Jan. 6, 1953 E. A. ROSE 2,624,552

HEAT EXCHANGER

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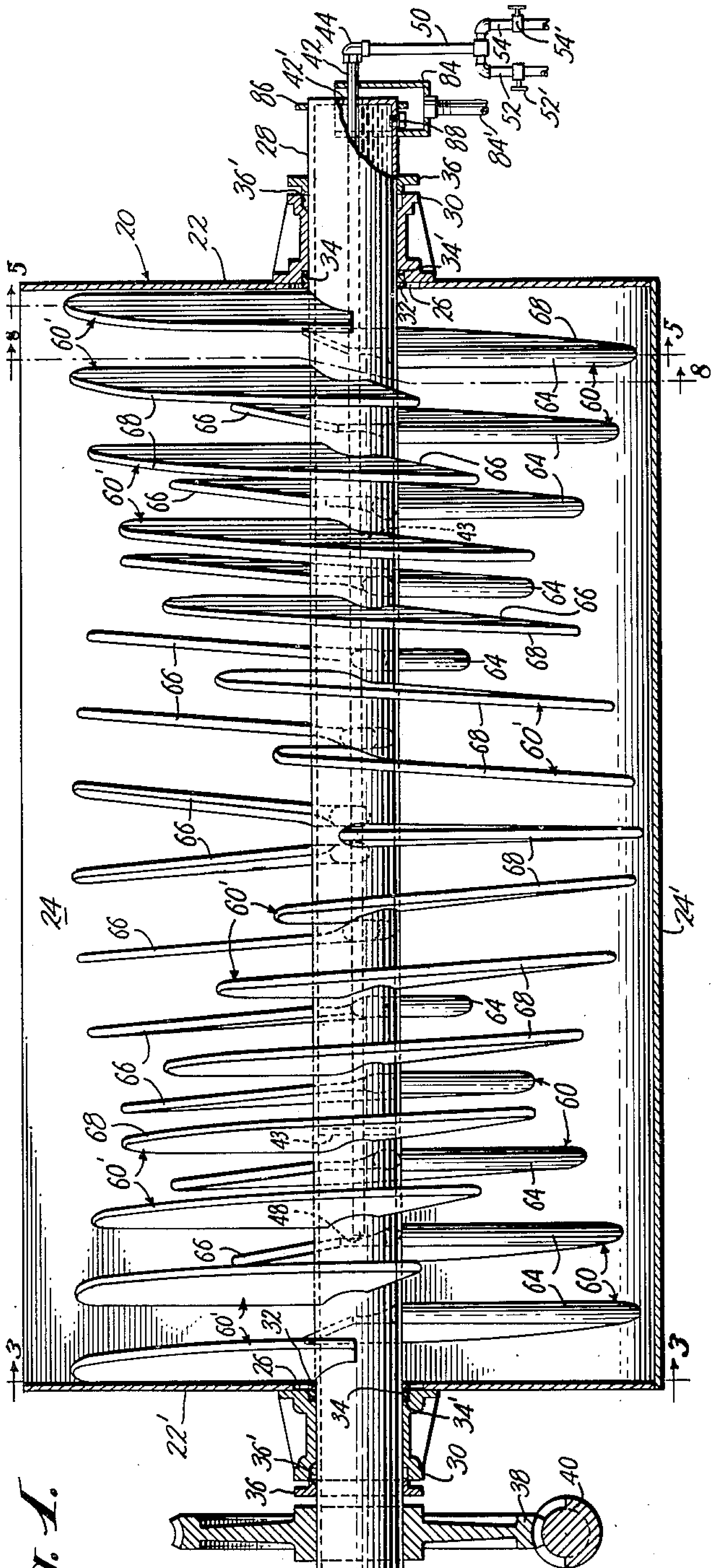

Fig. 1.

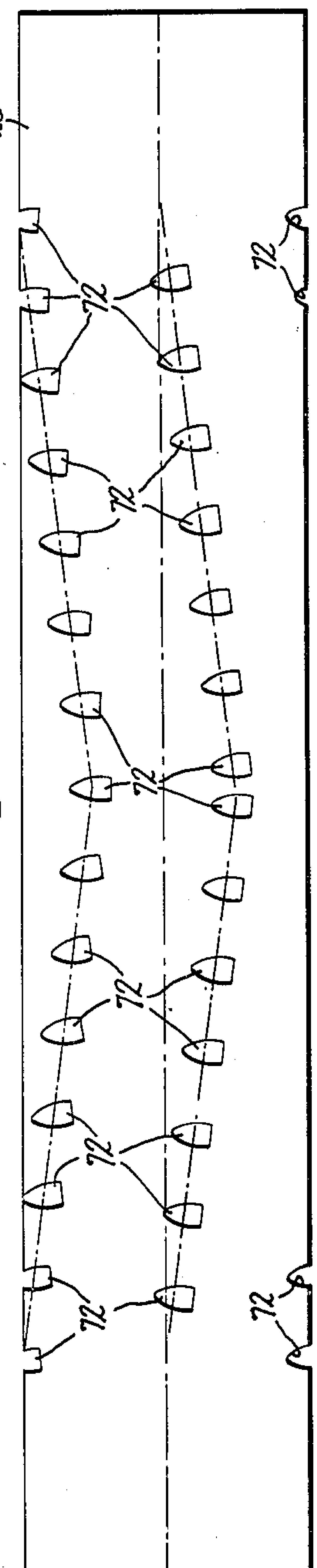

Fig. 2.

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Fig. 3.

