Aug. 20, 1935. L. F. MOODY 2,011,646

REFRIGERATION EQUIPMENT

Filed July 29, 1930 4 Sheets-Sheet 1

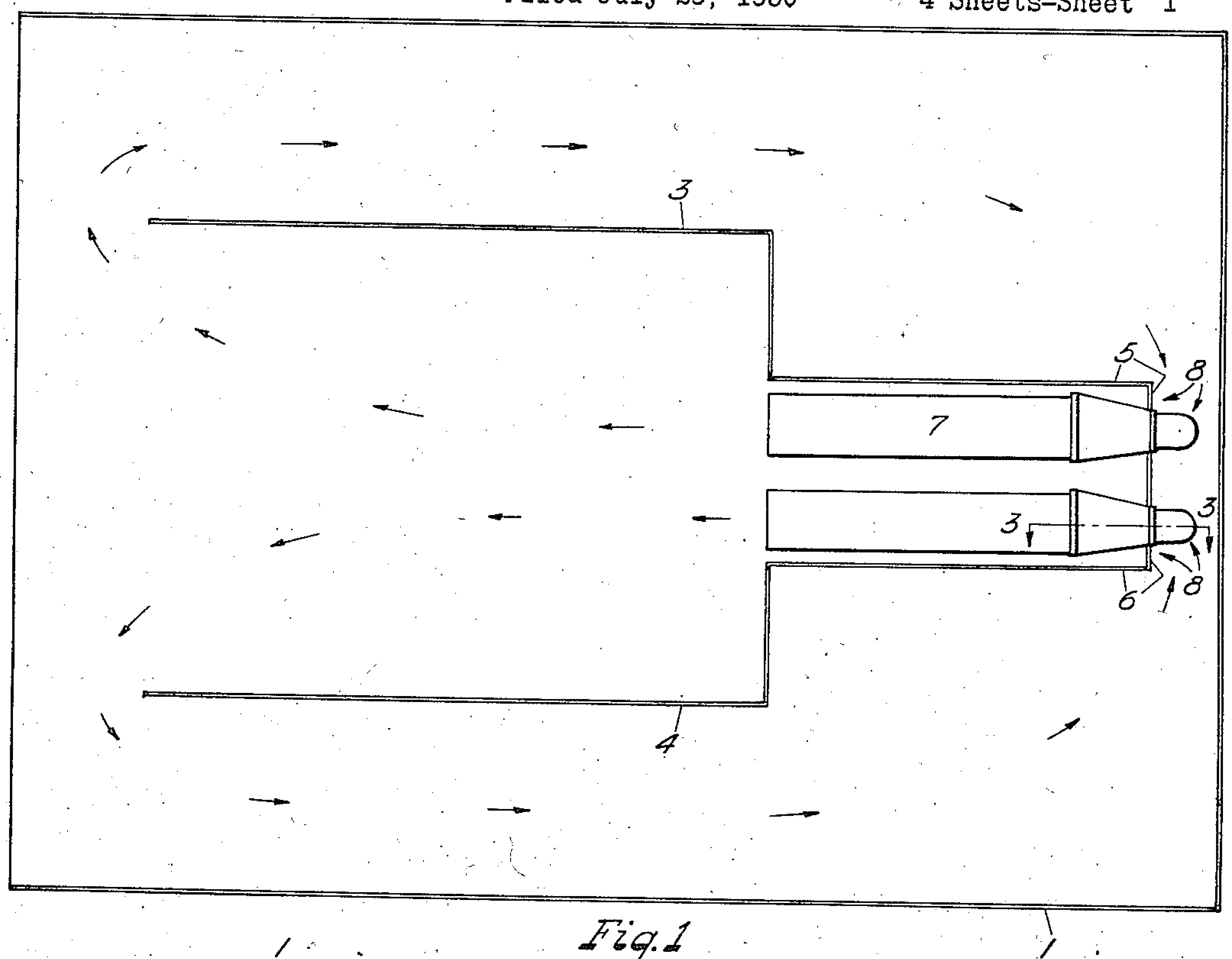

Fig.1

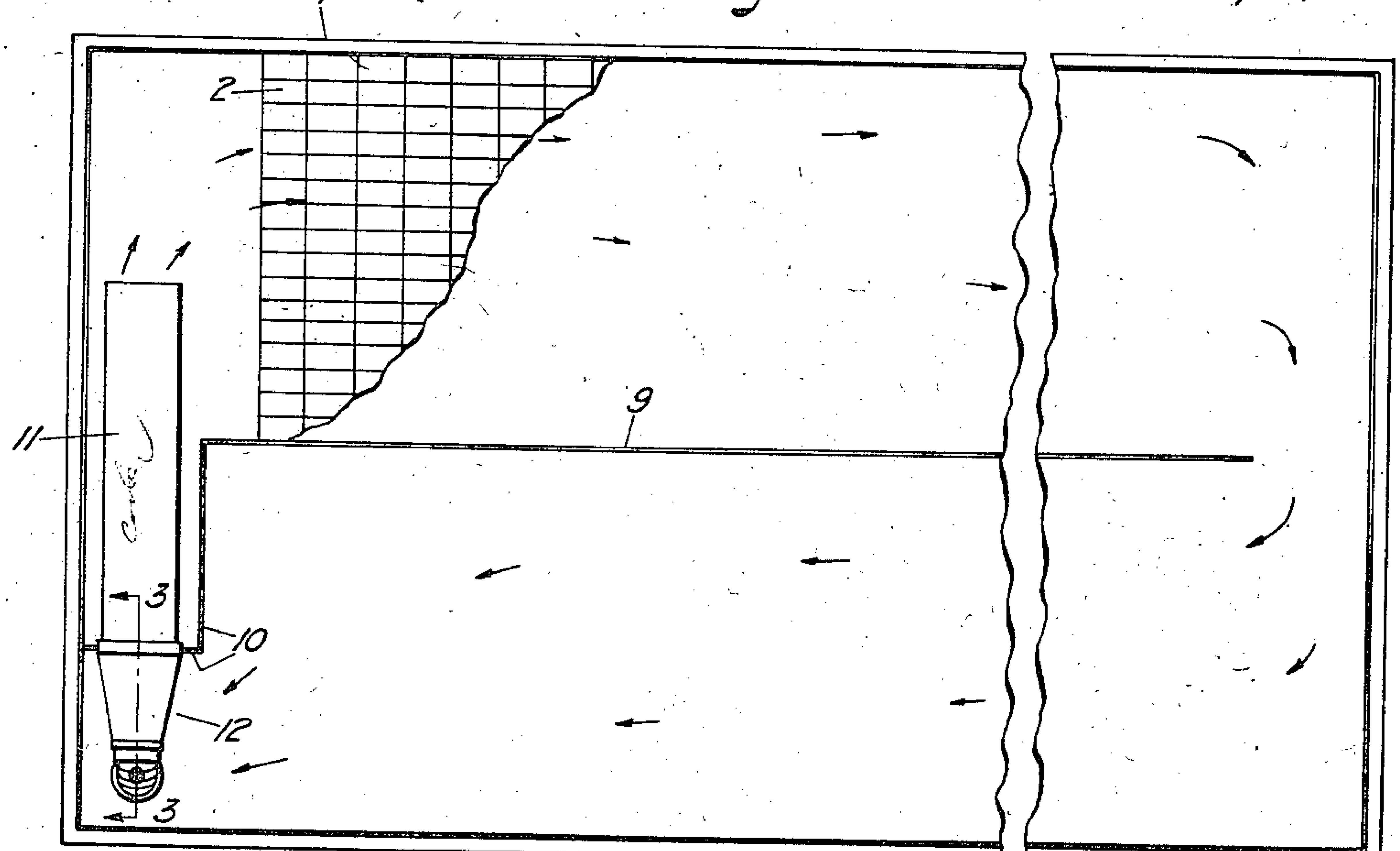

Fig.2

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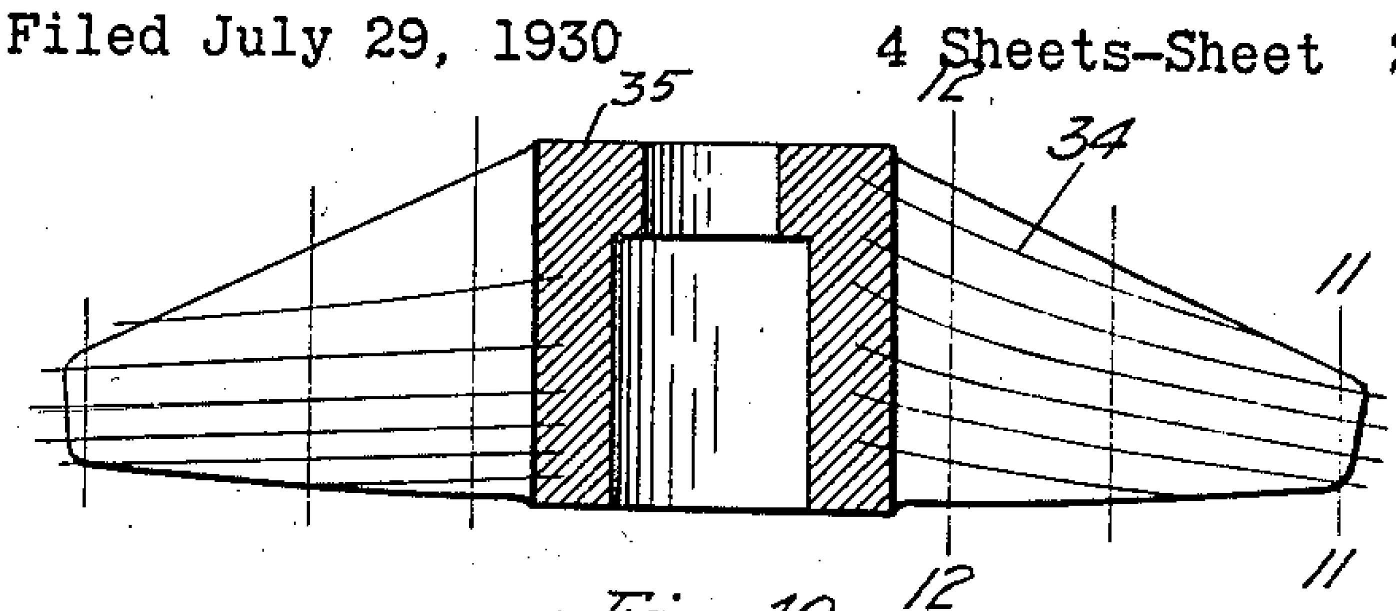

