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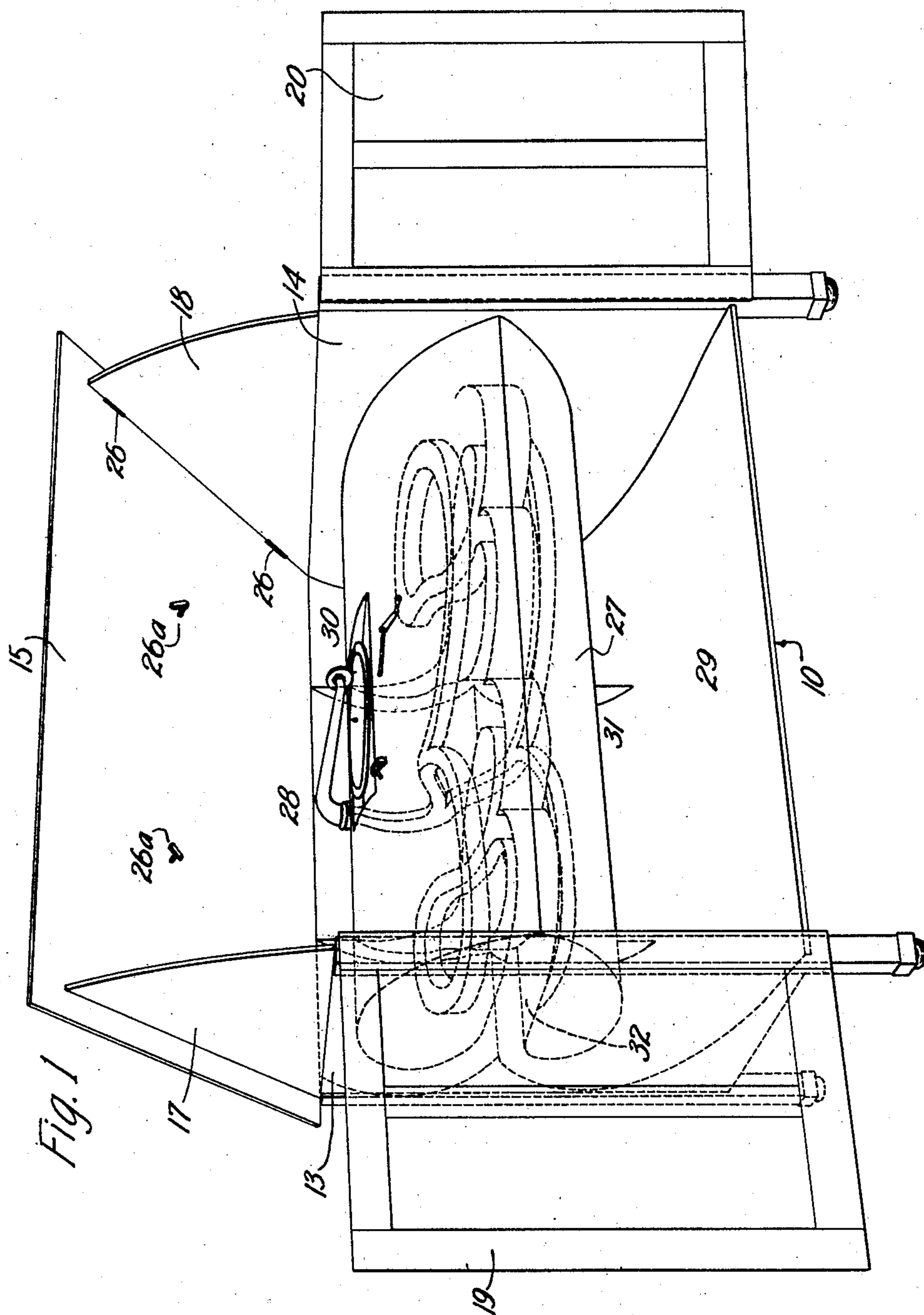
H. C. HARRISON