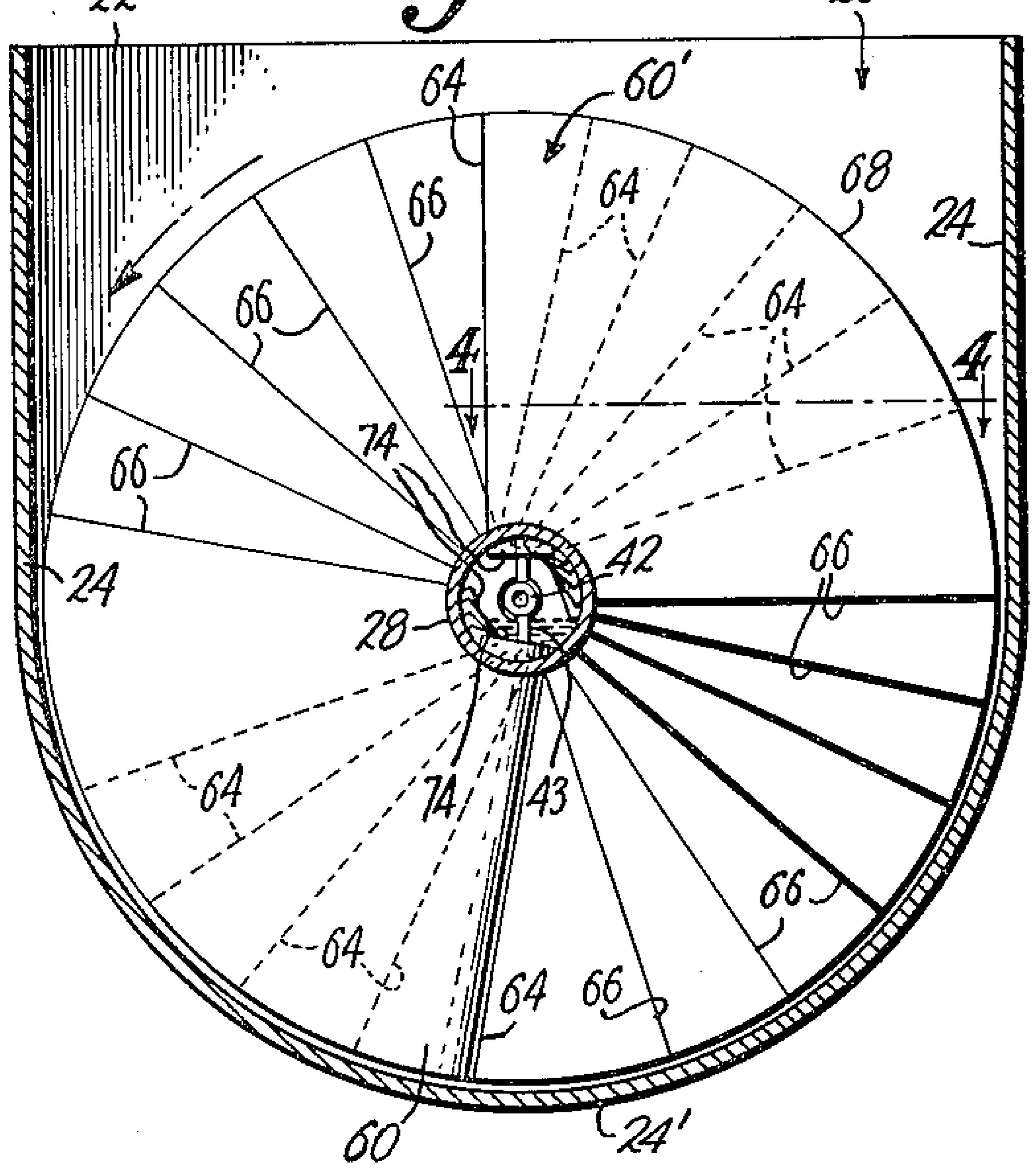

Fig. 5.

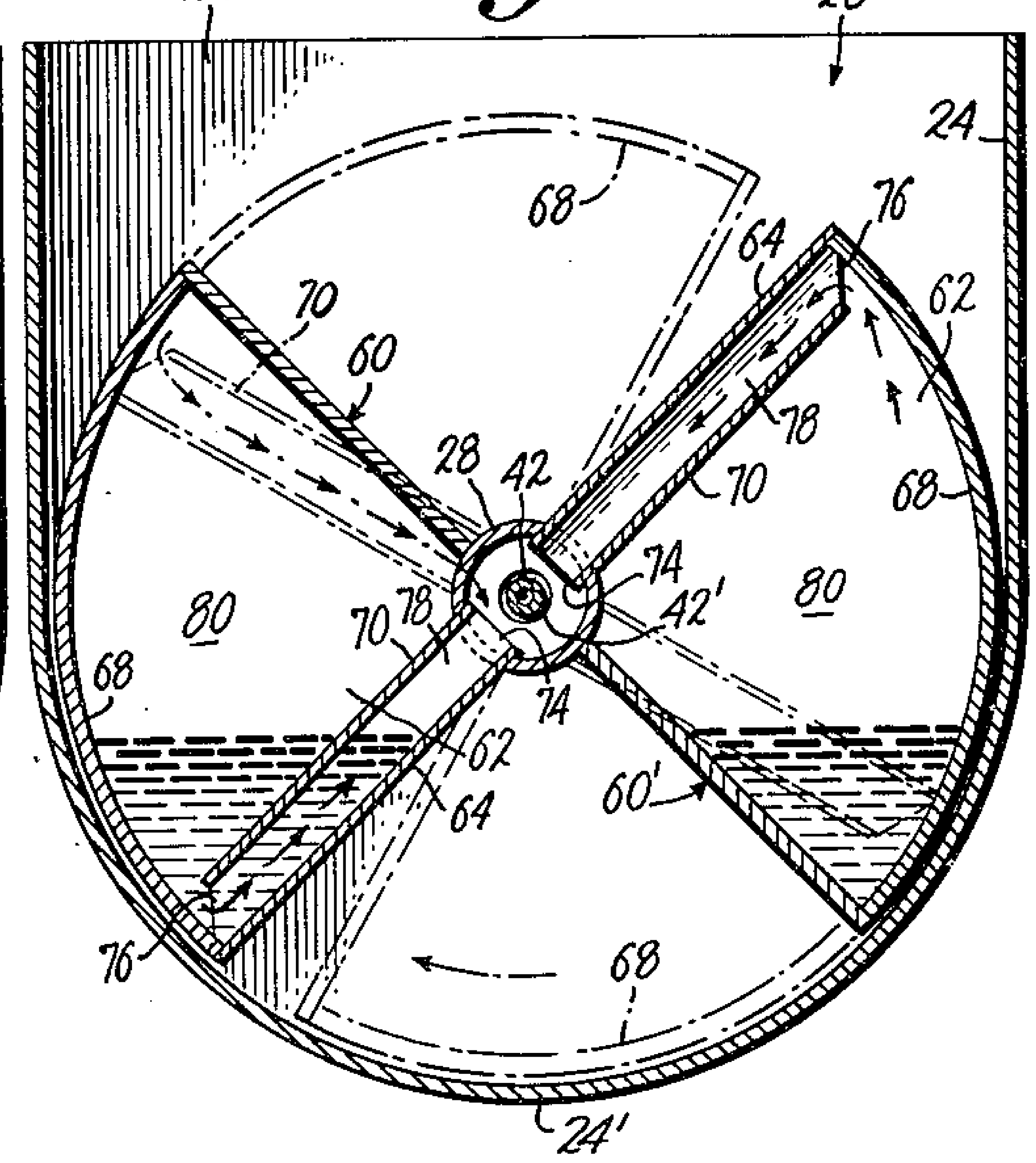

Fig. 4.

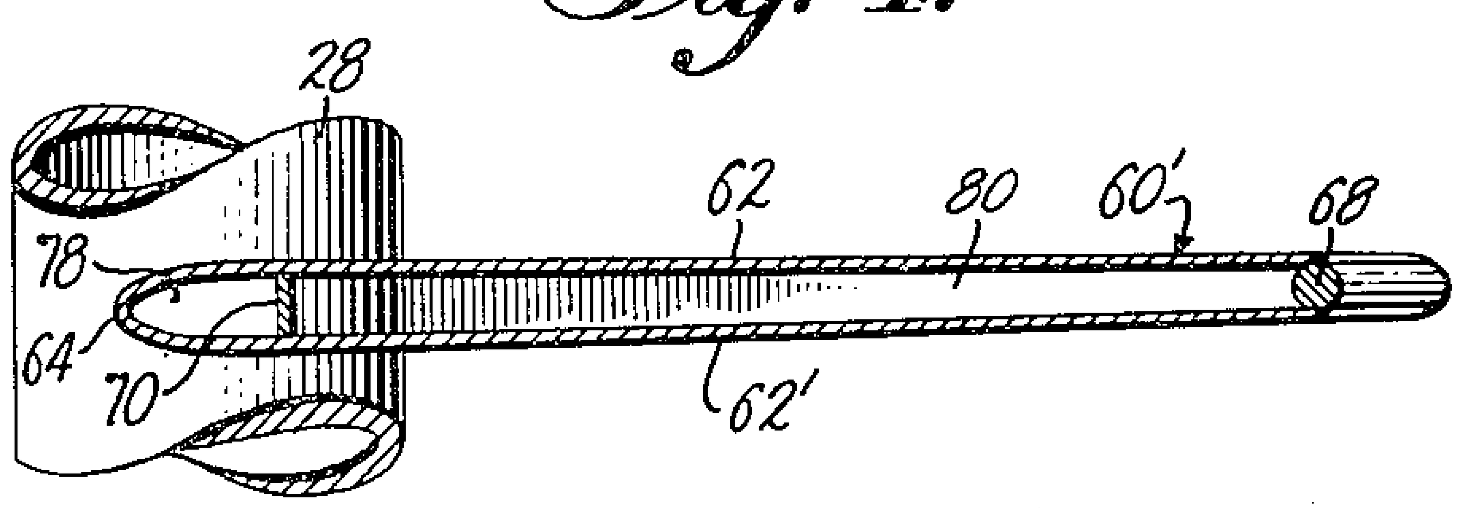

Fig. 6.