Fig.10

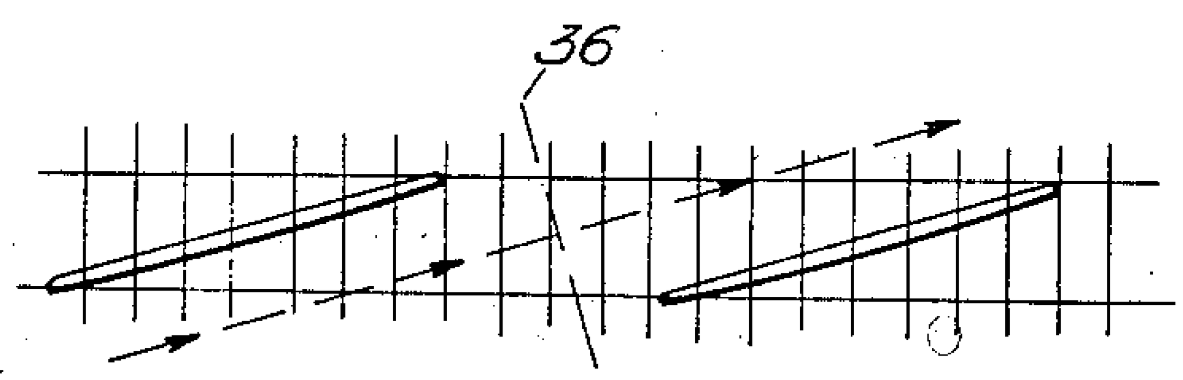

Fig.11

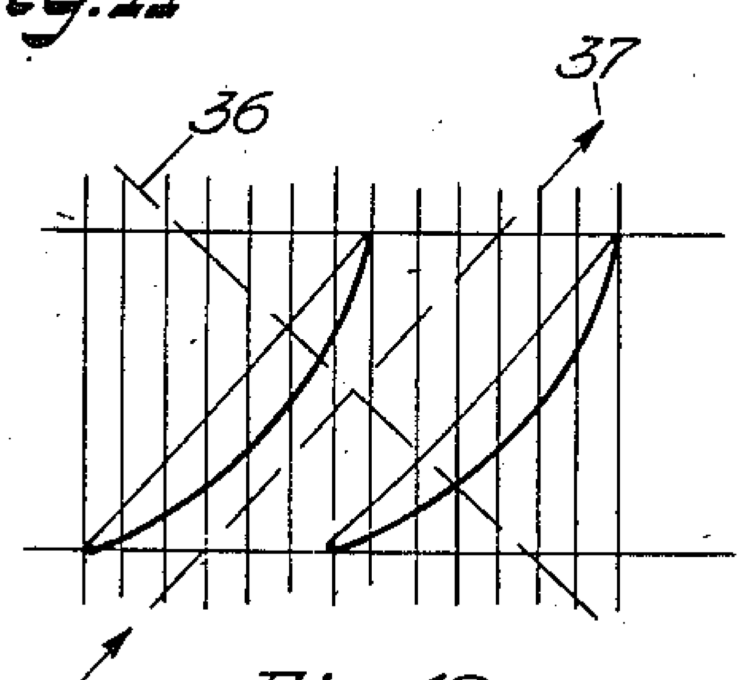

Fig.12

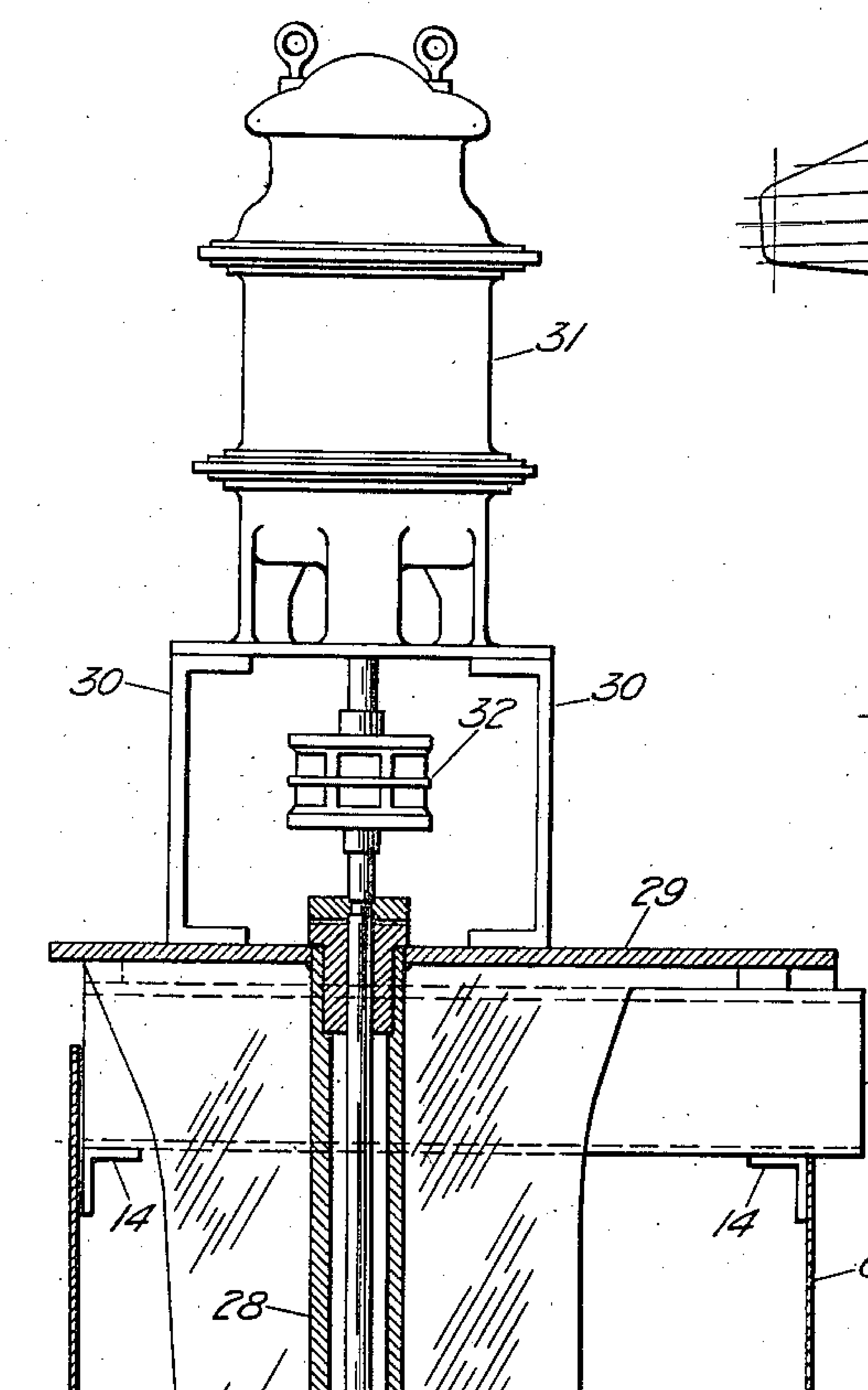
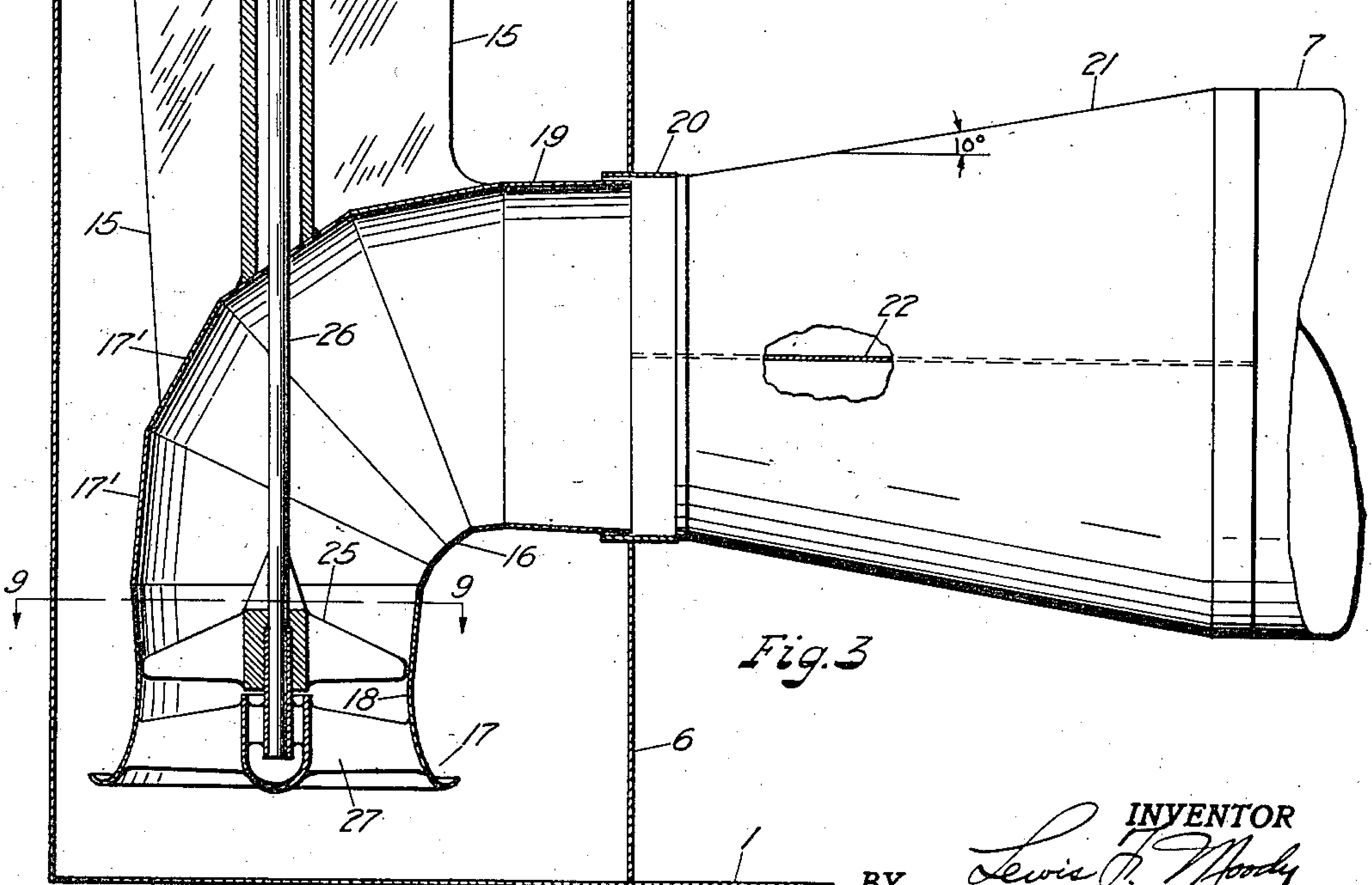

