PATENT SPECIFICATION

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738,864

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COMPLETE SPECIFICATION

Improvements in and relating to Ribbon Microphones

We, THE BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to ribbon microphones. In such microphones a thin conducting ribbon constitutes the vibratory element of the microphones, the ribbon being located in a magnetic field between magnetic pole pieces. When the ribbon vibrates in response to sound, electromotive forces, are induced therein. The magnitude of these electromotive forces is small and in order to preserve a good signal/noise ratio at the output of the microphone precautions have to be taken to reduce any unwanted voltage in the ribbon circuit to a very low level. Such unwanted voltages may be produced by induction in the ribbon, or in its connecting means, if the microphone is exposed to alternating magnetic fields, and such unwanted voltages may then be large enough to cause appreciable interference with the wanted signal.

It is known that the interference resulting from exposure of a ribbon microphone to alternating magnetic fields can be much reduced by duplicating the electrical connection at one end of the ribbon, the two connections being so disposed that they form in conjunction with the ribbon a pair of symmetrical loops. Alternating magnetic field will produce circulating currents in these loops, but, if the field is uniform, these currents will substantially cancel one another in the external circuit. The area of the loops is kept as small as possible in order to minimise the residual induction which will occur when the interfering field is not uniform.

The known balanced systems referred to have, however, certain disadvantages. The conductors which form with the ribbon the balanced system have to be placed directly in front of and behind the ribbon, and in order to avoid disturbance of the sound field relatively thin wires have to be used. These wires are not sufficiently rigid to be set up once and for all in their correct positions and the magnetic balance has to be adjusted for each microphone by bending the wires until the unwanted output produced by exposure to an alternating magnetic field is a minimum. The state of balance thus achieved is liable to be accidentally upset in the course of such maintenance operations as the removal of magnetic dust from the magnet pole or replacement of the ribbon.

The principal object of the present invention is to provide improved means for reducing the interference which occurs when the microphone is exposed to alternating magnetic fields, and at the same time reducing the disturbance of the sound field caused by such means. A subsidiary object of the invention is to facilitate withdrawal and replacement of the ribbon without thereby causing mechanical misalignment or magnetic unbalance.

According to the present invention, a ribbon microphone comprsies two substantially rigid conductors mounted in each of two parallel planes on opposite sides of the ribbon and substantially equally spaced therefrom, the four conductors being symmetrically disposed relatively to the longitudinal axis of the ribbon, one end of the ribbon being electrically connected to the nearer ends of the four conductors, the other ends of the four conductors being electrically connected together and forming one output terminal of the microphone and the other end of the ribbon forming the other output terminal of the microphone.

By providing in this way four symmetrically disposed loops the substantial cancellation of electromotive forces produced by alternating magnetic fields can be obtained without

conductors being disposed directly in front of and behind the ribbon, and disturbance of the sound field is thus greatly reduced. This disposition of the conductors also enables them to be made of substantial thickness, and hence rigid, without any great effect on the sound field in the neighbourhood of the ribbon. It also enables the areas of the loops formed between the conductors and the ribbon to be made small and thus minimise the residual induction pick-up in a non-uniform interfering field. The substantial rigidity of the conductors enables the arrangement to be set up once and for all and avoids the need for bending the conductors in order to obtain balance of the circulating currents.

The four conductors are preferably shaped to fit against surfaces of the magnetic pole pieces of the microphone and thereby serve to locate the ribbon correctly relatively to the pole pieces. One pair of the conductors may be made detachable, and it can be arranged that after this pair has been detached the remainder of the structure, including the other pair of conductors and the ribbon with its mounting, can be withdrawn as a unitary structure when it is desired to replace the ribbon.

The connections between the microphone and an external circuit are preferably made by means of a pair of flexible leads twisted together to reduce interference arising from magnetic fields linking these conductors.

