Sept. 20, 1960 D. E. MacLEOD 2,952,996

ICE CUBE MAKER

Original Filed July 1, 1950 2 Sheets-Sheet 1

FIG. 7

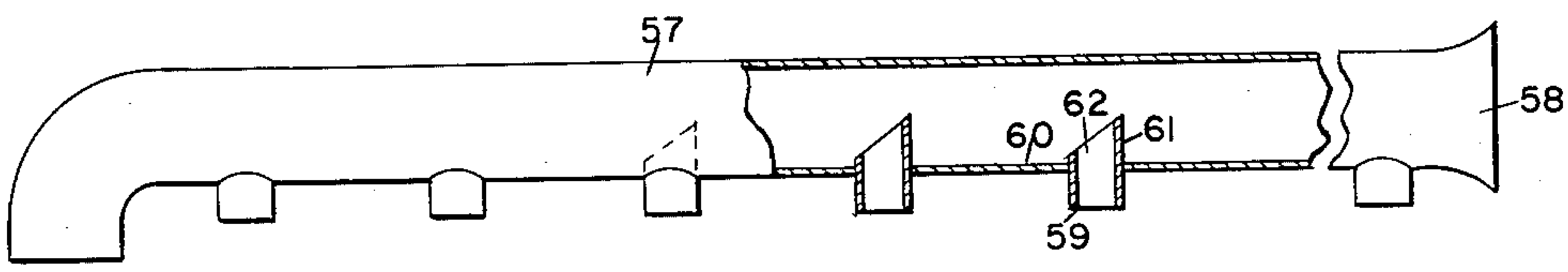


FIG. 1

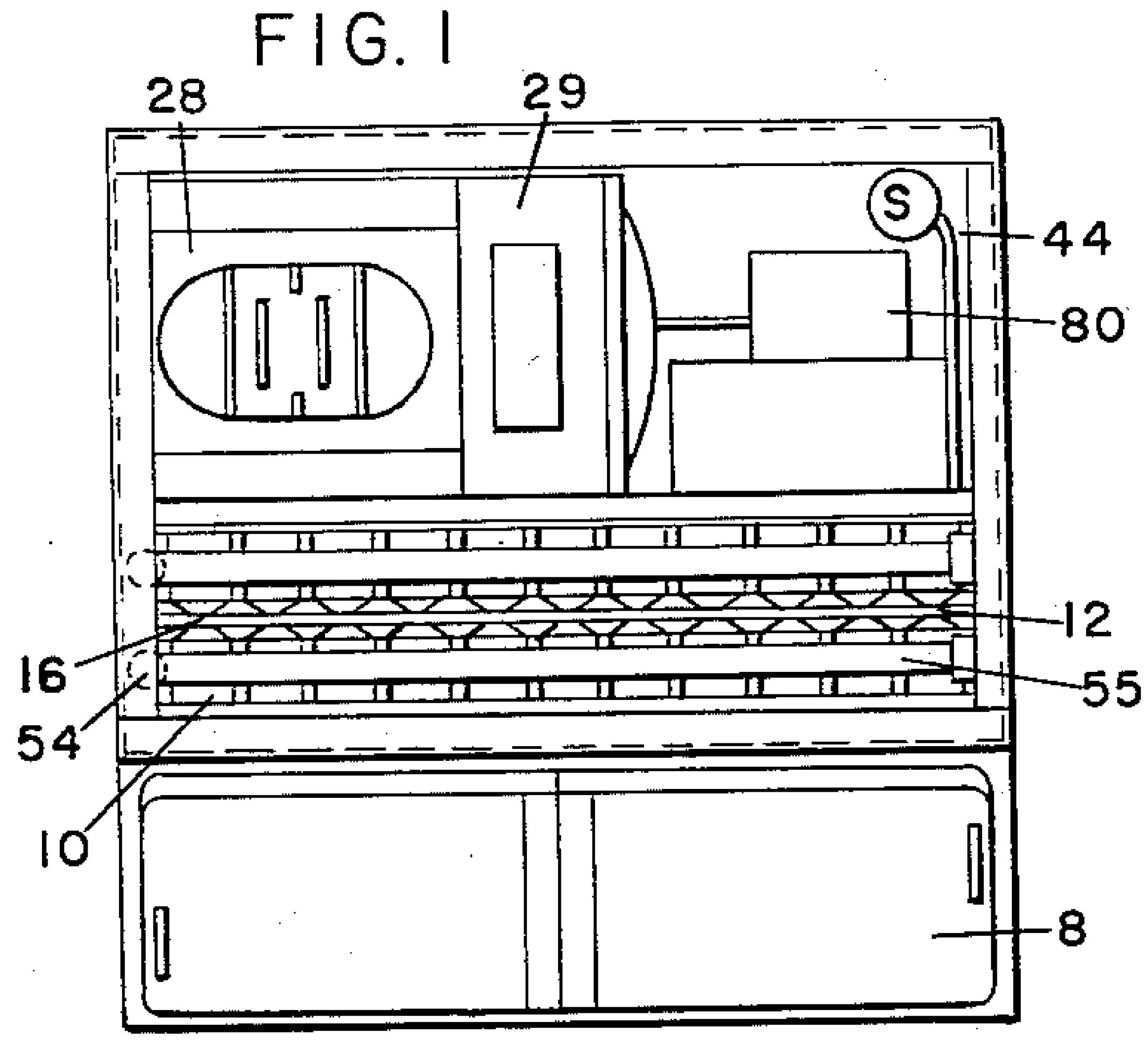
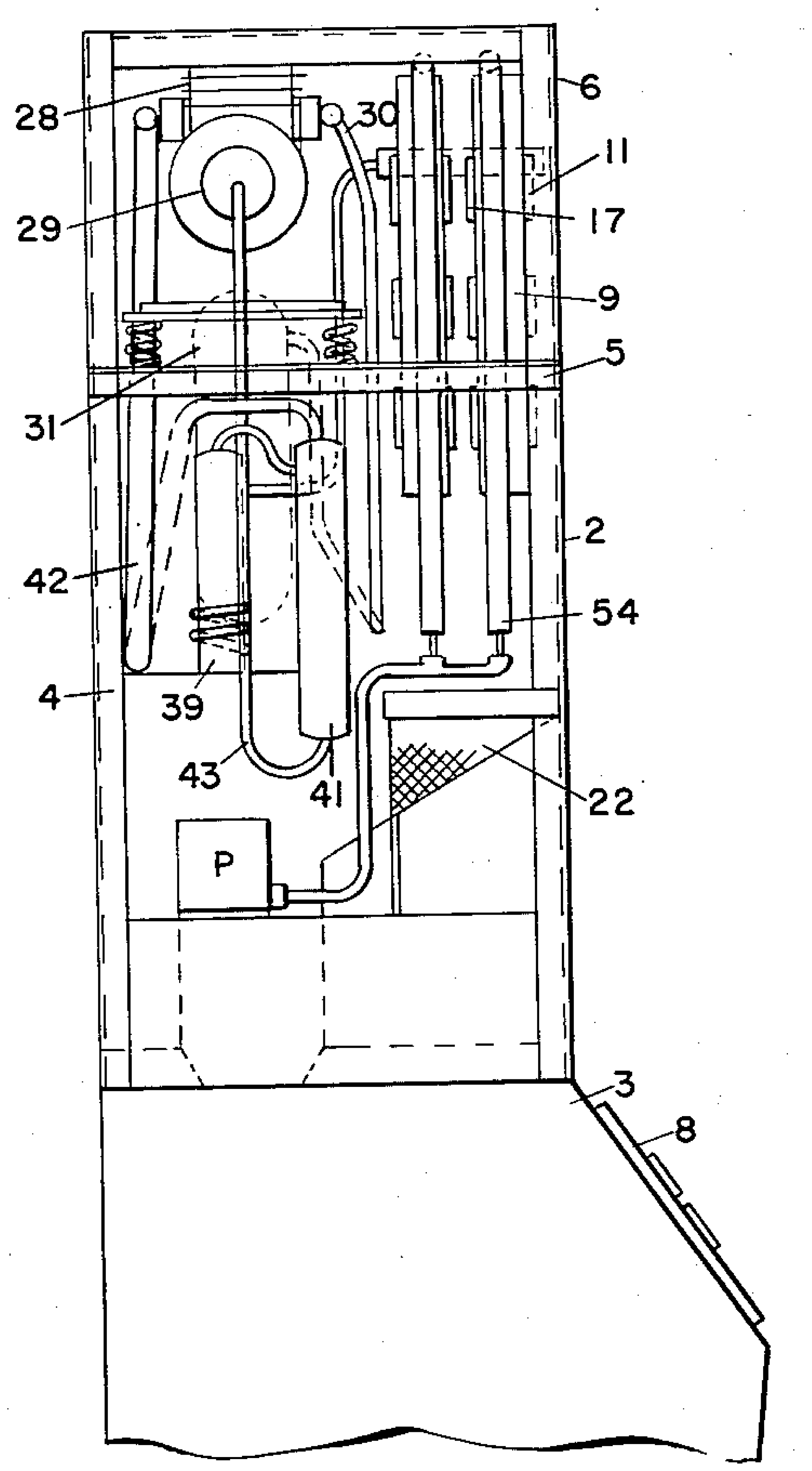


