Oct. 31, 1950 M. L. GAYFORD 2,527,540

UNIDIRECTIONAL DUAL MICROPHONE

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FIG. 1.

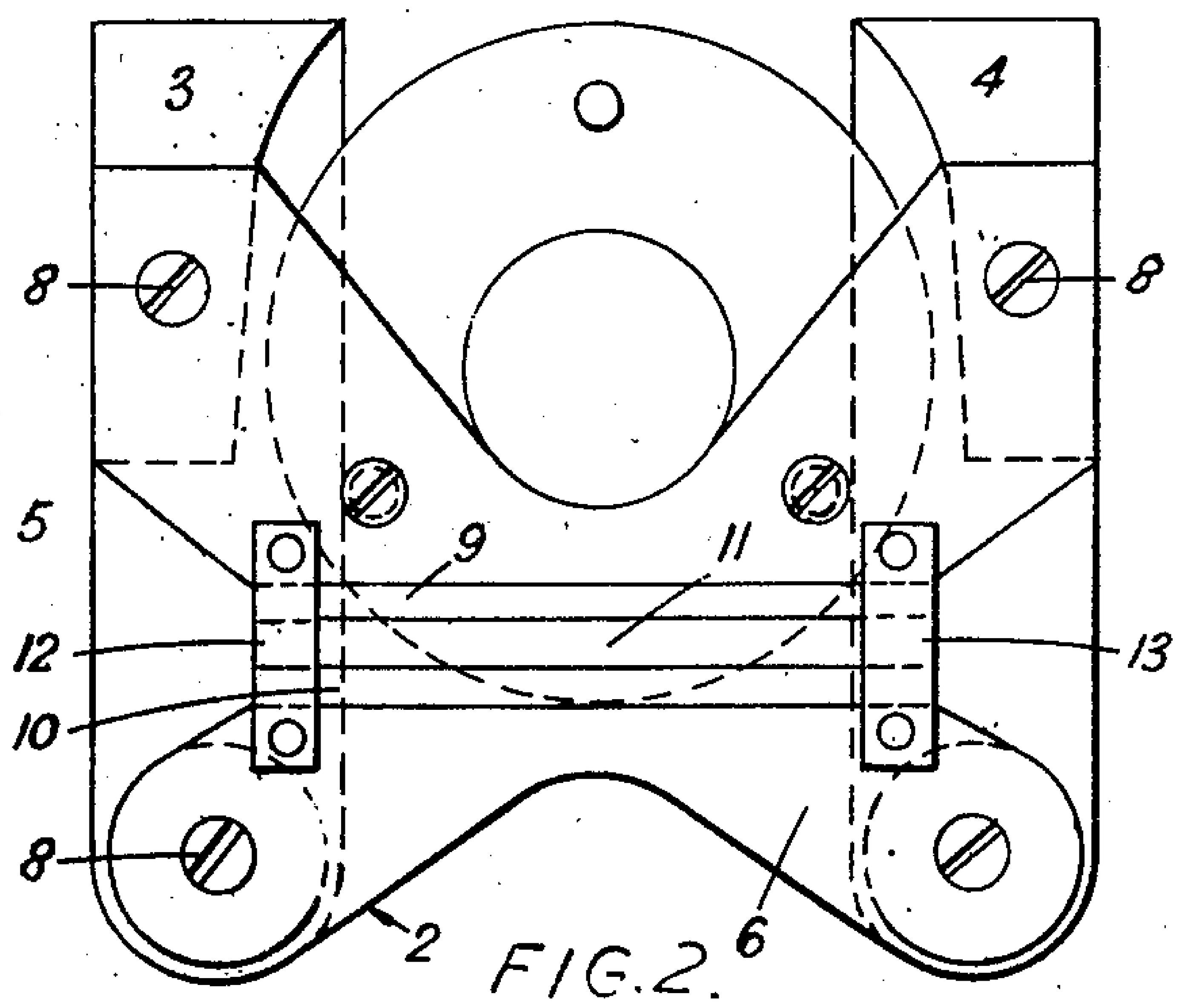


FIG. 2.