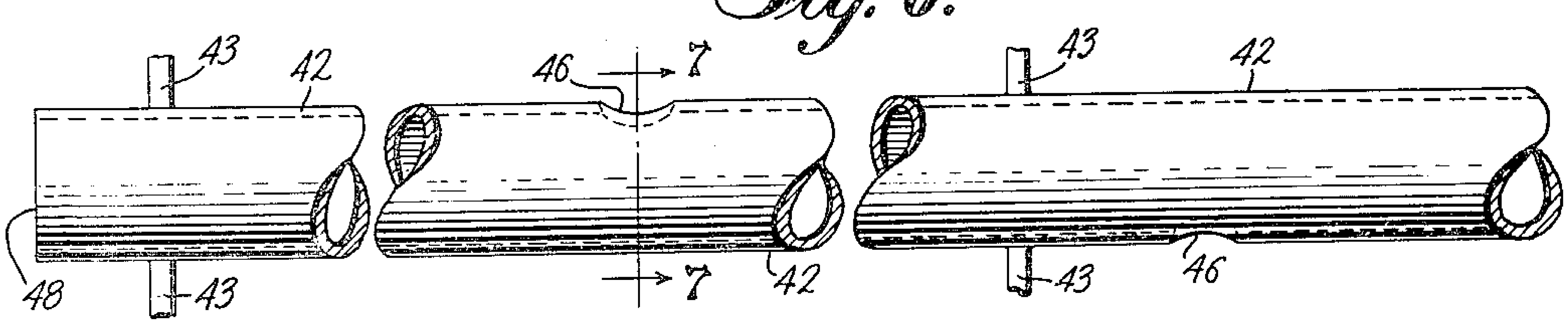

Fig. 7.

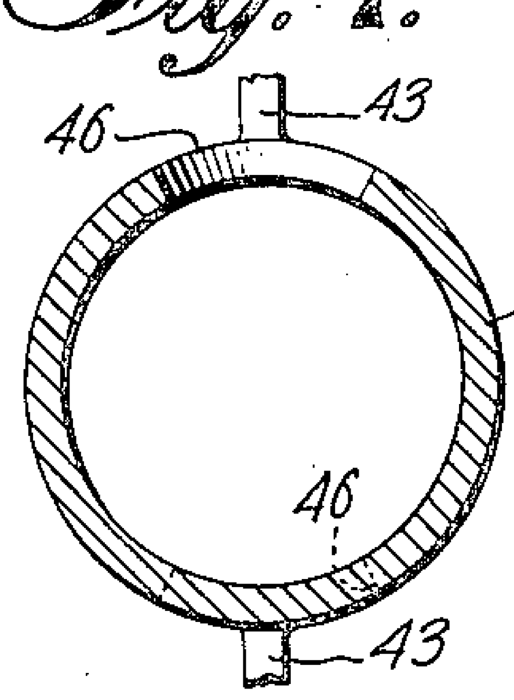

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Fig. 10.

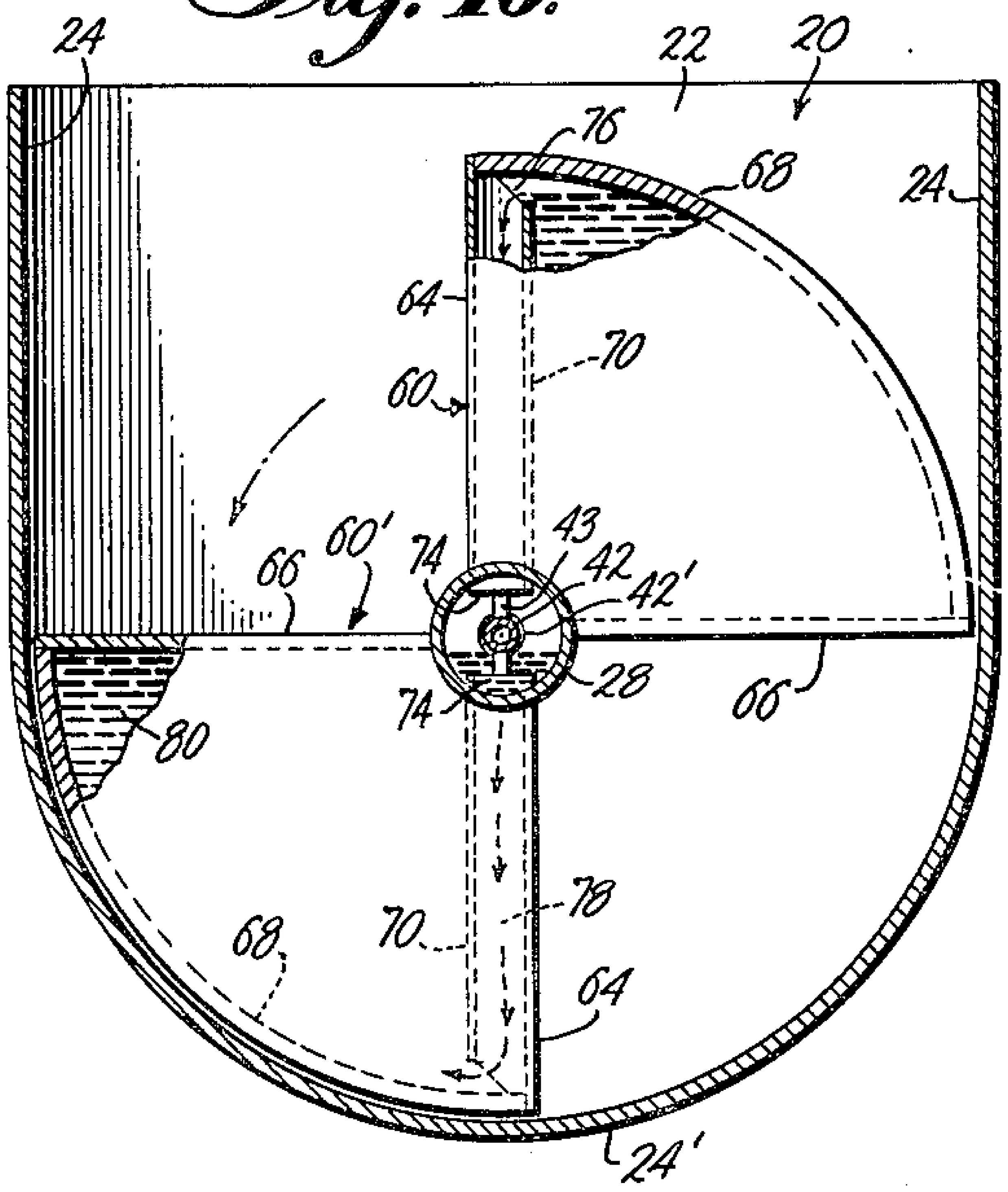


Fig. 8.