1,757,712

ACOUSTIC DEVICE

Filed July 31, 1926

4 Sheets-Sheet 1



Inventor:
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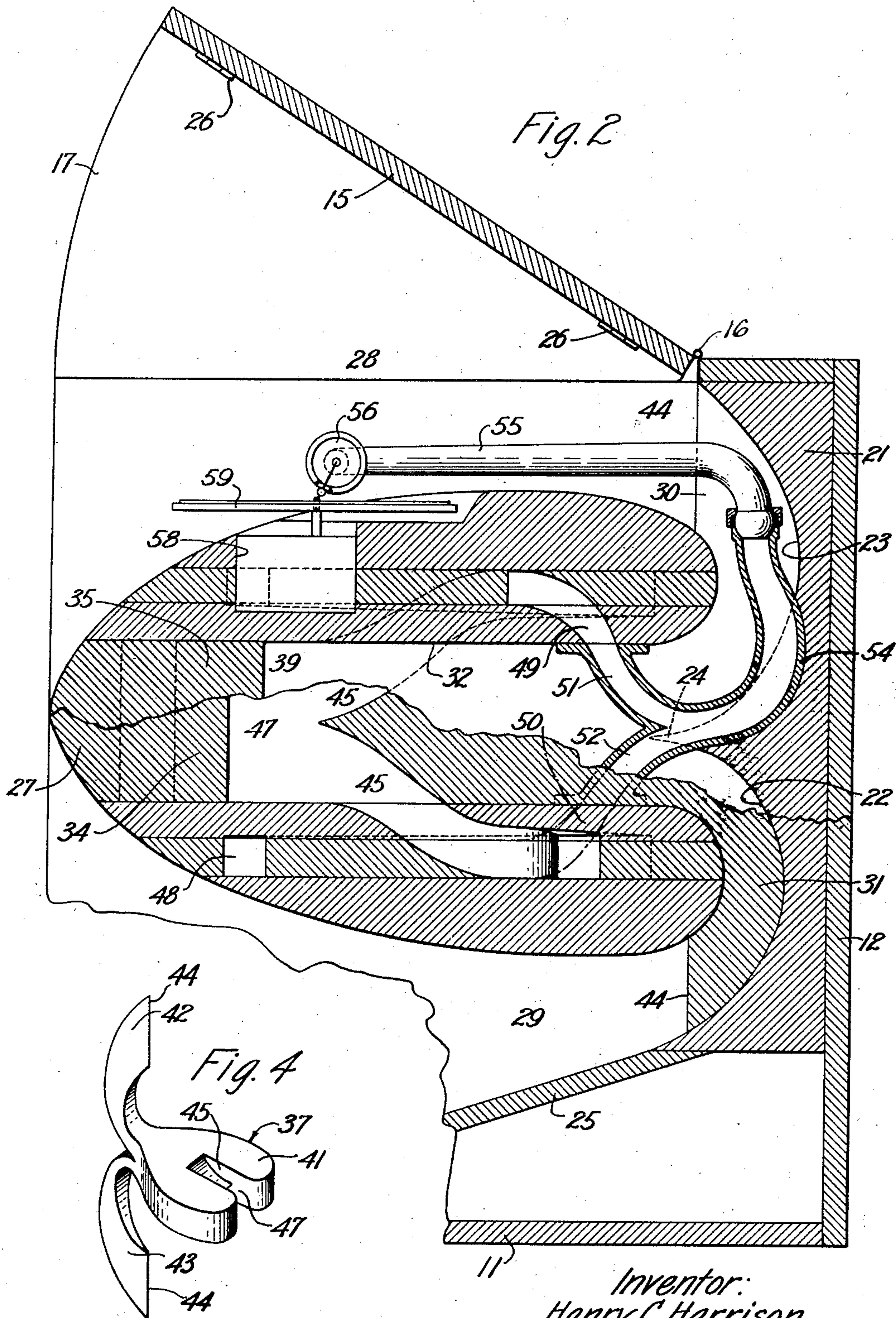
