(No Model.)

E. D. KENDALL.

APPARATUS FOR PRODUCING COLD AND ICE.

No. 502,438. Patented Aug. 1, 1893.

Fig. 1.

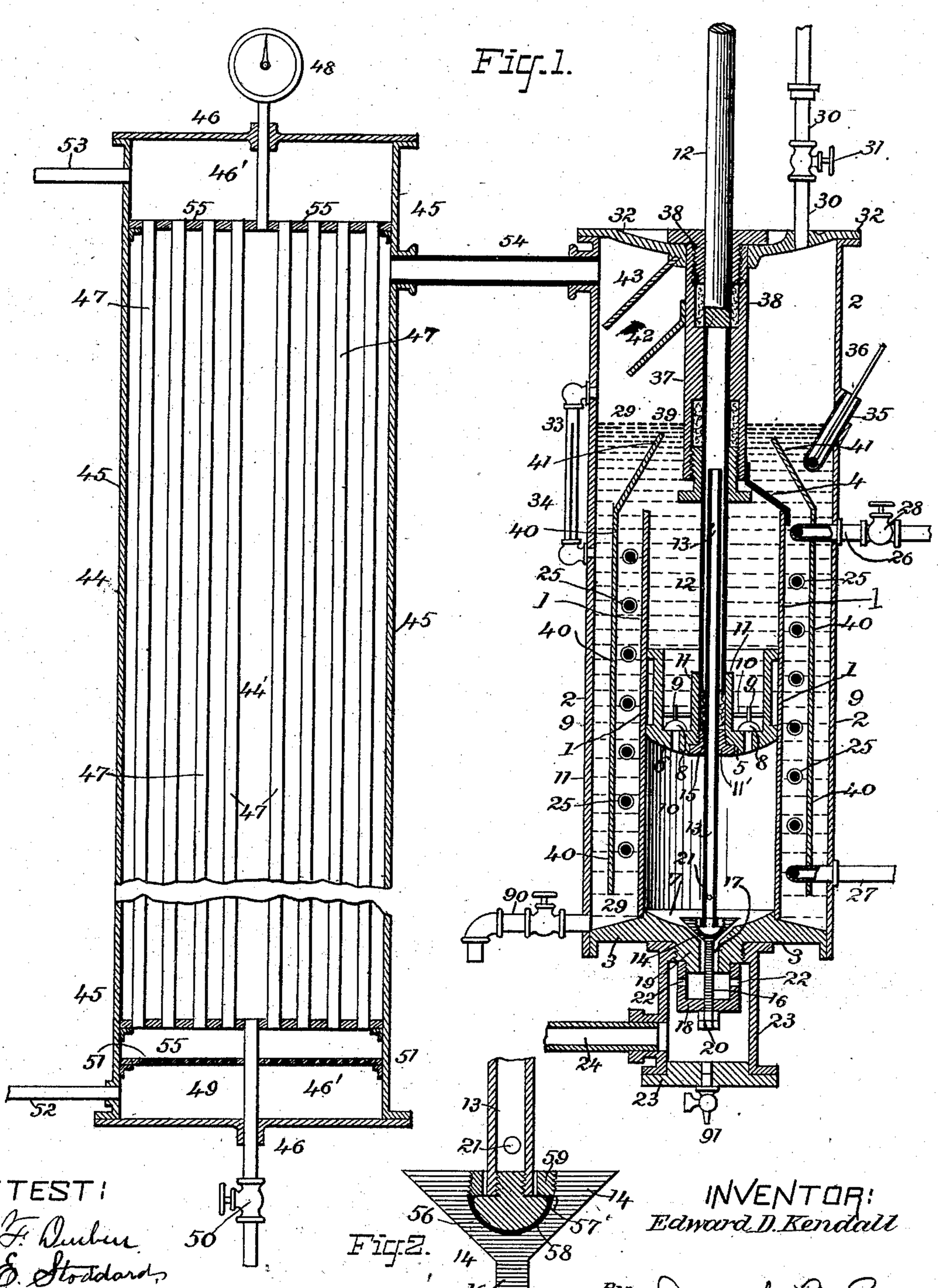

Fig. 2.

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APPARATUS FOR PRODUCING COLD AND ICE.

SPECIFICATION forming part of Letters Patent No. 502,438, dated August 1, 1893.

Original application filed March 4, 1891, Serial No. 383,805. Divided and this application filed June 24, 1891. Serial No. 397,273. (No model.)