FIG. 2



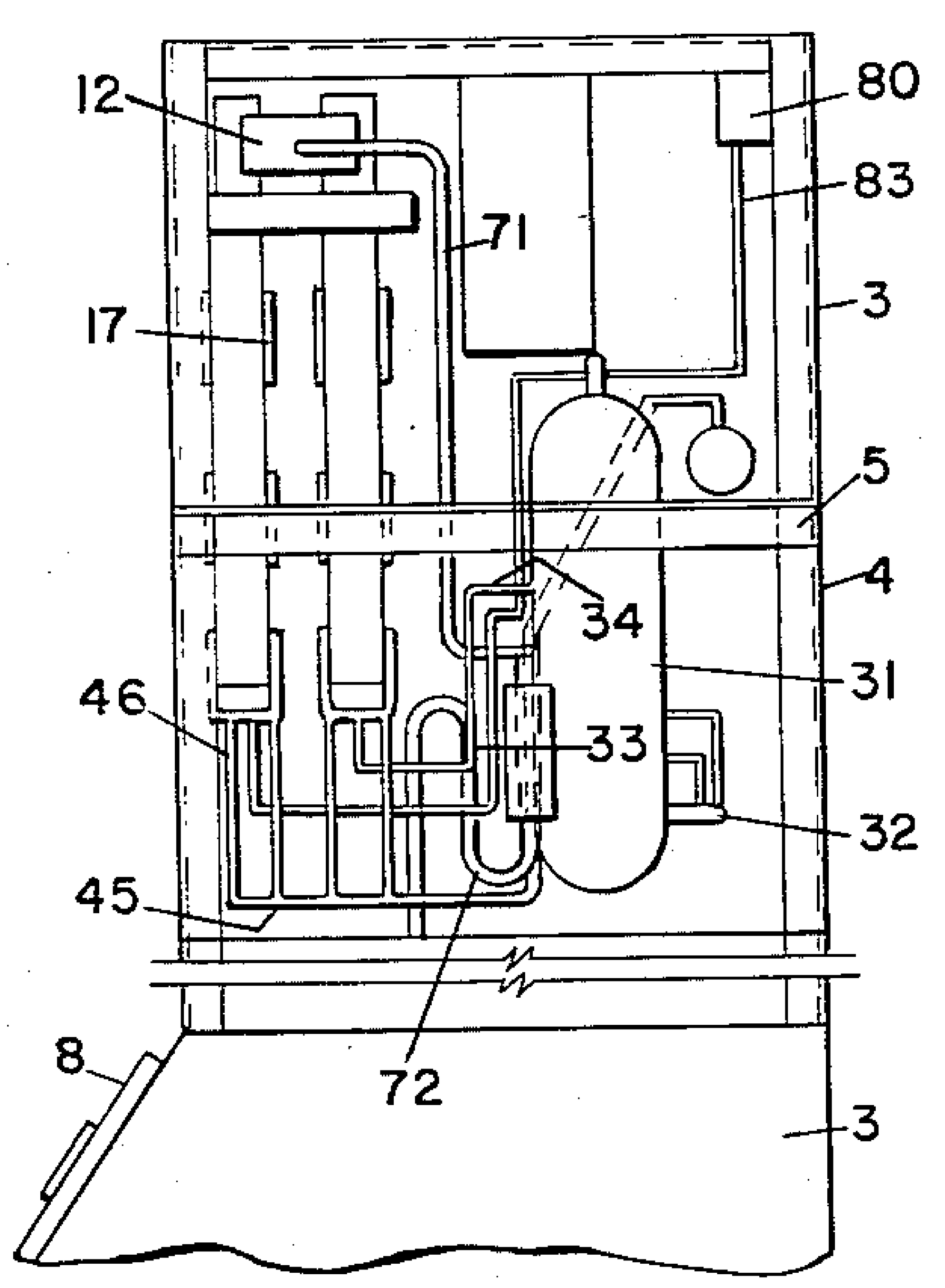


FIG. 3

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ICE