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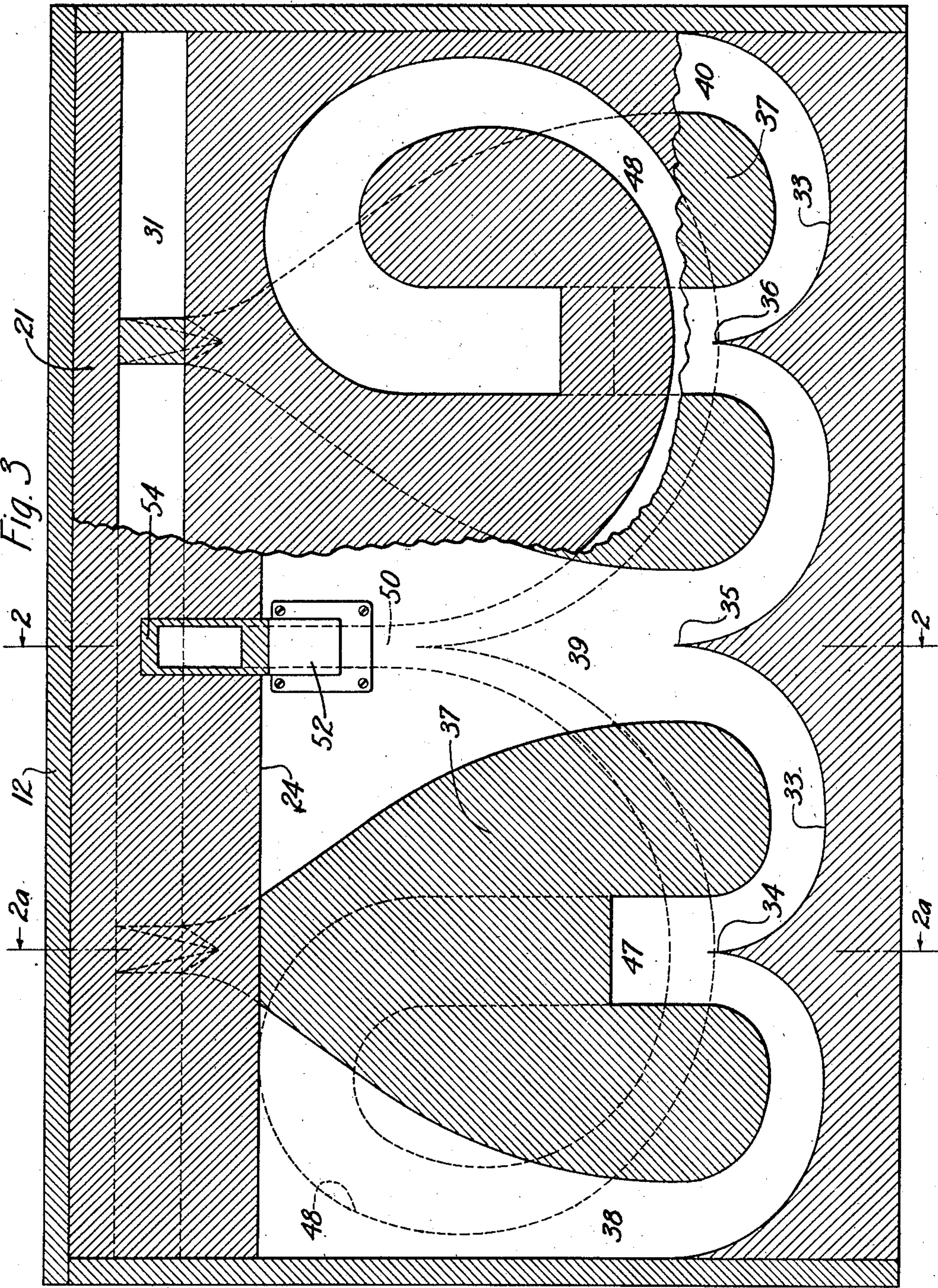
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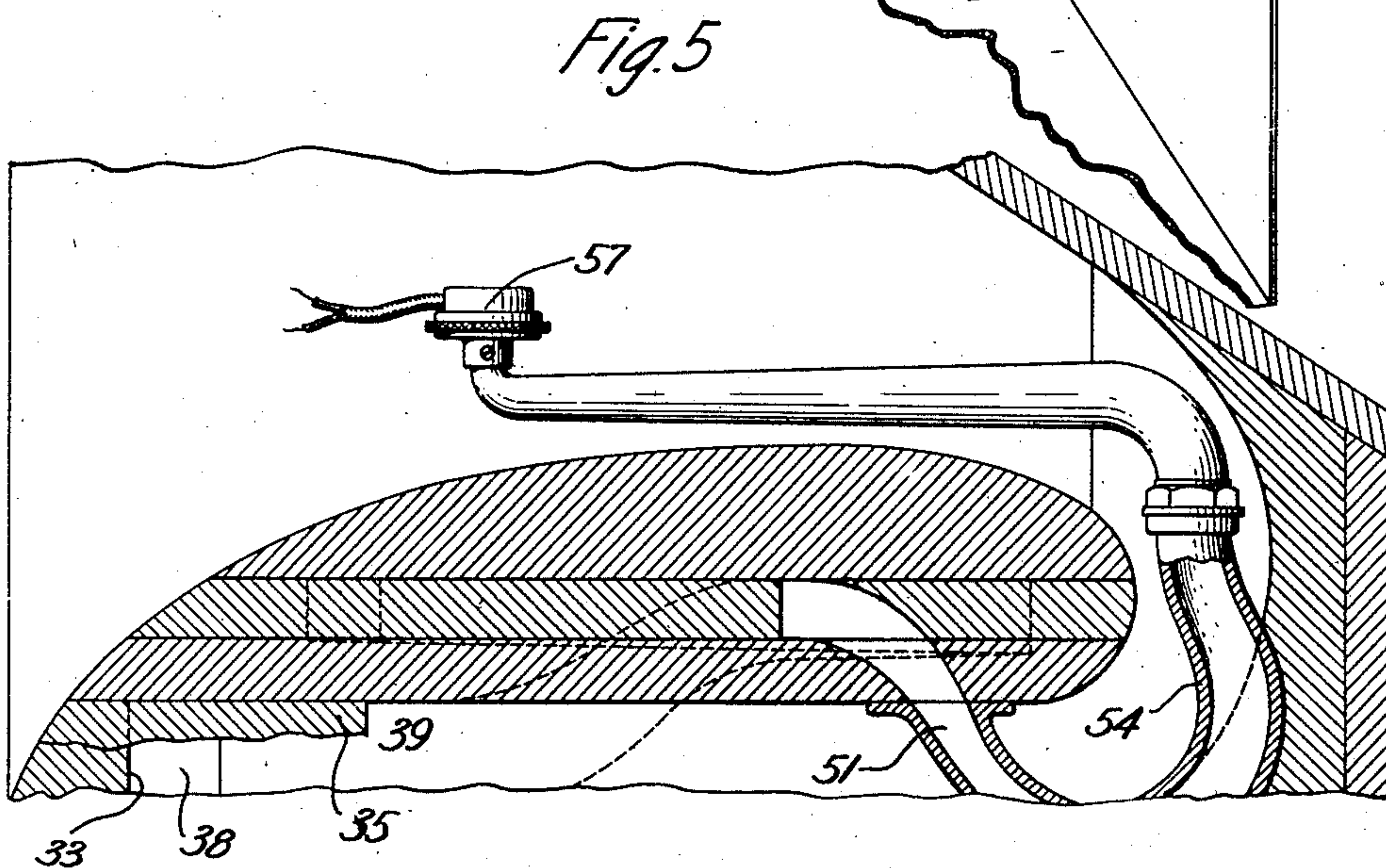
