Lyle Van, WOR-Mutual's ace news commentator (right) hears principles of Altec miniature microphone explained by Paul S. Veneklasen (left), Altec Lansing physicist, who with W. J. Moreland worked on 3-year development project of the tiny microphone. Lyle Van's six-o'clock news broadcast Tuesday, March 8, was first time the new microphone was used on the air.

JOHN K. HILLIARD*

Chief Engineer, Altec-Lansing Corp.
1161 N. Vine St., Los Angeles, Calif.

An Omnidirectional Microphone

The entire communication field advances to higher standards when previously unconquerable obstacles are surmounted. An indication that such a turn of events has occurred in the audio field comes with the introduction of a miniature condenser microphone, described in this article, with a diaphragm having the area of a human ear drum.

A large number of microphones have been developed since the original work of Alexander Graham Bell. In the broadcasting, recording, and sound reinforcement fields, the double-button carbon microphone was the earliest to come into widespread use. This was later replaced by the Wente type condenser microphone in 1927. A few years later, dynamic and ribbon microphones replaced the large diameter condenser type so as to obtain more uniform response and simplified equipment. Later, directional microphones incorporating features of both dynamic and ribbon types became available and were designed to provide various response patterns such as a figure eight (bi-directional), cardioid and modified cardioid patterns. Theoretical patterns indicate that ideal conditions can be achieved only under "dead room" conditions. These patterns are then considerably modified when used indoors, due to reflection from the wall surfaces. In the extreme case of very reverberant rooms, little directional gain can be obtained over that of non-directional microphones. Also, directional microphones are larger than non-directional units and the sound field is accordingly distorted by their obstacle effect. This results in a directional pattern that varies over wide limits in frequency. The response angle becomes smaller at the higher frequencies.

Obstacle interference is a direct function of size and frequency. This varies the directivity and absolute output of a microphone. The solution to the problem lies in making the size extremely small.

A high degree of cancellation in cardioid microphones is usually obtained only at the middle frequencies. Compromises must be taken in phase shift by the use of mechanical and electrical networks to obtain approximately 180-degree cancellation. Earlier experiments and data on phase shift indicated that the human ear has difficulty in distinguishing between a system with considerable phase distortion and one without. However, later experiments indicate that a minimum phase shift is highly desirable in high-quality systems. In a comparison of high-quality systems having small and large amounts of phase distortion, the difference can be detected by a critical listening test.

All the microphones mentioned which have been available for high quality work have many undesirable characteristics, the most important of which are listed below:

1. Their large bulk causes shadows in Motion Picture and Television work requiring that they be moved farther away from cast than otherwise desirable. In direct broadcasting or stage presentations they hide the face of the performer, since usual technique requires that the artist work very close to them.
2. Bass tones are unduly emphasized as the artists work closer to the microphones. This results in boomy reproduction with poor intelligibility.
3. Microphones having freely suspended ribbons are susceptible to puffs of air caused by breathing of the artist. This causes an objectionable rumble and in the extreme can produce damage. They are not shock-proof—a loud hand clap, or gun shot can render them inoperative. It is difficult to use them for exterior work in the presence of wind.
4. Because of their directional characteristics at close range, many microphones are used to give a required musical balance in orchestra or band pickup.
5. They have powerful magnets which attract iron filings and often block the microphone during operation.
6. The directional microphones limit the reproduction of the natural room tones which have been carefully designed by the architect for pleasing listening.

In order to overcome many of these undesirable features and limitations, a miniature condenser type microphone has been designed. Its overall dimension is 6/10" in diameter and 4/10" thick (approximately the size of a stack of six dimes). It weighs less the ¼ ounce (6 grams). A small circumferential sound entrance channel

20 mils thick provides protection for the diaphragm and aids in obtaining an omnidirectional pickup characteristic. The diaphragm is one centimeter in diameter and is of a special laminated construction. The resonance of the diaphragm is at a high frequency and its peak is controlled by the damping so that it is negligible, varying ±1 db from its low-frequency sensitivity.

The microphone is mounted on a base which has a maximum diameter of one inch. This base contains a 6AU6 miniature vacuum tube which is easily replaced and the bottom of the base contains a Cannon 6-pin plug.

The stand mount and output cable contains a Cannon receptacle and the necessary fitting with a ⅝" -27 thread for stand mounts. This cable is in effect a single-conductor shielded cable designed to perform the necessary functions of the impedance-transforming tube by dividing between the central conductor group and an outer group which also functions to shield the inner signal carrying group. This outer shield provides the leads for heater current, high voltage supply and ground from the power supply. This cable may be as long as 400 feet and is attached by a 6-pin Cannon plug to the power supply and matching transformer unit.

The output level of the microphone system is —50 dbm in a sound field of 10 dynes/cm.^{2} The matching transformer provides output impedances to work into equipment having assigned input impedances of 30-50, 150-250, 500-600 ohms. The output noise level is less than 30 phons.

The cable which supplies the impedance-transforming tube is in effect a single conductor cable in which the central signal-carrying conductors are surrounded and shielded by those which supply the tube operating power.

The blast-proof characteristics of the microphone make it unnecessary to protect it from extreme sound pressure levels and shocks which might cause distortion or damage to other type microphones. Tests made on this condenser microphone by firing a 22-calibre cartridge at a distance of eight inches indicate that its calibration is unchanged by such a blast. Based upon electrostatic rather than electromagnetic principles, it is not susceptible to iron filing damage or magnetic induction. The size of the housing and the diaphragm construction allow the microphone to be used under wind conditions in external pickup work that otherwise would be impractical. In public address and sound reinforcement applications, it is possible with this microphone to achieve at least 4 db higher amplification before feedback or howl is encountered than can be obtained with other non-directional microphones equal to the best directional microphones. Flat response (lack of peaks) explains why this is possible—plus the fact that the sound is practically all reflected energy when more than 20 feet away from the source (in rooms).

The miniature condenser type microphone, photographed inside a walnut shell, is shown here actual size.

The microphone base is separated from the microphone by an extension which serves to reduce the obstacle interference in the immediate field of the microphone and also permits the microphone to be used directly in front of the artist with little shadow.

The weight of the combined microphone, base and extension is approximately four ounces. It is anticipated that because of its extremely small size, weight and shadow as well as other outstanding characteristics mentioned above, this microphone will facilitate heretofore unachieved pick-up in the radio, television, recording and sound reinforcement fields.

The microphone system is the first of a series of apparatus resulting from a new basic investigation of sound pick-up limitations. Major changes in technique, the development of new uses, and correlative advances in other fields are expected to result from this development.

So many Altec engineers have contributed to the development of this new microphone that no one person can be singled out for special mention. This project was initiated and supervised by G. L. Carrington. P. S. Veneklasen and W. J. Moreland were responsible for important electronic and mechanical developments. Capacitance of the microphone unit is less than 20 micromicrofarads.