CUBE MAKER

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FIG. 4

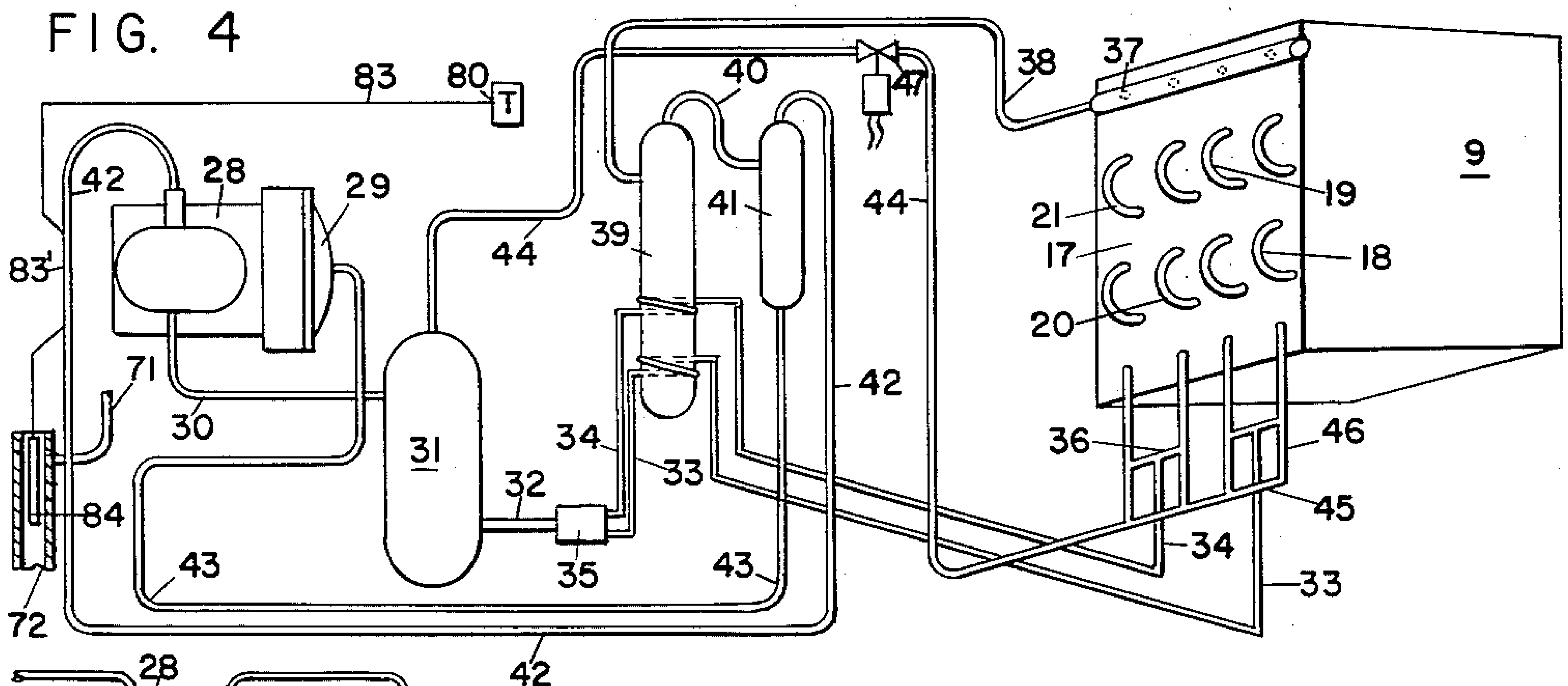