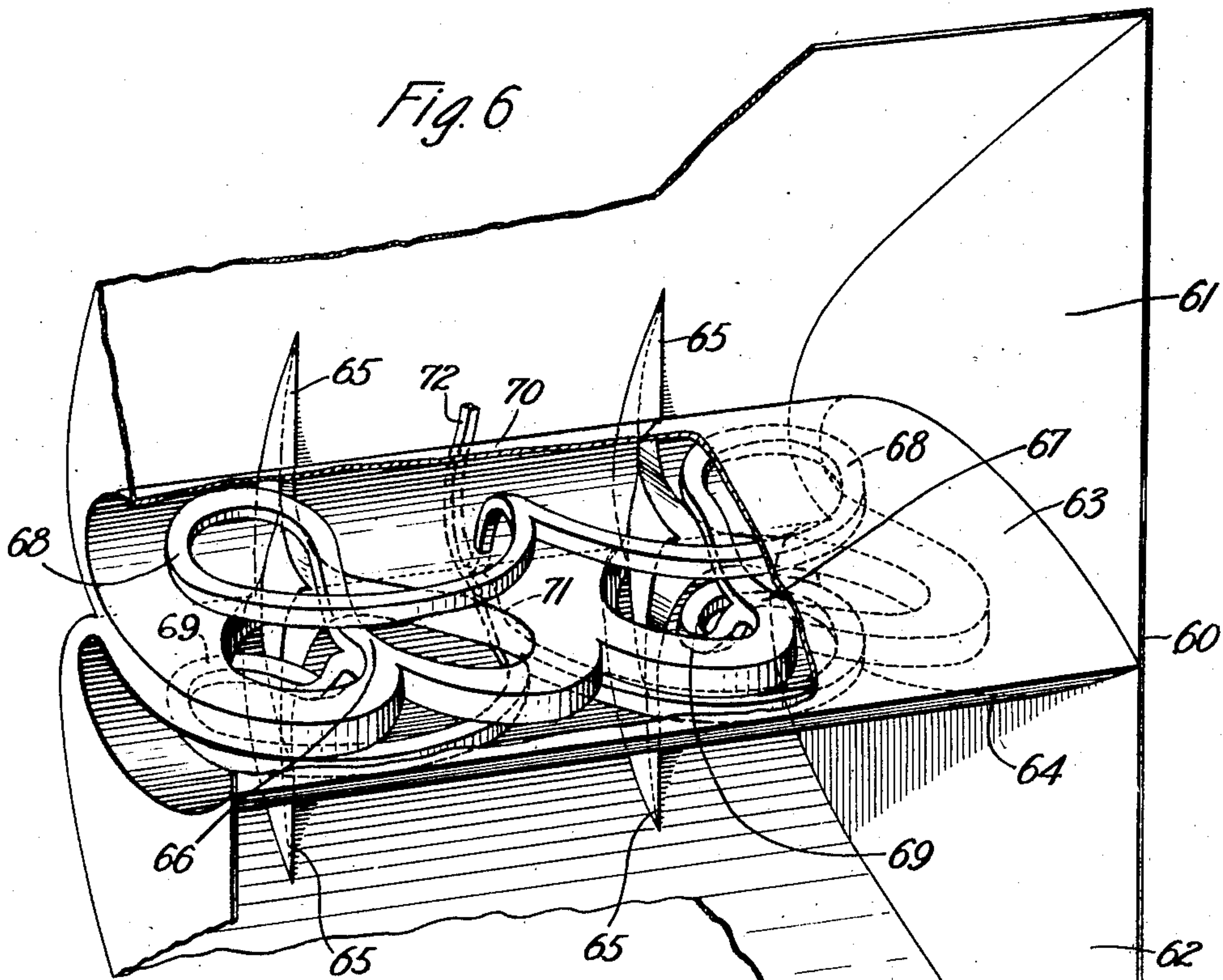
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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ACOUSTIC DEVICE