Fig.3

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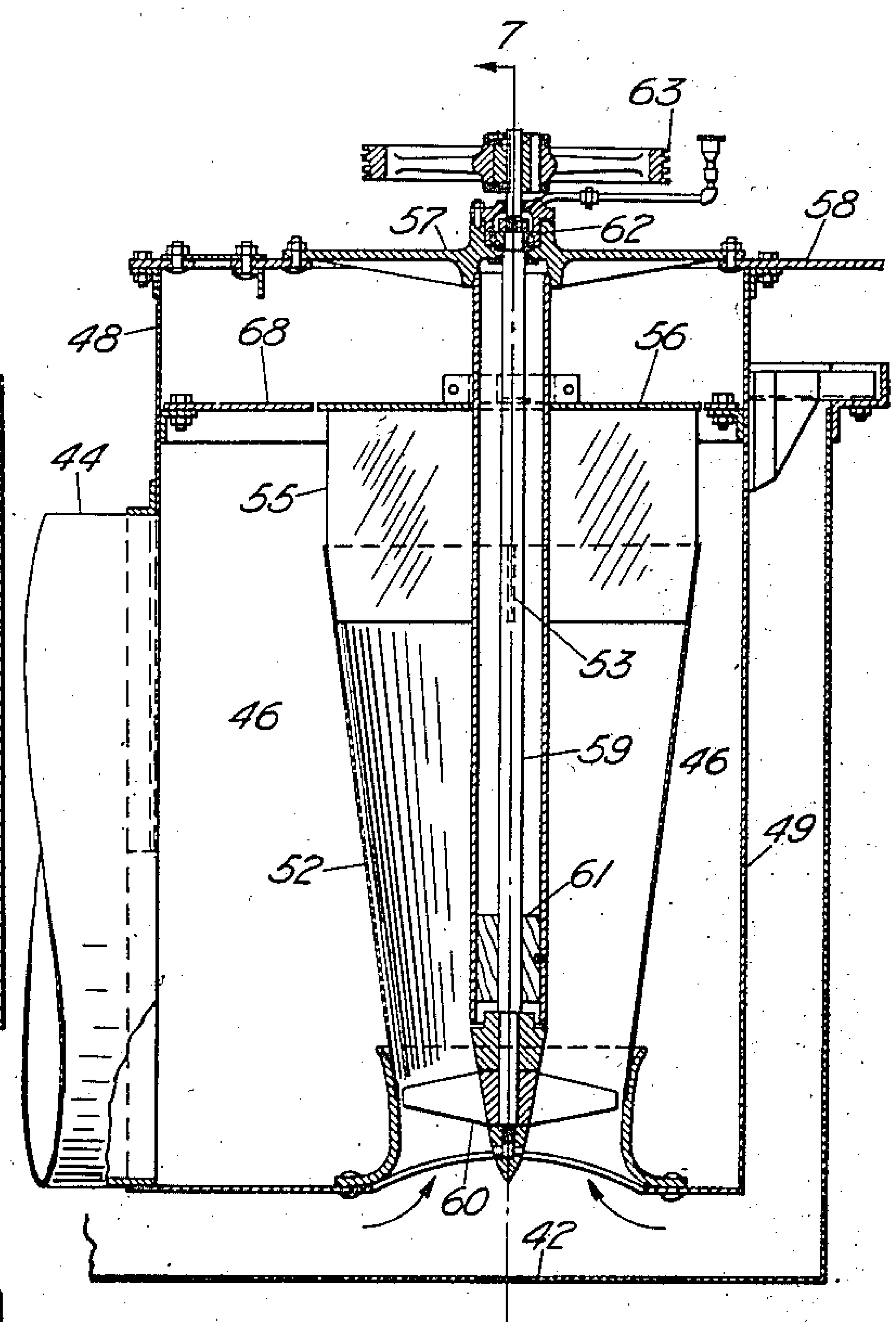

