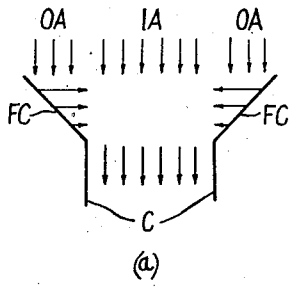
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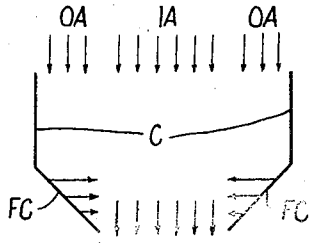
APPARATUS FOR CONDUCTING SOUND

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(a)

FIG. 1



(b)

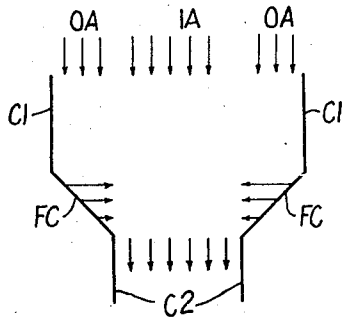


FIG. 2. (a)

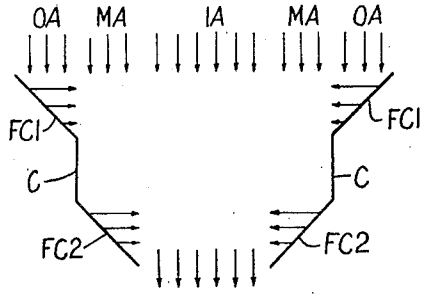


FIG. 2. (b)

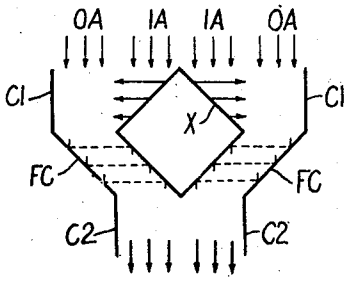


FIG. 2. (c)

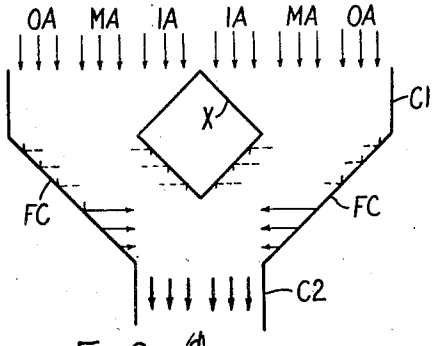


FIG. 2. (d)

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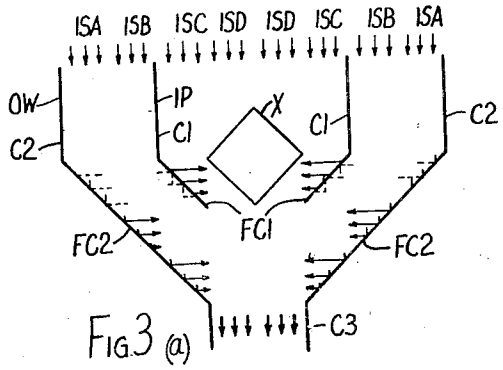


FIG. 3 (a)

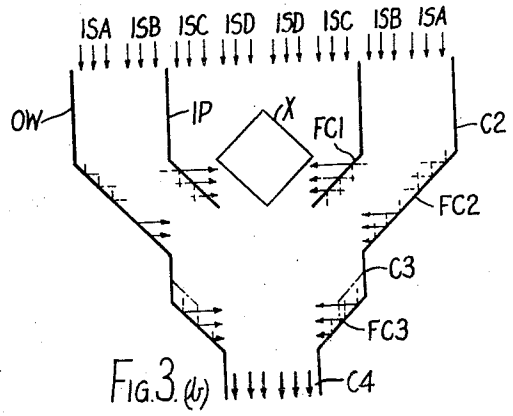


FIG. 3. (b)

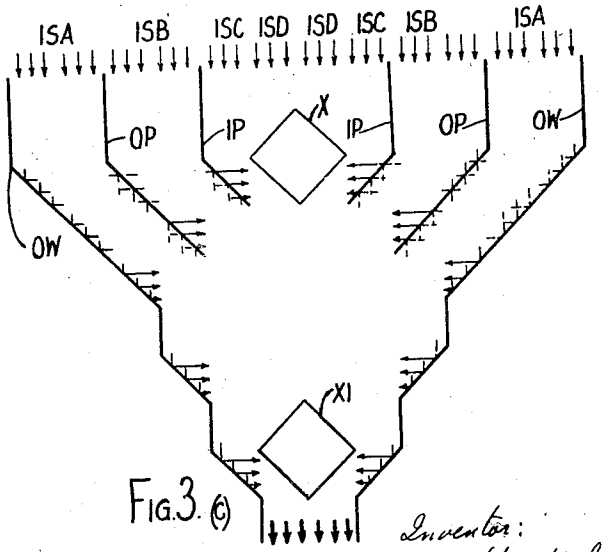


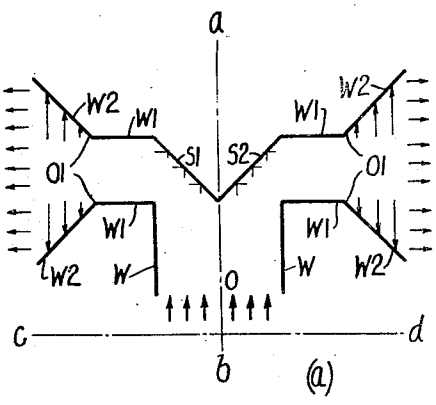
FIG. 3. (c)

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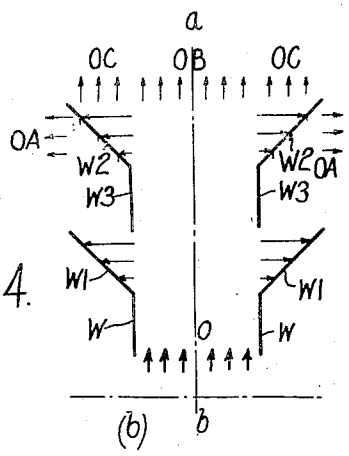


FIG. 4.