To all whom it may concern:

Be it known that I, EDWARD D. KENDALL, a citizen of the United States, residing at Jamaica, in the county of Queens and State of New York, have invented certain new and useful Improvements in Apparatus for Producing Cold and Ice, of which the following is a specification.

My invention relates to improvements in apparatus for the production of cold and ice, and the invention consists in novel apparatus wherein a liquefiable gas or vapor is used as a refrigerating or freezing agent for the production of cold and ice, which apparatus is divisible into several distinct and separately usable devices, one of which is called the compression apparatus in which the liquefiable gas is compressed, and the other the freezing or refrigerating apparatus in which the liquefied gas is utilized for the production of cold and ice. This refrigerating apparatus is the subject of an earlier application, filed March 4, 1891, Serial No. 383,805, of which the present application is a division. Between the compression and refrigerating apparatus I locate a condenser for the purpose of condensing the compressed gas into the liquid state.

In using my apparatus I use a liquefiable gas, such for instance, as dioxide of sulphur which may be compressed and reduced to a liquid condition, and while under pressure the gas is passed through a heat-absorbing medium which removes from the compressed gas the heat it has absorbed during the act of compression. This heat-absorbing medium I prefer should be a heavy hydrocarbon oil; of which more will be said farther on. The compression apparatus also comprises means whereby this heat-absorbing medium may be kept in a constant state of circulation, for the purpose of constantly presenting a fresh heat-absorbing surface to the compressed gas as it passes through it; also means whereby the heat taken up by the heat absorbing hydrocarbon may be transferred to another heat absorbing medium, which is kept constantly circulating through the hydrocarbon. In this way a complete state of absorption of the heat evolved in the act of compression is obtained. The compression cylinder also comprises novel arrangements, whereby the moving parts are thoroughly packed and lubricated, and a valve governing the admission of gas to the compression chamber is operated and seated.

My invention also consists in the peculiar construction of the condenser, for liquefying the compressed gas. This device as before stated may be omitted, and the compression apparatus modified to effect the condensation, as will be hereinafter set forth.

My invention also further extends to other features and combinations of parts set forth in the accompanying specification and claims, and illustrated in the accompanying drawings, in which—

Figure 1 is a vertical central section of the compressing apparatus and connected condenser; Fig. 2, a vertical section showing the connection of a valve with a valve rod.

Similar figures refer to like parts throughout both views.

In Fig. 1, is a cylindrical single acting pump cylinder 1, vertically disposed within a strong metallic outer cylinder 2 of larger diameter than the pump barrel, which pump barrel is fastened to and supported by a strong casting 3 which seals the bottom of the outer cylinder 2. The pump barrel 1 is open at the top and is steadied there by three braces, one of which, 4, is shown in the figure by heavy black lines. The plunger 5 of the pump is cup shaped and its bottom 6 conforms to the concaved portion 7 of the casting 3. Within the plunger 5 are valves 8 opening upward with stems 9 set in the perforated plate 10, and in the center between the valves, is an upright hollow stem 11 which is attached to the plunger rod 12, which rod may be connected with any source of power, as a hand lever or engine. This plunger rod is tubular for a part of its length, about equal to the stroke of the plunger in order to receive a tubular rod 13 smaller in diameter, which is connected with and actuates a valve 14. The tubular valve rod 13 passes through a stuffing box 15 in the hollow stem 11 and extends up into the hollow of the plunger rod. The packing is compressed within the stuffing box,

as the collar or bushing 11′ is screwed thereinto. The friction of the packing in the stuffing box 15 of the stem 11 raises this rod 13 and its attached valve 14 when the plunger begins its upward stroke. The valve 14 has its seat in the casting 3 or in a bushing inserted therein and is rigidly fastened to a spindle 16 which projects downward and passes through the port 17 in the casting 3, and through a central opening in a metallic cap 18 which is screwed onto a projection 19 of the casting 3. The lower end of the spindle 16 is threaded and carries nuts 20, and these being properly adjusted on the spindle 16 with regard to the cap 18 the upward motion of the valve 14 is thereby limited and stopped while the stuffing box 15 in the stem 11 slides over the tubular valve rod 13 as the piston continues its upward stroke.

Near the lower end of the tubular valve rod 13, and just above the valve 14 are placed small holes 21 which permit gas within the pump barrel to pass to and from the hollows of the valve and plunger rods, according to the motion of the piston and pressure of the gas for a purpose hereinafter set forth.

