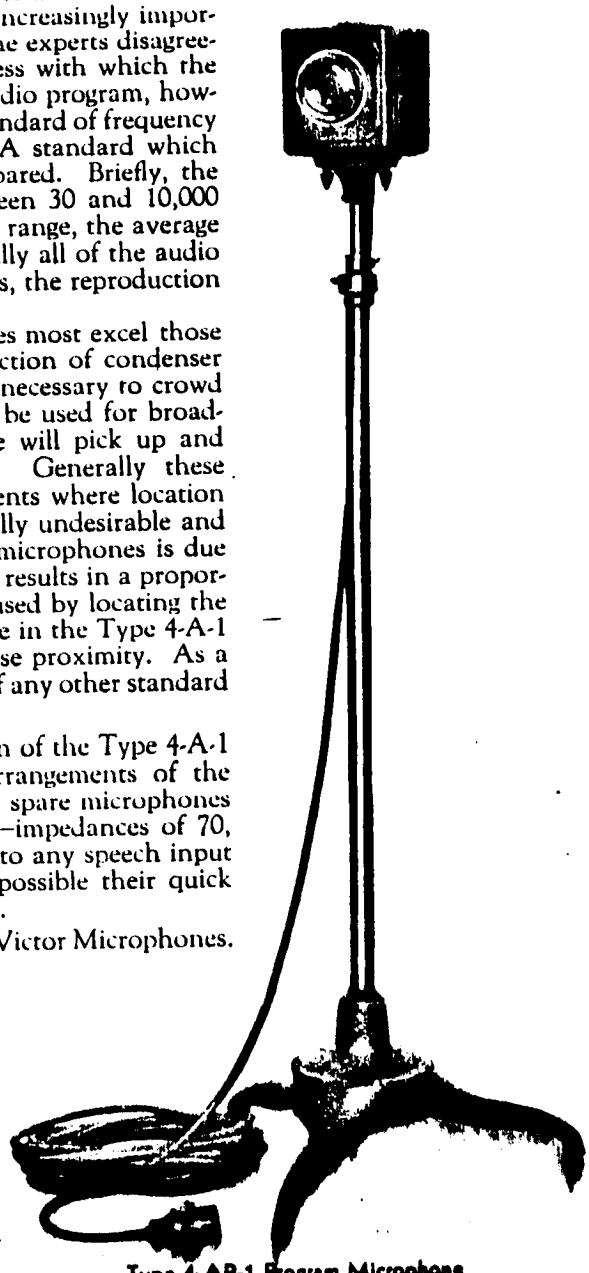
given to the staff of WGY and two more to the field group of the National Broadcasting Company. All fou. microphones were used continuously for several months on outside pickups. At the end of this thorough trial, both groups of engineers reported that the Type 4-A-1 Microphones were, by their ruggedness, better fitted for this work than any microphones previously available.

Fidelity of reproduction is a quality of program microphones which—because of rapid improvement in receiver characteristics—is becoming increasingly important. Unfortunately, it is a quality difficult to evaluate—even the experts disagreeing as to proper methods of calibration. About the faithfulness with which the Type 4-A-1 microphone converts into electrical currents the studio program, however, there can be no question, for it maintains the same high standard of frequency response set by its predecessor, the Type 4-A Microphone. A standard which made that microphone the one to which all others are compared. Briefly, the response of the Type 4-A-1 Microphone to frequencies between 30 and 10,000 cycles is substantially uniform. By this it is meant that, in this range, the average ear can detect no variation. Since this range includes practically all of the audio frequencies it is equivalent to saying that, for practical purposes, the reproduction of this microphone is perfect.

Sensitivity is the quality in which condenser microphones most excel those of other types. Because of their high sensitivity, the introduction of condenser microphones revolutionized studio technique. No longer is it necessary to crowd artists about the microphone—nor must several microphones be used for broadcasting a large orchestra, for a single condenser microphone will pick up and transmit faithfully the program of a full-sized orchestra. Generally these microphones have solved the problem of pickup at public events where location of the microphone in close proximity to the operators is usually undesirable and often as not, impossible. This high sensitivity of condenser microphones is due to their exceedingly low noise level. Increase of the noise level results in a proportionate decrease of sensitivity. Such an increase would be caused by locating the microphone amplifier at a distance from the condenser. Hence in the Type 4-A-1 Microphones the amplifier and condenser are mounted in close proximity. As a result, the sensitivity of these microphones is higher than that of any other standard microphones available for broadcast use.

