April 10, 1951 W. L. MORRISON 2,548,441

REFRIGERATOR AND EVAPORATOR THEREFOR

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Fig. 11.

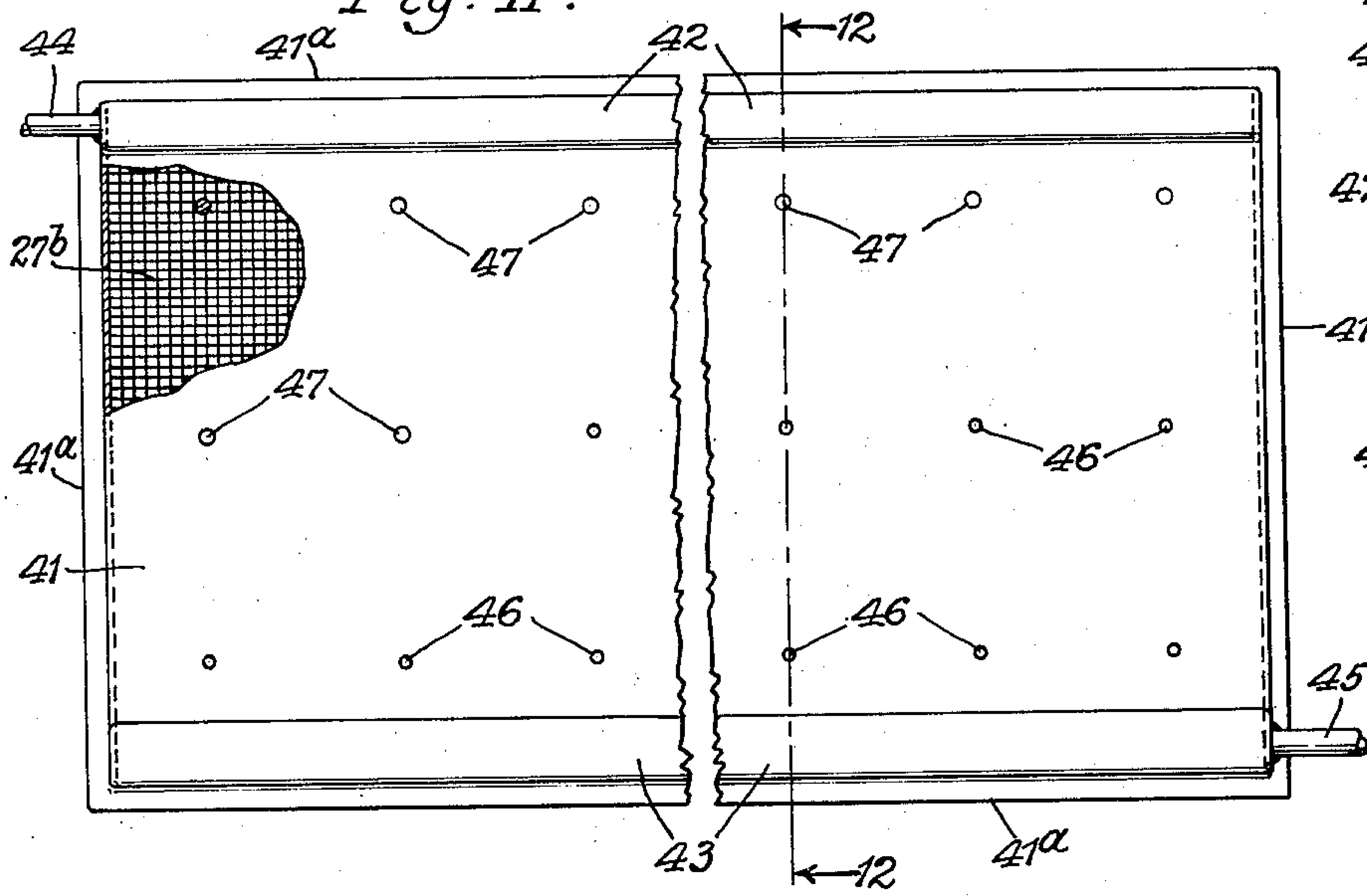
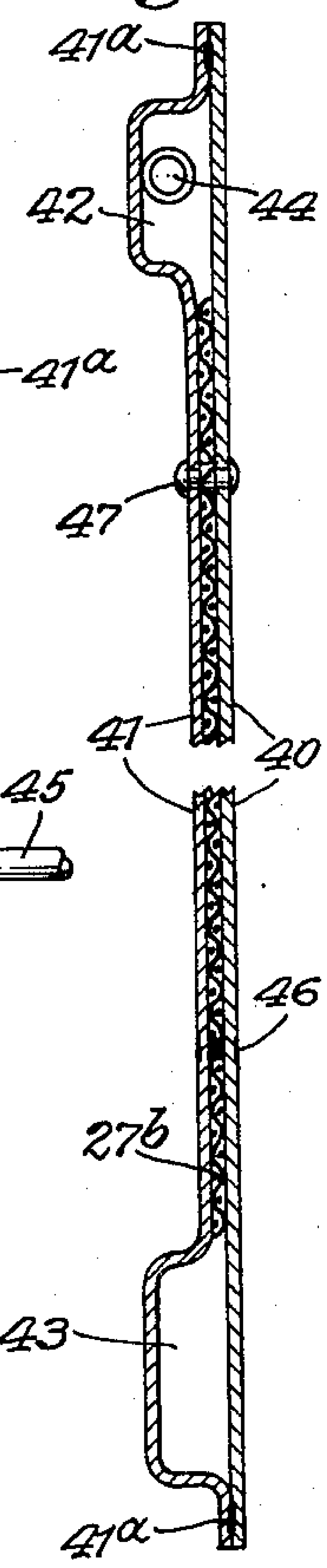


Fig. 12.



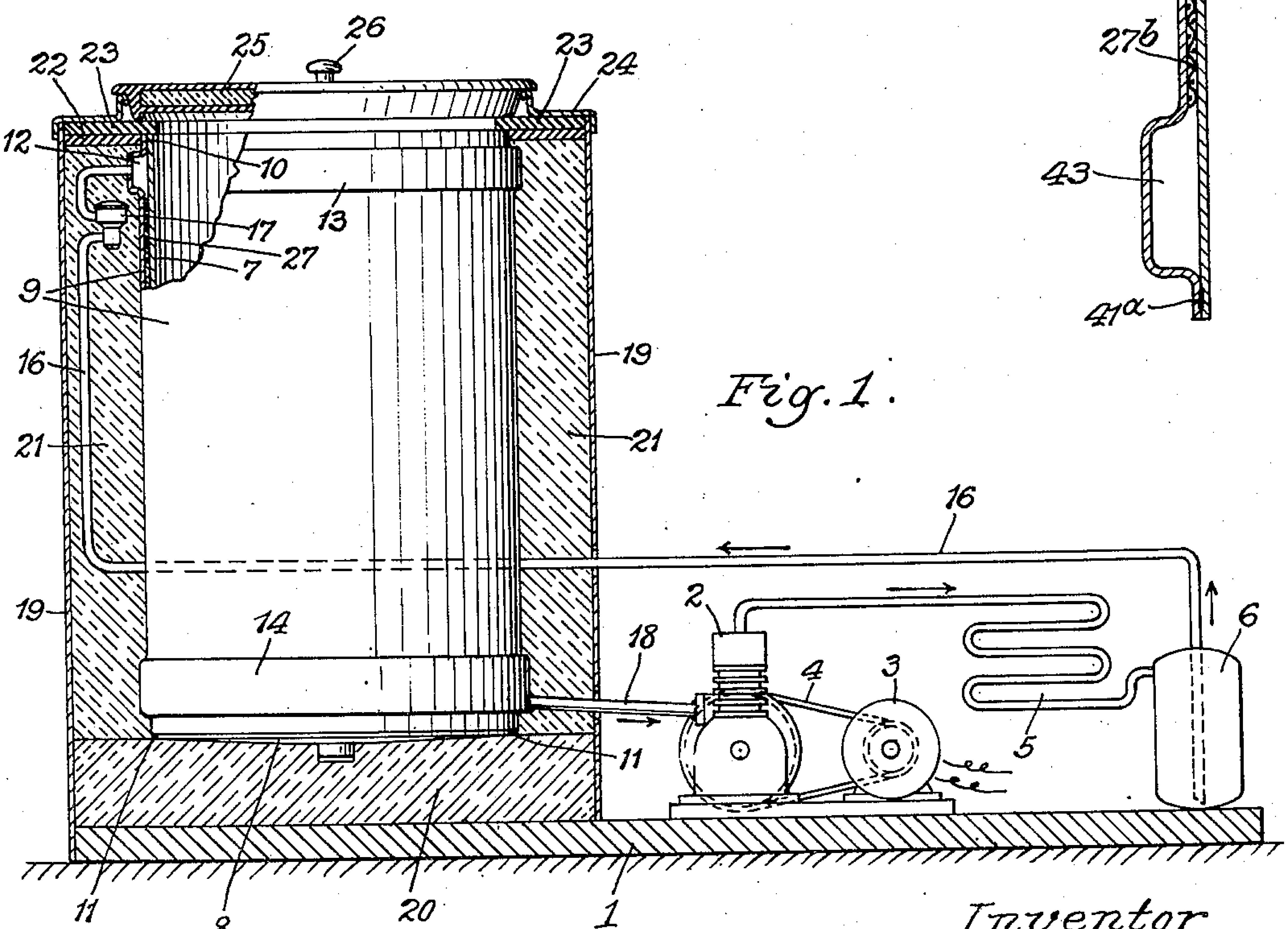


Fig. 1.

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Fig. 2.