Fig. 8

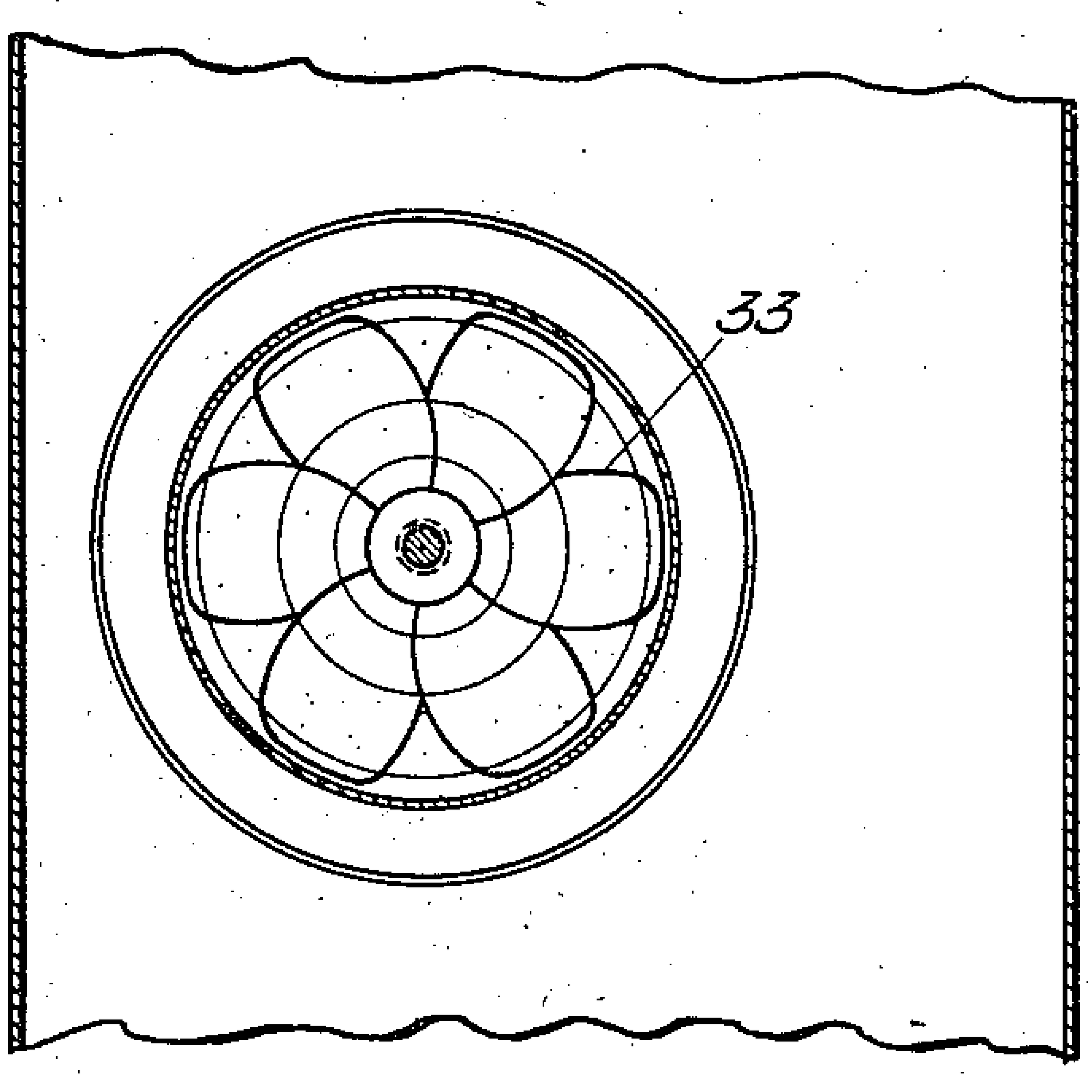

Fig. 9

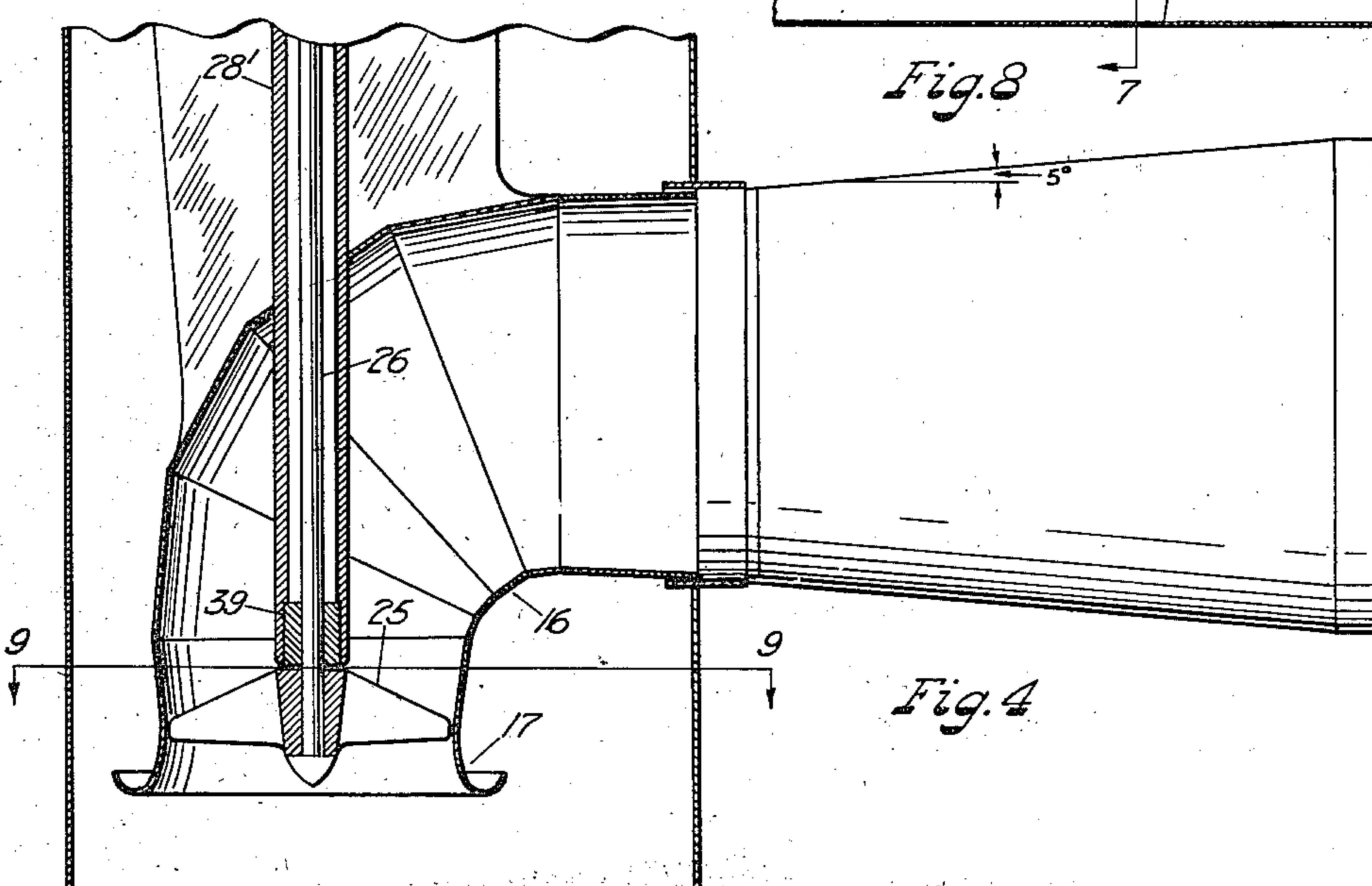