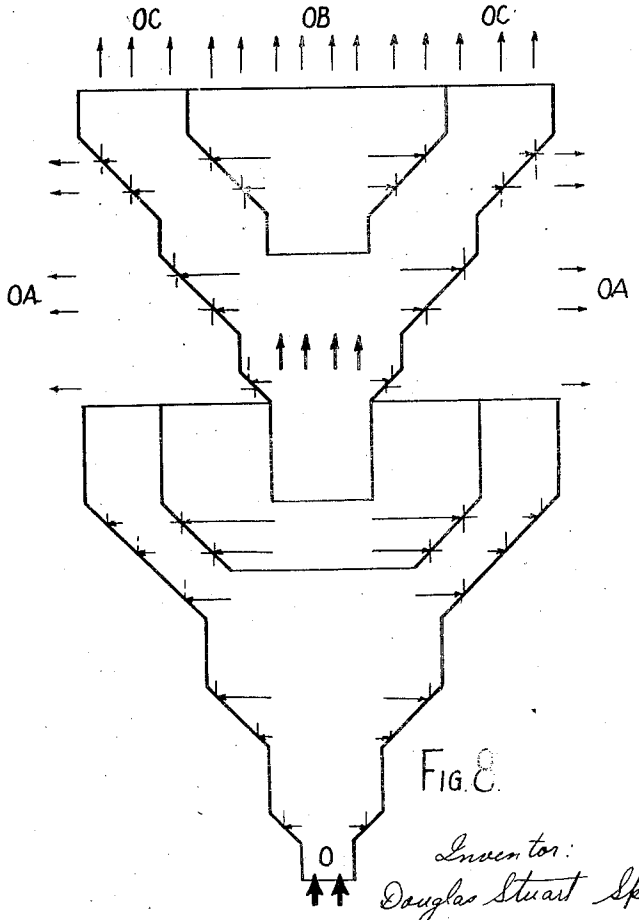


FIG. 8.

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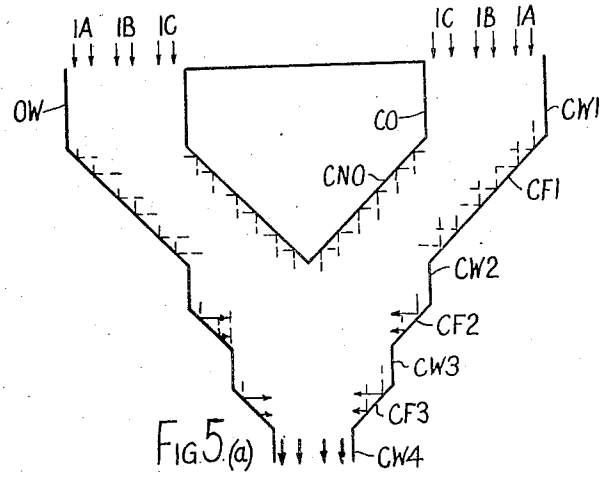


FIG. 5.(a)

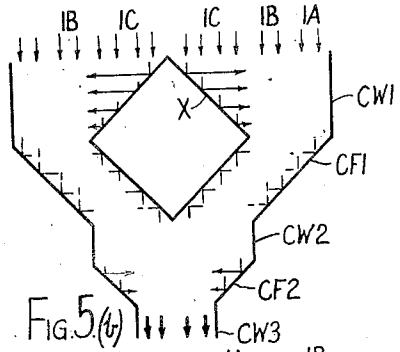


FIG. 5.(b)

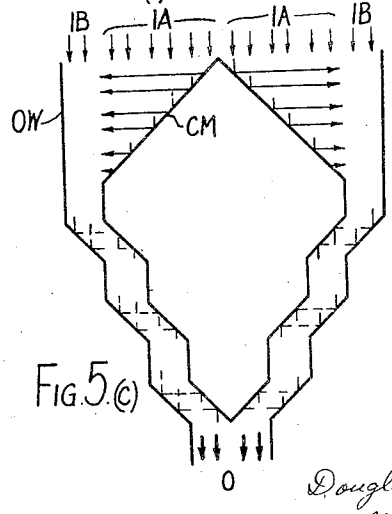


FIG. 5.(c)

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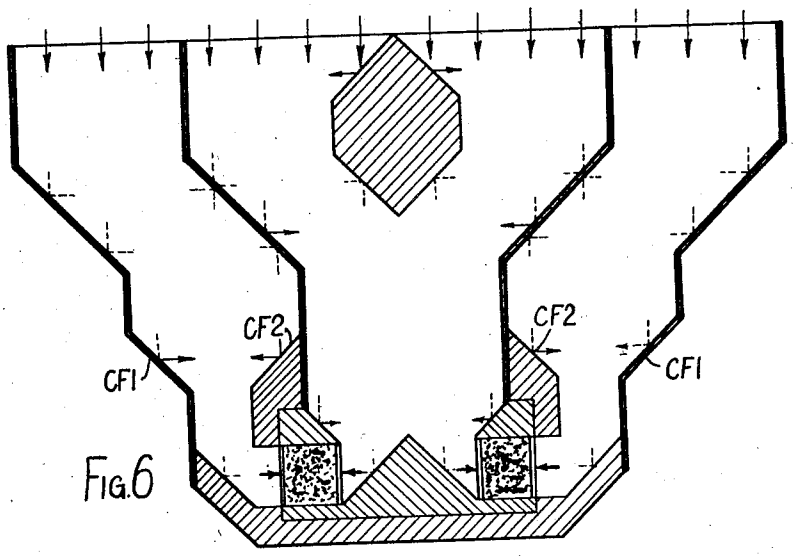