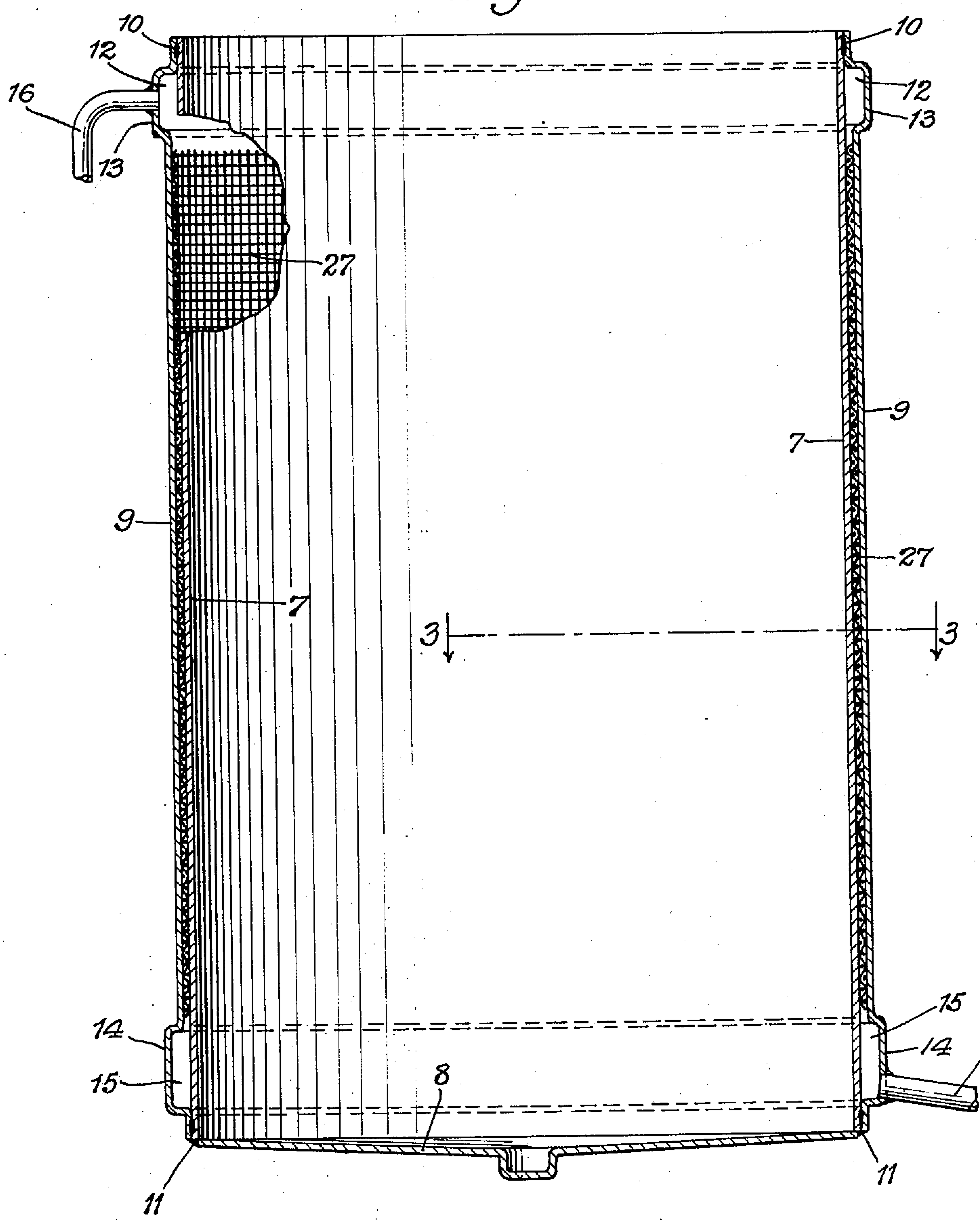

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Fig. 4

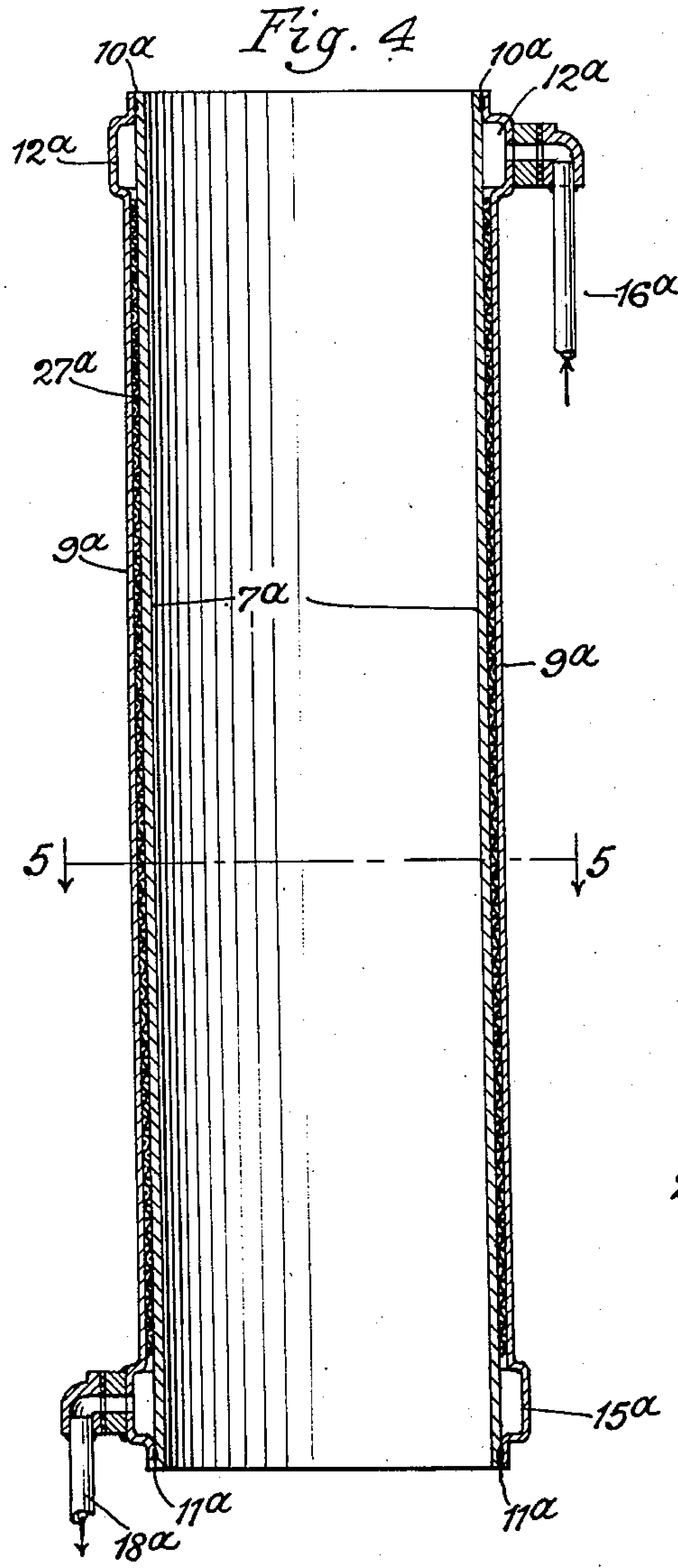

Fig. 3.