Convenience of use has not been forgotten in the design of the Type 4-A-1 Microphones. The interchangeable mountings facilitate arrangements of the studio microphones—small stations which do not carry many spare microphones find this feature particularly valuable. The several outputs—impedances of 70, 250 and 500 ohms—make them sufficiently flexible to work into any speech input system. Incorporation of the microphone amplifier makes possible their quick substitution for carbon microphones at outside pickup points.

Economy of a real sort is effected by stations using RCA Victor Microphones. First, because that old axiom "the best is the cheapest" particularly applies to these equipments, on which the quality of a broadcast program so strongly depends. Second, because their manufacture in large quantities, with consequent production efficiency, makes it possible for the RCA Victor Company, Inc. to offer them to broadcast stations at prices little above those of much inferior construction.



Type 4-AP-1 Program Microphone

Reputation of equipment and manufacturer should mean much in the selection of studio microphones. The RCA Victor Company, Inc. is proud that more than two thousand of these microphones are now in use,—that they are used by a majority of leading stations from coast to coast, including such pioneers as KDKA, WJZ, WGY, WENR, WFAA, WTIC, WBZ, KYW and WEAF—and by both national chains—that they are specified exclusively by the National Broadcasting Company for broadcasting, by the RCA Photophone Company for talking movie pickup, and by the RCA Victor Company for recording.

SPECIFICATIONS OF MODEL 4-A-1 MICROPHONES

Overall sensitivity (10 dynes/sq. cur. input)	—32.5 db.
Uniform frequency response	30 to 10,000 cycles
Amplifier stages	Three
Amplifier stage gain	17.5
Output impedance	70, 250 or 500 ohms
Height of stand (program style)	Adjustable 50 to 75 in.
Height of stand (announce style)	11.5 in.
Length of cable	30 ft.
Type of plug	Locking
Tubes required	Three UX-864 Radiotrons
Batteries required	"A" Battery, 6 volts "B" Battery, 180 volts

TYPE NUMBERS

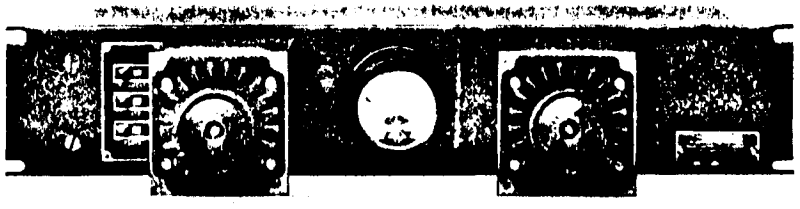
Material	*Type No.*
Program Microphone (complete)	No. 4-AP-1
Announce Microphone (complete)	4-AA-1
Suspension Microphone (complete)	4-AS-1
Condenser Unit	UZ-4083-B
Amplifier Unit	AA-4088-A
Program Stand	AZ-4090
Announce Stand	AZ-4091
Suspension Mounting	UP-4092
Cable and Plug	AP-4093-A
Plug	AX-4095
Wall Receptacle	UP-4089-A
Extension Cable (50 feet), with male and female plugs	AP-4094

COMPONENT PARTS

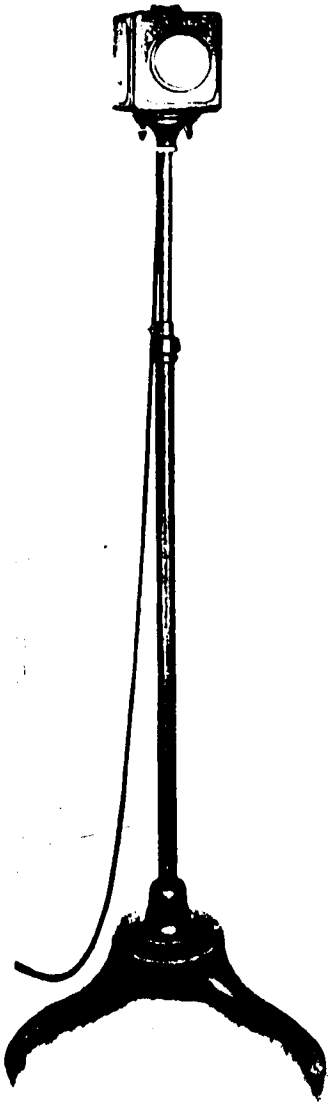
IN ADDITION to standard groups of equipment, many separate units are available for special purposes in broadcasting stations, or to supplement existing apparatus.