FIG. 6

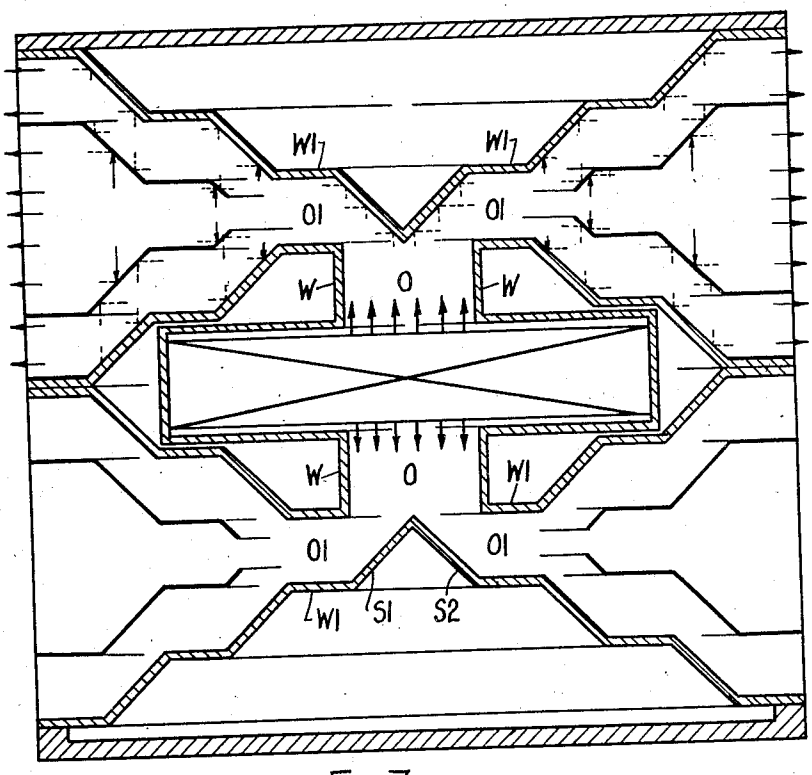


FIG. 7

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FIG. 10

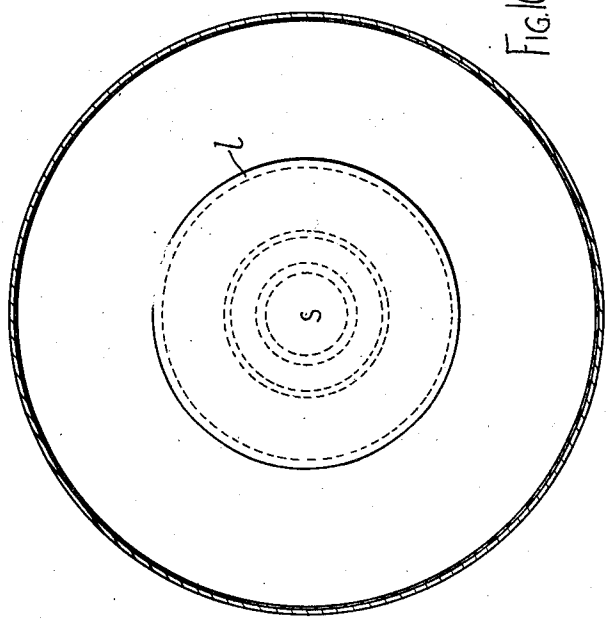
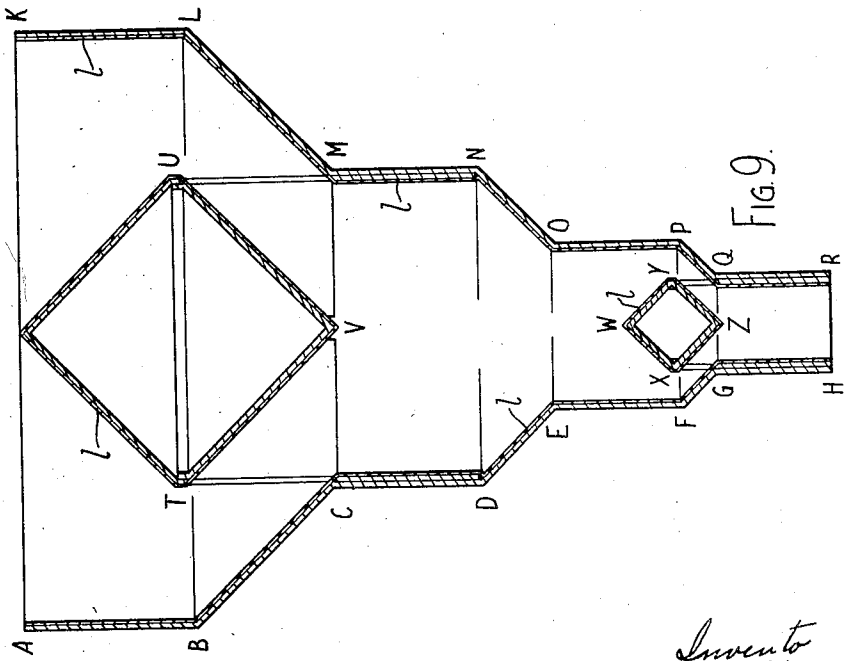


FIG. 9



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Patented July 13, 1937 2,087,052

UNITED STATES PATENT OFFICE

2,087,052

APPARATUS FOR CONDUCTING SOUND

Douglas Stuart Spens Steuart, London, England

Application November 29, 1935, Serial No. 52,255
In Great Britain December 10, 1934

16 Claims. (Cl. 181—0.5)

The present invention concerns improvements in or relating to apparatus for conducting sound, whether for transmission, reception, reproduction or location of sound or combinations of the same.

In known sound conducting arrangements of the type in which sound is led from a small opening to a large opening or vice versa the bounding surfaces of the conduit or conduits connecting the two openings have taken either of two forms.

In the first place they have been curved in the direction of travel of the sound, for instance they have taken the form of a flare or they have been designed to follow an expotential law or they have simply been provided with curves to avoid the presence of sudden changes in the contour of the surfaces. This form may conveniently be referred to as the "curved" form of construction.