Application filed July 31, 1926. Serial No. 126,312.

This invention relates to acoustic devices and particularly to horns for phonographs, loud speaking telephones and the like.

An object of the invention is to obtain compactness in acoustic instruments.

A further object of the invention is to embody in a phonograph cabinet of about the usual size, a horn of such length and mouth area that it will efficiently radiate sound waves of the lower frequencies of the speech and music range.

As explained in the applications of H. C. Harrison, Serial No. 628,168, filed March 28, 1923, a horn having a logarithmic taper will uniformly transmit waves of all frequencies above a definite critical frequency determined by the rate of taper and will efficiently radiate all waves whose wave lengths are not greater than 3 to 4 times the equivalent diameter of the mouth or bell opening. In order to efficiently radiate into the atmosphere sound waves of frequencies in the lower portion of the music range, it is necessary to use a horn having a length of about 13 ft. and a mouth opening equal in area to that of a circle of about 4 ft. diameter. In order to mount a horn of such dimension in an ordinary phonograph cabinet, it is necessary to provide a tortuous passage, for example of the type described in the application of H. C. Harrison referred to above. However, it has been found that reflection losses are produced by sharply bending a passage of large area.

In accordance with this invention the horn passage is bent without the introduction of reflection losses, by dividing the passage into a large number of small passages so that the area of any sharply bent passage is comparatively small.