For most purposes it is necessary that the body of the microphone and a supporting stem on which the microphone is mounted should be connected by a swivel joint in order to permit the axis of the microphone to be inclined to the horizontal if required. Some difficulty then arises in making satisfactory connection with an external circuit. Rubbing contacts are undesirable in circuits having a low resistance such for example as 0.1 ohm. Where flexible leads are used these should preferably be totally enclosed, both for reasons of appearance and for protection against damage. However, a flexible conductor passing through a swivel joint is liable to be subjected to local bending stress which may lead to failure.

According to a subsidiary feature of the invention, therefore, the microphone is mounted upon a support by means of a pair of swivel joints permitting limited rotary movement of the microphone relatively to the support and electrical connections from the microphone are taken out through apertures in one or both of the swivel joints in a direction parallel to the pivot axis of the joint. In this way, when the microphone is moved on the swivel joints, the strain to which the connections are subjected is mainly torsional and involves little bending. The length of the said apertures is preferably made substantial so that the strain to which the connections are subjected is small.

In view of the low impedance of the vibratory element of the microphone, which may for example be a resistance of 0.1 to 0.5 ohm, it is necessary to provide a transformer to match this impedance to an external circuit which may have an impedance of 20 ohms or more. In order to avoid the attenuation which would result from the use of long leads in the low impedance ribbon circuit, the matching transformer is commonly incorportated in the body of the microphone. The acoustic characteristics of the microphone are in general adversely affected by the presence of obstacles in the near neighbourhood of the vibratory element. The matching transformer if incorporated in the body of the microphone forms an appreciable obstacle, and should preferably be so disposed as to minimise its effect upon the sound field in the neighbourhood of the vibratory element.

For these reasons, according to a further subsidiary feature of the invention, the aforesaid support is made hollow and the microphone transformer is disposed within this support. Mechanical connections between the swivel joint and the support may be by tubes through which flexible electrical connections are passed to the transformer. In this way these connections are totally enclosed and protected from damage. In order to minimise interference through pick-up by the electrical connection from the microphone to the transformer, the leads constituting the connection are preferably twisted together. In addition, the connection is preferably duplicated, one twisted pair of flexible leads passing through one swivel joint and the other through the other swivel joint, the leads of one twisted pair being connected in parallel with those of the other pair respectively. This enables thinner and more flexible leads to be used for a given electrical resistance thereof.

The invention will be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a view in perspective of a ribbon assembly for a microphone according to the invention,

Fig. 2 is a view in front elevation of the assembly of Fig. 1,

Fig. 3 is a view in section on the line 3—3 of Fig. 2,

Fig. 4 is a sectional plan view of the assembly of Figs. 1 to 3 showing the way in which the assembly fits upon pole pieces of the magnet,

Fig. 5 is a view in part-sectional front elevation and Fig. 6 a view in part-sectional side elevation of a microphone according to the invention embodying the assembly of Figs. 1 to 4, parts of the casing being shown broken away.

Referring to Figs. 1 to 4, a horizontally-corrugated conducting ribbon 10 is mounted between two clamps, 11 and 12. One of these clamps, for example the upper 11, is of metal,

for instance brass, and consists of a bar 13, recessed centrally to receive a clamping block 14. The ribbon is clamped between the inner face of this block and the bottom of the recess by means of suitable screws 15. The lower clamp 12 consists of a body portion in the form of a bar 16 of insulating material centrally recessed to receive a fixed metal block 17 and a removable metal block 18, the lower end of the ribbon 10 being clamped between the inner faces of the blocks 17 and 18 by means of suitable screws 19. To the fixed block 17 is attached a metal pin 20 projecting outwardly therefrom, this pin serving for making electrical connection to the lower end of the ribbon and constituting one output terminal. The two clamps 11 and 12 are fixed in suitable positions relative to one another by means of four pillars 21 to 24 of rectangular cross-section, for instance of brass. Two of these pillars 21 and 22 are located on one side of the clamps and the other two, namely 22 and 23, on the opposite side, the pillars being arranged in two planes, one on each side of the ribbon. The arrangement is made symmetrical about the longitudinal axis of the ribbon. The pillars are fixed to the clamps by means of bolts 25 and the two pillars 23 and 24 on what will be called the back of the clamps are also soldered to the bar 13 of the uppermost clamp 11.