In the second form the surfaces have been straight in the direction of travel of the sound and have included reflecting surfaces inclined at a marked angle with respect to the direction of travel of the sound. In this case it has been assumed that the sound when striking against a deflecting or reflecting surface followed the same laws as light and that the angle of reflection is equal to the angle of incidence so that by arranging the deflecting surface at an angle of 45°, the direction of sound is deflected through 90°. This type will conveniently be referred to as the "rectilinear" type.

It would appear as a result of experiments that the curved type introduced considerable distortion of the sound but it offered certain constructional advantages. The rectilinear type seemed to give much better results as regards distortion but offered difficulties from the constructional point of view owing to the fact that to obtain a compact construction it was necessary to obstruct the available area of the larger opening of the conduit, or alternatively to make a very awkward shape, although it lent itself to more compact constructions than the "curved" type. Previously in the rectilinear type the deflecting surfaces were designed to direct the whole of the soundwave front from the inlet towards the outlet of the conduit so that the wave front was maintained in expanded or contracted form.

The rectilinear type of sound-conducting apparatus has taken two forms.

In one, co-axial and radial sections of a conduit have been connected to each other by providing surfaces opposite the ends of successive sections of the conduit which have taken the forms of conical frustums or as regards the central section of the passage the form of a cone having an inclination of 45° to the common axis. In some places the radial section of the conduit has been only virtually present by arranging that two conical frustums meet at the extension of two co-axial sections of the passages.

In another, non-co-axial sections of a conduit have been connected to each other by providing a surface inclined at 45° so as to lie across the directions of the two interconnecting sections of the conduit, while in some cases one section of the conduit has only been virtually present by arranging that two inclined surfaces meet at the extension of adjacent sides of two parallel sections of the conduit.

It has further been usual to curve or taper the sides of the conduit so that the actual wall surfaces of sections of the conduit are not strictly parallel with the direction of those conduit sections, while the surfaces inclined at 45° have been determined in accordance with the intersection of such surface by extensions of the sections of the conduit they interconnect. For instance extension of the surfaces of the walls of two interconnecting sections of the conduit tend to meet on the periphery of the surface inclined at 45° which is placed at their junction.

In sound-conducting apparatus according to the invention in which the sections of the conduit connecting a large perimeter region with a small perimeter region extend in a particular direction, while it may include one or more surfaces inclined at 45° whose periphery is determined by the junction of the extensions of the surfaces of two adjacent sections of the conduit including virtual sections includes at least one surface inclined at 45° which instead of facing two connecting sections of the conduit whether virtual or actual is placed in such a position as to increase the width of that section of the conduit in the direction from the small to the larger perimeter region. It should be understood that when the angle of 45° is referred to herein it may be taken as covering close approximations which give substantially equally satisfactory results. These and other features of the invention will be better understood by referring to the accompanying drawings, in which

Figure 1 represents cross-sections of two elementary forms of sound-conducting apparatus which while lying outside the scope of the claims

illustrate an important principle incorporated in the invention.

Figure 2 represents elementary forms which fall within the scope of the present invention.

Figure 3 represents forms of sound-conducting apparatus of much larger variation between sizes of inlet and outlet.

Figure 4 represents elementary forms of sound-conducting apparatus having a multi-directional opening.

Figure 5 represents forms of sound-conducting apparatus embodying the features of the invention with a central conduit section which prevents any soundwaves passing through the apparatus without reflection.

Figure 6 illustrates one example of a special apparatus embodying the features of the invention, while

Figure 7 illustrates a more complex form of multi-directional sound-conducting apparatus.

Figure 8 illustrates a further complex form of multi-directional sound-conducting apparatus.

Figures 9 and 10 illustrate yet another example.

As a result of experiments it has been ascertained that mouthpieces for telephone transmitters embodying the arrangements shown in Figure 1*a* give superior results to mouthpieces of either the curved or rectilinear type. This elementary mouthpiece is formed of two essential sections, one consisting of a section C of constant width such as a cylinder and the other consisting of a contracting or expanding section such as a frustum of a hollow cone FC, the angle of inclination of the surface of the expanding section to the surface of the constant width section being 45°. With an elementary mouthpiece such as is shown in Figure 1*a* soundwaves approaching the mouthpiece in the direction of the arrows may be considered as being formed of two groups, namely an inner group represented by the arrows IA and an outer group represented by the arrows OA.

The group represented by the arrows IA passes without reflection to the diaphragm of the microphone, while the group represented by the arrows OA is reflected so as to converge on the inner group at right-angles thereto.

It was noted that although no means were provided for again deflecting the waves indicated by OA so as to bring them in the direction of the waves indicated by IA, yet they did not appear to be lost as a much greater amplitude of sound was detected by the microphone than if a tube C only was employed.

Further experiments undertaken with this elementary form of sound-conducting apparatus indicated that it could equally well be used in connection with loudspeakers. That is to say the source of sound instead of entering in at the larger opening and being concentrated at the smaller opening could be led to the smaller opening and allowed to emerge from the larger opening. Furthermore the sectional view illustrated is not limited to a cylindrical construction but could be applied equally well to a square construction, or in fact any construction having a similar cross-section which statement includes walls having surfaces generated by the lines shown in the drawings when moved in a closed path or between planes parallel to the lines. These remarks apply equally to the subsequent figures to be described and for that reason no plan view is indicated but it is anticipated that for most constructional purposes the plan would be circular as this permits of the sound-conducting apparatus being constructed from spinnings.

The material of which the sound-conducting apparatus is constructed may consist of "bakelite" or other moulding material if the apparatus is to be formed by moulding but most satisfactory results have been obtained by employing aluminium anodically treated which is found to possess good sound-reflecting qualities.

Figure 1*b* operates in a similar way to Figure 1*a* but has the advantage in that the surface or surfaces of the enlarged opening are parallel to the desired direction of incoming waves and therefore the waves which reach the deflecting surfaces are more likely to be in the desired direction.