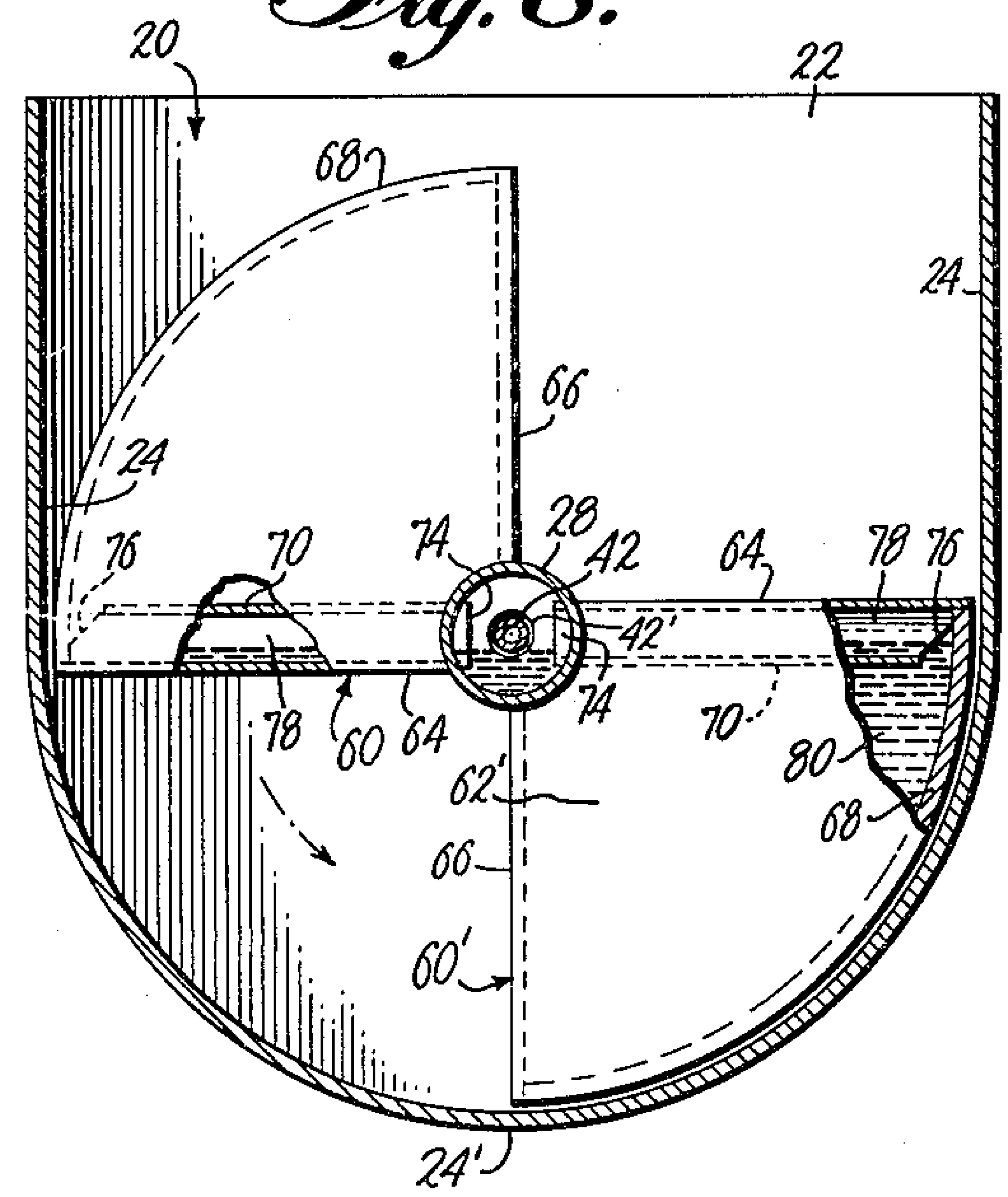


Fig. 11.