The ribbon is arranged between two pole pieces 26 and 27 (Fig. 4) of a permanent magnet 28 (Fig. 6), the pole pieces having vertical surfaces 29 and 30 tapering at a semi-apical angle of about 30°, and the edges of the ribbon 10 being close to the inward-facing ends 31 of the pole pieces. The central part of each of the pillars is twisted relative to the two ends through an angle of about 30° in order to provide surfaces which engage snugly against the tapered faces of the pole pieces, and thus locate the structure comprising the pillars, the clamps and the ribbon correctly in relation to the pole pieces. A thin coating of insulating varnish is provided on the inclined faces 29 and 30 of the pole pieces in order to insulate the pole pieces electrically from the pillars. The lower ends of the four pillars are connected together at 32 (Fig. 5) to form the second output terminal. The upper ends of the pillars are electrically connected through the blocks 13 and 14 to the upper end of the ribbon. With this arrangement it will seem that the four pillars together with the ribbon form four loops, and, since the arrangement is symmetrical, the electromotive forces generated at the output terminals due to an alternating magnetic field will substantially cancel one another.

In order to remove the ribbon assembly from the pole pieces when it is required to replace the ribbon, the electrical connections to the two pillars 21 and 22 on the front face of the clamp are removed, and these pillars are removed by loosening the clamping bolts 25, The remainder of the structure can then be withdrawn from the microphone body.

For supporting the microphone there is provided as shown in Figs. 5 and 6 a vertical tubular metal support 33 having fixed at its upper end a tubular stirrup 34, the centre of the stirrup being fixed to the upper end of the tubular support. The upper ends of the stirrup are inwardly turned as shown at 35 in such a manner as to be co-axial and form pivot bearings for supporting the microphone. A suitable transformer 36 is disposed within the upper end of the vertical support 33, Two twisted pairs 37 and 38 of flexible leads are passed through the two arms of the stirrup between the transformer and the microphone. One lead of each pair connects one output terminal of the microphone with one of the primary winding terminals of the transformer. The twisted pairs are a loose fit in the arms of the stirrup and the effect of rotating the microphone about the axis provided by the stirrup bearing is to twist and untwist the conductors over a length of about three-quarters of an inch. The maximum angle of tilt required is about 90° and a twist of this amount so distributed represents only a small strain on the individual strands of wire. Connections with the secondary winding of the transformer are made by a cable 39 passing through a branch 40.

What we claim is:—

1. A ribbon microphone comprising two substantially rigid conductors mounted in each of two parallel planes on opposite sides of the ribbon and substantially equally spaced therefrom, the four conductors being symmetrically disposed relatively to the longitudinal axis of the ribbon, one end of the ribbon being electrically connected to the nearer ends of the four conductors, the other ends of the four conductors being electrically connected together and forming one output terminal of the microphone and the other end of the ribbon forming the other output terminal of the microphone.

2. A microphone according to claim 1, wherein the four conductors are mechanically connected together at each end by a block, the ends of the ribbon being clamped to the blocks.

3. A microphone according to claim 2, wherein the structure comprising the four conductors and the two blocks is adapted to support the ribbon.

4. A microphone according to any of the preceding claims, wherein the ribbon extends between two magnetic pole pieces and wherein the said conductors are shaped to fit snugly against surfaces of the pole pieces.

5. A microphone according to any of the preceding claims, wherein electrical connections are made to the two said terminals by means of flexible leads twisted together.

6. A microphone according to any of the preceding claims, wherein the microphone is mounted upon a support by means of a pair of swivel joints permitting limited rotary movement of the microphone relatively to the support and electrical connections from the microphone are taken out through apertures in one or both of the swivel joints in a direction parallel to the pivot axis of the joint.