Figures 2*a* and 2*b* are developments of Figures 1*a* and 1*b* in that there are three conduit sections forming the mouthpiece, namely in Figure 2*a* a cylindrical section C1, a section constituted by a frustum of a hollow cone FC and a further cylindrical section C2 of smaller diameter than C1. The action of the arrangement of this figure seems to be substantially the same as Figure 1*a* except that it has the additional and most important feature of Figure 1*b* of having a certain directional effect associated with the soundwaves which reach the conical frustum FC.

Figure 2*b* illustrates a double stage of reflection. In this case incoming soundwaves may be considered as divided into three groups, namely the outer group OA, the middle group MA and the inner group IA, so that the soundwaves travelling in the direction of the arrows OA strike against the surface of the conical frustum section FC1 and are therefore reflected in a transverse direction to the soundwaves constituted by the other two groups IA and MA. Then the group of soundwaves MA is reflected by the surface of the conical frustum section FC2 to cause them to converge towards the soundwaves represented by IA so that in this case the principles of the invention are effected in two stages.

In Figures 2*c* and 2*d* the reflection takes place in the opposite direction to that previously described because in these cases it is the soundwaves represented by IA which are deflected outwards, while the soundwaves represented by the arrows OA are passing into the mouthpiece. In the construction of the mouthpiece shown in Figure 2*c* it will be noted that the outer surfaces are identical with those shown in Figure 2*a* but internally two cones X inverted with respect to each other and placed base to base lie with their axes co-incident with the axis of the mouthpiece and extending from the upper part of the cylindrical tube C1 to the upper part of the cylindrical tube C2. The slope of the cones X is at an angle of 45° and consequently the waves OA after being subjected to the transverse action of the waves IA strike against the frusto-conical surface of the section FC and are deflected at right-angles thereto following the principles of rectilinear reflection. They then strike against the lower surface of the double cone X and are thence deflected along the tube C2. It will be noted that the surfaces of the conical frustum section FC and the lower surface of the double cone X form a virtual path. This will be understood when it is considered as to how the design would be changed if the width of the opening between the bottom part of the tube C1 and the outer edge of the double cone was less than that shown. In that case the dimensions of both the conical frustum section and the lower surface of the double cone would be reduced so that a plane surface would require to be provided to

connect the upper and lower cones together and this plane surface could constitute a wall to the path referred to. In this case the soundwaves are intensified partly in accordance with the principles of the invention and partly in accordance with known principles of rectilinear reflection where the soundwaves are caused to converge from an outer cylindrical wall towards the axis. It is pointed out, however, that in the construction shown with the lowest reflecting surface in the form of a cone there appears to be a concentration of soundwaves at the centre which is found to be very advantageous in effecting the operation of a microphone.

Figure 2*d* is a modification of Figure 2*c* to the extent that the cylindrical section C1 is of greater diameter and the frusto-conical section FC is larger so that the opening of the cylindrical section C2 can remain the same size. In this case the soundwaves must be considered in three groups; an outer group OA, a middle group MA and an inner group IA. In this case the waves represented by IA are reflected so as to diverge transversely across the path of the waves OA and MA. The concentrated waves OA and MA strike against the frusto-conical reflecting surface of the section FC. The waves OA travel towards the lower surface of the double cone X and are there deflected along the cylindrical section C2, while the waves MA which are reflected by the lower part of the frusto-conical wall of the section FC converge in a transverse direction so as to again exert an amplifying effect on the waves OA.

It has been found that where it is desirable to increase the size of the outer opening so as to offer a larger deflecting surface for soundwaves, a division of the soundwaves gives improved results and Figures 3*a*, 3*b* and 3*c* illustrate examples of sound-conducting apparatus showing how the division of the soundwave may be effected.

In Figure 3*a* the mouthpiece comprises an inner partition IP resembling the elementary structure shown in Figure 1*b* and comprising a cylindrical wall C1 and a conical frustum wall FC1, together with an outer wall OW comprising a cylindrical wall C2, a conical frustum portion FC2 and a further cylindrical wall C3. A double cone X may be provided, if desired, and although it is not essential its presence does seem to improve the efficiency. In this manner a conduit having four sections is obtained, one section comprising the cylindrical walls OW, IP, the second section the inner frusto-conical wall FC1 together with that part of the outer frusto-conical wall FC2 lying between its junction with the wall OW and the plane of the lower termination of the wall FC1, the third section by the remainder of the wall FC2 and the fourth section by the cylindrical wall C3. The operation is as follows: The incoming soundwaves may be considered as comprising four parts represented by the arrows ISA, ISB, ISC, ISD. The soundwaves represented by ISD it will be noted pass direct to the tube C3. Those represented by ISC are deflected by the surface of the inner frustum of the cone FC1 so as to converge on the waves ISD at right-angles. Those represented by ISA are reflected successively by the upper part of the conical frustum FC2, the outer part of the conical frustum FC1 and by the lower part of the conical frustum FC2 so as to react at right-angles upon the stream ISD. The waves ISB are reflected by the middle part of the conical frustum FC2 and converge at right-angles on to the waves ISA and ISD.

It will thus be noted that the waves ISA and ISB are divided from the waves ISC and ISD by the inner partition IP and it seems as if there was an advantage in limiting the width of the sound passages; probably because this would tend to ensure soundwaves travelling in the desired direction and the avoidance of soundwaves being developed which travel in directions other than those indicated. If the doublecone X is used the waves ISC and ISD will be deflected in a similar way to that described in Figure 2*c*. It will be appreciated that the double cone as shown at X or XI can be inserted in any of the Figures 3*a*, 3*b*, 3*c*.

Referring to Figure 3*b*, this is very similar in operation to Figure 3*a* except that the outer wall comprises three cylindrical portions C2, C3 and C4 and two conical frustums FC2 and FC3. The only difference in operation is that the soundwaves ISA reflected successively by the upper part of FC2 and the outer part of FC1 now strike the surface FC3 instead of a continuation of the surface FC2. The extra cylindrical portion C3 seems to give a certain amount of advantage, probably due to enabling the soundwaves proceeding in the desired direction to be distinguished from any waves which have been created travelling in other directions. A still further sub-division is indicated by the chain dotted line and other modifications will readily occur, an important feature of all constructions being that there are no spaces in which soundwaves are not travelling but that the whole of the sound-conducting passage is serving a useful purpose, either in allowing the sound to pass straight through or reflecting it so that it will pass in a transverse direction to the waves which are passing through.