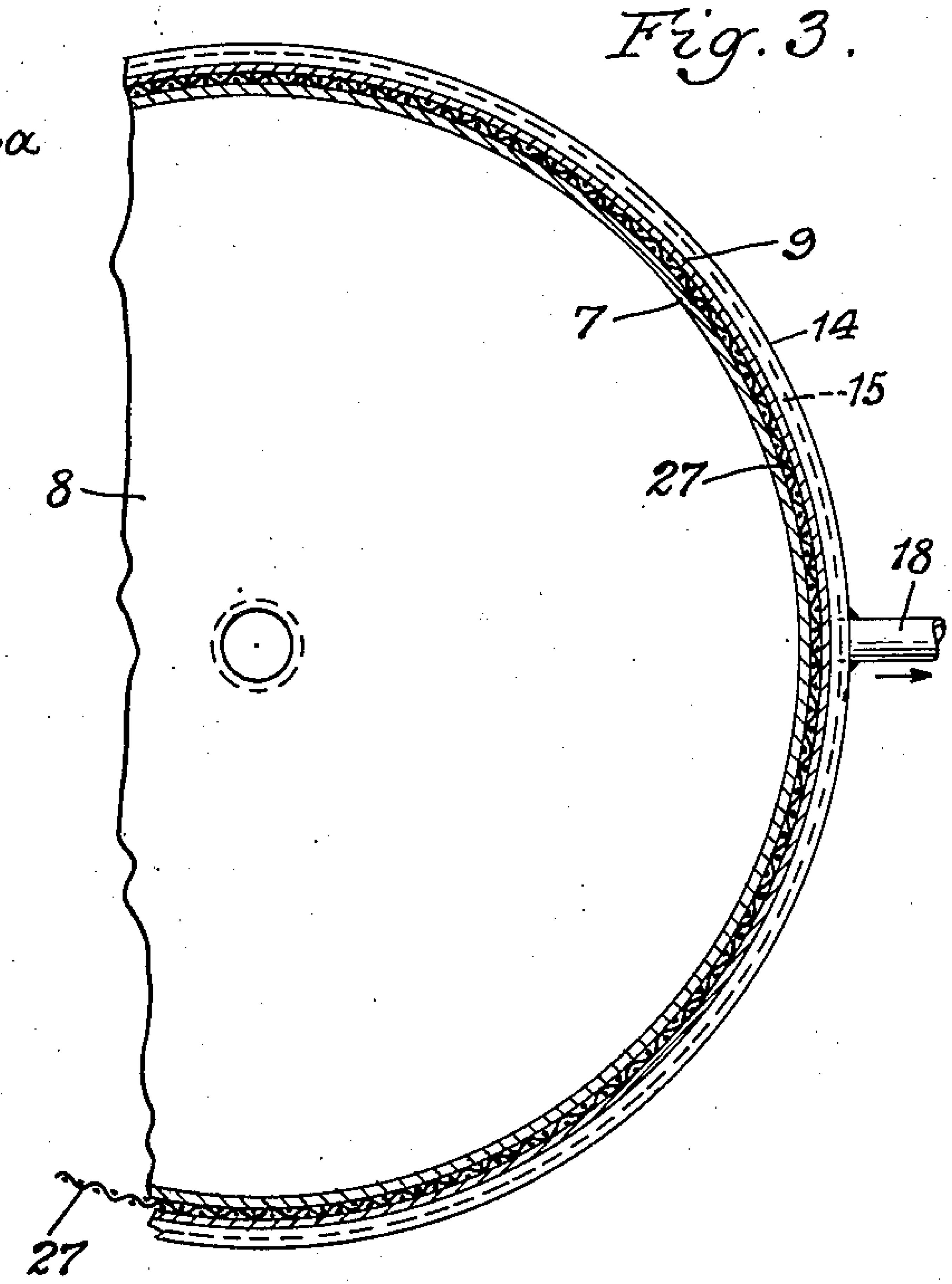

Fig. 5.

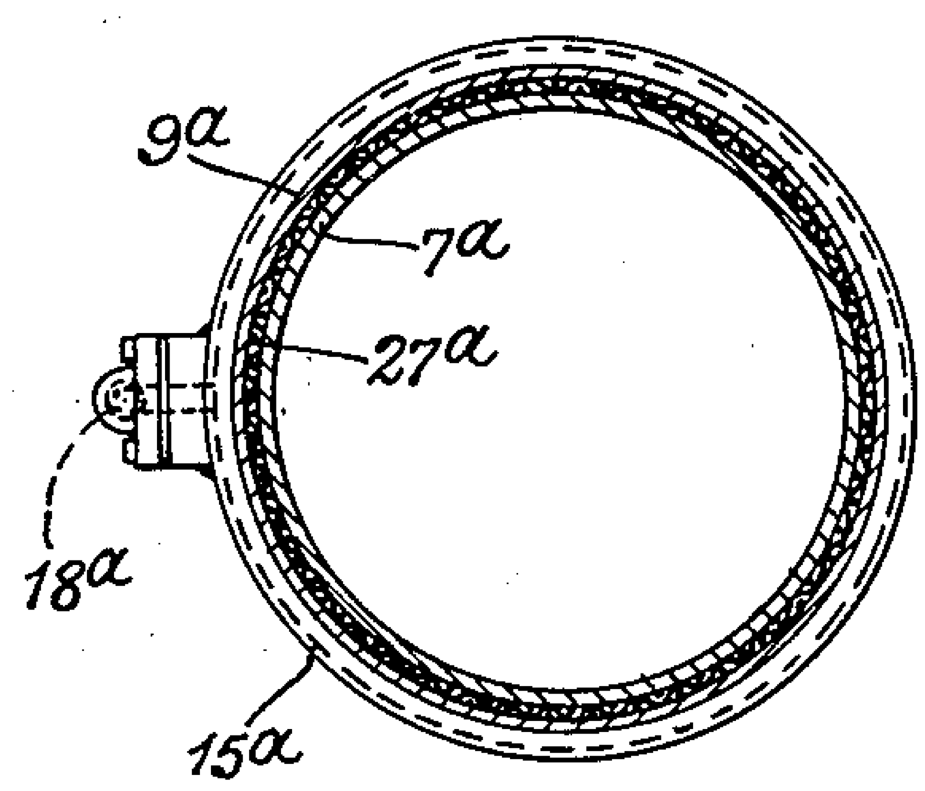

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Fig. 6.

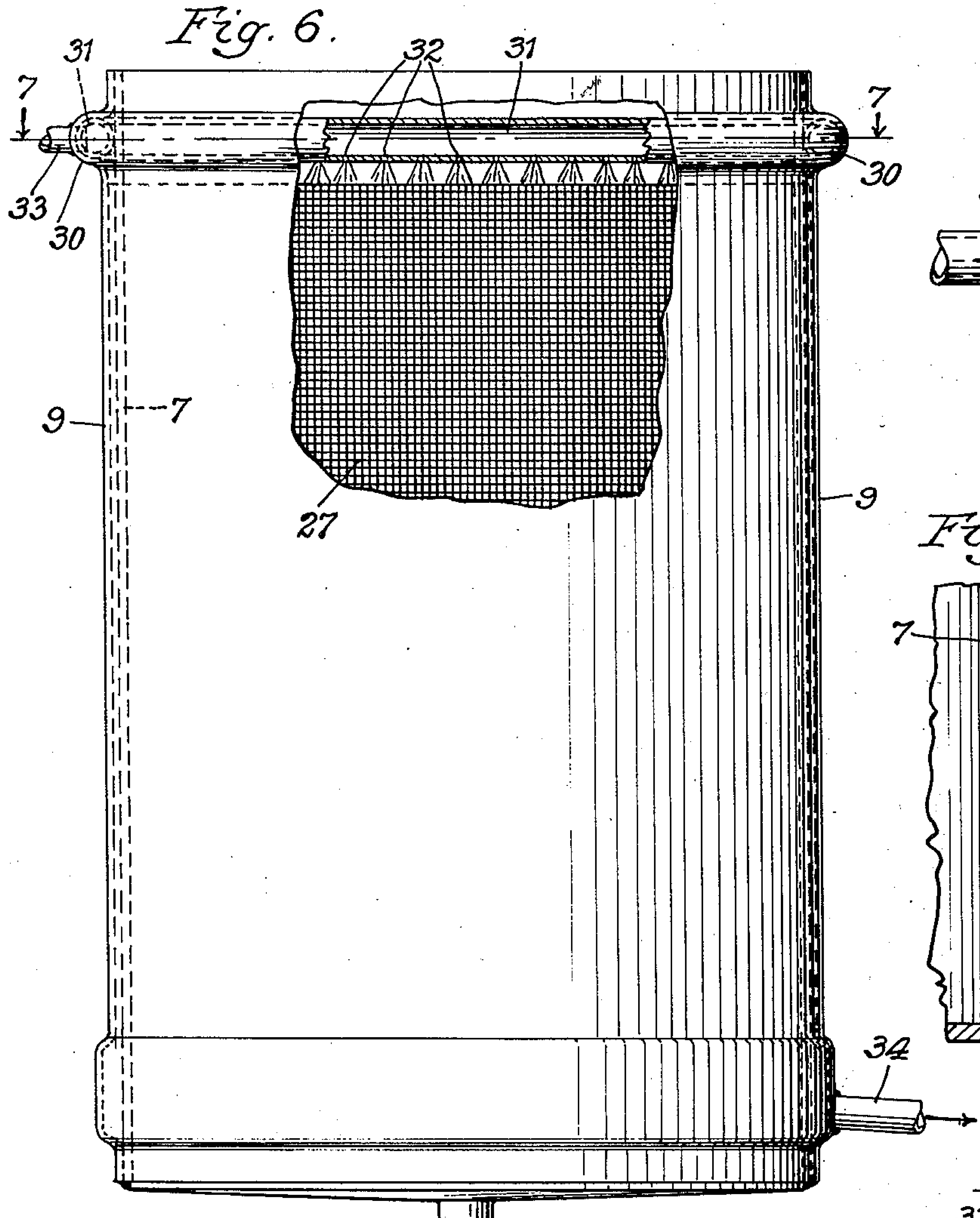

Fig. 8.

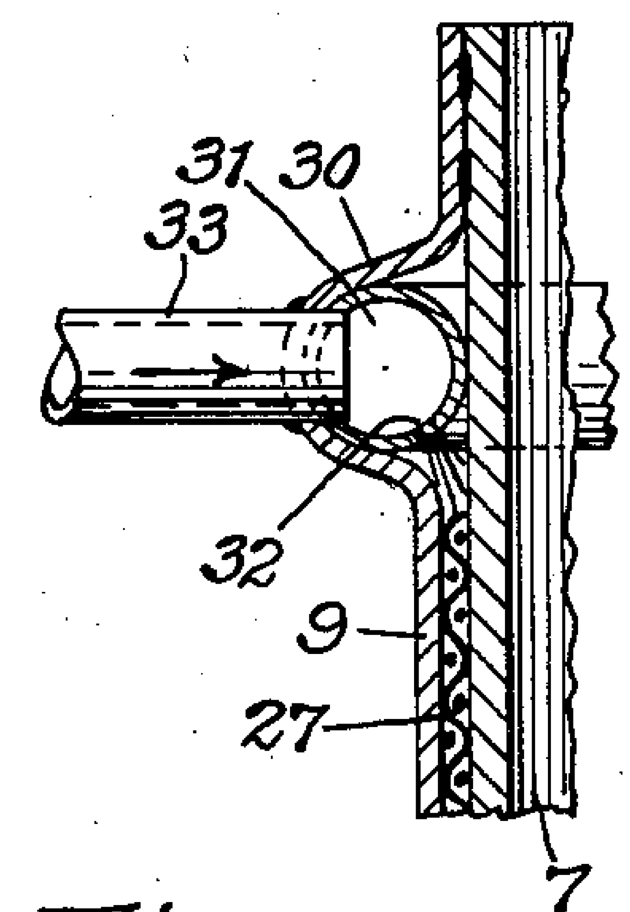

Fig. 9.