7. A microphone according to claim 6, wherein tubes are provided as mechanical connections between the swivel joints and the support, the said electrical connections passing through the tubes.

8. A microphone according to claim 7, wherein the electrical connections are duplicated, one twisted pair of flexible leads passing through one swivel joint and the other through the other swivel joint, corresponding leads of the two pairs being connected in parallel.

9. A microphone according to claim 6, 7 or 8, wherein the said support is hollow and a microphone transformer connected through the said electrical connections to the ribbon is disposed within the support.

10. A ribbon microphone substantially as described with reference to Figs. 1 to 4 or to Figs. 1 to 6 of the accompanying drawings.

Dated this 27th day of May, 1954.
REDDIE & GROSE,
Agents for the Applicants,
6, Bream's Buildings, London, E.C.4.

PROVISIONAL SPECIFICATION

Improvements in and relating to Ribbon Microphones

We, THE BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W.1, do hereby declare this invention to be described in the following statement:—

The present invention relates to ribbon microphones. In such microphones a thin conducting ribbon constitutes the vibratory element of the microphones, the ribbon being located in a magnetic field between magnetic pole pieces. When the ribbon vibrates in response to sound, electromotive forces are induced therein. The magnitude of these electromotive forces is small and in order to preserve a good signal/noise ratio at the output of the microphone precautions have to be taken to reduce any unwanted voltage in the ribbon circuit to a very low level. Such unwanted voltages may be produced by induction in the ribbon, or in its connecting means, if the microphone is exposed to alternating magnetic fields, and such unwanted voltages may then be large enough to cause appreciable interference with the wanted signal.

It is known that the interference resulting from exposure of a ribbon microphone to alternating magnetic fields can be much reduced by duplicating the electrical connections at one end of the ribbon, the two connections being so disposed that they form in conjunction with the ribbon a pair of symmetical loops. An alternating magnetic field will produce circulating currents in these loops, but, if the field is uniform, these currents will substantially cancel one another in the external circuit. The area of the loops is kept as small as possible in order to minimise the residual induction which will occur when the interfering field is not uniform.

The known balanced systems referred to have, however, certain disadvantages. The conductors which form with the ribbon the balanced system have to be placed directly in front of and behind the ribbon, and in order to avoid disturbance of the sound field relatively thin wires have to be used. These wires are not sufficiently rigid to be set up once and for all in their correct positions, and the magnetic balance has to be adjusted for each microphone by bending the wires until the unwanted output produced by exposure to an alternating magnetic field is a minimum. The state of balance thus achieved is liable to be accidentally upset in the course of such maintenance operations as the removal of magnetic dust from the magnet pole or replacement of the ribbon.

The principal object of the present invention is to provide improved means for reducing the interference which occurs when the microphone is exposed to alternating magnetic fields, and at the same time reducing the disturbance of the sound field caused by such means. A subsidiary object of the invention is to facilitate withdrawal and replacement of the ribbon without thereby causing mechanical misalignment or magnetic unbalance.

According to the present invention, a ribbon microphone comprises two rigid conductors mounted in each of two parallel planes on opposite sides of the ribbon and substantially equally spaced therefrom, the four conductors being symmetrically disposed relatively to the longitudinal axis of the ribbon, one end of the ribbon being electrically connected to the ends of the four conductors adjacent thereto, the other ends of the four conductors being connected together and forming one output terminal of the microphone and the other end of the ribbon forming the other output terminal of the microphone.

By providing in this way four symmetrically disposed loops the substantial cancellation of electromotive forces produced by alternating magnetic fields can be obtained without conductors being disposed directly in front of and behind the ribbon, and disturbance of the sound field is thus greatly reduced. This disposition of the conductors also enables them to be made of substantial thickness, and hence rigid, without any great effect on the sound field in the neighbourhood of the ribbon. It also enables the areas of the loops formed between the conductors and the ribbon to be made small and thus minimise the residual induction pick-up in a non-uniform interfering field. The rigidity of the conductors enables the arrangement to be set up once and for all and avoids the need for bending the conductors in order to obtain balance of the circulating current.