Fig. 4

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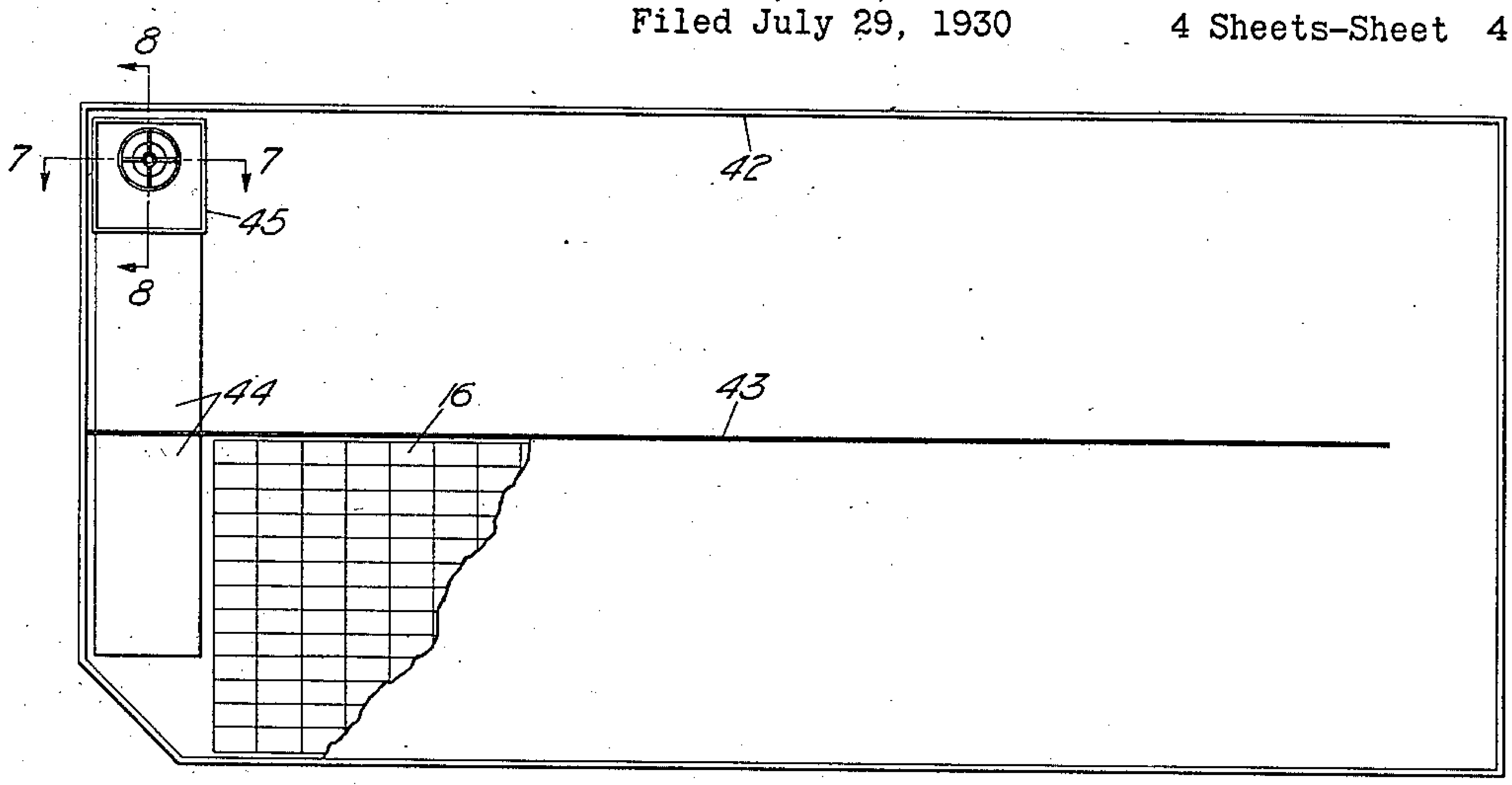