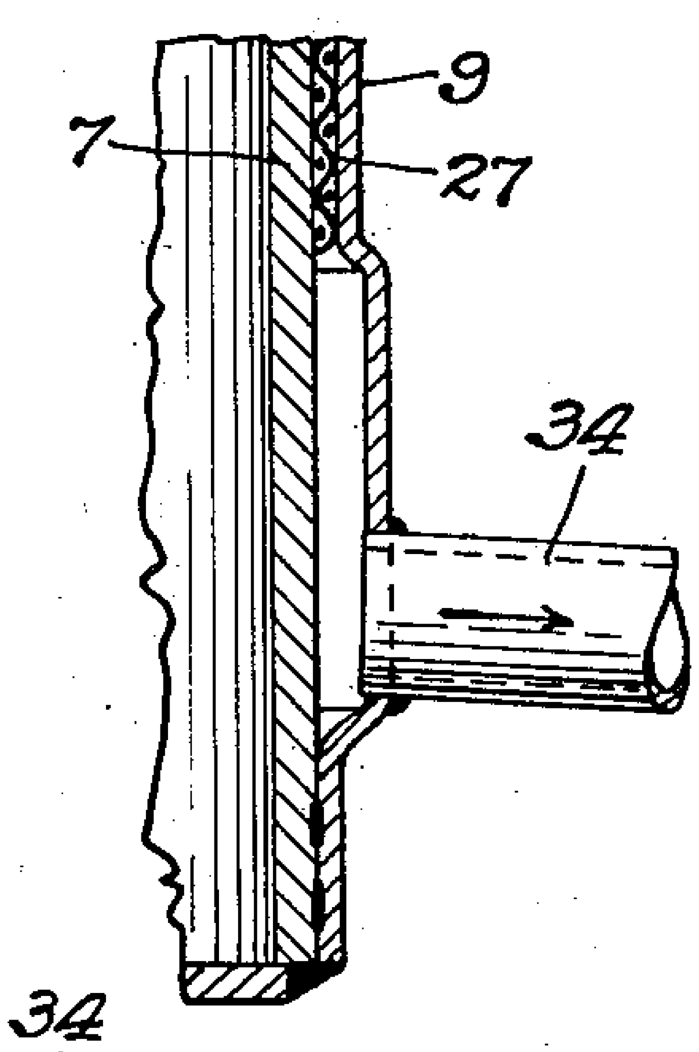

Fig. 7.

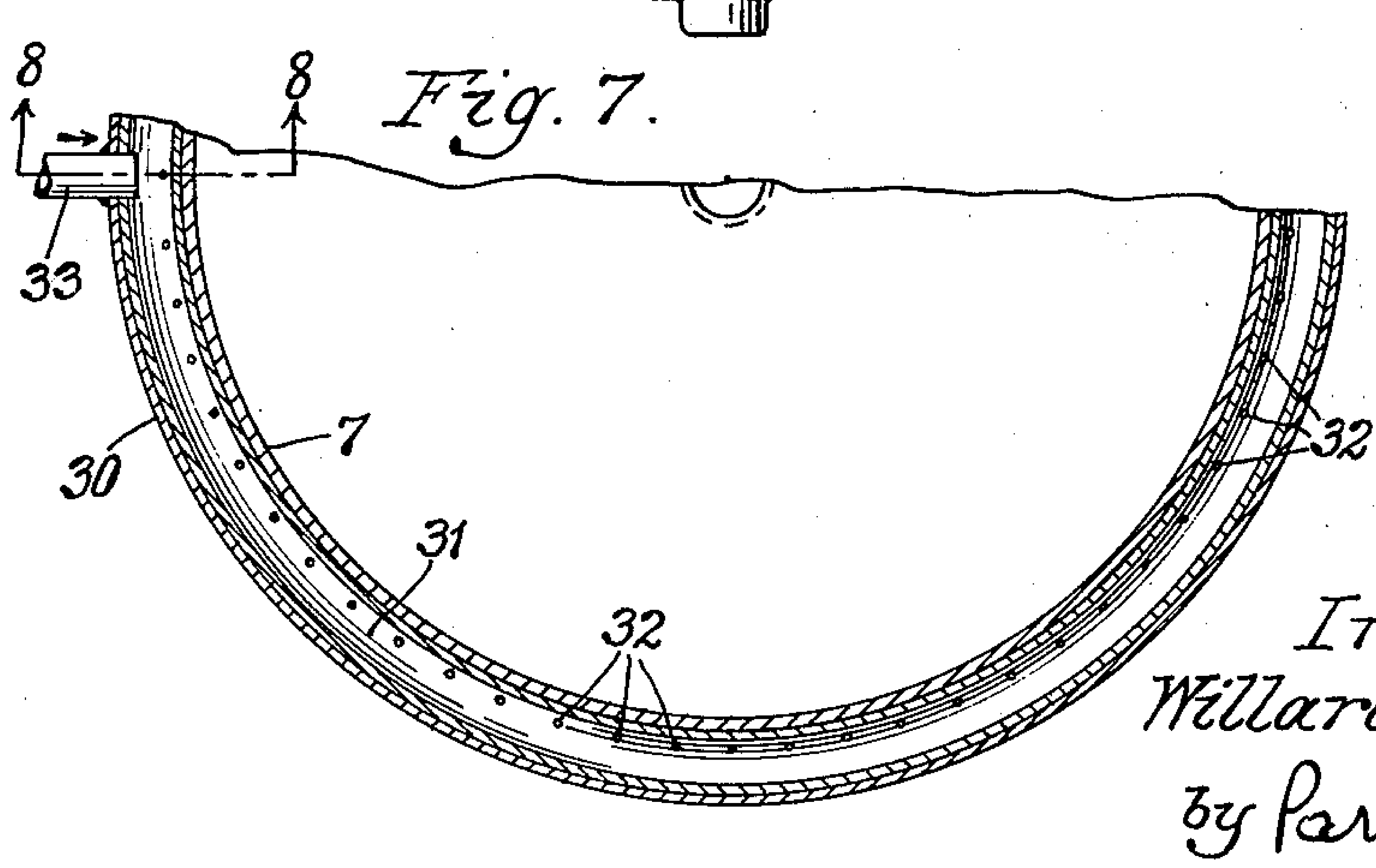

Fig. 10.

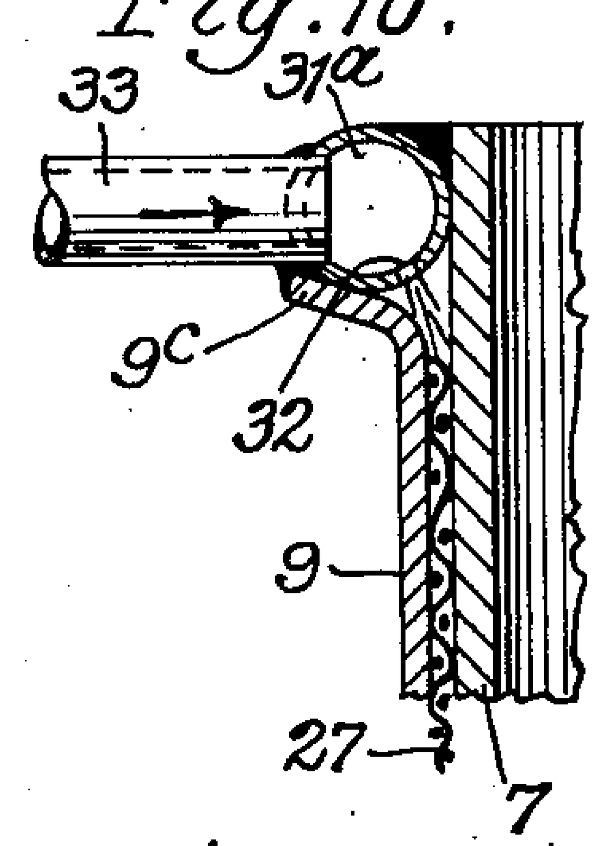

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Fig. 14.