The rigid conductors are preferably shaped to fit against the magnetic pole pieces of the microphone and thereby serve to locate the ribbon correctly relatively to the pole pieces. One pair of the conductors may be made detachable, and it can be arranged after this pair has been detached the remainder of the structure, including the other pair of conductors and the ribbon with its mounting, can be withdrawn as a unitary structure when it is desired to replace the ribbon.

The connections between the microphone and an external circuit are preferably made by means of a pair of flexible leads twisted together to reduce interference arising from magnetic fields linking these connections.

For most purposes it is necessary that the body of the microphone and a supporting stem on which the microphone is mounted should be connected by a swivel joint in order to permit the axis of the microphone to be inclined to the horizontal if required. Some difficulty then arises in making satisfactory connection with an external circuit. Rubbing contacts are undesirable in circuits having a low resistance such for example as 0.1 ohm. Where flexible leads are used these should preferably be totally enclosed, both for reasons of appearance and for protection against damage. However, a flexible conductor passing through a swivel joint is liable to be subjected to local bending stress which may lead to failure.

According to a subsidiary feature of the vention, therefore, the microphone is mounted upon a support by means of a pair of swivel joints permitting limited rotary movement of the microphone relatively to the support and connections from the microphone are taken out through apertures in one or both of the swivel joints in a direction parallel to the pivot axis of the joint. In this way, when the microphone is moved on the swivel joints, the strain to which the connections are subjected is mainly torsional and involves little bending. The length of the said apertures is preferably made substantial so that the strain to which the connections are subjected is small.

In view of the low impedance of the vibratory element of the microphone, which may for example be a resistance of 0.1 to 0.5 ohm, it is necessary to provide a transformer to match this impedance to an external circuit which may have an impedance of 20 ohms or more. In order to avoid the attenuation which would result from the use of long leads in the low impedance ribbon circuit, the matching transformer is commonly incorporated in the body of the microphone. The acoustic characteristics of the microphone are in general adversely affected by the presence of obstacles in the near neighbourhood of the vibratory element. The matching transformer if incorporated in the body of the microphone forms an appreciable obstacle, and should preferably be so disposed as to minimise its effect upon the sound field in the neighbourhood of the vibratory element.

For these reasons, according to a further subsidiary feature of the invention, the aforesaid support is made hollow and the microphone transformer is disposed within this support. Mechanical connections between the swivel joint and the support may be by hollow tubes through which the electrical connections are passed to the transformer. In this way these connections are totally enclosed and protected from damage. The leads from the microphone to the transformer are preferably duplicated, one twisted pair of flexible leads passing through one swivel joint an the other through the other swivel joint. This enables thinner and more flexible leads to be used for a given electrical resistance thereof. In order to minimise interference through pick-up by these leads, the leads of one twisted pair are preferably connected in parallel with those of the other pair respectively.

In carrying the invention into effect, we may proceed as follows. In the following description it will be assumed for convenience that the ribbon lies in a vertical plane with its longitudinal axis vertical. The ribbon is mounted between two clamps. One of these clamps, for example the upper, is of metal, for instance brass, and consists of a bar, recessed centrally to receive a clamping block. The ribbon is clamped between the inner face of this block and the bottom of the recess by means of suitable screws. The lower clamp consists of a body portion in the form of a bar of insulating material centrally recessed to receive a metal block, the lower end of the ribbon being clamped between the inner face of this block and the bottom of the recess by means of suitable screws. To this block is fixed a metal pin projecting outwardly therefrom, this pin serving for making

electrical connection to the lower end of the ribbon and constituting one output terminal. The two clamps are fixed in suitable positions relative to one another by means of four pillars of rectangular cross-section, for instance of brass. Two of these pillars are located on one side of the clamps and the other two on the opposite side, the pillars being arranged in two planes, one on each side of the ribbon. The arrangement is made symmetrical about the longitudinal axis of the ribbon. The pillars are fixed to the clamps by means of bolts and the two pillars on what will be called the back of the clamps are also soldered to the uppermost clamp.