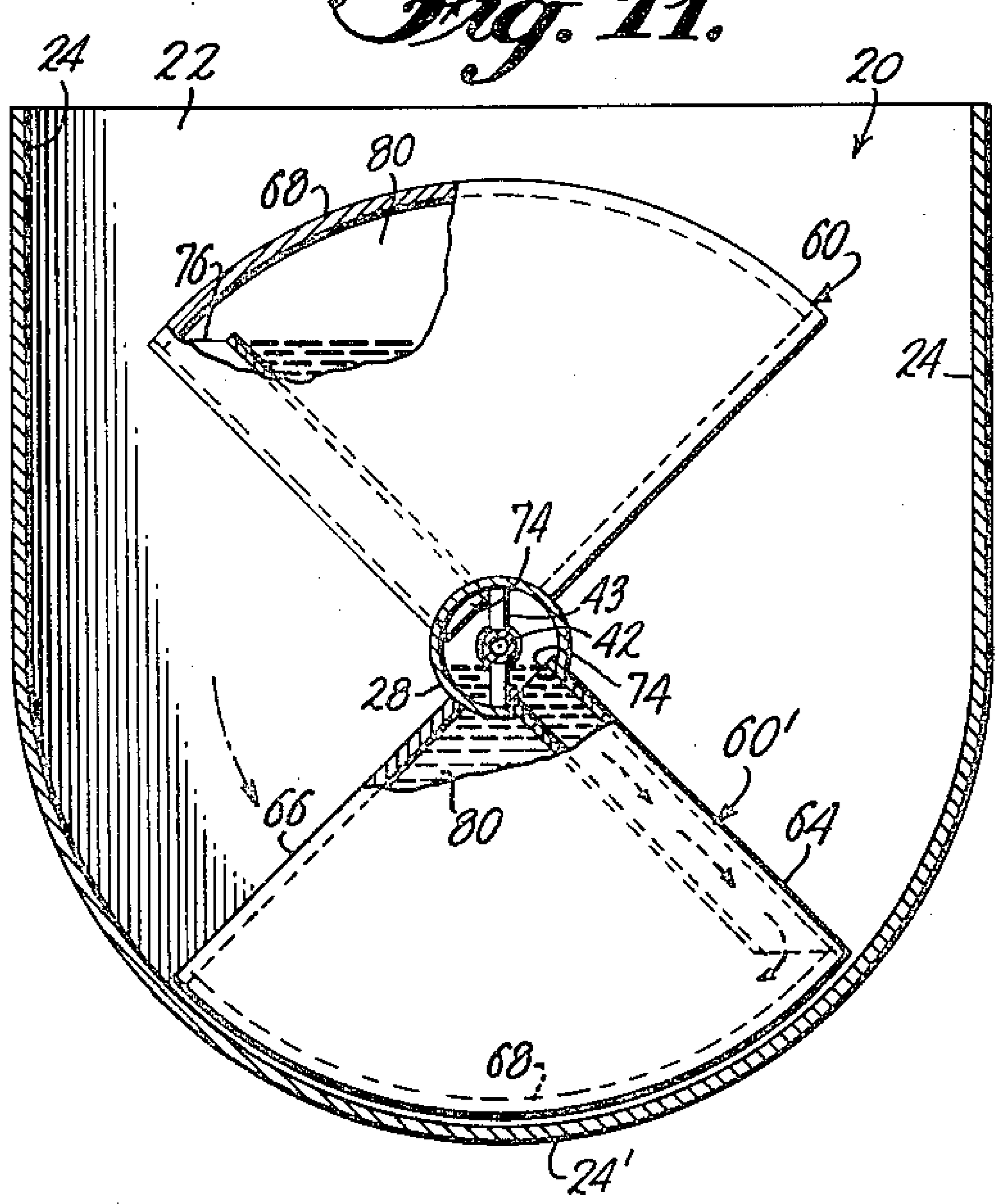
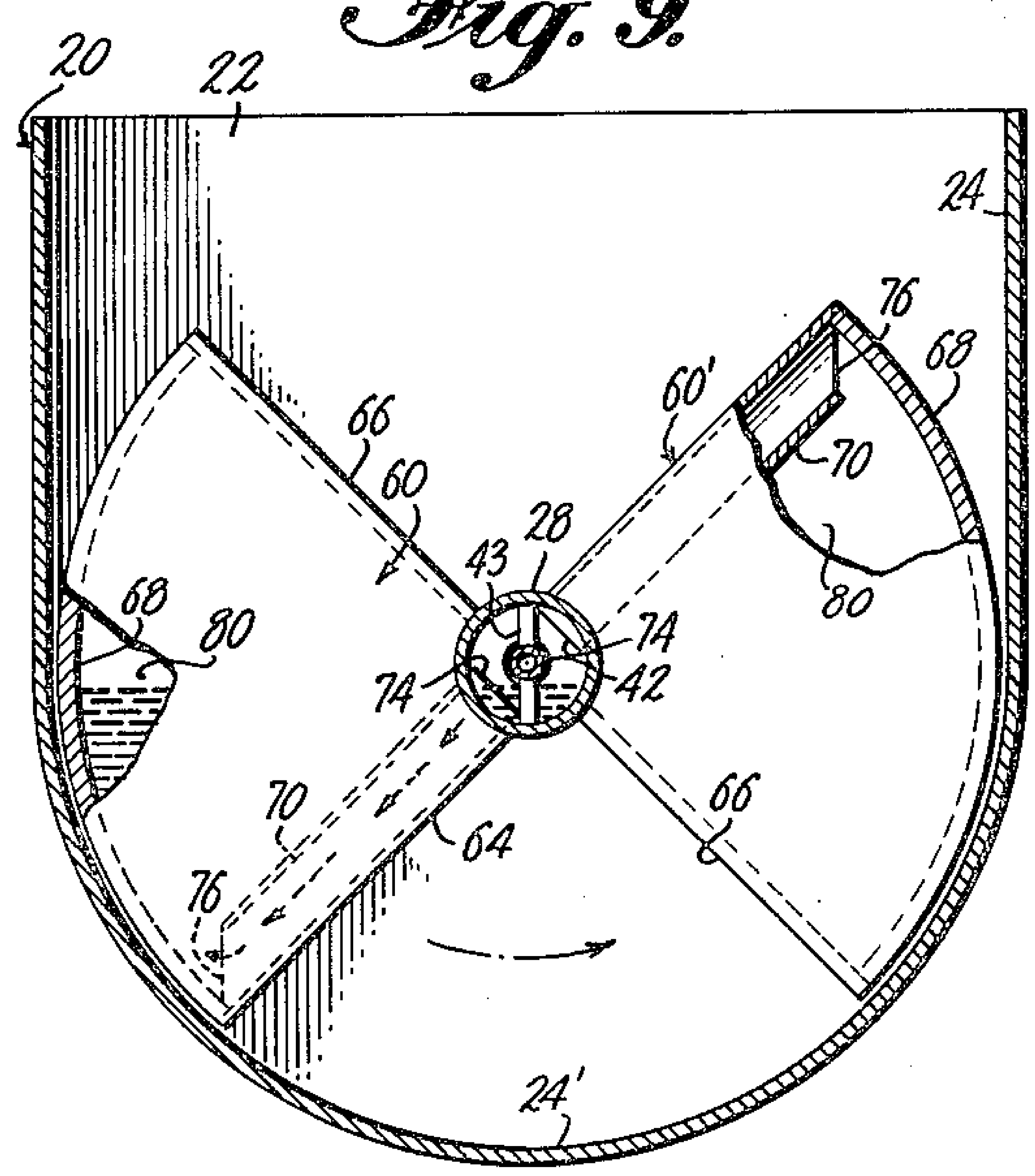


Fig. 9.



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

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Application April 27, 1950, Serial No. 158,484

9 Claims. (Cl. 257—80)

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The present invention relates in general to heat exchange apparatus, and more particularly to rapid heat transfer sugar crystallizers of the type employed in the manufacture of sugar and like materials.

Many varieties of apparatus have been devised to promote crystallization in massecuite and similar sugar crystallization solutions. In general, apparatus of this type depends upon rotary movement of heat conductive bodies or radial conduits through a mass of solution under treatment with the exchange medium, usually a suitable fluid circulated through the conductive bodies or radial circuits, to simultaneously effect slight agitation and cooling of the solution to promote crystallization. In many instances, prior art machines have been subject to objection in that they employ a relatively large surface area for the heat conductive bodies in comparison to the total space in which the treatment is performed, which tends to precipitate rotation of the mass of solution under treatment. This is objectionable, as anything other than a very gentle agitation will have the effect of either breaking up or grinding crystals already formed by gradual reduction of the temperature of the solution. It should be remembered that the optimum goal to be achieved in sugar crystallizers is the rapid production of large crystals from the massecuite or mother liquor. Realization of this condition requires some means of insuring that crystals are produced by gradual growth rather than abrupt formation of batches of minute crystals. The larger the crystals which are obtained, the easier and more efficient is the subsequent separation and consequently the better yield of sugar.

Attempts have been made to overcome the defects incident to large-surface-area heat conductive conduits, arising from the high degree of agitation occurring on rotation of the conduits, by providing a series of spaced, relatively small cooling fluid conduits projecting from a central driven shaft, through which the cooling fluid is circulated on rotation of the conduits to effect the desired heat exchange action. These, however, have been found objectionable, as the immersion of these small conduits, with comparatively limited surface area, effects localized sudden chilling in the mother liquor or massecuite and promotes rapid formation of minute new crystals rather than gradual growth of larger crystals from crystal nuclei. Continuous forced-circulation heat exchangers have likewise been employed as rapid sugar crystallizers, but the multitude of small diameter conduits and orifices and the network of valves required in such continuous forced-circulation systems, are in many instances conducive to becoming obstructed or otherwise inoperative, rendering parts of the heat exchanger inoperative, and destroying uniformity

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of the heat exchange action throughout the solution.

An object of the present invention, therefore, is the provision of a novel heat exchanger of simple design and durable construction, which is free of the above enumerated objections.

Another object of the present invention is the provision of a novel heat exchange apparatus in which a mass to be treated may be cooled or heated in a uniform manner throughout the mass.

Another object of the present invention is the provision of a novel heat exchange apparatus of the rapid sugar crystallizer type, in which a mass is brought into heat exchange relation with a cooling or heating fluid uniformly throughout the bulk of the mass.

Another object of the present invention is the provision of a novel heat exchange apparatus for circulating a fluid in heat exchange relation with a solution, wherein both the heat exchange fluid and the solution are gently agitated.