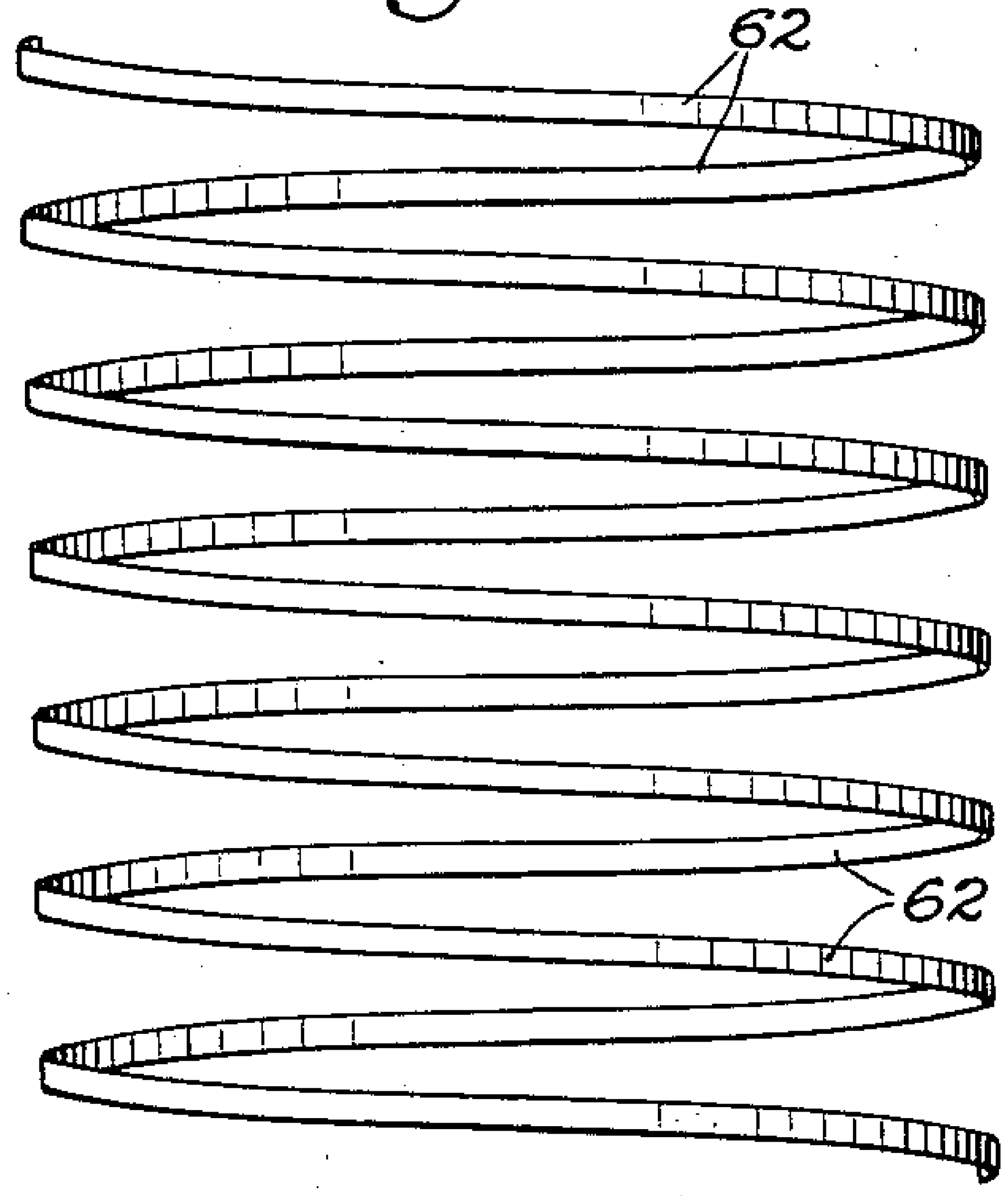

Fig. 16.

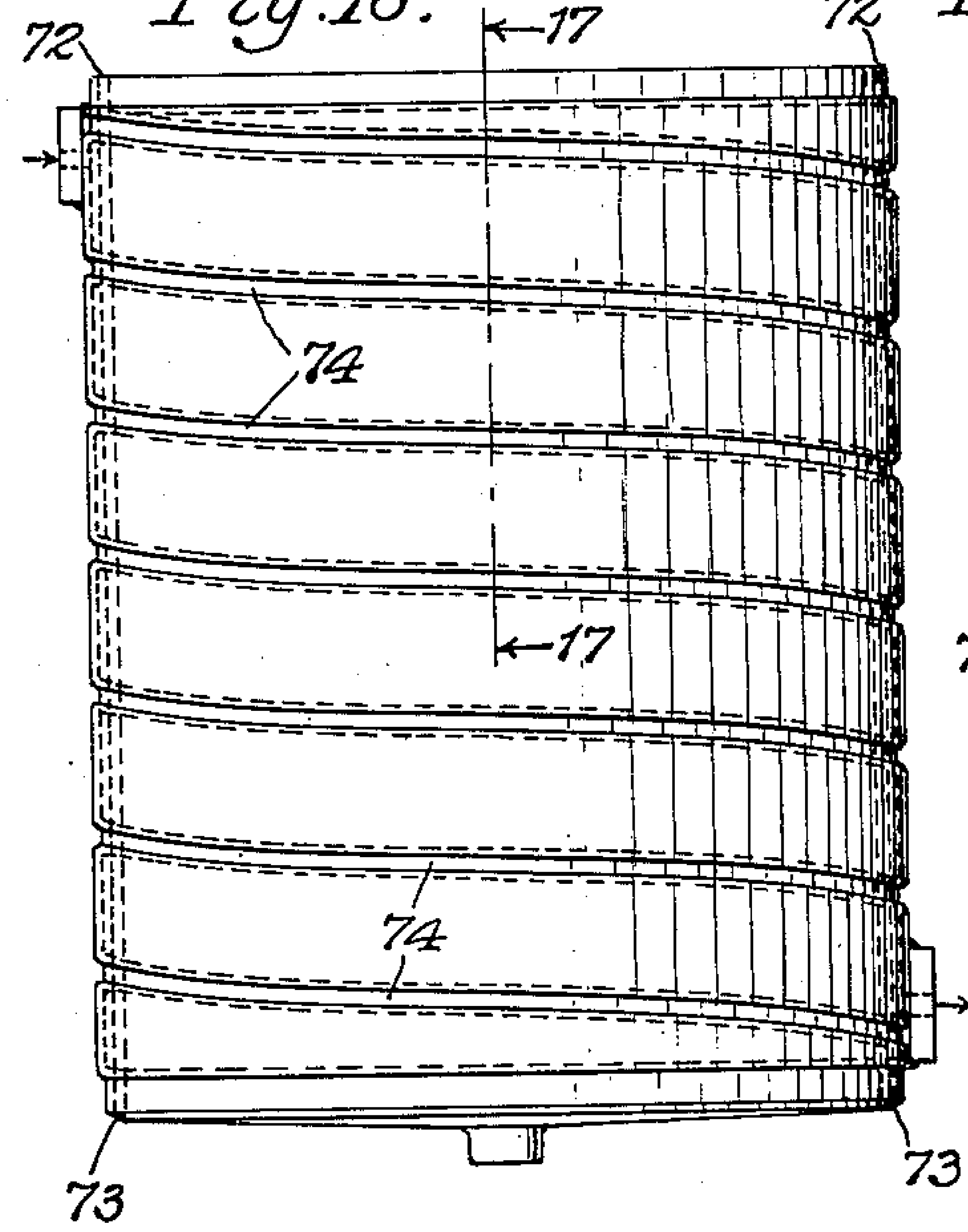

Fig. 17.

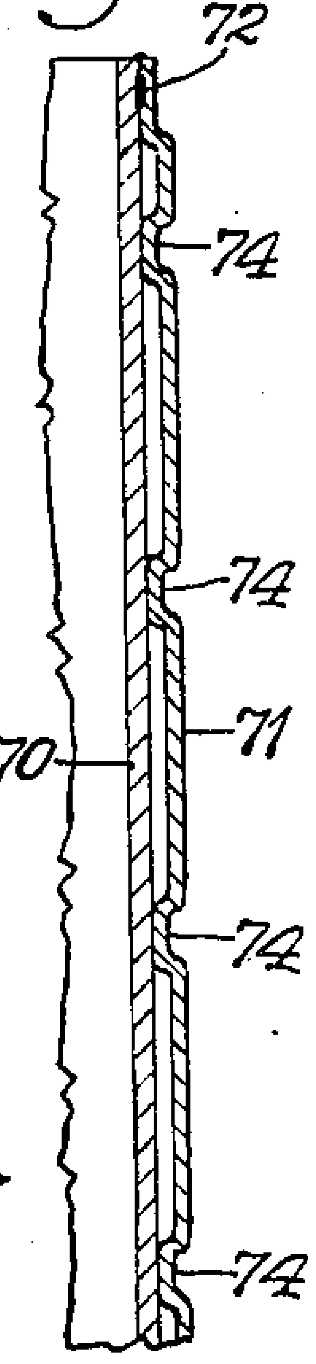

Fig. 13.