In a preferred embodiment of this invention a phonograph is constructed having a horn comprising a bell portion divided by a partition in which is located a plurality of folded horn passages arranged in multiple. The folded sound passages are formed by dividing the conduit leading from the tone arm so that it leads to two sections located respectively in the upper and lower portions of the dividing partition. Each of these sections contains two spirally expanding passages,

each of which leads to a sound passage in the central portion of the partition which is also connected to the corresponding spiral passage in the other portion of the partition. Each of these central passages is divided by means of a heart-shaped partition to form expanding passages which lead to the rear end of the partition where they open into the bell portion of the horn. The walls of the upper portion of the bell are hinged so that they may be folded to form a cover for the phonograph cabinet, and the turn-table and driving mechanism are mounted on the dividing partition.

Obviously the various features of this preferred embodiment may be useful separately or in various combinations. For example, the folded structure used in the horn may be used in various other acoustical devices such as musical instruments; the horn may be built with a considerably smaller mouth opening without much sacrifice in quality, in which case it may be built in a phonograph cabinet without the use of the cover as part of the horn and with the turn-table mounted elsewhere than in the mouth; the feature of mounting the turn-table within the mouth or that of using a folding cover as part of the mouth wall may be applied to other structures; and the arrangement of overlaid horn passages may be varied in many obvious manners; all within the limits of this invention.

In the accompanying drawing:

Fig. 1 is a perspective view of a phonograph embodying the invention;

Fig. 2 is a fragmentary transverse sectional view through the device, the upper portion being taken on the plane of line 2—2 of Fig. 3 while the lower portion is taken on the plane of line 2^a—2^a of Fig. 3;

Fig. 3 is an irregular horizontal sectional view of the device;

Fig. 4 is a perspective view of one of the heart-shaped partitions;

Fig. 5 is a fragmentary sectional view similar to Fig. 2 and illustrating the horn adapted for use with a loud speaking telephone receiver; and

Fig. 6 is a perspective view of a modified type of horn embodying this invention show-

ing the horn constructed of metal with portions broken away to more clearly illustrate the details of construction.

Referring first to Figs. 1 to 4, there is shown a cabinet comprising a frame supporting a bottom 11, back 12 and the sides 13 and 14. A cover 15 is hinged at 16 near the back 12 and carries two leaves 17 and 18 which, when open, form portions of the side walls of the upper portion of the bell or mouth of the horn.

As illustrated, the front of the cabinet is wholly open but may be closed by doors 19 and 20 which are hinged to the front edges of the sides 13 and 14.

Secured to the back 12 is a strip 21 which is provided in its front face with a pair of horizontal grooves 22 and 23, separated from each other by a horizontally disposed ridge 24 which extends throughout the entire width of the cabinet. A wall 25 extends forwardly and downwardly from the lower edge of the strip 21 to the forward edge of the bottom 11 and forms the bottom wall of the bell portion of the horn. The upper wall of the bell portion is formed by the cover 15 which is adapted to be raised into the angular position illustrated in Figs. 1 and 2 and retained in that position by means of the leaves 17 and 18 which rest on the upper edges of the sides 13 and 14.

When the cabinet is closed, the leaves 17 and 18 are swung inwardly on their hinges 26, and lie against the under side of the cover 15, in which position they are retained by the catches 26^a.

Mounted within the cabinet and extending longitudinally between walls 13 and 14 is a partition 27 which is substantially heart-shaped in cross section and divides the bell portion of the horn into two outwardly flaring tone chambers 28 and 29, which taper inwardly toward the back of the cabinet and communicate with the tapered passages 30 and 31 formed between the strip 21 and the heart-shaped partition 27, as most clearly illustrated in Fig. 2. The inner or reduced ends of these tapered passages 30 and 31 open into each other in such a manner that sound entering through passages in the partition 27 will be divided upon encountering the ridge 24 so as to be distributed into the chambers 28 and 29.

It will be noted that the chamber 28 and passage 30 are both larger in cross sectional area than are the chamber 29 and passage 31. While such an arrangement is not essential to the proper functioning of the horn, it has been found desirable to construct horns of this character in such a manner, in order to accommodate the phonograph mechanism to be more fully described hereinafter. Furthermore, experiment has shown that certain other desirable results may be secured and under certain conditions the tonal qualities of

the horn will be enhanced by offsetting the heart-shaped partition 27 relative to the ridge 24.