Another object of the present invention is the provision of a novel heat exchange apparatus for circulating treating fluid in heat exchange relation with a solution, wherein circulation of the treating fluid is effected by gravitational forces.

Another object of the present invention is the provision of a novel heat exchange apparatus for circulating a treating fluid in heat exchange relation with a mass through fluid conducting elements, wherein a complete change of the treating fluid in the fluid conducting elements is effected for each cycle of operation.

Another object of the present invention is the provision of a novel heat exchange apparatus for circulating a treating fluid in heat exchange relation with a solution, which is readily and conveniently adapted for complete exhaustion of fluid from the apparatus for cleaning the same.

Other objects, advantages and capabilities of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein only a preferred embodiment is shown.

In the drawings:

Figure 1 is a vertical longitudinal section view of a rapid sugar crystallizer embodying the present invention, showing the agitator vanes in elevation:

Figure 2 is an orthagonal development of the central rotary fluid drum illustrating the relative disposition of the heat exchange fluid openings in the periphery thereof:

Figure 3 is a vertical transverse sectional view of the instant sugar crystallizer, taken along the lines 3—3 of Figure 1;

Figure 4 is a horizontal, longitudinal section of one of the agitating vanes, taken along the lines 4—4 of Figure 3;

Figure 5 is a vertical transverse section view of one pair of agitating vanes, illustrating the heat exchange fluid flow paths therein, taken along the lines 5—5 of Figure 1;

Figure 6 is an elevational view of the fluid supply distributing pipe disposed coaxially within the central drum in the instant crystallizer;

Figure 7 is a vertical transverse elevation of the fluid distributing pipe, taken along the lines 7—7 of Figure 6; and

Figures 8 to 11 inclusive, are side elevational views of one pair of agitating vanes with parts of the side walls of the vanes broken away, illustrating the fluid content and fluid flow paths through the vanes at various positions of rotation, taken, for example, along the lines 8—8 of Figure 1.

Referring to the drawings, wherein like reference characters designate corresponding parts throughout the several figures, the instant sugar crystallizer comprises an upwardly opening tank or receptacle **20** having opposed end walls **22**, **22′** and a side wall **24**. The lower half of the tank **20** is preferably formed to define a half cylindrical surface similating a half drum, indicated at **24′**, while the upper portions of the side wall preferably extend substantially vertically. Suitable openings, generally indicated at **26**, are disposed centrally in the end walls **22**, **22′**, through which a hollow cylindrical drum **28** is extended. The drum **28** is intercoupled with the side walls **22**, **22′** of the tank **20** for rotation by means of a bearing or journal bracket **30** fixed to the end walls **22**, **22′** of the tank and snugly fitting the surface of the drum **28**. To prevent axial movement of the rotatably journalled drum **28**, thrust collars **32** are keyed or otherwise fixed to the drum **28** immediately inwardly of the inner end of the bearing bracket **30**, and suitable thrust washers **34** are disposed between the thrust collars **32** and walls of complementary recesses **34′** in the bearing brackets **30** at each end of the drum **28**. Suitable packing glands **36** are likewise provided surrounding the drum **28** and positioned adjacent the outwardly disposed end of each bearing bracket **30** to provide a closure for packing recesses **36′** formed in the outer surface of each bearing bracket **30**.

External drive means are provided for the drum **28**, comprising a worm wheel or gear **38** keyed or otherwise secured to one end of the drum **28** outwardly of the tank **20**, intercoupled in driving engagement with a worm **40** driven from a suitable motor or other convenient prime mover (not shown).

Means are provided to supply water or other heat exchange fluid substantially uniformly throughout the elongated portion of the drum **28**, comprising a centrally disposed, elongated fluid supply pipe **42** positioned concentric with the axis of the drum **28** for a substantial portion of the length thereof, and extending through a circular opening **42′** of slightly greater diameter than the diameter of the pipe **42** in one end of the drum **28**. The fluid supply pipe **42** terminates at one end in a flexible coupling **44** for rotation with the central drum **28**, and is rigidly intercoupled with and positioned by flat spacer bars or rods **43** extending to the inner surface of the drum **28**. The pipe **42** is provided with spaced fluid discharge outlets **46**, and an open inner end **48**, as illustrated in Figures 6 and 7, for supplying the heat exchange fluid to the interior of the central drum **28** substantially uniformly along the entire length thereof. The main fluid supply line **50** is intercoupled between flexible coupling **44** and hot and cold water branch supply conduits **52** and **54** controlled by suitable valves to stop cocks **52′**, **54′**, respectively, disposed in the branch conduits, to permit manual control of the heat exchange fluid supply to the drum **28**.

The fluid is brought into heat exchange relationship with a solution such as massecuite in the tank **20** by means of a series of agitating vanes, indicated at **60**, formed of one quadrant hollow sectors disposed in diametrically opposed pairs in relatively offset relation along helical paths on the drum **28**. These agitating vanes, more clearly illustrated in Figures 3 to 5 and 8 to 11, comprise a one quadrant hollow sector having spaced sides **62** and **62′** suitably formed of sheet metal or like material cut in the form of one quarter of a circle. The sides **62** and **62′** are secured together along their radial edges forming leading edges **64** and trailing edges **66**, and are secured to an arcuate strip **68** along their outer curved edge, to form a closed liquid receptacle. The inner portion of the sides **62**, **62′** are shaped, near the projected intersection of the radial edges **64** and **66**, to define an arcuate recess adapted to snugly accommodate a portion of the surface of the drum **28** and be rigidly secured thereto.

An intermediate divider partition **70** is provided between the sides **62**, **62′** near and parallel to the leading edge **64** and extends, with the portion of the sides **62** and **62′** lying between the partition **70** and the leading edge **64**, for a short distance through complementary openings **72** formed in the surface of the drum **28**, forming in effect a substantially elliptical section of pipe extending into the interior of the drum **28** for a short distance beyond the inner periphery thereof, as indicated at **74**. The divider partition **70** extends outwardly parallel with the leading edge **64** to a point near the arcuate strip **68** at the curved end of the sector **60**, but spaced therefrom to provide an opening **76**. The partition **70** thereby defines a radial primary channel **78** along the leading edge of the sector **60** and extending into the drum **28**, and a heat exchange fluid reservoir **80** throughout the remaining portion of the sector **60**.

The vanes **60** are disposed in oppositely radiating pairs along the length of the drum **28** lying within the tank **20**, and are arranged on helical paths beginning at the outer portions of the drum **28** adjacent the thrust collars **32** and converging to an apex at the longitudinal center of the drum **28**, as clearly indicated in Figure 2 by the orthogonal development of the surface of the drum **28**, showing the relative disposition of the openings **72** for receiving the inner extensions **74** of the sector members forming the primary channel **78**. This spiral or helical disposition of the vanes along the length of the drum **28** reduces shock and wearing forces exerted on the agitating vanes **60** by their striking the massecuite solution in the tank on rotation of the vanes when the tank is not completely filled. It will be apparent from an inspection of Figures 1 and 2 that the agitating vanes **60** are spaced on the drum **28** in relatively staggered pairs and are inclined slightly relative to the medial longitudinal axis of the drum **28** so that the paths swept out by the vanes overlap and extend substantially continuously over the entire internal volume of the tank **20**.