All control room equipment is mounted on metal panels designed to fit on standard steel racks. Covers are provided which are easily removable from the rear. Panels are 19" wide, of $\frac{3}{16}$" cold rolled steel, finished in handsome semi-glossy black. Gain controls are of the projection type and may be removed from the front of the panel for inspection.

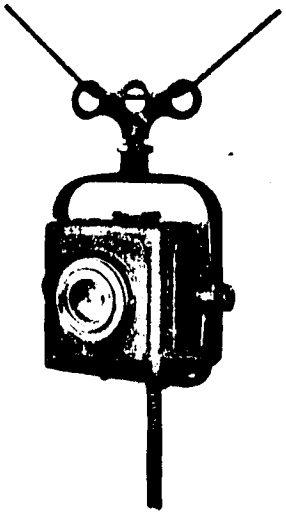
As each unit is complete in itself, its use is not limited to any one purpose in broadcasting and such a system of units adapts itself admirably to the conditions of use found in a particular station.



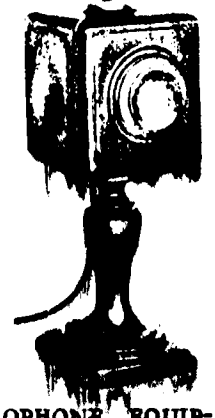
RCA TYPE 11-A CONDENSER MICROPHONE CONTROL PANEL



CONDENSER MICROPHONE, AMPLIFIER, AND PROGRAM STAND, TYPE 4-AP WALL RECEPTACLE NOT SHOWN



SUSPENSION MOUNTING UP-4092 FOR USE WITH RCA CONDENSER MICROPHONES



CONDENSER MICROPHONE EQUIPMENT, TYPE 4-AA. WALL RECEPTACLE NOT SHOWN

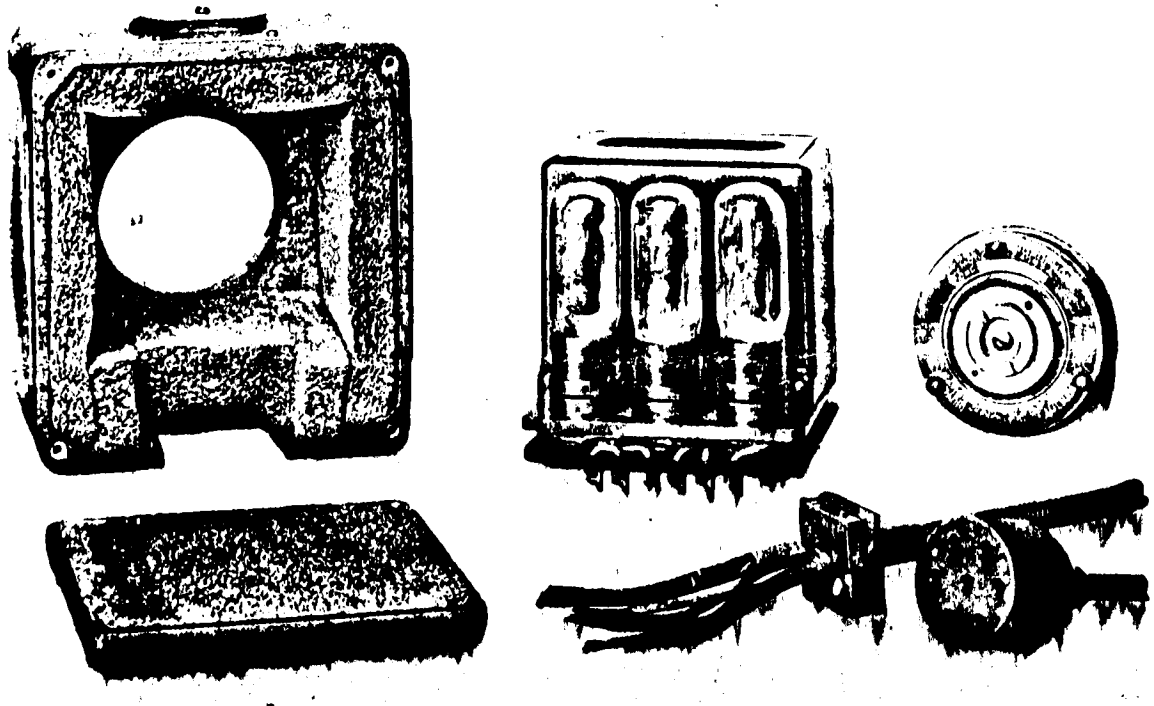
MICROPHONE EQUIPMENT

Types 4-AA, 4-AP, 1-A, 2-A, UP-4092. Control panels 11-A, 11-B, 10-A

A DISTINCTLY superior type of sound converter has been developed by RCA for use in modern high quality broadcasting stations. Type 4A-condenser microphones possess the inherent advantages of excellent frequency characteristics as well as negligible background noise and hiss. They are designed to convert faithfully into electrical vibrations sound waves of frequencies from 30 to 10,000 cycles.