Intermediate its upper and lower curved faces, the partition 27 is provided with a plurality of longitudinal passages 38, 39 and 40 which open out through the back of the partition and have inner or back walls formed by a curved face piece 33 provided with perpendicular ridges 34, 35 and 36. The curved faces formed between these ridges cooperate with the heart-shaped partitions 37 in producing the curved tapered sound passages 38, 39 and 40, the larger ends of which communicate with the reduced ends of the passages 30 and 31, through a common discharge mouth.

The heart-shaped partition 37 is best illustrated in Fig. 4, and comprises a heart-shaped body 41 formed at its apex with oppositely disposed arms 42 and 43 arranged in a plane perpendicular to the plane of the body. The rear faces of these arms are curved to conform to the curvature of the grooves 22 and 23, while the front faces of the said arms are curved to conform to the curvature of, and to partially embrace the rear edges of the transversely heart-shaped partition 27. As illustrated, the side faces of the arms 42 and 43 converge toward the front edges 44, in order to permit the wave front to expand both horizontally and vertically as the sound waves enter the vertically expanding bell portions from the horizontally expanding passages in the partition.

Formed in the forward end of each heart-shaped partition 37 is a pair of converging passages 45 which meet well back near the center of the partition and form a throat 47 through which sound is conducted into the passages 38, 39 and 40. Each of the passages 45 connect with substantially spiral, tapered passages 48 formed in those sections of the partition 27 which overlay and underlay the central passages 40, 38 and 39 so that each of the throats 47 of the central passages is connected with two spiral passages, one located in the upper section of the partition 27 and the other in the lower. Each of the spiral passages contracts in area as the spiral expands, the small ends of the two passages in each section of the partition joining in the passages 49 and 50, respectively which connect with the legs 51 and 52 of the conduit 54.

The conduit 54 turns upwardly as illustrated in the drawings and is connected at its upper end with a tone arm 55 carrying at its free end a phonograph reproducer 56. It is to be understood, however, that any type of sound reproducer may be substituted for that shown, for example a telephone receiver 57 as illustrated in Fig. 5.

Owing to the division of the horn into a plurality of sound passages of small area each passage may be bent at a sharp angle without creating serious reflection losses in

the sound being transmitted, so that a horn of great effectual length can be embodied in a relatively small cabinet.

When the horn is in use in a phonograph some form of turn-table and driving mechanism must be provided, and for this purpose the upper face of the partition 27 is recessed as at 58 to receive a suitable motor upon which the turn-table 59 is mounted. In this manner compactness of construction may be readily achieved and the whole may be enclosed in a single cabinet of minimum size consistent with the great effectual length of the horn.

In operation it will be understood that sound introduced into the tone arm 55 will enter the sound conduit 54 where it will be divided and directed through the passages in the arms 53 thereof, entering the passages 49 and 50 through which it is conducted to the spiral passages 48. Passing through both the upper and lower sets of passages 48, the sound waves from the corresponding upper and lower passages merge upon entrance into the throat 47, only to be again divided by the perpendicular ridges 34 and 36 and directed around the heart-shaped partitions 37 through the tapered passages 38, 39 and 40 from the discharge mouths of which they are directed rearwardly against the ridge 24 and divided so as to enter the passages 30 and 31 from whence they expand out through the tone chambers 28 and 29 of the bell portion of the horn.

The tortuous course pursued by the sound waves is such as to permit of the construction of a horn of great effectual length, allowing a slow taper from a small throat to a large mouth opening, in a cabinet of moderate size.

In the modification shown in Fig. 6, the horn is constructed of metal conduit the passages being arranged in a similar manner to those of the horn of Figs. 1 to 4. The bell portion 60 is divided into two separate expansion chambers 61 and 62, by means of a pair of longitudinally disposed curved walls 63 and 64 which are bent back at their rear edges to form the horizontal walls of the central passages. These converge to the throat portions 66 and 67.

Leading from each of the throat portions, are tapered spiral tubes 68 and 69 which respectively overlay and underlay the central passages above mentioned, and join at their reduced ends where they are connected to the divergent legs 70 and 71 of a sound conduit 72.

Secured to the walls 63 and 64 adjacent their rear edges and extending rearwardly to the outer walls of the bell or flare portion 60 are perpendicularly disposed partitions 65, the side faces of which are tapered toward the front of the horn, similar to the arrangement in the horn previously described.