Figure 3*c* shows a construction employing two partitions instead of one but it does not appear necessary to describe its operation in detail as this will be readily understood from the description of the other figures. The inner partition IP is similar to the partition IP of Figures 3*a* and 3*b*. The partition OP is an additional partition which operates similarly to the upper part of the outer wall OW Figure 3*b*, while the outer wall OW acts along the same general principles. Mouthpieces according to this construction have been found to give good results.

In Figures 4*a* and 4*b* examples are shown of sound-conducting apparatus having one opening extending in different directions, for instance if the diaphragm of a telephone receiver or like apparatus be placed opposite the opening O (Figure 4*a*) waves generated would travel between the walls W and be deflected by the surfaces S1 and S2 so as to travel between the parallel walls W1 and the waves issuing past the opening O1 would tend to travel in the same direction but owing to the walls W2 diverging at 45° a wave appears to be generated in a transverse direction which is reflected by the walls W2 and issues parallel with the waves proceeding through O1. If the arrangement shown is considered as being generated round the dotted line AB, it will be appreciated that the walls W2 extend in all directions, the upper walls W2 forming one conical frustum and the other walls W2 forming another conical frustum. Alternatively the section shown may be generated about a line such as CD, in which case each of the walls W2 will generate a frustum of a cone and the sounds will proceed in two directions to the right and to the left. Fur-

thermore it will be understood that instead of a telephone receiver or other instrument producing sound a microphone or similar instrument receiving sound could be placed opposite the opening O and sounds issued in the vicinity would be received through the space appointed by the walls W2. It should be understood that this figure is only an elementary form of multi-directional sound-conducting apparatus and that mouthpieces used in practice could be developed in a similar way to that described with relation to Figures 1, 2 and 3.

These latter remarks apply equally to Figure 4*b* which illustrates an alternative arrangement of forming a multi-directional sound-conducting apparatus which is also in an elementary form. In this case the sound entering the opening O passes successively past the walls W and the walls W1 where due to the open space formed it appears that soundwaves are generated in a direction at right angles to the original stream and are reflected by the walls W1 on to the outer portion of the walls W2 and thence in the direction of the arrows OA. The main soundwave proceeds past the wall W3 and when it passes beyond these walls the sound waves seem to be generated as before so as to strike against the walls W2 and be reflected so as to emerge parallel to the original sound wave. As with Figure 4*a*, the surfaces of the walls shown could be generated about the line AB or alternatively about the line CD and similarly the loudspeaker could be replaced by a microphone.

Figures 5*a*, 5*b* and 5*c*, show examples of mouth-pieces where there is a substantial obstruction in the centre. In Figure 5*a* the obstruction takes the form of a cylindrical portion CO and a conical portion CNO. The cylindrical portion could, for instance, take the form of a dial switch in an automatic telephone instrument or could be used for affixing information thereto or any other like purpose. The outer wall OW comprises a cylindrical portion CW1, a conical frustum CF1, cylindrical portion CW2, conical frustum CF2, cylindrical portion CW3, conical frustum CF3 and a cylindrical portion CW4. The arrangement of this figure gives a conduit having seven sections, the location of which will be clear from the explanation given with regard to Fig. 3*a*. The incoming soundwaves may be considered as divided into three groups represented by the arrows IA, IB and IC. The waves IC are deflected by the lower part of the conical frustum CF1 and by the bottom portion of the cone CNO in a direction which will pass through the cylinder CW4. The waves IB strike the central portion of the conical frustum CF1 and are deflected so as to strike the central portion of the conical portion CNO and thence to strike the surface CF3 and be deflected so as to converge on the waves represented by IC at right-angles. The soundwaves represented by the arrows IA which strike against the upper portion of the conical frustum CF1 are reflected so as to strike against the upper portion of the cone CNO and thence be reflected so as to strike against the surface of the conical frustum CF2 and be again reflected so as to converge at right-angles to the main waves IC. A disadvantage of Figure 5*a* is that the area represented by the upper surface of the cylinder CO is lost as regards sound receiving or emitting. This is avoided by the arrangement shown in Figure 5*b* in which a double cone is employed. It will be noted that this figure does not differ very much from Figure 2*d* except that it is of larger dimensions and the operation can readily be followed. In Figure 5*c* an example is shown by which this feature of the invention is only carried out in one stage, namely at the enlarged opening where the sound waves IA strike against the surface of the conical member CM and are deflected at right-angles to the soundwaves represented by the arrows IB. These soundwaves pass by rectilinear reflection to the opening O.

Figure 6 shows an application of the invention to a mouthpiece for a special design of transmitter having dual sound-receiving surfaces, in which the inner portion closely resembles the constructions which have already been described, while there is provided an outer portion giving a separate sound channel which embodies both means for giving rectilinear reflection and means comprising the surfaces of the conical frustums CF1 and CF2 whereby part of the soundwaves are caused to converge at right-angles to those which reach the transmitter.

Figure 7 illustrates an example of multi-directional sound-conducting apparatus in a somewhat more complex form than is illustrated in Figure 4*a*, while Figure 8 illustrates a multi-directional sound-conducting apparatus of a more complex form to that shown in Figure 4*b*. In view of the description which has already been given it does not appear necessary to describe these in any detail.

It should be explained that in the designs of sound-conducting apparatus in accordance with the invention the length of each sound surface has been in experiments limited to one length of 3.8 cms. as a maximum to much smaller values as regards the surfaces inclined at 45° to the direction of the passage where the width of the passage is small, and while the invention is not restricted to any precise dimensions and while it is believed that the best results will be obtained by working within the dimensions indicated, it is possible that dimensions differing considerably from those specifically mentioned may be found to give satisfactory results in particular cases. It is believed that there is a relationship between these dimensions and the frequency of the soundwaves which are being received. If therefore the apparatus was to be used for listening to the location of aeroplanes, for instance where the noise is likely to be of a low frequency it would possibly be found that very much larger dimensions gave satisfactory results, while if on the other hand it was intended to respond to very high frequencies then the dimensions might require to be made smaller than indicated but it would appear that the best results were obtained by ascertaining for the particular nature of sounds which were being received the best dimensions to employ having regard to the fact that the larger the dimensions the greater the tendency to distortion and the smaller the dimensions, particularly of the passages, the greater the apparent loss in transmission.