FIG. 5

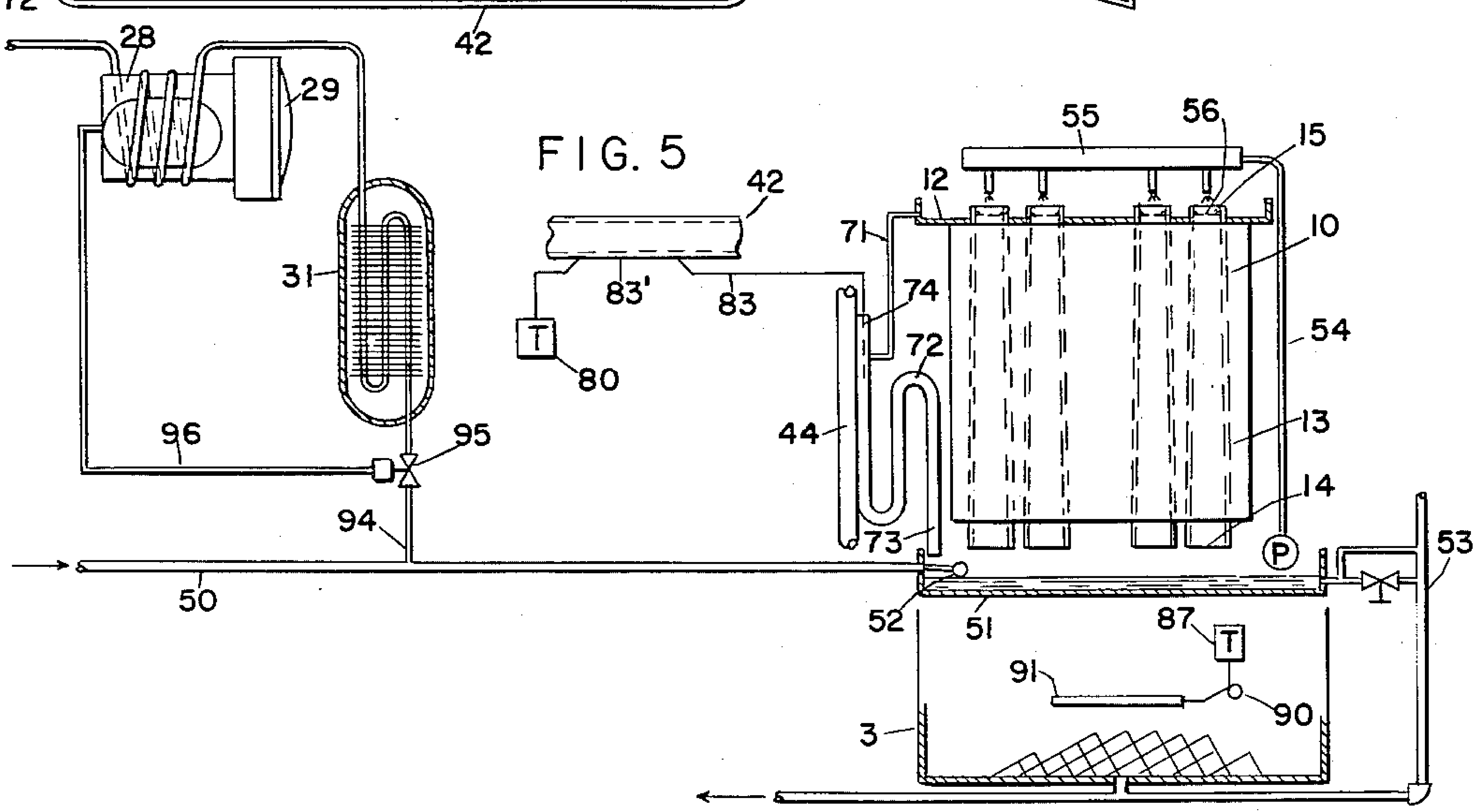
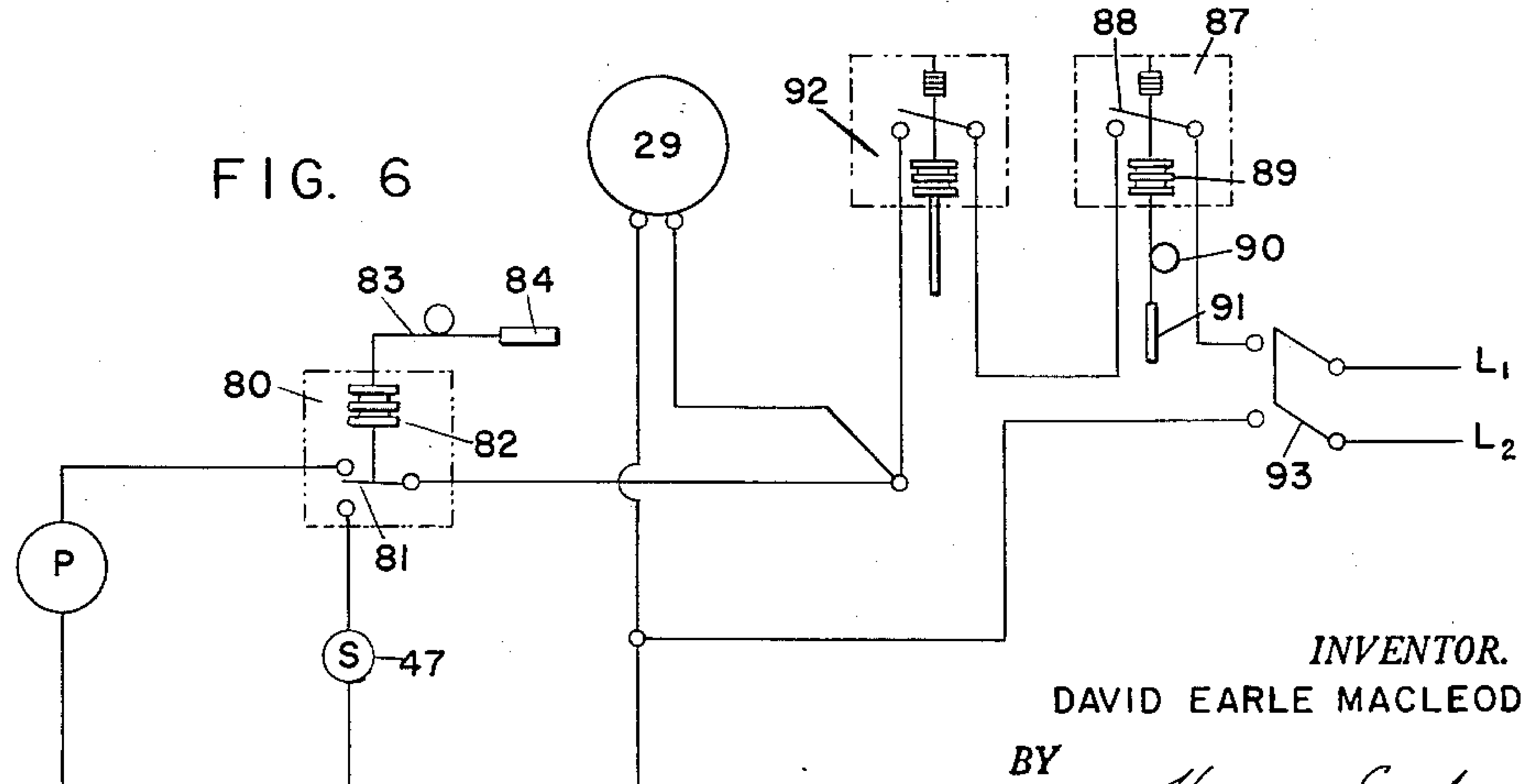