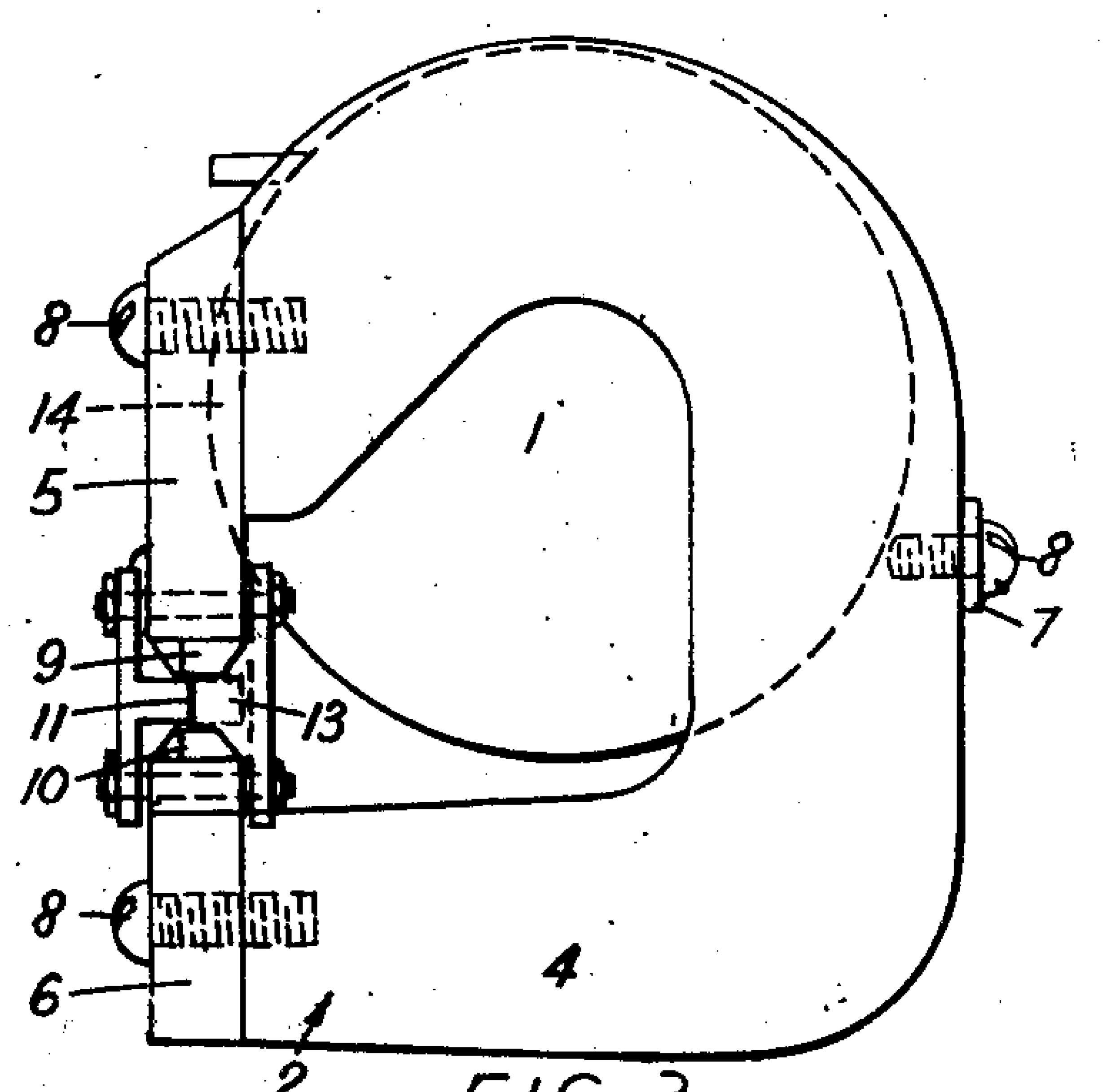


FIG. 3.