Figures 9 and 10 illustrate an example of sound conducting apparatus constructed in accordance with the invention and of which the dimensions are as follows:

The diameter AK of the uppermost cylindrical portion is 11.25 cms., the diameter CM of the next cylindrical portion is also the diameter TU of the base of the double cone TU equals 5.6 cms., the diameter EO of the third cylindrical portion equals 2.8 cms., and the diameter GQ of the fourth cylindrical portion equals 1.4 cms.

The length AB=3.1 cms. slightly greater than half the length SV which of course equals 5.6 cms. seeing that the slope of the lines ST, TV, SU, UV is 45°. The lengths of the other cylindrical portions are as follows: CD equals 2.8 cms., EF equals 2.5 cms., GH equals 2.2 cms.

As the lines BC, LM, DE, ON, FG, QP represent the sides of conical frustums having slopes of 45° their dimensions can be readily determined.

The sound-conducting apparatus when used in conjunction with a microphone for receiving sound usually requires a larger opening than one having a 1.4 cm. diameter, and for this purpose the parts FGQP and GHRQ are omitted.

Tests with a mouthpiece of this construction which it will be noted closely resembles Fig. 5*b* gave very good results indeed when employed in connection with a microphone as just described.

The length EF and CD when employing a microphone at the section FP were varied and it was found that when the length EF was reduced to 1.2 cms., inferior results were obtained as regards distortion but when the length CD was reduced to 1.2 cms., the results were not as inferior. It seems, therefore, that the lengths of the cylinders nearer the smaller end are of greater importance than elsewhere.

It will be appreciated that while it has been assumed that the sound waves traversing the sound-conducting apparatus according to the invention behave in a particular way it is difficult to ascertain whether this assumption is entirely justifiable. Mouthpieces in accordance with the invention have been constructed and if proper attention is paid to the selection of the dimensions more efficient results can be obtained than with mouthpieces of the curved or the rectilinear type of construction.

In the rectilinear type of constructions it is to be observed that at each reflection minute individual components of the wave front are deflected so as to cross the paths of other individual components and the effect of such crossings is not known but only the general results of the passage of the sound through the sound-conducting apparatus taken as a whole. In the type of construction in accordance with the invention it will be noted that it is not the effect of the minute individual components which is considered as important but the provision of means whereby the path of a substantial part of the wave front taken as a whole is caused to cross the path of another part of the wave front and it is found that the general results of the passage of sound through the sound-conducting apparatus taken as a whole which is provided with such means is considerably better than in cases when such means are not provided.

Mouthpieces constructed in accordance with the invention enable sound waves created at a distance from the larger end of the mouthpiece, such as by a person speaking, to be received and conducted as described to a microphone or the like and it is found that such soundwaves are led to the microphone with a minimum of distortion and very efficient transmission so that the microphone need not be especially sensitive, in fact the microphone used in ordinary telephone instruments may be employed and yet a speaker one to two feet (30–60 cms.) away can be apprehended as well as if not better than with the ordinary telephone with the user's lips close to the mouthpiece, particularly as regards intelligibility. It further appears that the full sound collecting value of the larger end of the mouthpiece can be utilized so that to a certain extent the larger the opening the greater the volume of sound which is picked up. Experiments have been made up to a maximum diameter of 16 cms.

While the use of a single double-cone, such as shown at X in certain figures, has been described, it is also to be understood that in some constructions two or more double-cones may be employed, such as both of those shown at X and X1 in Fig. 3*c*. These double cones may be either of equal size or of different size, according to the position in which they are used. For example, in addition to the double cone STUV shown in Fig. 9, further double cones may be inserted at the positions DN and/or FP. Such a double cone is shown at WXYZ situated at the position FP.

The apparatus shown in Figures 9 and 10 is preferably constructed of a series of aluminium parts, which may be formed as spinnings. The sound reflecting surfaces and the parallel walls of the inside of the device are anodically treated so as to form thereon a suitably hard layer *l*. If desired, the outer surfaces of the device may be similarly treated.

I claim:—

1. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having at least three sections including a large perimeter section and a small perimeter section each embracing said passage, one of said sections having a wall with its surface parallel to a certain direction so as to form a part of said passage of constant width and the other of said sections having a wall with a surface inclined at approximately 45° to said direction and extending so as to form a part of said passage increasing in width in that direction of the passage leading from the small to the large perimeter section.

2. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having at least three sections including a plurality of continuous sections forming said passage connecting a large opening with a small opening, a number of alternate sections of said plurality of sections having walls whose surfaces are parallel to a particular direction and the remaining sections having walls whose surfaces are inclined at approximately 45° to said direction.

3. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having at least three sections including at least one section having one wall with its surface parallel to a certain direction and another wall facing said first wall with its surface inclined at approximately 45° to said direction and a section having walls with surfaces parallel to each other, said sections forming said passage having a large perimeter at one end and a small perimeter at the other end.

4. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having at least three sections including a section forming part of said passage of constant width with the surface thereof lying parallel to a certain direction and a second section abutting on one end of the first section and forming a further part of said passage with a cross-section where it meets the first section equal to the cross-section of constant width and coincident with it, while having an increasing width the further it is away from the junction, a surface of the wall of said second section being inclined at approximately 45° to said direction.

5. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having at least three sections including a section forming a part of said passage of constant width with the surface thereof lying parallel to a certain direction and a section abutting on one end of the first section and forming a further part of said passage with a cross-section where it meets the first section equal to the cross-section of constant width and coincident with it while having a decreasing width the further it is away from the junction, a surface of the walls of said second section being inclined at approximately 45° to said direction.

6. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having a section forming a part of said passage of constant width with the surface thereof lying parallel to a certain direction, a second section abutting on one end of the first section and forming a further part of said passage with a cross-section where it meets the first section equal to the cross-section of constant width and coincident with it while having an increasing width the further it is away from the junction, a surface of the wall of said second section being inclined at approximately 45° to said direction and a third section abutting on the other end of said second section and forming a further part of said passage with a cross-section of constant width equal to the largest cross-section of the second section.

7. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having a section forming a part of said passage of constant width with the surface thereof lying parallel to a certain direction, a second section abutting on one end of the first section and forming a part of said passage with a cross-section where it meets the first section equal to the cross-section of constant width and coincident with it while having an increasing width the further it is away from the junction, a surface of the walls of said second section being inclined at approximately 45° to said direction and a third section abutting on the other end of said first section and forming a part of said passage with a cross-section where it meets the first section equal to the constant cross-section and coincident with it while having a decreasing width the further it is away from the junction, the surface of said third section being inclined at approximately 45° to said direction.

8. Sound conducting apparatus comprising a section having an outer walled member with the surfaces thereof lying parallel to a certain direction with an inner walled member lying within the outer walled member and having a wall with its outer surface inclined at approximately 45° to said direction, a second section having an outer walled member abutting on the outer walled member of said first section and forming an extension of the outer surface of a passage enclosed between said outer walled member and said inner walled member of said first section and having a surface inclined at approximately 45° to said direction and an inner walled member abutting on the larger end of said inner walled member of said first section and also having a surface inclined at approximately 45° to said direction, the inner and outer walled member of said second section forming a passage having a smaller perimeter than the perimeter of the passage between the outer and inner walled members of said first section.

9. Sound conducting apparatus comprising a first section having an outer wall with its inner surface parallel to a certain direction, a second section having a wall contiguous with the outer wall of said first section and having its inner surface inclined to an angle of substantially 45° to said direction, a third section having a wall contiguous with the wall of the second section at its smaller end and having its inner surface parallel to the said direction, a walled member having a surface lying between the walls of the first section and whose outer surface is inclined at an angle of substantially 45° to said direction so as to reduce the cross-sectional distance between said outer surface and the inner wall of said first section towards the end of said first section connected to the second section and a second walled member also inclined at substantially 45° to said direction and located between the walls of said second section and having its surface parallel to the inner surface of said second section, said second walled member being contiguous to said first walled member.

10. Sound conducting apparatus comprising a conduit of at least three sections and having a continuous passage therethrough, at least one section being formed of an outer wall and an inner wall and another section being formed with an outer wall only, the outer walls of all of said sections being successively joined together, the arrangement being such that throughout the completed conduit the width of the passage is in a number of sections substantially constant, the bounding surfaces being parallel to each other and to the direction of the passage of the conduit and in other sections varies uniformly, one surface at least of said remaining sections being inclined at 45° to the direction of the conduit.

11. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having a section adjacent one end of said passage formed of a wall of circular cross-section, a second section situated adjacent the other end of said passage and formed of circular outer and inner walls giving a passage of annular cross-section, at least two interconnecting sections between said first section and said second section, at least one of said interconnecting sections having walls with surfaces parallel to a particular direction and at least one other interconnecting section between said first section and said second section having surfaces inclined at approximately 45° to said direction while one of said latter interconnecting sections has walls which effect a uniform variation of cross-section of the conduit.

12. Sound conducting apparatus comprising a conduit of at least three sections one section being of constant circular cross-section a second section abutting on one end of said first section and forming an extension thereof with a bounding surface resembling that of a frustum of a cone having an inclination of approximately 45° and a third section abutting on the outer end of one of said other sections and having a structure similar to that of the section which is most distant from it.

13. Sound conducting apparatus comprising a conduit having a section provided with a cylindrical walled member, a sound reflecting member centrally located in said cylindrical walled member and having a conically shaped outer surface inclined at approximately 45° to the surface of the walls of said cylindrical walled member, a second section provided with a frusto-

conical walled member having its larger perimeter end abutting on said cylindrical walled member and having its inner surface with an inclination of approximately 45°, and having a second sound reflecting member centrally located therein said second sound reflecting member having a surface resembling the surface of a cone and inclined at approximately 45° and having its larger end abutting on the larger end of said first sound reflecting member, and a third section abutting on the outer end of one of said other sections and having a structure similar to that of the section which is most distant from it.

14. Sound conducting apparatus comprising a conduit having a section provided with a cylindrical walled member, a sound reflecting member centrally located in said walled member and having a conically shaped outer surface inclined at approximately 45° to the surface of said cylindrical walled member, a second section provided with a frusto-conical walled member abutting on said cylindrical walled member and having its surface inclined at approximately 45° to said cylindrical walled member and a second sound reflecting member centrally located in said frusto-conical walled member and having a surface resembling the surface of a cone and inclined at approximately 45° and abutting on the larger end of said first sound reflecting member, the second section forming a passage having a perimeter decreasing in size from the perimeter of the first section and a third cylindrical walled section which abuts on the smaller end of said second section and forms an extension thereof.

15. Sound conducting apparatus comprising a conduit having a continuous passage therethrough and having a section with a passage part of constant cross-sectional width with the surface thereof formed of anodized aluminium and lying parallel to a certain direction and a second section abutting on one end of the first section and forming part of said passage with a cross-section at the junction where it meets the first section equal to the cross-section of the constant width dimension and coincident with it, while having progressively increasing width in a direction away from said junction, the surface of said second section being also formed of anodized aluminium and being inclined at approximately 45° to said certain direction.

16. Sound conducting apparatus comprising a conduit having a large perimeter section, a small perimeter section each of circular cross-section, the walls of one of said sections lying parallel to a certain direction and having a cross-section of constant width and the other of said sections having a frusto-conical inner surface with an inclination of substantially 45° and extending so as to increase the width of that part of the passage in the direction of the passage from the small to the large perimeter section.

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