Fig. 5

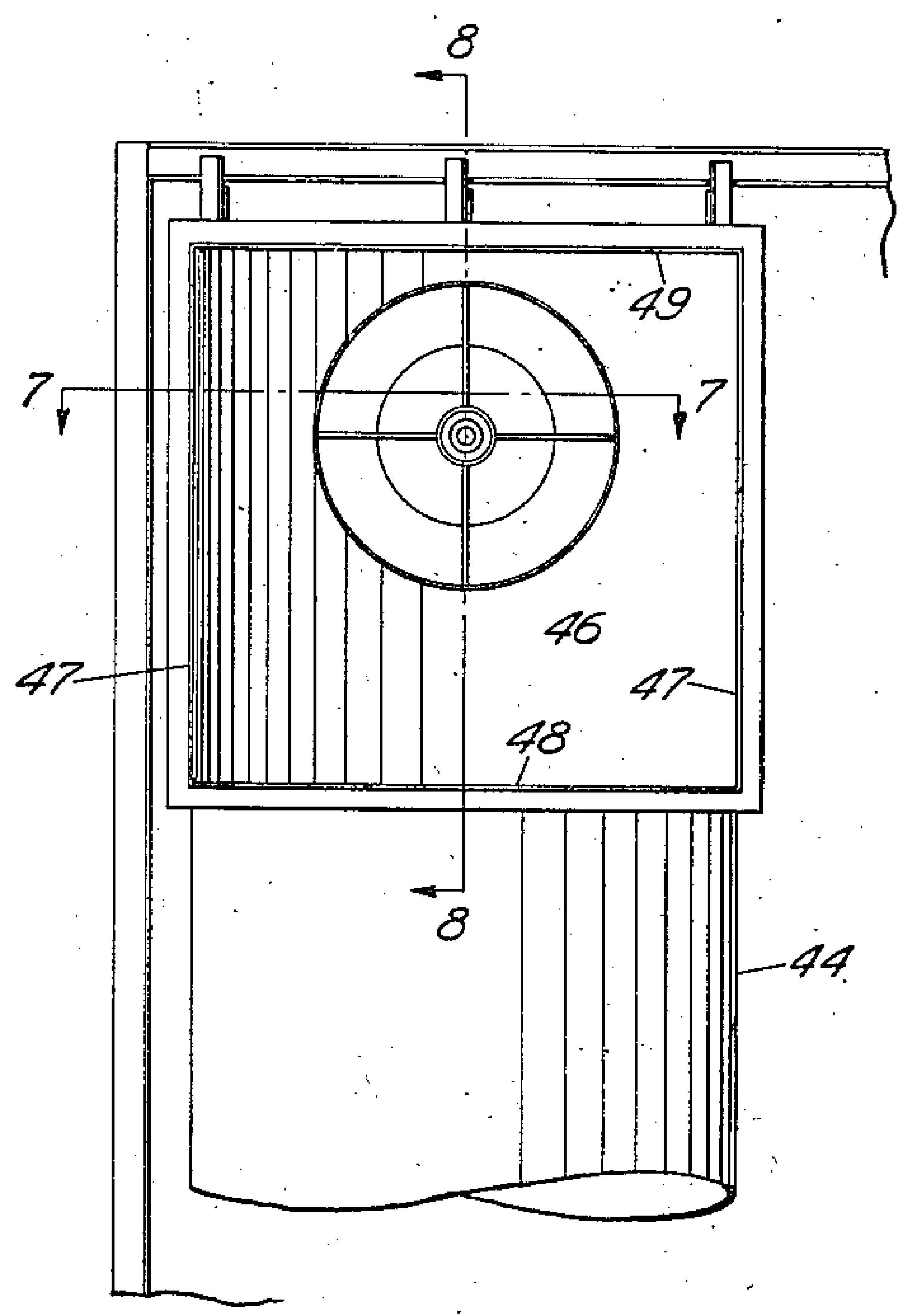

Fig. 6

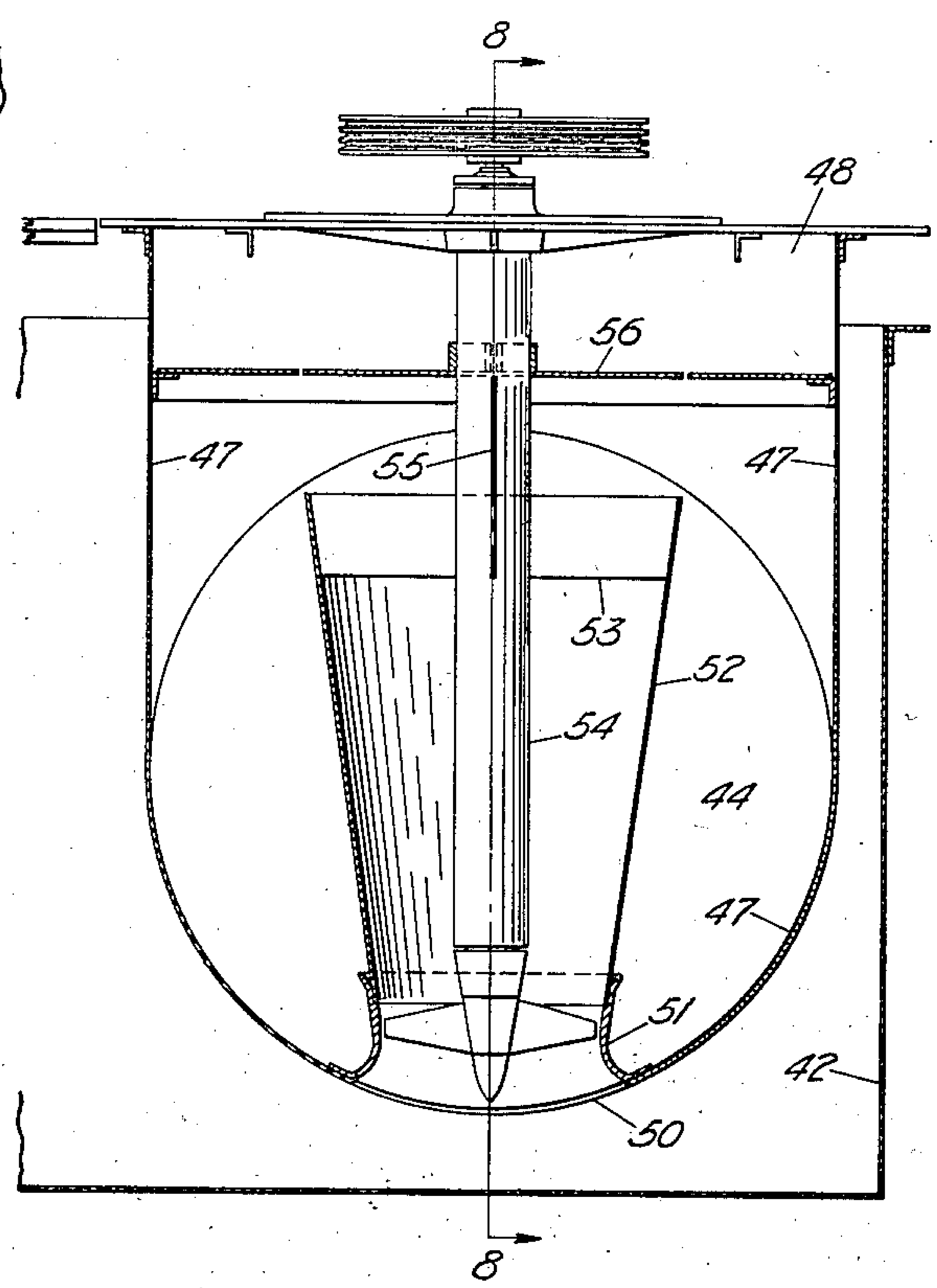

Fig. 7

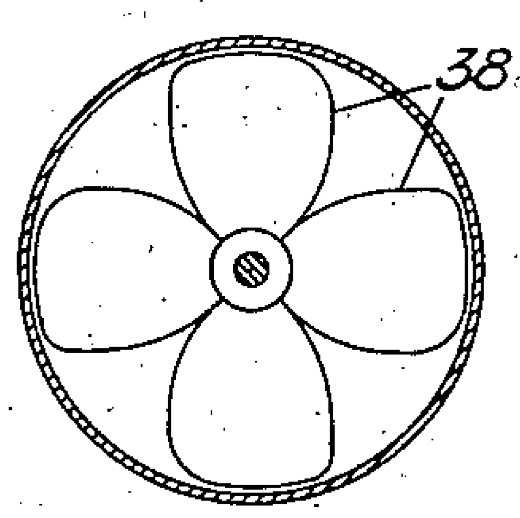

Fig. 13

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UNITED STATES PATENT OFFICE

2,011,646

REFRIGERATION EQUIPMENT

Lewis Ferry Moody, Philadelphia, Pa.

Application July 29, 1930, Serial No. 471,467

9 Claims. (Cl. 259—97)

This invention relates generally to refrigeration equipment and more particularly to an improved arrangement and means for circulating brine in a commercial ice-making plant wherein ice cans are disposed within a brine tank and the brine is circulated around the cans to effect the necessary freezing of the water therein.

An object of my invention is to provide improved means whereby the brine may be efficiently circulated so as to permit the use of smaller and therefore more economical circulating equipment. A further object is to provide improved brine circulating equipment which is relatively simple in construction while another object is to provide circulating equipment which has not only simplicity, economy of construction and operation, but also is relatively compact.