The cap 18 has openings 22 through its sides for the passage of gas to the pump barrel and is covered with a larger cap 23 into which enters the pipe 24 bringing gas or vapor to the compressor.

In the space between the pump barrel 1 and the outer cylinder 2 is a coil of pipe 25, the ends of which are shown at 26, 27, the end 26 being provided with a valve 28. Through this coil flows cold water. The coil is immersed in a non-volatile liquid or oil 29 which liquid is indifferent to or not chemically acted upon by the liquefiable gas or volatile fluid employed as a refrigerating agent; such a non-volatile chemically unchanging and suitable liquid I have found in the heavy paraffinous hydrocarbons from which the solid paraffine has been separated by congelation in the paraffine works. It is well adapted for use in my apparatus when sulphur dioxide is employed as the refrigerating agent, but may be used in connection with other refrigerants. A measured quantity of the heavy hydrocarbon is poured into the outer cylinder 2 through the supply pipe 30 and valve 31, which enters the cylinder head 32 that closes the upper end of the cylinder. The surface of the hydrocarbon 29 when the plunger 5 stands midway of its stroke, should be at or near the line 33. A gage 34 may be attached to the cylinder 2 to indicate the quantity of contained hydrocarbon. A short tube 35 closed at its lower end is secured in an opening in the side of the cylinder 2 and projects downward at an angle into the hydrocarbon within the cylinder. In this tube is put a small quantity of the hydrocarbon or other liquid (if the tube be of iron, mercury may be used), and in this liquid is immersed the bulb of a thermometer 36 to indicate the temperature of the hydrocarbon contained in the cylinder. This tube may be inserted into the cylinder at any suitable point. The plunger rod 12 moves within a sheath 37 the top of which sheath passes through and is fastened to the center of the cylinder head 32. The lower end of the sheath 37 should always be under the surface of the hydrocarbon. At either end of the sheath is a stuffing box 38, 39 containing suitable packing. A good packing for the upper stuffing box 38 is cotton imbued with soft potash soap, containing a small proportion of rosin. A cylinder 40 of thin sheet metal contracted conically at its upper end 41, is disposed vertically between the pump barrel 1 and the outer cylinder 2. Two shields or deflectors 42, 43, which are pieces of thin sheet metal fastened in place to the sheath 37 and cylinder head 32 respectively, prevent the projection of the agitated hydrocarbon out of the cylinder.

At 44 is shown the condenser which may be of any suitable form or even dispensed with under circumstances mentioned farther on. A simple condensing coil may be used; but as it is advisable to have an abundant supply of the liquefied refrigerating agent, it is advantageous to use a capacious condenser. A useful form of condenser is a sufficiently strong and capacious shell 45 having heads 46, tubes 47, and tube sheets 55 through which cold water flows. The heads 46 and 55 form chambers 46′ at both ends of the condenser.

48 is a pressure gage, 49 a pipe, and 50 a valve to conduct a regulated supply of the liquefied gas or vapor to the brine tank, Fig. 2, or other refrigerating device. A perforated diaphragm 51 distributes equally to the tubes 47 the water which enters the shell through the pipe 52, diaphragm 51, up through the tubes 47 and out and away through the pipe 53. The pipe 54 connects the compression cylinder with the condenser, and enters both near the tops thereof.

Fig. 2 shows the mode of connecting the valve 14 with its actuating valve rod 13. At the lower end of the valve rod and preferably closing the same is a hemispherical knob 56 with the flat side 57 uppermost, and is held within the socket 58 of larger dimensions in the upper part of the valve, by a bushing 59 which slides very loosely over the valve rod and screws into the upper and threaded part of the sides of the socket. The conical valve 14 while secured to the end of the valve rod 13 has such lateral play by reason of the socket connection as enables it to find and fit closely to its seat. If the valve rod were rigidly fastened to the valve and moving even slightly out of the central line of the correct valve motion the valve could not adjust itself accurately to its seat; the accurately and timely seating and closing of this valve being very important.

The compacting of all of the parts of the

valve connections shown in Fig. 2 within the cone of the valve, cheapens the construction of the valve and its seat, and simplifies their construction. The detachable knob 56 which screws into the end of the hollow valve rod 13, closes that end, and I consider this form of ball and socket-joint connection cheaper and simpler than making the knob integral or solid with the rod 13.