FIG. 6



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ICE CUBE MAKER

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Original application July 1, 1950, Ser. No. 171,593, now Patent No. 2,775,098, dated Dec. 25, 1956. Divided and this application June 1, 1956, Ser. No. 588,727

4 Claims. (Cl. 62—347)

This application is a division of my copending application, Serial No. 171,593, filed July 1, 1950, now Patent No. 2,775,098, issued December 25, 1956, entitled Ice Cube Maker and Control Mechanism Therefor, and relates to ice making apparatus in which ice is formed in a plurality of refrigerated, hollow, vertical tubes by flowing liquid through the tubes and, more particularly, to ice making apparatus of this type including mechanism for supplying liquid to the ice forming tubes.

The chief object of the present invention is to provide ice making apparatus in which ice is formed in a plurality of refrigerated, hollow tubes by flowing liquid through the tubes and including, header means for supplying and distributing the liquid to the various tubes.

An object of the invention is to provide a water header for supplying water to the ice forming tubes of ice making apparatus. Other objects will be readily perceived from the following description.

This invention relates to an ice making apparatus in which ice is formed in a plurality of refrigerated hollow vertical tubes by flowing liquid through the tubes which includes liquid header means for supplying liquid to the tops of the tubes, said liquid header means comprising a horizontally extending pipe having one closed end to receive liquid from a source of supply, a series of distributing tubes extending downward from the pipe to distribute liquid within the ice forming tubes, the first and second tubes of the series extending substantially flush with the interior wall of the pipe, subsequent tubes of the series extending inwardly from the interior wall of the pipe and having the extended portion of each tube cut away to intercept liquid from the stream flowing into the pipe, the last tube of the series being substantially flush with the interior wall of the pipe, the tubes being so constructed and arranged within the pipe as to distribute liquid entering the pipe in substantially uniform quantities to the ice forming tubes.

The attached drawings illustrate a preferred embodiment of my invention in which

Figure 1 is a plan view, the casing being removed, of the device of the present invention;

Figure 2 is a view in elevation, the casing being removed, of one side of the device;

Figure 3 is a view in elevation, the casing being removed, of the opposite side of the device;

Figure 4 is a diagrammatic view of the refrigeration circuit;

Figure 5 is a diagrammatic view of the water circuit;

Figure 6 is a diagrammatic view of the electrical circuit for the control; and

Figure 7 is a sectional view of the waterheader.

Referring to the drawings, there is disclosed an ice cube maker which includes a machine compartment 2 and an insulated ice storage compartment or bunker 3 placed below the machine compartment. Preferably these compartments are formed as separate elements being attached to one another when the ice cube maker is assembled at the place of use in order that the machine

compartment may be utilized with bunkers of different capacity. It will be understood of course that the machine may be formed as a single unit if desired.