Other objects and advantages will be apparent to persons skilled in the art from the following description of the accompanying drawings in which:

Figs. 1 and 2 are plan views of different forms of brine tanks, the actuating means and its supporting structure for the agitating mechanism being omitted for the sake of clearness,

Fig. 3 is a vertical partial sectional view of the circulating mechanism taken substantially on the line 3—3 of Fig. 2,

Fig. 4 is a modification of Fig. 3, showing a different bearing arrangement for supporting the circulating rotor shaft and a modified arrangement of the diffusing passage leading to the brine cooler,

Fig. 5 is a plan view of a brine tank with a modified form of circulating mechanism shown therein,

Fig. 6 is an enlarged fragmentary plan view of Fig. 5 with the top removed therefrom to show the vertical baffles,

Fig. 7 is a vertical section taken substantially on the line 7—7 of Figs. 6 and 8, certain parts however being shown in elevation for simplicity,

Fig. 8 is a vertical sectional view taken on line 8—8 of Figs. 5, 6 and 7,

Fig. 9 is a transverse section taken on the line 9—9 of Figs. 3 and 4, and showing in plan the form of circulator rotor used preferably in all forms of circulator mechanisms shown,

Fig. 10 is a vertical sectional view through the brine circulating rotor showing two blades in elevation by having the elements thereof rotated into the plane of the paper,

Fig. 11 is a developed section taken along a vertical cylindrical surface concentric to the runner axis and located at the line 11—11 of Fig. 10,

Fig. 12 is a similar section taken on the line 12—12 of Fig. 10,

Fig. 13 is a plan view of a four-bladed circulating element or rotor the blades of which are formed generally similar to those shown in Figs. 10–12.

While I have shown my improved circulating mechanism in connection with various forms of brine tanks it is of course to be understood that any of various other forms of such tanks may be employed and that various arrangements of the circulating mechanism with respect to the brine tank and brine cooler may be used. For purposes of illustration it will therefore suffice to consider only a few of these arrangements of which the form shown in Fig. 1 comprises a brine tank 1 of sufficient depth to receive a series of ice cans indicated diagrammatically at 2 in Fig. 2 while suitable partitions 3 and 4 are provided to insure a predetermined path of brine circulation as indicated by the arrows. These partitions are relatively close together as at 5 and 6 to house the brine coolers 7 while circulating mechanism per se generally indicated at 8 effects the necessary circulation of brine therethrough. Two such mechanisms are shown in connection with the Fig. 1 system and they are identical.

In the Fig. 2 form a single central partition 9 is provided in a brine tank 1 while an L shaped portion 10 of this partition provides a space for receiving a single brine cooler 11 and circulating mechanism generally indicated at 12. This circulating mechanism is identical to those shown in Fig. 1.

The various elements of the circulating mechanism are so arranged and constructed that they cooperate in a very efficient manner to produce brine circulation around the ice cans. Details of the elements of the circulating mechanism comprise as shown in Fig. 3, which is a section on line 3—3 of Fig. 2, a short beam 13 removably supported upon flanges 14 secured to the sides of the brine tank 1 and partition 10. Projecting downwardly from this beam is a supporting arm 15 carrying my improved diffusing passage generally indicated at 16. The arm 15 may be made of any suitable material, preferably plate metal of sufficient thickness to provide the necessary rigidity and this plate is welded or otherwise suitably secured to the beam 13 and the various elements of the passage 16. The connection to the passage is preferably along the longitudinal centerline thereof. The casing or passage 16 includes a bell-shaped inlet 17 which gradually tapers inwardly and thence outwardly to provide a throat at 18. This outward tapering or flaring of the passage is continued by the provision of relatively simple sections 17′ made preferably of sheet metal and having substantially straight line elements extending longitudinally of the passage. These sections also are circular in cross section with their edges lying in diverging planes so that an elbow is formed. The final section 19 has its outer end projecting freely so that it may be readily moved into telescopic connection with a circular inlet 20 of a normally immovable passage generally indicated at 21. This passage continues the gradual enlarging of the elbow passage and has an angle of flare which preferably does not exceed substantially 10° and is connected to the brine cooler 7 of any conventional design. The circular entrance 20 may be welded to the partition 6 or bolted thereto if such should be desired for purposes of assembling or removal of the diffusing passage 21. A longitudinal plate 22 extending entirely across the conical diffuser 21 subdivides the same, in order to guide the flow and permit efficient deceleration within the relatively rapidly enlarging passage.

A circulating element or rotor 25 cooperates with the casing 16 by being disposed preferably slightly above the throat of the section 17. The rotor is secured to a shaft 26, the lower end of which is guided in a bearing supported by radial stay vanes 27 secured to the walls of passage 16. Vanes 27 may be either entirely vertical or inclined in the direction of flow to impart whirl thereto. Shaft 26 projects upwardly through a pipe 28 welded or otherwise suitably secured to the top of sections 17′, while the other end of pipe 28 is similarly secured to a floor plate 29. In the upper end of pipe 28 is a suitable bearing for the shaft 26 while supported upon the plate 29 as by suitable I-beams 30 is an electric motor 31 whose shaft is connected to shaft 26 as by a coupling 32. From the disclosure so far it is seen that the motor 31, plate 29, I-beam 13, supports 15, and passage 16 constitute a unitary structure or unit adapted to be bodily removed from the brine tank passage 21.

The circulating element or rotor 25 has, as shown in Fig. 9, six unshrouded blades 33. The general description of one blade will suffice for all, although it is to be understood that any type of rotor may be employed which is adapted for its primary function to effect efficient circulation of liquid, although in the preferred form of my invention the rotor is of the axial inlet and discharge type. Such rotors are adapted for efficient operation when used with my improved gradually enlarging passage arrangement. The rotor has a high specific speed of 500 and upwards when computed on the basis of

$$N_s=\frac{N\sqrt{Q}}{H^{3/4}}$$

where N_s is specific speed, N is revolutions per minute, Q is cubic feet per second and H is head in feet of brine. The blade surfaces are made up of substantially straight line elements lying in meridian planes which are planes containing the runner axis. As shown in Figs. 11 and 12 the blade tips, in the direction of flow thereover, which is transversely of the longitudinal axis of the blades, are inclined more nearly to the horizontal than to the vertical. A similar section taken adjacent the hub such as on line 12—12 of Fig. 10 is inclined substantially at 45° on its front or driving face. It is also seen that the driving face over substantially the whole of the blade is relatively flat in the direction of flow thereover while the total actual surface area of the blades is approximately equal to the disc area between the hub 35 and the walls of the casing section 17, measured in a plane normal to the runner axis. Also, as shown in Fig. 9 the blades when viewed in plan preferably overlap over the major portion of the blade length, but have open spaces adjacent the tips. The overlap is measured with respect to a line 36 which is normal to the direction of flow 37 such as shown in Fig. 12. This open characteristic as shown in Fig. 11 may if desired extend throughout substantially the whole length of the blades due to the circulating rotor operating against a relatively small circulating head of possibly only a few inches. Such a completely open type circulator element is shown in Fig. 13 wherein only 4 blades 38 are provided. The other characteristics of these blades are the same as those described for the six-bladed runner. The rotor is adapted for operation at a relatively high number of revolutions per minute while circulating large quantities of fluid under a small head, and has high efficiency and correspondingly low power consumption.

In the modification shown in Fig. 4 the entrance or bellmouth 17 is entirely free of any vanes or obstructions. In order to support the shaft 26 of circulator element 25 a hollow support 28′ extends through the wall of casing 16 to support a bearing 39. The structural arrangement for the remainder of the equipment in this form is the same as in the form above described.

The operations of the forms shown in Figs. 3 and 4 are the same in that upon rotation of the circulator or agitating rotor 25 brine will flow from the brine tank upwardly through bellmouth 17, thence axially to and from the rotor and on through the gradually flaring elbow passage 16 thereby gradually decelerating the flow and thence into the continued gradually flaring passage 21 where further gradual deceleration of the flow takes place. The brine or other fluid then flows through the brine cooler 7 or 11. In the case of the Fig. 4 form, the angle of flare is shown at 5° while in the Fig. 3 form it is shown at 10° which values represent generally the preferred minimum and maximum limits of flare, although in either case the gradual rate of flow deceleration will insure an efficient discharge of brine into the brine tank. No central guide plate such as 22 is needed when the space permits the smaller flare of Fig. 4 to be used.