The ribbon is arranged between two pole pieces of a permanent magnet, the pole pieces having vertical surfaces tapering at a semi-apical angle of about 30°, and the edges of the ribbon being close to the inward-facing ends of the pole pieces. The central part of each of the pillars is twisted relative to the two ends through an angle of about 30° in order to provide surfaces which engage snugly against the tapered faces of the pole pieces, and thus locate the structure comprising the pillars, the clamp and the ribbon correctly in relation to the pole pieces. A thin coating of insulating varnish is provided on the inclined faces of the pole pieces in order to insulate the pole pieces electrically from the pillars. The lower ends of the four pillars are connected together to form the second output terminal. The upper ends of the pillars are electrically connected to the upper end of the ribbon. With this arrangement it will seem that the four pillars together with the ribbon form four loops, and, since the arrangement is symmetrical, the electromotive forces generated at the output terminals due to an alternating magnetic field will substantially cancel one another.

In order to remove the ribbon assembly from the pole pieces when it is required to replace the ribbon, the electrical connections to the two pillars on the front face of the clamp are removed, and these pillars are removed by loosening the clamping bolts. The remainder of the structure can then be withdrawn from the microphone body.

For supporting the microphone there is provided a vertical tubular metal support having fixed at its upper end a tubular stirrup, the centre of the stirrup being fixed to the upper end of the tubular support. The upper ends of the stirrup are inwardly turned in such a manner as to be co-axial and form pivot bearings for supporting the microphone. A suitable transformer is disposed within the upper end of the vertical support. Two twisted pairs of flexible leads are passed through the two arms of the stirrup between the transformer and the microphone. One lead of each pair connects one output terminal of the microphone with one of the primary winding terminals of the transformer. The twisted pairs are a loose fit in the arms of the stirrup and the effect of rotating the microphone about the axis provided by the stirrup bearing is to twist and untwist the conductors over a length of about three-quarters of an inch. The maximum angle of tilt required is about 90° and a twist of this amount so distributed represents only a small bending effect on the individual strands of wire.

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6, Bream's Buildings, London, E.C.4.

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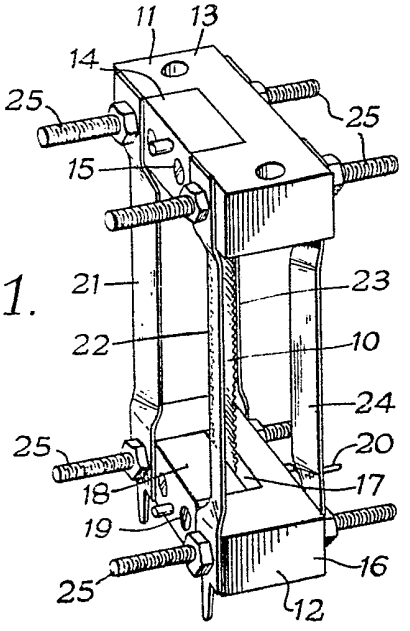

Fig.1.

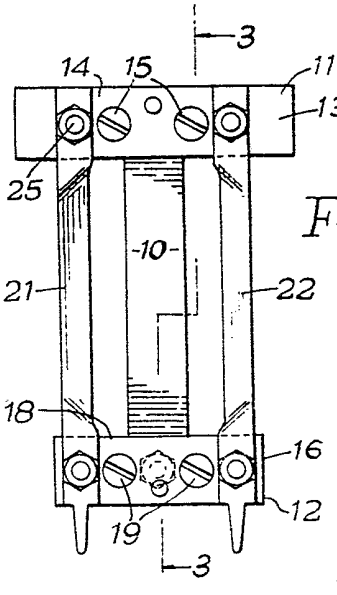

Fig.2.