Machine compartment 2 includes standards 4 and braces 5 forming supporting framework. Decorated removable metal sheets 6 are attached to the frame to form the walls of the machine compartment. Compartment 2 may be insulated to prevent condensation on the surfaces of sheets 6. Storage compartment 3 is provided with an opening (not shown) through which ice enters the storage compartment 3 after formation in machine compartment 2. Removable and/or hinged lids 8 are provided to permit easy access to and removal of ice from compartment 3 for use.

The machine elements are placed and supported in compartment 2. Such elements include the ice forming members, the refrigerating and harvesting systems, the water supply system, the controls, and an electrical circuit connecting the controls.

The ice forming member 9 includes a plurality of vertically extending tubes 10 formed of stainless steel, tubes 10 having a plurality of copper bands or rings 11 placed about the exterior thereof, the bands 11 being spaced from one another longitudinally on the tubes. The copper bands may be preformed and secured to the tubes by a friction fit or, if desired, molten copper may be sprayed on the tubes to form the bands, or, the tubes may be plated with copper bands. Tubes 10 are assembled in two parallel rows and an overflow trough 12 is placed between the parallel rows for a purpose hereinafter explained.

Each tube 10 is formed from a single sheet of metal in such manner that its side wall 13 inclines downward and outward substantially uniformly throughout the length of the tube so that the opening 14 in the bottom of the tube is greater in area than the opening 15 in the top of the tube. Two adjacent side walls have flanges extending outwardly therefrom, the flanges being pressed together and welded, for example, to form the tube. The top of each tube is formed with a pitcher lip 16.

The evaporator 17 of the refrigeration system is formed of a plurality of coils 18, 19, 20, 21; coils 18, 19 being secured to the bands 11 on opposite sides of the first row of tubes 10 while coils 20, 21 are secured to the bands 11 on opposite sides of the second row of tubes 10. If desired, coils 18, 19, 20, 21 may be flattened on one side to assure a greater area of contact with bands 11.

The ice forming member 9 is more fully described and claimed in the copending application of Carlyle M. Ashley, Serial No. 171,621, filed July 1, 1950, now Patent No. 2,775,096, issued December 25, 1956, to which reference is made for a more complete description.

Below the ice forming member 9 is an inclined deflector or guide 22 on which the pieces of ice fall from tubes 10 during the harvesting operation and down which the ice slides into bunker 3. Deflector 22 may be a suitable screen or grid to permit water to pass therethrough while preventing passage of ice cubes. Water from the tubes passes through deflector 22 into a sump as hereinafter explained.

Referring to Figures 4 and 5, there is shown the refrigerating and harvesting circuit of the ice cube maker. Such circuit includes a thermal hermetic compressor motor unit, the compressor 28 being actuated by motor 29. Compressor 28 is connected by discharge line 30 to condenser 31, preferably water cooled, although if desired, an air-cooled condenser may be employed. Liquid line 32 includes two capillary tubes 33, 34 adapted to serve as expansion means to regulate supply of liquid refrigerant to evaporator 17. A strainer and drier 35 may be placed in line 32 between condenser 31 and capillaries 33, 34. Other expansion means may be employed if desired. Capillary 33 supplies refrigerant to coils **18**, **19**; capillary **34** supplies refrigerant to coils **20**, **21**. Each capillary as shown in Figure 4 is connected to a return bend **36** at approximately the central point betwen the two coils to which it supplies refrigerant.

Refrigerant passes from each of coils **18**, **19**, **20**, **21** into a return header **37** for return to compressor **28**. Header **37** is connected by line **38** to accumulator **39**. A line **40** connects accumulator **39** to a second accumulator **41**. Accumulator **41** is connected by suction line **42** to the compressor **28**. Accumulator **41** is also connected by a drain line **43** to motor **29** to permit oil and liquid refrigerant in accumulator **41** to pass to the motor. Line **43** must be as short and as friction-free as possible to offer less resistance to refrigerant flow than the main line **42**. This is an important feature since any liquid refrigerant draining from accumulator **41** with the oil is returned to compressor **28** over the heated coils of the motor, thus flashing the refrigerant to assure that gaseous refrigerant only returns to the compressor, thereby avoiding excessive wear and tear of compressor elements.

Capillaries **33**, **34**, are wrapped about accumulator **39** in heat exchange relation therewith.

A heated refrigerant vapor line **44** connects the top of the condenser **31** with a supply header **45** connected by lines **46** to coils **18**, **19**, **20**, **21**. A solenoid valve **47** is placed in line **44** and closes the same to the passage of heated refrigerant vapor. It will be appreciated line **44** may connect header **45** with the compressor **28** or line **30** if desired, to permit heated refrigerant vapor to be supplied to coils **18**, **19**, **20**, **21** to melt formed pieces of ice from the interior walls of tubes **10**.

In Figure 5, the water distribution system is shown diagrammatically. Line **50** conducts water from a source of supply (not shown) to a sump or reservoir **51** placed in the bottom of machine compartment **2** below tubes **10** and deflector **22**. A float valve **52** regulates the level of water in sump **51**. A drain line **53** may bleed a minor amount of water continuously from sump **51** thereby preventing concentration of minerals in water in the sump. A pump P circulates water from sump **51** through lines **54** to water headers **55** placed above the rows of tubes **10**.