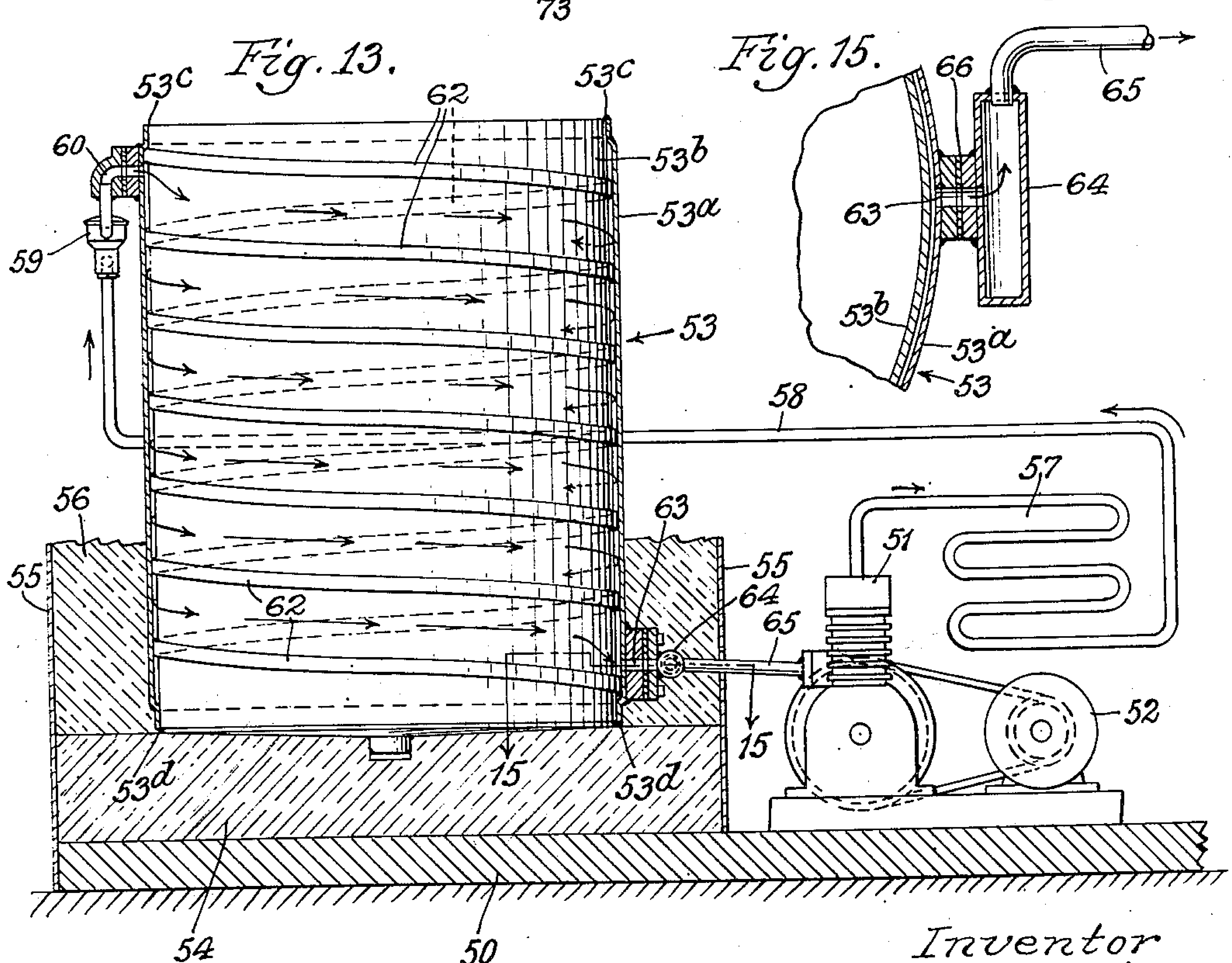

Fig. 15.

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Fig. 18.

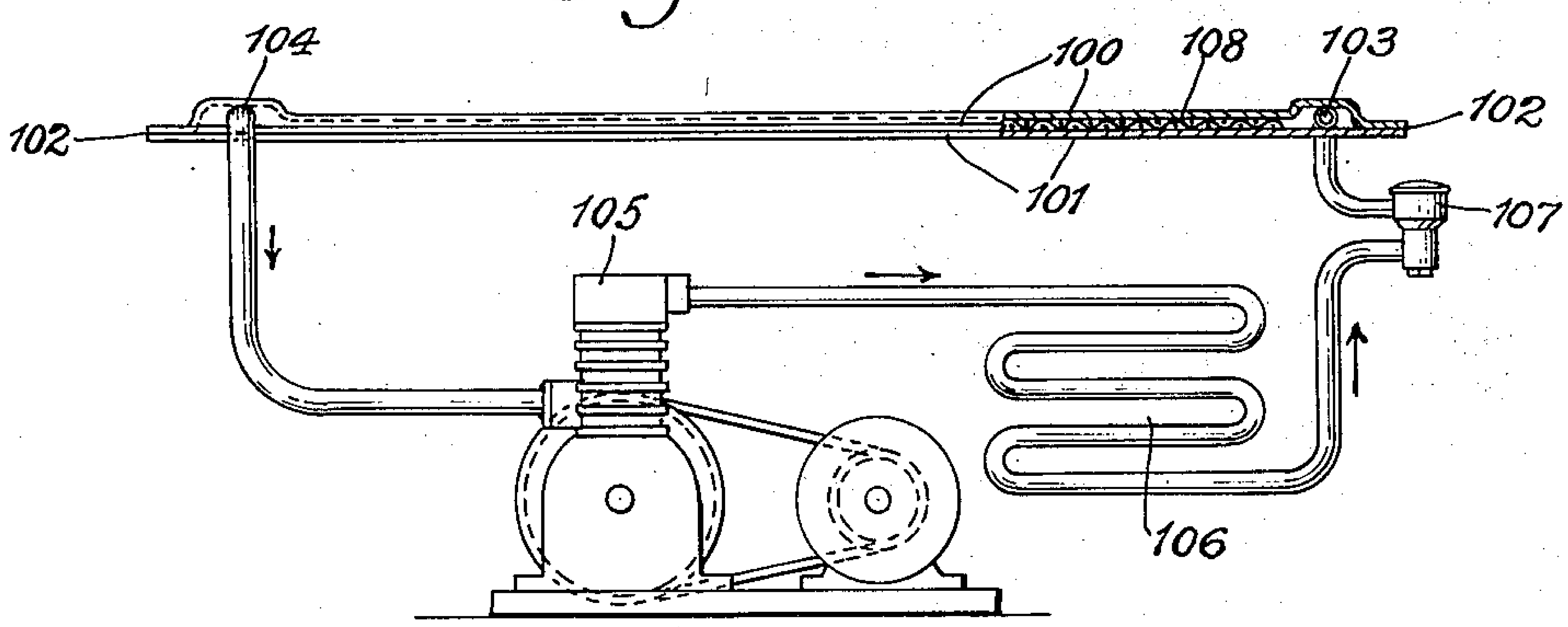

Fig. 19.