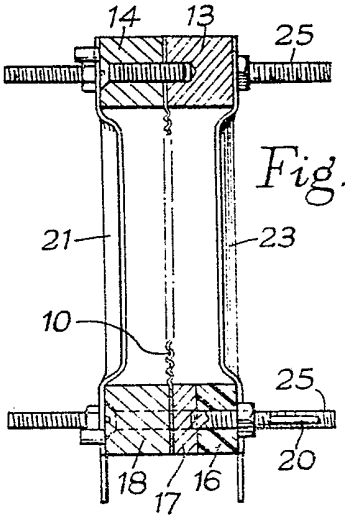

Fig.3.

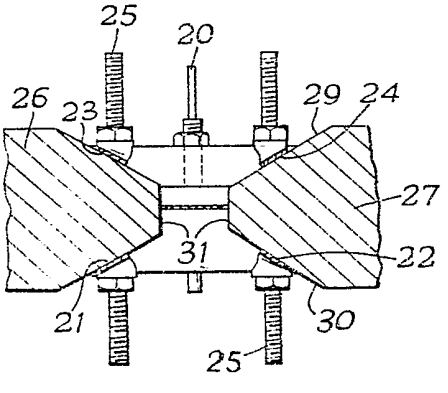

Fig.4.

738,864 COMPLETE SPECIFICATION

2 SHEETS

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SHEETS 1 & 2

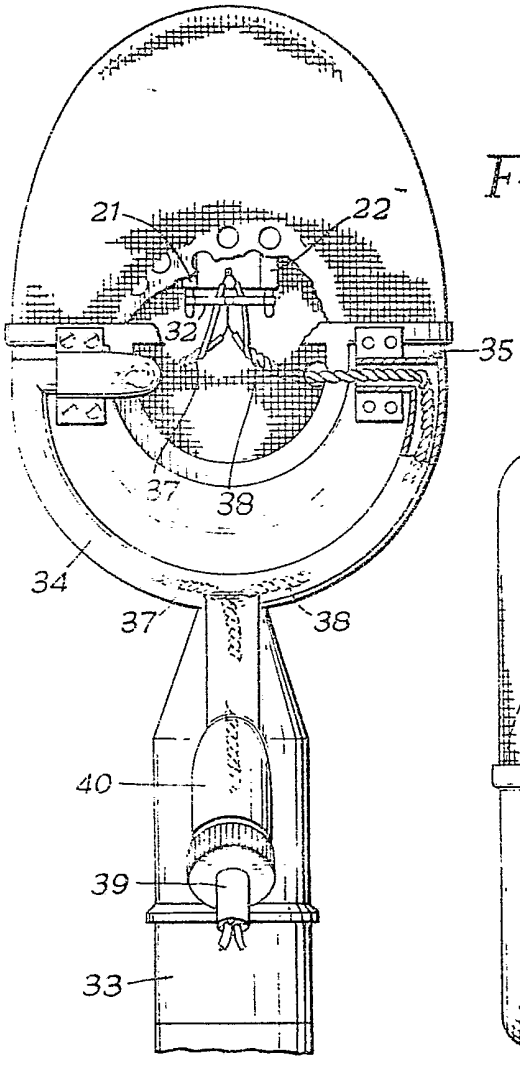

Fig.5.

Fig.3.