Means are provided at the end of the drum **28** through which the fluid supply pipe **42** extends, to collect and dispose of fluid overflowing from within the drum **28** through the aperture **42'**. This means comprises a splash box **84** substantially surrounding the end of the drum **28** and provided with a discharge conduit **84'** extending from the lower end thereof to carry off overflow liquid to a sewer, or to a spray pond for recirculation, as desired. To lead the overflow liquid to the splash box **84**, a suitable annular drip ring **86** extends around the surface of the drum **28** adjacent but spaced slightly from the end of the drum **28** to prevent liquid adhering to the undersurface of the drum and passing beyond the edge of splash box **84**. In addition, a drain plug **88** is provided at the lower surface of the drum **28** within the area enclosed by the splash box **84** to effect complete drainage of fluid from the drum, as will be later described.

Operation of the instant rapid crystallizer will be more fully understood by specific reference to Figures 1 and 8 to 11. Water of desired temperature is admitted through the conduit **50** to the discharge pipe **42** by adjusting appropriate valves **52'**, **54'** in the branch conduits **52** and **54**. The water flows through the central supply pipe **42** and spaced discharge outlets **46** substantially uniformly throughout the length of the hollow drum **28**. On continuous admission of water to the drum **28**, the water level rises in the drum until it reaches the lower edge of the opening **42'** through which the pipe **42** extends, after which the liquid level is maintained at this point by overflow of liquid through the opening **42'** into the splash box **84**.

The instant device is operative to effect a complete change of cooling liquid in the agitating vanes **60** for each cycle of rotation of the vanes in the following manner. Beginning the description of the operating cycle of a diametrically opposed pair of vanes **60** and **60'** with the primary channels **78** extending horizontally and to the left and right of drum **28**, as viewed in Figure 8, the leading edge **64** of the vane **60** is, at this point, disposed below the level of the fluid in the hollow core **28** so that fluid flows into the primary channel **78** of the vane **60**. On progressive counterclockwise rotation of the vane **60** from the position illustrated in Figure 8 to a position of rotation with the axis of the primary channel **78** disposed directly downwardly from the drum **28**, increasing quantities of water from the hollow drum **28** are drawn, under influence of gravity, through the primary channel **78**, opening **76**, and into the reservoir **80** in the vane **60**, the fluid capacity of the primary channel **78** and opening **76** being sufficient to maintain the fluid level in the reservoir **80** in the vane **60** commensurate with the fluid level in the drum **28**. Fluid flow in the vane **60** and liquid level therein during this quadrant of rotation of the vane **60** are illustrated in Figure 9 of the accompanying drawings.

During further rotation of the vane **60** from a position with the axis of the primary channel **78** extending vertically downward to a position extending horizontally to the right of drum **28**, as indicated by the vane **60'** in Figure 8, the primary channel **78** and reservoir **80** of the vane **60** are maintained filled with the cool water as both of these chambers are below the liquid level established in the drum **28**.

When the primary channel **78** of the vane **60** passes through the horizontal axis, however, and thus progresses above the liquid level established in the drum **28**, the liquid in the primary channel **78** is progressively discharged under the influence of gravity back into the hollow drum **28**, and as the vane is further rotated through ninety degrees to dispose the axis of the primary channel **78** vertically upward from the drum **28**, all of the liquid in the primary channel **78** of vane **60** is discharged. During this quadrant of rotation, the opposite vane **60'** is rotated from the horizontal to the vertically downward position to fill the primary channel **78** and reservoir **80** of vane **60'** in the same manner as described in connection with the first quadrant movement of vane **60**. It will be noted, however, that substantially no liquid is discharged from the reservoir **80** of the vane **60** during this rotation through the third quadrant of its cycle, as the upper end of the divider partition **70** in the vane **60** is sufficiently near the arcuate strip **68** to prevent more than a very minute amount of liquid from spilling through the opening **76** into the primary channel **78**.

On fourth quadrant rotation of the vane **60** from a position with its primary channel **78** and lead edge **64** disposed vertically to the initial position with the primary channel **78** disposed horizontally extending to the left as viewed in Figure 8, liquid in the reservoir **80**, under the influence of gravity, collects along the divider partition **70** and spills through the opening **76** and primary channel **78** back into the hollow drum **28**. Thus, during the fourth quadrant rotation only is the liquid which has been collected in the reservoir **80** of the vane **60** exhausted from the vane and discharged back into the hollow drum **28**. The opposite vane **60'** follows precisely the same cycles of filling and discharging as the vane **60**, but lags 180° out of phase with the cyclic filling and discharging of the vane **60**.

It will be seen, therefore, that during each cycle of rotating of the hollow drum **28**, the vanes **60** and **60'** are completely filled during one quadrant or 90° of rotation, and continue in rotation for 180° with the reservoir **80** of the vanes filled with the cooling liquid. During the remaining 90° of rotation, the liquid is completely discharged from the vanes **60**, **60'** and the vanes readied for refilling during the next succeeding 90° of rotation.

It will be apparent, therefore, that this arrangement of agitating vanes will effect very gentle agitation of the massecuite solution in the tank **20**, and produce gradual cooling of the solution by bringing a large surface area of cooling fluid in heat exchange relation with the solution throughout a substantial portion of one cycle of operation of any given agitating vane **60**. By distributing the cooling fluid throughout vanes of relatively large surface area, extending along the plane in which the vane rotates, very little agitation is effected in the solution, while the heat transfer to the solution is maintained sufficiently gradual to promote growth of crystals, rather than shocking a large batch of minute crystals into existence. Likewise, the complete charging and discharging of the cooling fluid from each vane in one cycle of operation markedly increases the efficiency and speed of heat transfer in the device, as well as maintaining the heat transfer substantially uniform throughout the length of the tank **20**. Uniformity is likewise improved by discharging the cooling fluid from the supply pipe **42** to the hollow drum **28** through the series of spaced liquid discharge outlets **46** extending along the pipe **42** substantially throughout the length of the hollow drum **28**.

After the desired temperature in the crystallizer has been attained, the mother liquor is still found to be supersaturated with sugar, in the usual case. Useful advantage of this fact can be made by passing steam or hot water from the branch conduit **52** through the hollow tube **28** and vanes **60** and **60'** and thus heating the solution so as to make the separation of the mother liquor from the sugar crystals easier in the centrifugal separators. No sugar is dissolved during this heating as the mother liquor is still supersaturated.

At the end of the grinding season, it is the usual practice to drain all the fluid contained in the crystallizer, particularly if the crystallizer is located in a climate where hard freezes likely to fracture the vanes **60** may be expected. In order to facilitate this complete drainage of the crystallizer, the inner ends of the sector members defining the primary channels **78** are projected through the openings **72** in the hollow drum **28** and for a finite distance into the drum **28** beyond its inner surface, as indicated at **74**. The drain plug **88** is then removed from the hollow drum **28** and the liquid in the drum **28** allowed to drain into the splash box **84**. By rotating the drum **28** and vanes **60** and **60'** in a clockwise direction, as viewed in Figure 5, the liquid still trapped in the reservoirs **80** and primary channels **78** of the vanes is more quickly exhausted from the reservoirs into the primary channels and discharged into the hollow drum **28**. As the inner ends of the primary channels **78** project a finite distance into the core of the hollow drum **28**, only minute quantities of liquid discharged from the primary channels **78** of the upwardly disposed vanes is permitted to run back into the inwardly projecting openings **74** of the primary channels in the downwardly disposed vanes, thus providing for relatively rapid exhaustion of all the liquid in the vanes from the crystallizer.

While but one particular embodiment of the invention has been shown and described, it is distinctly understood that the invention is not limited thereto, but that various modifications may be made in the invention without departing from the spirit and scope thereof, and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and as set forth in the appended claims.