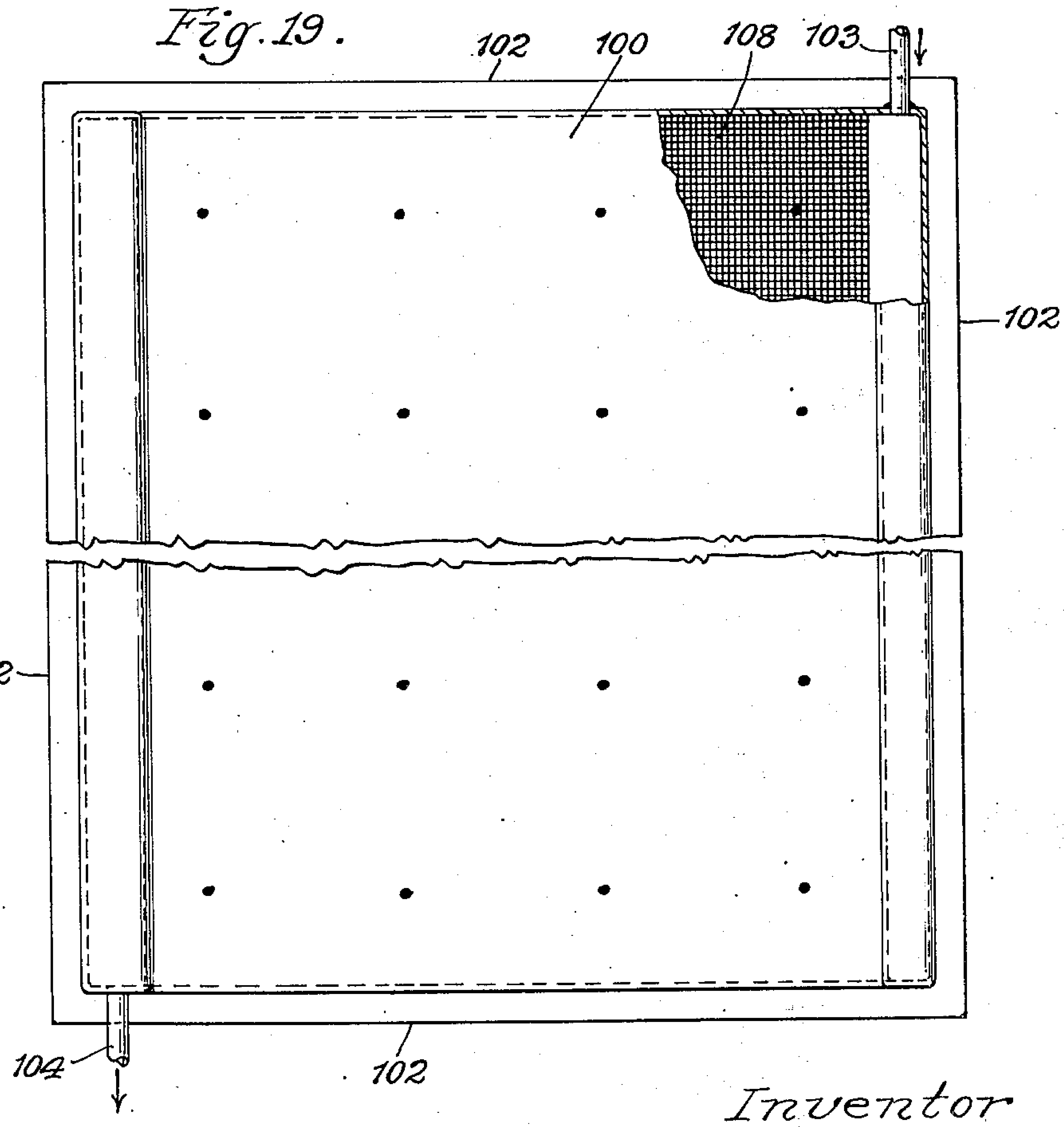

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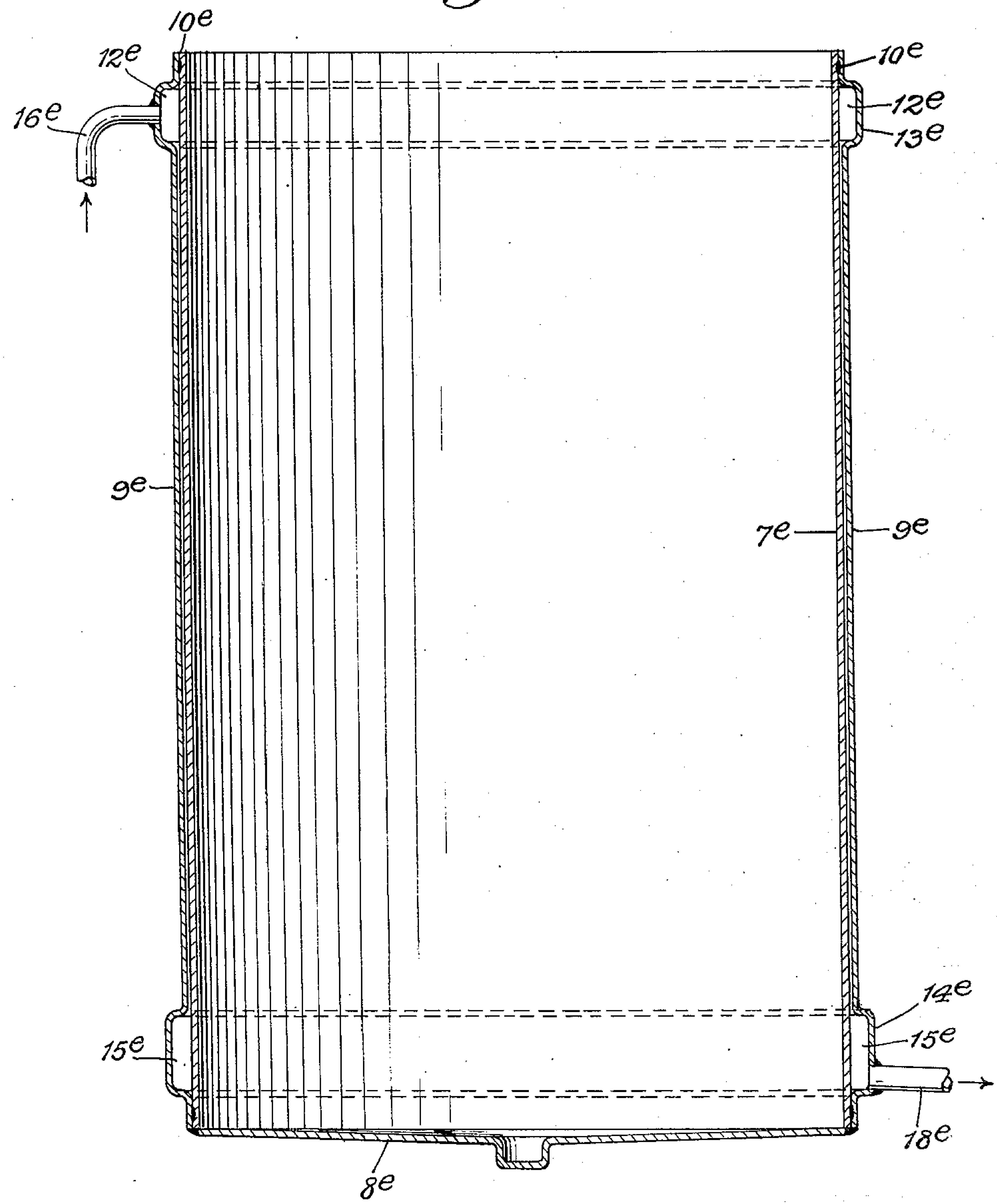
Fig. 20.



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UNITED STATES PATENT OFFICE

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REFRIGERATOR AND EVAPORATOR THEREFOR

Willard L. Morrison, Lake Forest, Ill.

Application May 26, 1945, Serial No. 596,047

4 Claims. (Cl. 62—126)

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My invention relates to an improvement in refrigerators and has for one purpose to provide an improved evaporator structure.

Another purpose is to provide an improved evaporator structure in which a volatile refrigerant flows downwardly or uni-directionally through the evaporator.

Another purpose is to provide an evaporator and refrigerator system in which the refrigerant, during its evaporation, flows downwardly through the evaporator, the evaporated refrigerant flowing downwardly from the evaporator to the compressor.

Another purpose is to provide an improved refrigerator system in which lubricant oil loss or trapping is reduced to a minimum.

Another purpose is to provide a refrigerating system in which the lubricant is carried downwardly through the evaporator with the evaporating refrigerant and is returned, in a downward path, from the evaporator to the compressor, with the evaporated refrigerant.

Another purpose is to provide a refrigerating system in which the entire inner surface of the evaporator, or the entire surface of the evaporator which is exposed to the space to be cooled, constitutes primary refrigerating surface.

Another purpose is to provide improved means for distributing the refrigerant throughout the effective cooling area of the evaporator during its evaporation.

Another purpose is to provide means for assuring complete evaporation of the refrigerant in an evaporator in which the refrigerant flows downwardly or uni-directionally through the evaporator without flooding the evaporator.

Another purpose is to provide an improved evaporator and refrigerant system in which a minimum of liquid refrigerant is returned to the compressor.

Other purposes will appear from time to time in the course of the specification and claims.

I illustrate the invention more or less diagrammatically in the accompanying drawings wherein:

Figure 1 is a vertical axial section illustrating a refrigerant system with parts in elevation;

Figure 2 is a vertical axial section, on an enlarged scale, through a particular form of evaporator;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is an axial section through a variant form of evaporator;

Figure 5 is a section on the line 5—5 of Figure 4;

Figure 6 is a side elevation, with parts broken away, illustrating a variant form of evaporator;

Figure 7 is a section on the line 7—7 of Figure 6;

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Figure 8 is a section, on an enlarged scale, on the line 8—8 of Figure 7;

Figure 9 is a section, on an enlarged scale, illustrating the outlet from the evaporator shown in Figure 6;

Figure 10 is a vertical section, on an enlarged scale, illustrating a variant form of inlet;

Figure 11 is a side elevation with parts broken away, of a variant form of evaporator;

Figure 12 is a section, on an enlarged scale, on the line 12—12 of Figure 11;

Figure 13 is a vertical axial section through a variant form of evaporator and refrigerating circuit therefor, with parts in elevation;

Figure 14 is a side elevation view of an inner part;

Figure 15 is a section, on an enlarged scale, on the line 15—15 of Figure 13;

Figure 16 is a side elevation illustrating a variant form of evaporator;

Figure 17 is a section on the line 17—17 of Figure 16;

Figure 18 is a side elevation partly in section illustrating a variant evaporator;

Figure 19 is a plan view of the evaporator shown in Figure 18, with parts broken away; and

Figure 20 is a view similar to Figure 2 showing a modification.

Like parts are indicated by like symbols throughout the specification and drawings.

Referring first to the form of Figure 1, 1 generally indicates any suitable base, which may be of insulating material. 2 indicates any suitable compressor on said base, which may be driven by any suitable motor 3, through a belt 4. 5 is any suitable condenser the details of which do not form part of the present invention. 6 is any suitable receiver. The evaporator employed, which is illustrated in an enlarged scale in Figure 2, includes an inner cylinder 7 having a closed bottom 8, and an outer cylinder 9 sealed to the inner cylinder at top and bottom as at 10, 11. The outer cylinder is shown as having formed therein a top plenum chamber 12 extending circumferentially about the evaporator. In Figure 2 the plenum chamber is shown as formed by an outward distortion or offsetting 13 of the outer cylinder 9. A similar distortion 14 at the lower end of the cylinder forms or encloses a bottom plenum chamber 15. 16 indicates a high pressure duct extending from the receiver 6 through any suitable pressure reducing means 17 to the upper plenum chamber 12. 18 is a low pressure return duct extending from the lower plenum chamber 15 "downhill" to the compressor 2. 19 indicates an outer housing or sleeve for the evaporator, the evaporator is shown as seated upon an insulating disc 20, which may center the sleeve 19. Any suitable insulation 21 may be packed in between the outer face of the evaporator and the inner face of the wall 19. Part of the ducts 16 and 18 may be enclosed within the housing 19 and may be surrounded by the insulation. 22 is any suitable top seal of non-conducting material which closes the top of the previously mentioned loose insulation 21. 23 is an inner ring of insulating material. 24 is a top closure which may be metal or plastic and which is shown as resting upon the heat insulating ring 23, so that there is no heat transmitting connection between the outside and the inside of the structure. However, it may be advantageous to employ heat insulating material, a plastic or the like, for the ring 24. 25 is any suitable top closure preferably of insulating material, having a handle 26, for access to the storage space surrounded by the evaporator.

With reference to the interior structure of the evaporator, a cylinder of mesh or netting 27, of any suitable metal, is shown as positioned in the space between the cylinders 7 and 9. It constitutes a distributing and delaying element for the refrigerant as the evaporating refrigerant flows downwardly through the evaporator between the opposed faces of the cylinders 7 and 9. The layer 27 of mesh may be compressed between outer and inner cylinders and may constitute spacing means for establishing the radial separation between the cylinders 7 and 9. Or any suitable spacing means may be employed.

In the form of Figures 4 and 5, I illustrate a similar structure used as an open ended refrigerating or cooling element, which may be used for room cooling, air cooling or the like. The inner cylinder *7a* is therein shown as open ended. The outer cylinder *9a* surrounds it and is sealed to it at the end as at *10a* and *11a*. The mesh *27a* is compressed between the inner cylinder *7a* and the outer cylinder *9a*. The evaporator is preferably but not necessarily generally upright. In any event, a volatile liquid refrigerant is delivered at low pressure, to the interior of the plenum chamber *12a* through the duct *16a*. The vaporized refrigerant flows from the opposite plenum chamber *15a* along the discharge duct or suction line *18a*.

With reference to the form of Figures 6 to 9 the structure is the same as shown in Figures 1 and 2 except for the below described top distributor, and, except for said distributor, the same indicating numerals are applied to the parts of the evaporator. However, the outer cylinder 9 is outwardly distorted at its upper end as at 30 to surround a tubular distributor 31, shown as abutting against the upper portion of the inner cylinder 7 at a point above the upper edge of the mesh 27. The distributor 31 is provided with a plurality of discharge ducts 32. Liquid refrigerant under reduced pressure is received in the ring 31 from the duct 33. The ring 31 constitutes a circumferential distributor which insures that the liquid refrigerant flows downwardly toward the upper edge of the mesh 27 at a substantially uniform concentration throughout the circumference of the evaporator. The outlet passages 32 may be so proportioned to the rate of liquid refrigerant delivery as to obtain this result. In this form, as in the preceding forms, the refrigerant flows continuously through and about the evaporator.