What is claimed is:

1. A horn comprising a throat portion, a bell portion and at least three sound passages in multiple therebetween.

2. A horn comprising at least three sound passages in multiple, said passages being sharply bent to reduce the volume occupied by the horn.

3. A horn having a discharge mouth, a throat, and a divided sound passage, the rate of taper of which increases by a constant per cent per unit of length, each division of the passage being subdivided to provide thin sound conduits which are sharply curved, the sum of the cross sectional areas of the conduits at a predetermined distance from the throat being equal to the cross sectional area of a single passage following the same rate of taper.

4. A horn comprising a bell portion, a hollow partition in said bell portion and means for dividing the space within said partition into at least three passages to reduce the cross sectional areas of the paths traversed by transmitted sound to a value below that at which serious reflection loss would occur due to sharp bending.

5. A horn comprising a bell portion and means associated therewith having a divided sound passage therein discharging into the bell portion, and having overlaid sound passages discharging into the first mentioned sound passage.

6. A horn comprising a bell portion and means associated therewith having a divided sound passage discharging into said bell portion, and having a sound passage on each side of and discharging into the first mentioned sound passage.

7. A horn comprising a bell portion, and a partition therein having sound passages discharging into the bell portion and overlaid sound passages discharging into the first mentioned sound passages.

8. A horn comprising a bell portion, and a partition therein, said partition having sound passages communicating with the bell portion and having sound passages on opposite sides of the first mentioned passages communicating therewith.

9. A horn comprising a bell portion, and a partition therein, said partition having sound passages disposed in the plane of its longitudinal axis, and having sound passages on opposite sides of the first mentioned passages communicating therewith.

10. A horn comprising a bell portion, a partition dividing said bell portion into two chambers, a throat portion, and an intermediate portion located within said partition, said intermediate portion comprising a curved passage in one plane and a spirally curved passage in another plane.

11. A horn comprising a bell portion, a partition dividing said bell portion into two

- chambers, a throat portion, and an intermediate portion located within said partition, said intermediate portion comprising a curved passage in one plane and a spiral passage located in a plane on each side of the first plane, both of said spiral passages having one end connected to said curved passage and the other end connected to said throat portion.
12. A horn comprising a bell portion, a partition dividing said bell portion into two chambers, a throat portion, and an intermediate portion located within said partition, said intermediate portion comprising two sets of passages, each comprising two oppositely curved substantially flat passages and a pair of spiral passages located on each side of said sets of passages, one spiral passage on each side being connected with one of said sets of passages.
13. A horn comprising a bell portion, a partition therein, said partition having sound passages expanding in the plane of said partition and opening into a common discharge mouth from which sound conducted through the passages enters the bell portion, and having sound passages on opposite sides of the first mentioned passages communicating therewith, and partitions perpendicular to the plane of the first mentioned partition for expanding the wave front of the sound waves in both planes as they enter the bell portion.
14. A horn comprising a bell portion, a longitudinally grooved partition therein dividing the bell portion into sound discharge chambers, a plurality of heart-shaped partitions extending into the groove and forming tapered sound passages, the first mentioned partition being provided with sound passages communicating with the tapered sound passages, and a sound conduit through which sound is introduced into the horn.
15. A horn comprising a bell portion, a horizontally disposed longitudinally grooved partition therein dividing said bell portion into sound discharge chambers, heart-shaped partitions extending into the groove in the partition and forming tapered sound passages, the first mentioned partition being provided with spiral sound passages on opposite sides of the groove, said spiral passages communicating with the tapered passages, and a sound conduit having divergent legs through which sound is conducted to the spiral passages.
16. A horn comprising a bell portion expanding in one plane, a partition dividing said bell portion into two chambers, a sound passage within said partition expanding in a plane perpendicular to the plane in which the bell portion expands and partitions perpendicular to said first partition and wedge shaped as to permit the wave front of the transmitted sound to expand in both planes as it enters the bell portion.
17. A horn comprising a throat portion, a bell portion, and an intermediate portion therebetween, said intermediate portion comprising diverging sound passages from said throat portion, each of said diverging sound passages being divided, said divided passages being reunited upon entering the bell portion.
- In witness whereof, I hereunto subscribe my name this 30th day of July, A. D., 1926.
HENRY C. HARRISON.