Water from headers **55** is discharged against distributors **56** placed within tubes **10**, the distributors directing or guiding the water toward or against the interior walls of tubes **10**. The water flows through tubes **10** in contact with the interior walls thereof, through deflector **22**, and returns or falls into sump **51**. The water, of course, is cooled by its passage through the refrigerated tubes **10** to substantially freezing temperature. Thus cooled or chilled water not formed into ice is continuously recirculated through tubes **10** to reduce the time required for ice formation and to increase the capacity of the machine.

Water header **55** as shown in Figure 7, consists of a horizontally extending pipe **57**, pipe **57** having a closed end **58**. A series of distributing tubes **59** extend downward from pipe **57** to distribute water within the tubes **10**. One pipe or tube is provided for each ice forming tube **10** to assure adequate distribution of water to each tube **10**. The first and second tubes **59** of the series extend substantially flush with interior wall **60** of pipe **57**. Subsequent tubes or pipes **59** of the series extend inward from the interior wall **60**, the extended portion **61** being cut away as shown at **62** to intercept water from the stream flowing into pipe **57**. The last tube of the series is also substantially flush with the interior wall **60** of pipe **57**.

The passage of water through tubes **10** is ultimately prevented or retarded by the formation of ice in the tubes. The tubes overflow, the lip **16** on each tube directing the water into trough **12** from whence it takes a different path to return to sump **51**. The overflow water in trough **12** drains therefrom through a line **71** connected to an S-shaped pipe arrangement **72** which forms an overflow well. Water from well **72** returns to sump **51** through line **73**. Well **72** contains an open leg **74** which is connected to line **71** as shown in Figure 5. Leg **74** of well **72** is clamped in contact with the heated refrigerant vapor line **44** of the refrigeration system for a purpose hereinafter explained.

To control the refrigeration and harvesting cycles, a wide differential thermostatic control **80** is provided which includes a switch lever **81** (refer to Figure 6) actuated by a thermal responsive system including a bellows **82** connected to the switch lever **81** and a capillary tube **83** connecting bellows **82** with a bulb **84**. The thermal responsive system contains a temperature responsive fill. Bulb **84** is placed in well **72** and a portion **83'** of capillary tube **83** is placed in contact with suction line **42**. Preferably portion **83'** is placed in contact with the portion of suction line **42** adjacent compressor **28** to assure that it is affected as little as possible by liquid refrigerant or wet liquid vapor flooding back to the compressor **28**. When water overflows from trough **12** into well **72** it displaces water present in well **72** and gradually cools bulb **84** until it becomes the coldest point of the thermal responsive system, thereby governing thermostat **80** from such point. Switch lever **81** is accordingly moved from a first position to a second position to discontinue operation of pump P and to actuate the solenoid S of valve **47**, to open the heated refrigerant vapor line **44** to supply heated refrigerant vapor to coils **18**, **19**, **20**, **21** to thaw formed pieces of ice from the interior walls of tubes **10**.

During the harvesting operation, the heated refrigerant line **44** warms the water in well **72** so that the control point shifts to portion **83'** of capillary tube **83** which is in contact with the suction line **42**. Refrigerant passing through the suction line is below the cut-in point of thermostat **80** so long as ice remains in tubes **10**. As the last piece of ice is removed from tubes **10**, temperature in the suction line rises to the cut-in point of the thermostat, the thermostat then being actuated to start pump P and to discontinue current flow to solenoid S, thereby closing valve **47** and resuming the refrigeration cycle.

A second thermostat control **87** is provided to discontinue operation of the refrigeration system and the pump when a desired quantity of ice is present in the bunker. Control **87** includes a switch lever **88**, a bellows **89** connected by capillary tube **90** to a bulb **91** placed in bunker **3** adjacent the top thereof. A suitable fill is present in bellows **89**, capillary tube **90** and bulb **91**. When a predetermined quantity of ice is present in bunker **3**, bulb **91** is cooled, thereby actuating thermostat **87** to open the circuit to control **80** and the compressor **28**, discontinuing operation of the system. Upon removal of ice from bunker **3**, bulb **91** warms to a point at which thermostat **87** is again actuated to close the circuit, permitting supply of current to actuate the compressor and control **80**.

Preferably a high pressure cut-out control **92** is provided as a safety control, control **92** being responsive to head pressure to shut down the system upon the occurrence of a pressure so high that it might harm elements of the system. In Figure 6, I have shown the electrical circuit connecting the various controls and actuating elements of the device. A manual double pole single-throw switch or single pole, single throw switch **93** is employed to actuate the device. The remaining elements are connected in the circuit as shown.

As previously described, a water-cooled condenser **31** is employed for the refrigeration system. Condenser **31** may be connected by a line **94** to line **50** to supply water to condenser **31**. Preferably an automatic control valve **95** is placed in line **94** and is connected by line **96** to compressor **28** to permit head pressure to be applied to actuate valve **95**. The water passing through condenser **31** is thus regulated in response to head pressure.

Considering the operation of the device, manual switch **93** is closed thereby actuating motor **29** to operate compressor **28** of the refrigeration system and pump P to supply water from sump **51** to header **55** for distribution in tubes **10**. Water flows downwardly through distributing tubes **59** to each tube **10** and strikes distributor **56** therein, distributor **56** directing the water toward the interior wall of the tube. Water flows downward over the interior wall of each tube **10** and returns to sump **51**. The walls of tubes **10** are refrigerated in spaced portions by means of coils **18, 19, 20, 21** and the copper bands **11**. Thus water flowing through the tubes is cooled and within a short time separate pieces of ice begin to form within the tubes **10** adjacent the refrigerated portions thereof. As ice formation continues, within a short time the spaced pieces of ice present in the tubes are so large as to impede or retard passage of cooled water therethrough so that the tubes overflow into trough **12**.