What is claimed is:

1. Heat exchange apparatus comprising, a stationary receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means delivering a heat transfer fluid to the interior of said drum, means maintaining a preselected fluid level in said drum, and a plurality of hollow fluid circulating elements radially disposed on said drum for rotation therewith, said elements having feed duct means opening therein remotely from said drum for progressively admitting fluid thereto from said drum to fill said elements during the descending quarter cycle of rotation below said fluid level, said feed duct means including partition means in said elements retaining the fluid in said elements during the ascending half cycle of rotation of said elements, and said feed duct means discharging the fluid from said element during the descending quarter cycle of rotation of the leading edge thereof into alignment with the fluid level in said drum.

2. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum, means maintaining the fluid level in said drum substantially at its medial axis, means delivering a heat transfer fluid to said conduit means, and a plurality of hollow radial fluid circulating elements having leading and trailing edges mounted on said drum for rotation therewith, said fluid circulating elements having fluid chamber means and feed duct means opening remotely from said drum into said chamber for progressively admitting fluid thereto from said drum to substantially fill each of said elements during the descending quarter cycle of rotation of the leading edge thereof below sad fluid level, said feed duct means including partition means in said elements retaining the fluid in said elements during the ascending half cycle of rotation of the leading edge thereof, said feed duct means discharging the fluid from said elements during the descending quarter cycle of rotation of the leading edge thereof above the fluid level in said drum.

3. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum substantially uniformly along the length thereof, means maintaining the fluid level in said drum substantially at its medial axis, means delivering a heat transfer fluid to said conduit means, and a plurality of hollow radial fluid circulating elements having leading and trailing edges mounted on said drum for rotation therewith and disposed along said drum to sweep out overlapping paths traversing substantially the entire area of said receptacle, said fluid circulating elements having a fluid storage chamber and radial feed duct means intercoupled therewith remote from said drum for progressively admitting fluid thereto from said drum to substantially fill each of said elements during the descending quarter cycle of rotation of the leading edge thereof below said fluid level, said feed duct means including partition means in said element retaining the fluid in said elements during the ascending half cycle of rotation of the leading edge thereof, and said duct means discharging the fluid from said elements during the descending quarter cycle of rotation of the leading edge thereof above the fluid level in said drum.

4. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum, means maintaining the fluid level in said drum substantially at its medial axis, means delivering a heat transfer fluid to said conduit means, and a plurality of fluid circulating elements formed of hollow one quadrant sectors having leading and trailing edges radially disposed on said drum for rotation therewith, said sectors each having flow control means including a divider partition therein adjacent the leading edge thereof to define a primary channel coupled to the interior of said drum for coupling fluid therebetween and a fluid reservoir extending throughout the remainder of each sector coupled to said primary channels by an opening in said partition remote from said drum, whereby fluid is progressively admitted through the primary channel and remote partition opening from said drum to substantially fill the reservoir of each of said sectors during the descending quarter cycle of rotation of the primary channel thereof below said fluid level, the

fluid being maintained in said sector reservoirs by said divider partition during the ascending half cycle of rotation of the primary channels thereof and discharged through said remote opening and primary channel into said drum during the descending quarter cycle of rotation of the primary channels thereof into alignment with the fluid level in said drum.

5. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum horizontally journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum including a plurality of spaced discharge openings extending along said conduit means to uniformly distribute fluid throughout the length of said drum, overflow means maintaining the fluid level in said drum substantially at its medial axis, means delivering heat transfer fluid to said conduit means, and a plurality of fluid circulating elements formed of hollow one quadrant sectors having leading and trailing edges radially disposed on said drum for rotation therewith and disposed along said drum to sweep out overlapping paths traversing substantially the entire area of said receptacle, said sectors each having flow control means including a divider partition disposed therein to define a primary channel adjacent the leading edge thereof coupled to the interior of said drum and a fluid reservoir extending throughout the remainder of each sector coupled to said primary channels by an opening in said partition remote from said drum, whereby fluid is progressively admitted through the primary channel and remote partition opening from said drum to substantially fill the reservoir of each of said sectors during the descending quarter cycle of rotation of the primary channel thereof below said fluid level, the fluid being maintained in said sector reservoirs by said divider partitions during the ascending half cycle of rotation of the primary channels thereof and discharged through said partition opening and primary channel into said drum during the descending quarter cycle of rotation of the primary channels thereof into alignment with the fluid level in said drum.

6. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum, means maintaining the fluid level in said drum substantially at its medial axis, means delivering a heat transfer fluid to said conduit means, and a plurality of radial fluid circulating elements mounted on said drum for rotation therewith formed of radial sectors having means defining a radial primary channel aligned with a leading edge thereof and a fluid reservoir, the primary channel progressively admitting fluid under gravitational bias from said drum to the reservoir associated therewith to substantially fill the reservoir during the descending quarter cycle of rotation of the primary channel below said fluid level, said channel defining means retaining the fluid in said reservoir during the ascending half cycle of rotation of the leading edge, and said primary channel discharging the fluid under gravitational bias from the reservoir through the primary channel to said drum during the descending quarter cycle of rotation of the primary channel into alignment with the fluid level in said drum.

7. Heat exchange apparatus comprising, a stationary outer receptacle, a hollow rotary drum journaled in said receptacle, means for continuously rotating said drum, fluid conduit means for admitting fluid to the interior of said drum, including a plurality of spaced discharge openings extending along said conduit means to uniformly distribute fluid throughout the length of said drum, overflow means maintaining the fluid level in said drum substantially at its medial axis, means delivering a heat transfer fluid to said conduit means, and a plurality of radial fluid circulating elements mounted on said drum for rotation therewith and disposed along said drum to sweep out overlapping paths traversing substantially the entire area of said receptacle, formed of radial sectors having partition means defining a radial primary channel aligned with a leading edge thereof and a fluid reservoir, the primary channel progressively admitting fluid under gravitational bias from said drum to the reservoir associated therewith to substantially fill the reservoir during the descending quarter cycle of rotation of the primary channel below said fluid level, said partition means retaining the fluid in said reservoir during the ascending half cycle of rotation of the leading edge, and said primary channel discharging the fluid under gravitational bias from the reservoir through the primary channel to said drum during the descending quarter cycle of rotation of the primary channel into alignment with the fluid level in said drum.

8. Heat exchange apparatus comprisng an outer receptacle, fluid coupling means disposed in said receptacle for rotation about a horizontal axis, means for continuously rotating said coupling means, means delivering a heat transfer fluid to said coupling means, means maintaining a reference fluid level proximate to the axis of rotation of said coupling means, a plurality of radial circulating elements coupled to said fluid coupling means for rotation therewith, and means for gravity charging and discharging fluid from said coupling means to said elements including feed duct means to progressively charge each element with fluid at a point remote from said fluid coupling means to substantially fill the same during the descending quarter cycle of rotation of each element below said reference fluid level, said feed duct means including partition means in said elements to retain the fluid in each element during the ascending half cycle of rotation thereof, said feed duct means discharging the fluid from each element during the descending quarter cycle of rotation of the leading edge thereof into alignment with said reference fluid level.

9. In heat exchange apparatus, the combination recited in claim 1, wherein said feed duct means includes a tubular conduit projecting through the wall of said drum and into the hollow core thereof providing a raised surrounding lip to prevent drainage of fluid into downwardly oriented elements when fluid is exhausted from said drum.

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