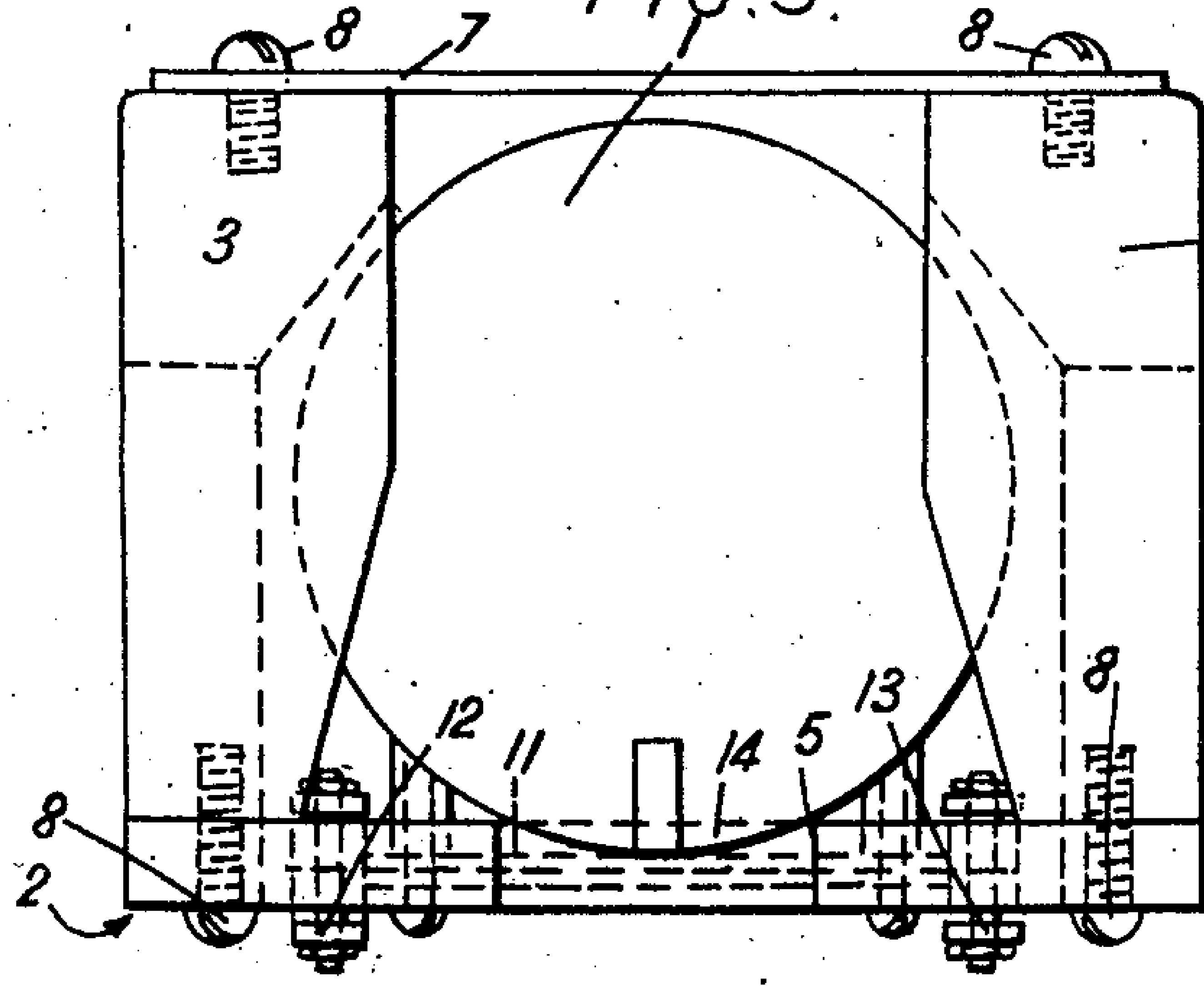


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FIG. 4 (part)