For the purpose of amplifying and transforming the weak output of the condenser unit, a three-stage amplifier and output transformer have been included in the case. Three non-microphonic UX-864 radiotrons, resistance coupled, comprise this amplifier. The entire equipment is contained in a compact, cubically shaped unit, which is attractively finished. A thirty foot, five conductor cable terminating in a wall plug, provides battery and output connections.

Several types of mountings have been devised to fit the many uses of these microphones. The 4-AA unit includes a short stand suitable for use in announcing. Program microphones (4-AP), are mounted upon an adjustable stand which can be raised or lowered and clamped in position. This stand may be varied in height from 50 to 75 inches. In some cases it is desirable to suspend microphones from overhead, and type UP-4092 suspension has been designed for the purpose. If the microphone must be concealed, the condenser unit may be removed from its socket and placed in the 4-AX extension unit. This is attached to a ten-foot



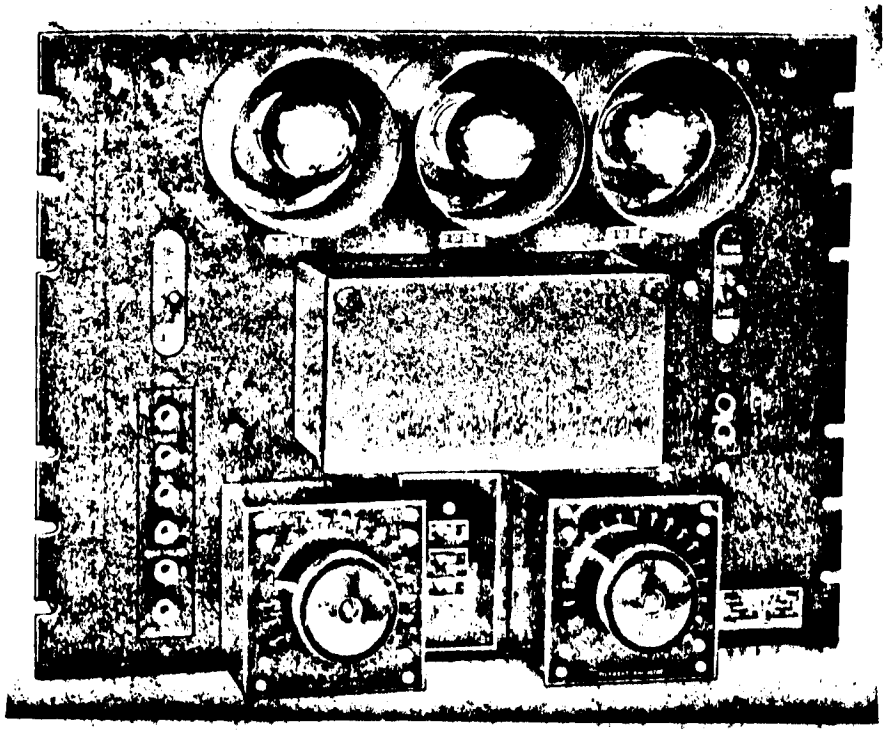
EXPLODED VIEW CONDENSER MICROPHONE UNIT

cable, the other end of which terminates in a plug arranged to fit in the 4A- case.

The latest type of carbon microphone equipment is included in the RCA line of speech input equipment.. These may be obtained with either an adjustable program pedestal (2-A) or a short announce stand (1-A).

Whether condenser or carbon microphones are used, means must be provided for controlling the output energy and for switching and adjusting the supply voltages. To fit this need, standard microphone control panels have been designed. Types 11-A and 11-B are provided for use with condenser microphones and type 10-A for carbon microphone control. Besides switches and voltage control devices, a volume control graduated in steps of 2 d.b. is supplied.

DATA—Condenser microphones (4-A), 3 UX-864 Radiotrons employed. Output impedance 200 or 500 ohms. Average output level with 10 dynes per sq. cm. input sound pressure, —35 d.b. Required supplies, filament 6 volts, plate 90 and 180 volts. Microphone control panels—dimensions, 19" x $3\frac{15}{32}$".



RCA TYPE 12-A PROGRAM AMPLIFIER