In Figure 10 the distributor ring *31a* serves as the top closure for the space between the cylinders 7 and 9. In that form the outer cylinder 9 has an outward offset portion or flange *9c* upon which the distributor ring *31a* rests. The ring is welded or otherwise suitably secured in sealing relationship, to the flange *9c* and to the upper edge of the inner cylinder 7.

Figure 11 may be taken as a distortion or unfolding of a cylindrical evaporator, but indicates primarily a relatively flat evaporator or cold plate formed by opposite sheets of metal 40 and 41, having the mesh or netting *27b* positioned between them. A top plenum chamber 42 and a bottom plenum chamber 43 may be formed between the two plates. In Figure 12 the plenum chambers are both formed as distortions from the plate 41. It may be understood, however, that they may be formed in either plate or by an aligned distortion of both plates. The plates 40 and 41 may be sealed at all edges as at *41a*.

The refrigerant may flow through the inlet 44 and the evaporated refrigerant returns to the compressor through the return duct or suction line 45 which will be understood to extend "downhill' to the compressor, it beng thought unnecessary to illustrate the compressor again, since the relationship of the passages between the evaporator and compressor is intended to be the same as that shown in Figure 1. Since flat plates are involved, which are not self-sustaining by their cylindrical form, I employ any suitable spacing and connecting means. I illustrate for example spot welded connections 46, the two plates 40 and 41 being welded together through the mesh *27b*. I may also employ a spacer or spacers 47 to which the plates 40 and 41 may be riveted or otherwise secured. I thus obtain the double result of maintaining a proper spacing between the plates 40 and 41 and of holding them against internal pressure. It will be understood that a spacing and securing means shown in Figures 11 and 12 may, if desired, be employed in such evaporators as shown in Figure 2. However, under most circumstances this is not necessary.

In Figure 13, I illustrate a modified structure in which on the base 50 I position any suitable compressor 51 driven by a motor 52. The evaporator, generally indicated as 53, rests upon the insulating disc 54 and is surrounded by an outer housing 55 between which and the evaportor any suitable insulation 56 is employed. The evaporator includes an outer cylinder *53a* and an inner cylinder *53b*, the cylinders being secured in sealing relationship at top and bottom as at *53c* and *53d*.

The compressed refrigerant flows through any suitable condenser 57 and may flow directly from the condenser, without any intermediate receiver, along the high pressure liquid delivery duct 58, through any suitable pressure reducing means 59 to the top inlet assembly 60 through which the refrigerant is delivered, at reduced pressure, to the space between *53a* and *53b*. As delaying and distributing means I employ, in the forms of Figures 13 and 14, a spiral strip 62 of sheet metal or the like which starts at the top of the inner cavity of the evaporator, defined between the walls *53a* and *53b* and terminates at the bottom. It defines a spiral passage through which the refrigerant flows downwardly as it evaporates. An outlet duct 63 delivers the evaporated refrigerant to a small horizontal accumulator 64 in which any unevaporated refrigerant may be evaporated, so that substantially no liquid refrigerant is returned to the compressor. The evaporated refrigerant returns to the compressor "downhill" along the suction line 65. 66 is any suitable insulating means or layer whereby the accumulator 64 is somewhat insulated from the evaporator. In the form of Figures 13 and 14 it will be understood that the strip 62 defines a wide but radially very shallow passage through which the refrigerant flows during evaporation and by which it is constrained to an elongated path passing a number of times about the evaporator. However, the strip 62 is not welded or permanently secured, except so far as it may be necessary to spot weld it at a few points for positoning. The clearance is such that the refrigerant can escape across bends of the strip 62, to the end that the inner cylinder 53b constitutes through its entire surface a direct refrigeratng member, with the evaporating refrigerant passing across its entire outer area, the space to be cooled being surrounded by its entire inner area. In this form I do not employ plenum chambers at all and find that the spiral passage system, or the spiral member 62 maintains an adequate distribution of the refrigerant throughout the area of the evaporator, and holds back the refrigerant from an unduly or direct passage downwardly through the evaporator.

In the form of Figures 16 and 17 I substitute for the separate spiral members 62 a spiral passage formation obtained by distorting one of the cylinders toward the other. In this form I illustrate an inner cylinder 70 and an outer cylinder 71, the two cylinders being sealed together at top and bottom as at 72 and 73. One of the cylinders may be distorted toward the other to form a spiral passage by the spirally distorted portion 74. Whereas I illustrate the outer cylinder as somewhat distorted, it will be understood that the inner cylinder may be distorted or the passage may be formed by an opposed and aligned distortion of both cylinders. Where the evaporator is used as a storage container, however, it may be advantageous to have a smooth inner face defining the storage space, as shown in Figures 16 and 17.

In the form of Figures 18 and 19, I illustrate a generally flat evaportor lying in a substantially horizontal plane. It may be formed by an upper plate 100 and a lower plate 101 sealed together about the edges as at 102. Liquid refrigerant is delivered at reduced pressure through the inlet duct 103. The evaporated refrigerant is withdrawn from the opposite end of the evaporator by the suction line 104, which flows "downhill" to the compressor 105, thence through condenser 106, and pressure reducing means 107 to the inlet duct 103, in the manner explained in the system shown in Figure 13. Any suitable spacing means may be employed for spacing the opposite walls of the evaporator apart, such as the netting 108.

The form of Figure 18 has in common with the systems of the other drawings that a liquid refrigerant is delivered to the evaporator having a substantially restricted internal space. The refrigerant is entirely or substantially entirely evaporated in the evaporator, without flooding the system. The evaporated refrigerant is withdrawn by the suction line and is returned "downhill" to the compressor.

Wherever I use the term "downhill," I will be understood to intend that the relation between the inlet and the outlet is such that any liquid which travels with the evaporated refrigerant will be carried through, without gathering in any pocket or being trapped by gravity in any part of the system.

Figure 20 illustrates a form of structure substantially the same as that of Figure 2 except for the elimination of the mesh 27. I therefore identify the corresponding parts with the same numerals as are employed in Figure 2, with the addition of the letter *e*. Referring to Figure 20 it will be noted that the cylindrical portions 7*e* and 9*e* are spaced so closely that the smaller clearance is itself sufficient to hold back or delay the downward passage of the refrigerant, giving it time to evaporate fully before it escapes through the suction return line 18*e*.

It will be realized that, whereas, I have described and illustrated a practical and operative device, nevertheless many changes may be made in the size, shape, number and disposition of parts without departing from the spirit of my invention. I therefore wish my description and drawings to be taken as in a broad sense illustrative or diagrammatic, rather than as limiting me to my precise showing.

I claim:

1. In an evaporator for refrigerators and the like, an inner cylinder and an outer cylinder, said cylinders being sealed together to define therebetween a space for the evaporation of a volatile refrigerant, the axis of said evaporator being generally upright, a refrigerant supply duct extending to the upper end of said space, a refrigerant return duct extending from the bottom of said space, means for circulating a refrigerant through said ducts and space, and means for distributing the refrigerant substantially uniformly throughout said space while maintaining a generally downward movement of the refrigerant throughout said space, whereby substantially all of the outer face of the inner cylinder is subjected to the evaporating refrigerant, said inner cylinder constituting, substantially throughout its entire area, a primary refrigerating surface.

2. In a refrigerating system, an evaporator including an inner cylinder and an outer cylinder, said cylinders being sealed together to define therebetween a space for the circulation and evaporation of a volatile refrigerant, the axis of said evaporator being generally upright, a compressor and means for actuating it, a condenser, a high pressure duct extending from said compressor to said condenser, a high pressure duct extending from said condenser to the top of the space between said cylinders, pressure reduction means between said duct and said evaporator, a return passage extending from the bottom of said space to said compressor, said return passage being adapted to conduct the refrigerant downhill to said compressor, whereby the refrigerant travels continuously downwardly from top to bottom of the evaporator and downwardly from the bottom of the evaporator to the compressor, and means for maintaining a substantially uniform distribution of the refrigerant about the circumference of the evaporator during the downward movement of the refrigerant through the evaporator.

3. In an evaporator for refrigerators and the like, an inner cylinder and an outer cylinder, said cylinders being sealed together at the top and bottom to define therebetween a space for the evaporation of a volatile refrigerant, a refrigerant supply duct extending to the upper end of said space, a refrigerant return duct extending from the bottom of said space, means for circulating a refrigerant through said ducts and evaporator, and means for distributing the refrigerant throughout the space between the two

cylinders, including a thin metal insert positioned between the two cylinders, the radial clearance between the two cylinders being substantially uniform from top to bottom of said space.

4. An evaporator for refrigerators and the like including an inner and an outer cylinder sealed together to define between them a space of substantially uniform radial width from top to bottom of the evaporator for the evaporation of a volatile refrigerant, the axis of the evaporator being generally vertical, a refrigerant supply duct extending to the upper end of said space and a refrigerant return duct leading from the bottom thereof, means for circulating a refrigerant through said ducts and said space and means for distributing the refrigerant substantially uniformly throughout said space, including the opposed walls of said cylinders and associated

means for forming a spiral passage extending from the supply duct to the return duct while permitting leakage across the outer face of substantially the entire surface of the inner cylinder to permit subjection of substantially all the outer face to the evaporating refrigerant.

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