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Microphone developments, by M.L. Gayford

1.0 Introduction

The general trend towards electronic miniaturisation has broadly affected microphone development in two ways:-

(i) In the first place, present transistorised amplifiers have many characteristics which make them particularly suitable for use with microphones of various types. Apart from the carbon microphone, virtually all other microphones require low level amplification to be introduced, preferably as close to the transducing element as possible. Specialised amplifiers with low noise figures and the desired impedance characteristics may be made small enough for incorporation inside microphones. The small d.c. power supplies required may conveniently be fed along the two signal leads by phantom or by relatively simple blocking circuits.

In addition to the benefits of amplification at the microphone, there is now a demand for more elaborate functions such as equalisation, a.g.c., limiting, threshold level adjustment, etc. Sophisticated amplifier techniques of this kind may involve quite elaborate circuits using up to 100 transistors and diodes as well as other components. Current and earlier discrete component techniques, such as printed circuit boards, are generally too bulky and too expensive to incorporate in individual microphones or handsets except where only a comparatively simple amplifier is required. Modern microelectronic techniques offer a radical reduction in size and promise in the future to give considerable reduction in cost. In many cases this will enable an optimum system design to be achieved from both a technical and an economic point of view. For example, it is difficult to avoid an excessive amount of electrical interference pick up on low level microphone lines and the main system may tend to an undesirable amount of complication if indiv-

idual amplification, equalisation, limiting, a.g.c. and other functions have to be carried out on a number of microphone input lines. Future microelectronic trends may well make it economically as well as technically feasible to adopt an integrated approach to the complete microphone head design in many cases.

(ii) A further step of integration may eventually occur when the microphone element becomes effectively a part of the microelectronic structure, as opposed to the microphone merely providing a frame or casing within which a semiconductor circuit may be mounted. Certain types of microphone, for example, capacitor units and piezoresistive devices, might be designed as additions or even as an integral part of the crystal wafer used to produce the associated electronic amplifier and control circuit. Transducers of this type seem likely to find increased application in due course, so as to suit integrated automatic circuit assembly processes where the transducer and the electronic devices may be manufactured on the same production line.

Basic types of microphones for present and future use will be described. Figures 1 and 2 illustrate representative units.

2.0 Microphone amplifiers and control functions

The characteristics required of input stages in particular determine the type of transistors to be used in microphone amplifiers. Magnetic or moving coil microphones are basically low impedance devices and provide a low output voltage which may have to be stepped up by an input transformer before the first transistor. The optimum input impedance level for bi-polar transistors is normally of the order of > 2 kilo-ohms. Moving iron microphones may be conveniently wound to this impedance but moving coils are usually 300 ohms or less, so as to avoid using wires less than about 1.5 mil diameter. Suitable input transformers of between 1/3 and 1/10 turns ratio may now be made in extremely small sizes. Piezoelectric or capacitor microphones require a high input impedance at the first transistor. This may be provided by suitable low noise unipolar FET transistors.

It must be accepted that low noise transistors are more critical to make than types required only to perform comparatively simple functions such as switching. Discrete devices may be graded by selection, but integrated circuits will require close manufacturing control in order to obtain a high yield of low noise amplifiers within the desired tolerances.

Equalising, filtering and volume control functions may often be realised by the use of suitable RC networks in the main or feedback paths of microphone amplifiers. Advantage may be taken of suitable standard analogue operational or other amplifier modules to achieve the desired overall characteristics by external interconnecting or feedback circuits.

Threshold, a.g.c. or limiting functions may be added in order to suppress acoustic background noise, to maintain a constant output signal for various input levels or to avoid overloading by loud sounds. An auxiliary circuit is required which samples the input signal and processes it to provide a timed bias which varies the transmission characteristics of a device in the main amplifier path. The timing of these circuits is akin to that of voice-operated switching devices in that they have to have a fast attack time in order to avoid mutilating initial speech consonants etc., whilst the hold and release times must be adequately long in order to avoid surges and disconcertingly rapid swings of the speech and background levels. A hold time approximating to the average syllabic envelope duration with a release time of about 10 times the attack time is often found suitable. Figure 3 shows a typical transistorised microphone amplifier for general purpose use.

3.0 Power feed systems

The simplest type of d.c. power feed circuit is obtained by placing the d.c. transistor supply source in series with one of the microphone signal leads, suitable blocking capacitors being used if required to isolate the speech circuits at each end. A single coaxial cable may be used with the shield as a common earth return. In some cases problems may arise due to earthing points and interfering currents induced in the cable shield. It may then be advisable to use a balanced phantom type of feed system and/or extra connection leads inside the shield. The manufacturers use feed circuits of various types.

References

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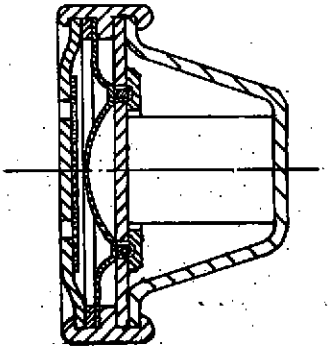
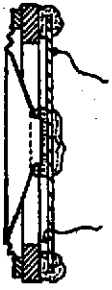
Figure 1



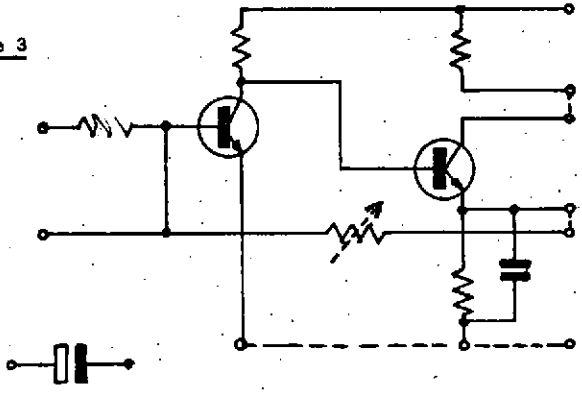
A small moving coil microphone for communications sets

Figure 2



A ceramic bar piezoelectric microphone

Figure 3



A thin film general purpose amplifier with provision for an input coupling capacitor and gain control