:3

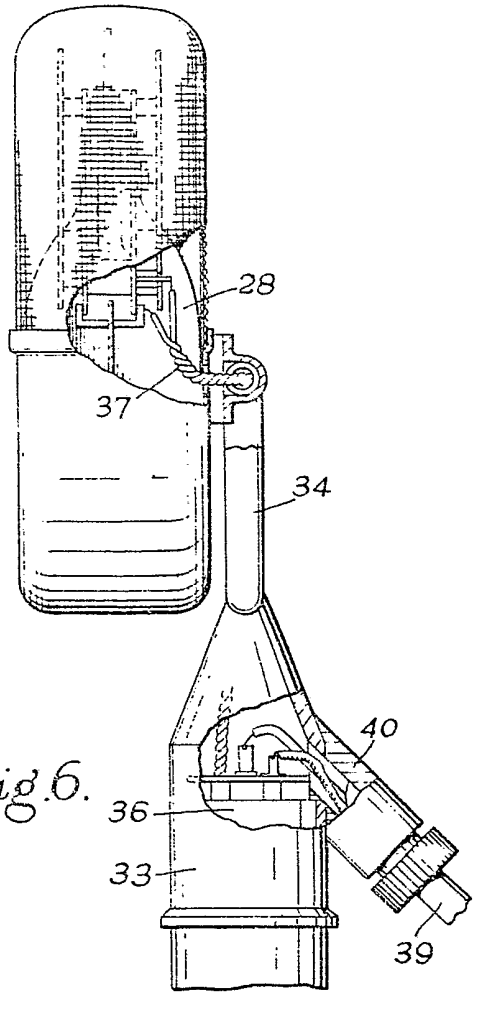

Fig.6.

738,864 COMPLETE SPECIFICATION

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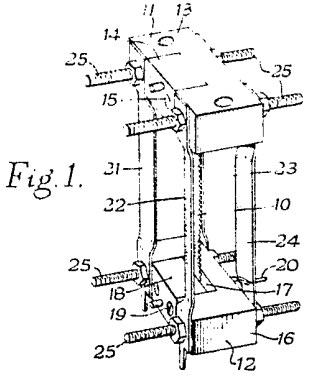

Fig.1.

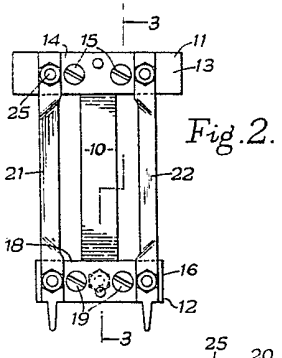

Fig.2.

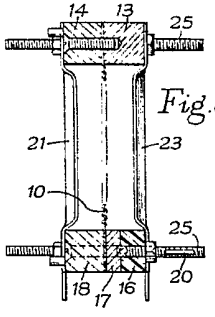

Fig.3.

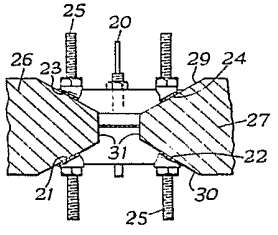

Fig.4.

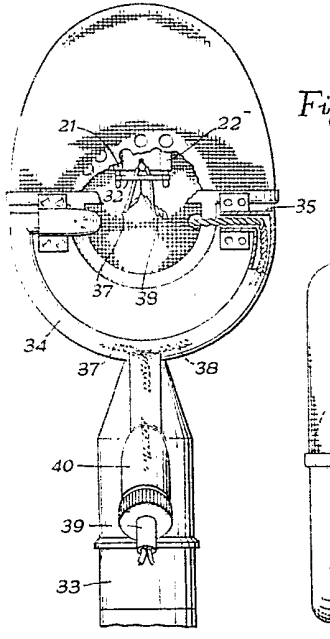

Fig.5.

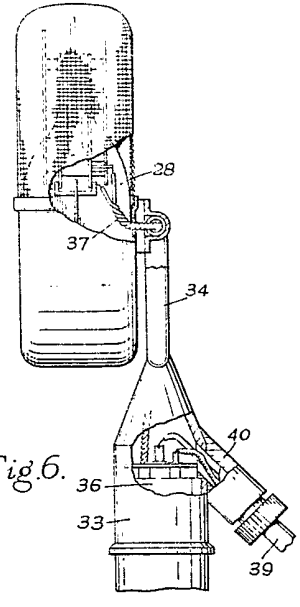

Fig.6.