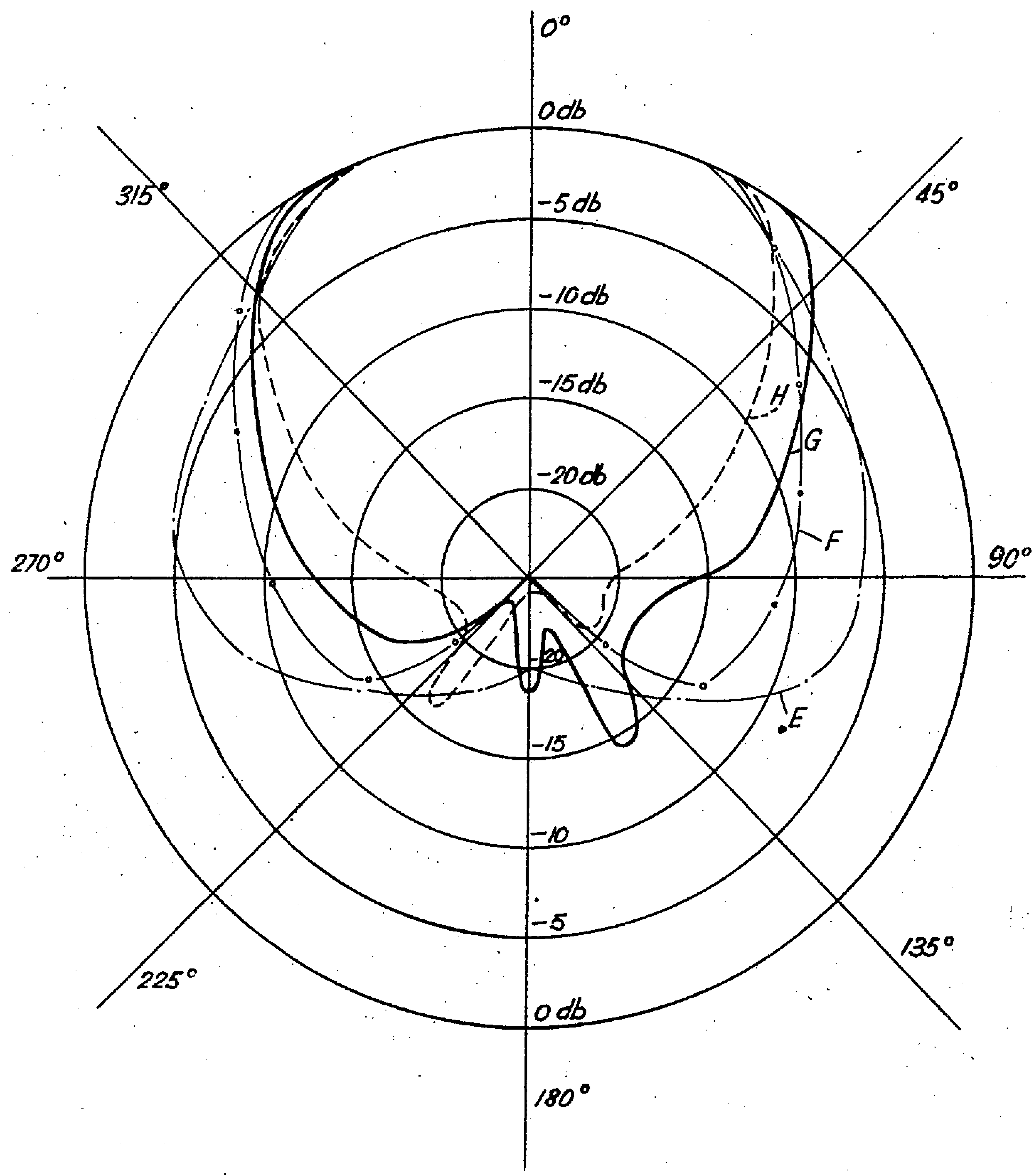


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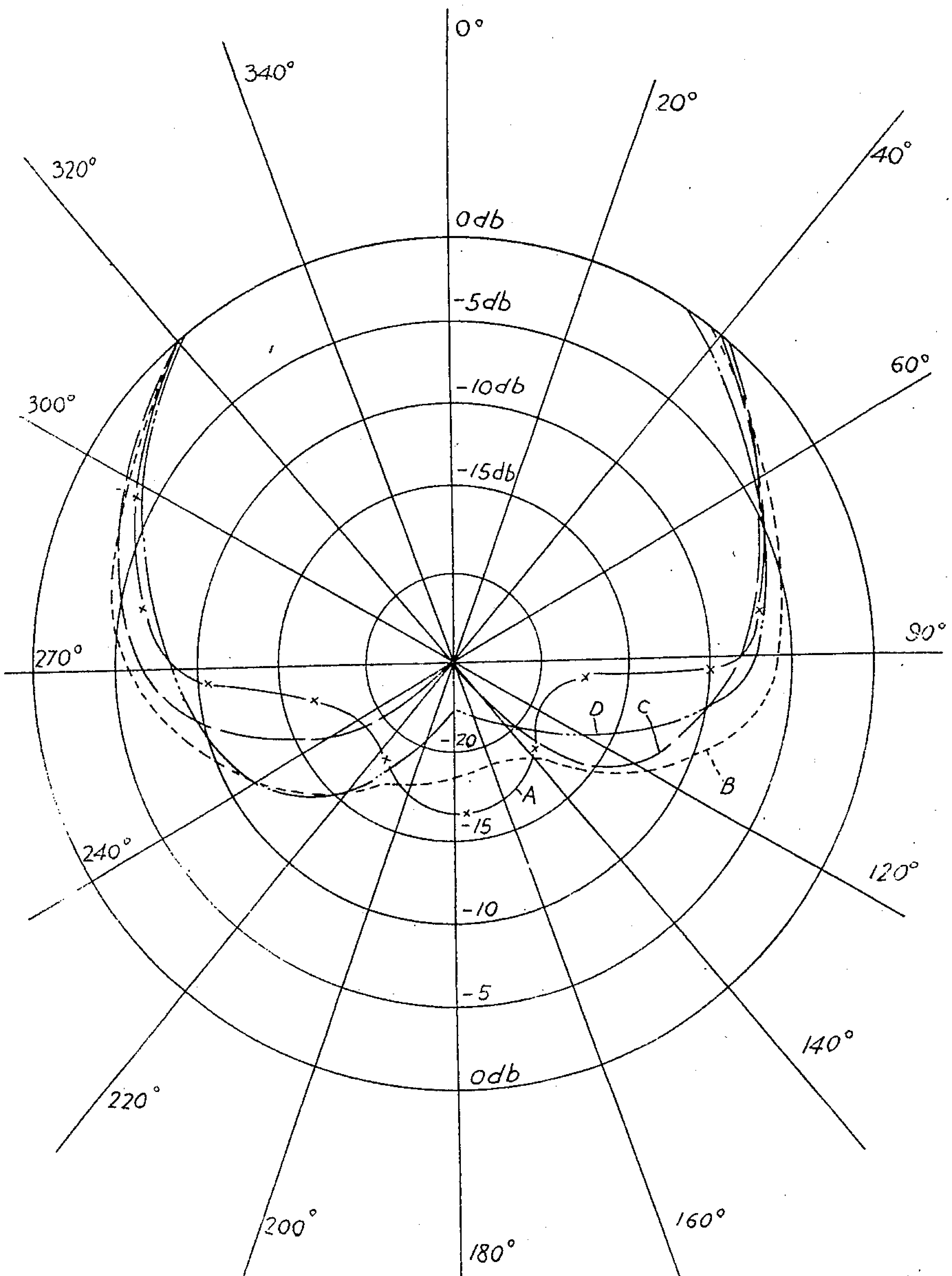
FIG.4 (part.)

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Patented Oct. 31, 1950 2,527,540

# UNITED STATES PATENT OFFICE

2,527,540

## UNIDIRECTIONAL DUAL MICROPHONE

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Application August 18, 1945, Serial No. 611,408
In Great Britain August 29, 1944

1 Claim. (Cl. 179—105)

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This invention relates to microphones, and more particularly to compound microphones designed to have a non-circular unidirectional polar response curve, an example of such a microphone being that shown and described in U. S. Patent No. 2,227,580.

The above mentioned patent specification shows a moving coil microphone unit and a ribbon microphone unit both arranged in a single case, their outputs being connected in series via a suitable multi-winding transformer and equalising elements to give substantially a cardioid polar response curve. This cardioid shape of the response curve results fundamentally from the fact that in general the moving coil unit has a circular (non-directional) polar curve and no change occurs in the phase of its output voltage for different angles of sound incidence, whilst the ribbon unit has a figure-of-eight (bi-directional) polar response with a 180° change of output voltage phase between sounds arriving at the front and back respectively. The outputs of these two units are connected so as to give ideally a resultant output of twice that of each unit for sounds arriving from the front and ideally to give complete cancellation, i. e. zero output for sounds arriving from the rear.

It is of fundamental importance that the acustic wave pressures acting on each unit should be nearly identical at any instant of time, and this condition must hold for all angles of incidence of the sound wave. In practice this means that the diaphragms of the two units must be as close together as possible so that the accoustic path difference between the two shall be so small as to avoid any serious accoustic phase shift between the two units at any frequency of interest. The phase shifts introduced in the actual units themselves must be accurately matched by suitable acoustical and electrical equalising elements. In the above specification the microphone units were shown as mounted one on top of the other with the long axis of the ribbon vertical. This meant that the distance between the centers of the diaphragms was considerable. The resultant acoustic phase shift distorted the polar response considerably above 2000 cycles/sec.; particularly in the vertical plane and in fact the specification shows and described means whereby, at frequencies above 3000 cycles/sec., the ribbon unit's output was deliberately filtered out and the microphone as a whole was entirely dependent on the moving coil unit for its output and directionality.

It is an object of the present invention to provide a dual-unit microphone which is improved in the respects just discussed and to extend the frequency range in which such a microphone achieves the desired polar response curve by means of the proper functioning of the two units.