Water from trough **12** flows through line **71** into overflow well **72** displacing the water therein and cooling bulb **84** so that it becomes the control point. When a predetermined low point is reached thermostat **80** is actuated, moving switch lever **81** from a first position to a second position, discontinuing operation of pump P and passage of water to tubes **10**, and actuating solenoid S to move valve **47** to an open position permitting heated refrigerant vapor to flow into coils **18, 19, 20, 21** to melt the formed pieces of ice from the interior walls of tubes **10**, simultaneously water in well **72** being in heat exchange relation with line **44** is heated to shift the control point of thermostat **80** to capillary tube portion **83'**.

Capillary tube portion **83'** does not become sufficiently warm to actuate thermostat **80** until all ice is removed from tubes **10** since it is in heat exchange relation primarily with liquid refrigerant condensed by heat exchange of the heated vapor with the formed ice in tubes **10**.

Ice drops from tubes **10** by gravity upon reflector **22** and slides into bunker **3** through the openings in the bunker. After the last piece of ice is removed from the tubes, the hot vapor passing into suction line **42** raises the temperature of the fill in capillary tube portion **83'**, thereby actuating thermostat **80** to move from its second position to its first position closing the solenoid valve **47**, resuming refrigeration of tubes **10**, and starting pump P to supply water from sump **51** through tubes **10**.

The refrigerating and harvesting cycles repeate automatically until a predetermined quantity of ice is formed. When a predetermined quantity of ice is collected in bunker **3**, thermostat **87** is actuated to break the electrical circuit, discontinuing operation of the machine. Upon removal of ice from bunker **3**, thermostat **87** is again actuated to begin operation of the machine.

The present invention provides an economical, automatically operable ice cube maker in which header mechanism adequately supplies or distributes water to the various tubes of the apparatus. The header mechanism is economically and quickly manufactured and is very effective in use.

While I have described a preferred embodiment of my invention it will be understood my invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In combination with an ice making apparatus having a plurality of refrigerated hollow vertical tubes in which ice is formed by flowing liquid through the tubes, liquid header means for supplying liquid to the tops of the tubes, said liquid header means comprising a horizontally extending pipe having one closed end and an inlet to receive liquid from a source of supply, a series of spaced distributing tubes placed longitudinally of said pipe and extending downward from the pipe to distribute liquid within the tubes, the first and second distributing tubes of the series extending substantially flush with the interior wall of the pipe, subsequent distributing tubes of the series extending inwardly from the interior wall of the pipe and having the extended portion of each tube cut away at an angle to the axis thereof to intercept liquid from the stream flowing into the pipe, the last distributing tube of the series being substantially flush with the interior wall of the pipe, the distributing tubes being so constructed and arranged within the pipe as to distribute liquid entering the pipe in substantially uniform quantities to the tubes.

2. In combination with an ice making apparatus having a plurality of refrigerated hollow vertical tubes in which ice is formed by flowing liquid through the tubes a liquid distributor placed in the tubes to direct the liquid against the walls of the tubes, liquid header means for supplying liquid to the tops of the tubes, said liquid header means comprising a horizontally extending pipe having one closed end and an inlet to receive liquid from a source of supply, a series of spaced distributing tubes placed longitudinally of the pipe and extending downward from the pipe to distribute liquid within the tubes, the first and second distributing tubes of the series extending substantially flush with the interior wall of the pipe, subsequent distributing tubes of the series extending inwardly from the interior wall of the pipe and having the extended portion of each tube cut away at an angle to the axis thereof to intercept liquid from the stream flowing into the pipe, the last distributing tube of the series being substantially flush with the interior wall of the pipe, the distributing tubes being so constructed and arranged within the pipe as to distribute liquid entering the pipe in substantially uniform quantities to the tubes.

3. In a header for supplying water to the ice forming tubes of an ice cube maker, the combination of a horizontally extending pipe having one closed end and an inlet to receive water from a source of supply, a series of spaced distributing tubes placed longitudinally of the pipe and extending downward from the pipe to distribute water within the tubes, the first and second distributing tubes of the series extending substantially flush with the interior wall of the pipe, subsequent distributing tubes of the series extending inwardly from the interior wall of the pipe and having the extended portion of each tube cut away at an angle to the axis thereof to intercept water from the stream flowing into the pipe, the last distributing tube of the series being substantially flush with the interior wall of the pipe, the distributing tubes being so constructed and arranged within the pipe as to distribute water entering the pipe in substantially uniform quantities to the ice forming tubes.

4. An ice making apparatus in which ice is formed in a plurality of refrigerated hollow vertical tubes by flowing water through the tubes, water distribution means for supplying water to the tubes, said distribution means including a horizontally extending pipe having one closed end and an inlet to receive water from a source of supply, a series of distributing tubes extending downward from the pipe to distribute water within the ice forming tubes, the first and second tubes of the series extending substantially flush with the interior wall of the pipe, subsequent tubes of the series extending inwardly from the interior wall of the pipe and having the extended portion of each tube cut away at an angle to the axis thereof to intercept water from the stream flowing into the pipe, the last tube of the series being substantially flush with the interior wall of the pipe, the tubes being so constructed and arranged within the pipe as to distribute water entering the pipe in substantially uniform quantities to the ice forming tubes, and water distributors

placed within each of the tubes to direct water supplied thereto against the walls of the tubes.

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