In the modification shown in Figs. 5 to 8 the brine tank 42 has a partition 43 through which the brine cooler 44 extends, this cooler being of circular cross-section. The circulating mechanism is shown generally at 45 and comprises a square collecting chamber 46 at the entrance end of cooler 44, formed by a continuous side and bottom element 47 substantially tangent to the lower portion of the cooler as shown in Fig. 7 and a front wall 48 terminating adjacent the upper edge of the cooler, while a wall 49 closes the rear end of the passage. An inlet opening 50 is provided in the bottom of the member 47 at a point adjacent the rear wall 49. A circular inlet guide 51 having somewhat of a bellmouth entrance and a diverging upper part is secured in alignment with opening 50. Projecting upwardly from the passage 51 is a diffusing cone 52 formed preferably by a straight line generatrix. This cone merely has a snug removable fit within a suitable circular recess formed in element 51, and is supported at its upper end by two diametrically opposite relatively narrow vertical baffles 53 welded or otherwise suitably secured at their outer ends to cone 52. The inner ends are likewise welded or otherwise secured to a vertical hollow support in the form of a pipe 54. If desired, baffles 53 and 55 could merely bear against the walls of the cone instead of being secured thereto. There is also provided a pair of relatively deep vertical baffles 55 diametrically disposed in the direction of the longitudinal axis of the cooler 44, these baffles also being secured to the support 54 at their inner ends, while the lower portion of their outer ends is secured to the wall of the cone 52. The pipe support 54 extends upwardly through and is secured to a horizontal baffle 56 and to the vertical baffles 55 as by welding or otherwise, and terminates in a suitable recess formed in a cover 57 removably secured to a floor plate 58 as by bolts or other desired means. The pipe 54 is rigidly secured to the cover 57. A shaft 59 carries a circulator rotor 60 and is supported in a lower removable bearing 61 and an upper bearing 62. This shaft may be connected either directly to a motor as shown in the Fig. 2 form or provided with a pulley or rope sheave 63. From the construction so far described it is seen that the diffusing cone, circulating element 60, vertical and horizontal baffles 53, 55 and cover 57 constitute a unitary structure or unit adapted to be bodily removed without disturbing the remaining portion of the circulating mechanism. It is to be noted that in all forms shown the passages leading to the brine cooler are relatively long in comparison to their minimum diameter; the Fig. 8 form having, for instance a length at least one and one-half times that of the minimum diameter. The angle of flare of the sides of cone 52 with respect to the axis should be preferably between about 6° and 10°. Inasmuch as the discharge passages of all modifications are conical it is seen that generically the angle of flare of these or corresponding passages is determined by comparison to an equivalent conical tube of preferably straight form such as shown in Fig. 8 at 52.

In the operation of this form, rotation of the circulator rotor 60 causes fluid to flow upwardly through the inlet 50 from the brine tank 42, thence with a gradually decelerating rate of flow through the diffusing cone 52 from which the fluid is discharged into the relatively large collecting chamber 46 surrounding the cone. Any whirling of the fluid caused for instance by rotation of the circulator 60 will be substantially removed as the fluid discharges from the cone past the vertical baffles 53 and 55. In order to improve the efficiency of the circulating mechanism the horizontal baffle 56 is spaced relatively close to the upper end of the cone 52 thereby leaving an appreciable chamber between the horizontal baffle and the cover 57. As a result of this horizontal baffle, fluid flows uniformly out of the cone and into the chamber 46 without eddy currents or entraining of air, as might occur if the fluid had a free surface, which would be made possible if the horizontal baffle was omitted and the fluid allowed to discharge entirely freely in the space between the horizontal baffle and the cover 57. This feature is found to be highly effective in increasing the circulation of brine even though the head, against which the circulator 60 operates, amounts to only a few inches. As the fluid discharges into the collecting chamber it then flows outwardly through the brine cooler, thence around the ice cans 66 and back to the inlet passage 50. The walls of passage 50 are preferably smoothly curving as shown and preferably in the form of a surface or revolution. A continuation of the horizontal baffle is had by the provision of a square plate 68 bolted to the sides of the walls of chamber 46 and having an opening suitably cut to conform to the shape of the horizontal baffle which is preferably circular.

From the foregoing description of the several modifications shown it is seen that I have provided a circulating system which is highly efficient, compact and economical in construction and operation, although it will of course be understood that various changes and modifications may be made in these different forms without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A refrigeration system having a brine tank and mechanism for circulating brine therein including a circulator element of the axial inlet and discharge blade type, a vertically disposed relatively long vertically extending gradually flaring straight discharge passage for conducting the fluid flow directly from said circulator element upwardly through said passage, and means providing a surface disposed transversely of said passage below the normally free surface of the brine in the tank.

2. A refrigeration system having a brine tank and mechanism for circulating brine therein including a circulator element of the blade type, a relatively long vertically extending gradually flaring straight discharge passage for conducting the fluid flow directly from said circulator rotor, and a horizontal baffle having a relatively smooth surface disposed at the end of said passage and transversely thereof whereby the fluid engages said baffle so as to be smoothly turned away from the axis of said passage.

3. A refrigeration system having a brine tank, a cooler, and mechanism for circulating brine therein including a circulator element of the unshrouded blade type, a relatively long vertically extending gradually flaring straight discharge passage for conducting the fluid flow directly from said circulator element, a horizontal baffle disposed at the end of said passage transversely thereof, and other baffles extending longitudinally of said passage.

4. A refrigeration system having a brine tank, a cooler, and mechanism for circulating brine therein including a circulator element of the unshrouded blade type, a relatively long vertically extending gradually flaring straight discharge passage for conducting the fluid flow directly from said circulator element, a horizontal baffle disposed at the end of said passage transversely thereof, and other baffles extending longitudinally of said passage near the discharge end thereof.

5. A refrigeration system having a liquid tank, and mechanism for circulating liquid therein including a gradually flaring vertically extending straight discharge passage from which liquid to be circulated overflows the top edge thereof in a horizontal direction, said passage having a substantially continuous wall surface whereby the brine flows uninterruptedly through said passage with a gradual rate of deceleration, and a rotatable circulator element of the axial flow unshrouded blade type disposed in the lower portion of said passage to cause upward flow

of the fluid therein and having constant clearance with the wall of said passage thereby.

6. A refrigeration system having a liquid tank, and mechanism for circulating liquid therein including a gradually flaring vertically extending straight discharge passage from which liquid to be circulated overflows the top edge thereof in a horizontal direction, said edge being disposed below the free level of the discharge fluid, a horizontal baffle disposed below said free level and transversely of the upper end of said passage, and a circulator element located in the lower end of said passage to cause upward flow of the fluid therein.

7. A refrigeration system having a liquid tank, and mechanism for circulating liquid therein including a gradually flaring vertically extending straight discharge passage from which liquid to be circulated overflows the top edge thereof in a horizontal direction, a horizontal baffle spaced from but disposed over the upper end of said discharge passage, a collector box surrounding said passage for receiving discharged fluid therefrom, said box being spaced from the bottom of said tank and having an inlet opening communicating with the lower end of said passage, and a circulator element disposed adjacent said lower end whereby fluid is circulated from said tank upwardly through said inlet and through said gradually flaring passage and against said horizontal baffle into said collector box.

8. A refrigeration system for a brine tank, having circulating mechanism including a collector box, a vertical upwardly discharging diffuser therein having an axial entrance leading from outside of said box, a flow space around said diffuser and within said box, and an axial flow circulator rotor at the entrance to said diffuser.

9. A liquid circulating system comprising a collector box which is substantially rectangular in horizontal section, a vertical upwardly discharging diffuser therein having an axial entrance leading from outside of said box, a closed space around said diffuser and within said box, and an axial flow circulator rotor at the entrance to said diffuser.

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