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In order to attain this object the moving coil unit is placed close alongside the ribbon pole piece and the magnets of the ribbon unit are designed to be of such a shape as to accommodate the moving coil unit in that position. Thus the distance between the diaphragm centers is reduced to a minimum and a compact structure for the whole microphone is arrived at. The moving coil unit is housed in a spherical case in order to minimise its acoustic obstacle or diffraction effects on the sound waves. The ribbon unit magnets and pole pieces are made of as open a construction as possible in order to achieve the same end.

The following description relates to the accompanying drawings, in which:

Figs. 1, 2 and 3 are respectively front, side and plan views of a composite microphone in accordance with the present invention; and

Fig. 4 is a set of polar response curves for various frequencies for the microphone shown in Figs. 1, 2 and 3.

As shown in Figs. 1, 2 and 3, the moving coil microphone 1 of spherical contour nestles snugly between the permanent magnets of the ribbon microphone 2.

The ribbon microphone 2 comprises two permanent magnets 3 and 4, having what may be described as a triangular U-shape, and being similarly poled. These two magnets standing vertically and parallel with one another are fixed together by pole-pieces 5 and 6 at the front and by a tie-bar 7 at the back, the pole-pieces and tie-bar being secured to the magnets by bolts 8. The pole-pieces 5 and 6 are V-shaped, with straight parallel portions 9 and 10 which define between them a horizontal air gap for a ribbon diaphragm 11 which extends between supports 12 and 13 themselves bolted to the pole-pieces.

The moving coil microphone 1, which may be as shown in Figs. 1 to 4 of our copending patent application Ser. No. 554,407, filed Sept. 16, 1944 now Patent No. 2,509,224, is mounted between the magnets 3 and 4 which are shaped to receive it, and has its diaphragm 14 situated at the bottom of the V-recess in the polepiece 9 so that it is as near as possible to the centre of the ribbon diaphragm 11.

Fig. 4 shows a set of polar response curves for the microphone described above. The output is expressed in decibels referred to the output in the 0° or head-on front position of incidence. The curves A, B, C, D, E, F, G and H relate respectively to frequencies of 50, 500, 1000, 2500, 5000, 7000, 8000 and 9000 C./S. For the purpose of obtaining these curves, the ribbon microphone was connected to a step-up transformer and the output terminals of this transformer were connected in series with the output of the moving coil microphone. No attempt was made to cut the ribbon unit out of circuit by a condenser above 2000 cycles as was done in the U. S. Patent No. 2,227,580 already referred to. The curves show the desired polar curve holding up to 9000 cycles per sec., the curve at 9000 cycles being only slightly different from that at 1000 cycles per sec., or at the very least it may be said that the polar response curves remain substantially uniform up to a frequency of 5000 cycles per second, this being the limit towards which modern development is pushing as defining the voice-frequency range to be faithfully reproduced in telephony.

In this design at frequencies above 6000 cycles per second the output of the ribbon unit falls off due to the distance round the pole-pieces and the mass reactance of the ribbon; on the other hand the moving coil unit maintains its output to over 10,000 cycles per second and is unidirectional above 6000 cycles per second; so the combination still has a satisfactory polar response and output up to over 10,000 cycles. Ideally, the combination of a perfect non-directional unit with a perfect bi-directional cosine response unit could give a cardioid polar curve. In practice neither unit has an ideal response and hence the combined polar response departs from an actual cardioid curve. However, a unidirectional response with



very little change of curve shape with frequency has been attained. This is a type of response which is much sought after in modern sound reproduction.

What is claimed is:

In a compound microphone comprising a ribbon microphone and a moving-coil microphone, said ribbon microphone comprising a pair of similar U-shaped permanent magnets arranged in spaced substantially parallel relationship, a common pair of pole pieces bridging the space between like poles of said two magnets and having parallel portions defining a slit-like gap extending transversely relative to the open ends of the substantially parallel U-shaped magnets, a ribbon diaphragm mounted in the said gap, said moving coil microphone being nested in a substantially spherical case between the said pair of permanent magnets, and said moving coil microphone having its diaphragm in proximity to the area substantially intermediate the ends of the said ribbon diaphragm whereby the mean distance between the midpoints of the diaphragms of both microphones is minimized.

MICHAEL LAWRENCE GAYFORD.


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| 2,227,580 | Harry et al. | Jan. 7, 1941 |