I shall now set forth the operation of the compression and condensing devices. When the plunger 5 is drawn upward the valve 14 is at once raised as far as the nuts 20 on the spindle 16 will permit, and gaseous sulphur dioxide delivered through the pipe 24 from some suitable source of supply, passed through the chamber within the cap 23 and through the perforations of the inner cap 18, to the interior of the pump barrel 1. The stuffing box 15 in the stem 11 slides over the valve rod 13 and gas passes into the hollows of the valve rod 13 and plunger rod 12, and prevents the creation of a vacuum. Without the hollow valve rod, and aperture in the same, gas and liquid hydrocarbon (from desirable and calculated leakage at the stuffing-box) would be gradually sucked into the plunger rod and interfere with the motion of the plunger. As the plunger ascends, it carries upward the liquid hydrocarbon 29 that was within the pump barrel 1, and thereby the surface of the liquid is raised above the line 33; when the plunger descends the valve 14 promptly finds its seat and the gas within the pump barrel, being compressed until it has power to raise the valves 8 within the bottom of the plunger, bubbles up through the liquid hydrocarbon 29 (which is cooled by the cold water pipe 25) and is thereby deprived of most of the heat developed by compression. From the upper part of the cylinder 2 the compressed gas passes through the pipe 54 to the condenser 44, the plates 42, 43 preventing the hydrocarbon from being carried into the pipe 54. As the plunger 5 descends, the hydrocarbon falls directly into the pump barrel 1 until the surface of the liquid is lowered to the contracted upper ends 41 of the metal cylinder 40, after which a portion of the hydrocarbon flows downward outside of the cylinder 40, under its lower edge, and upward within the said cylinder and over the piping coil 25 on its way to the interior of the pump barrel, so that the motion, circulation, and cooling of the hydrocarbon extend to the bottom of the containing cylinder 2 and throughout the entire body of the liquid.

The flow of cold water through the coiled pipe 25 is to be regulated so as to maintain a considerably higher temperature within the cylinder 2 than in the condenser 44 unless it be desired to dispense with a separate condenser and to liquefy the sulphur dioxide within the compressor. In this case the capacity of the cylinder 2, the quantity of hydrocarbon and the surface of the cooling water pipes 25 should all be increased, and the action of the pump and consequent agitation of the liquid contents of the cylinder 2, should occasionally be stopped for a few minutes to allow the comparatively heavy liquefied sulphur dioxide to subside and collect under the hydrocarbon, whence it may be discharged through a valve 90, near the bottom of the cylinder 2. It is more convenient to use a separate condenser and then it suffices that excessive heating of the hydrocarbon is prevented. A temperature of 65.5° centigrade (150° Fahrenheit) is not excessive. The hydrocarbon is practically non-volatile at 163.5° centigrade or 400° Fahrenheit, but it is well to keep the temperature near 100° Fahrenheit. The flow of hydrocarbon outside of the pump barrel 1 and within it and within the cup shaped plunger and over the valves 8 cools those parts, and prevents injury to the valves and excessive expansion of the plunger. Besides its necessary cooling action on the gas and apparatus, the hydrocarbon has other and important uses in this apparatus. It seals and renders gas tight the valves 8 within the plunger; it seals the lower end of the sheath 37, and prevents the compressed sulphur dioxide escaping through the upward and outward motion of the piston rod, and a small quantity, dribbling through the valve openings, drops to the bottom of the pump barrel 1 and smears the seat of the conical valve 14 making it gas tight, and any excess of hydrocarbon in the bottom of the pump barrel finds its way to the bottom of the cap 23 and is discharged occasionally through the cock 91 shown at that place in the drawings.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination in an ice producing apparatus, of a closed outer vessel containing an inner compression cylinder said compression cylinder having a movable piston, and a piston rod extending out through said outer cylinder, a sheath or covering surrounding the piston rod and extending down into the outer cylinder and a non-volatile fluid within the said outer cylinder covering one end of said sheath, substantially as described.

2. The combination, in a cold producing apparatus, of a gas compressor having a piston and hollow piston rod, a stuffing box at its piston end, a tubular valve rod extending through the piston rod and stuffing box, a valve flexibly secured to the valve rod, apertures in the valve rod, a spindle on the valve, and nuts on the spindle for limiting the upward movement of the valve, substantially as described.

3. The improvement in cold producing apparatus, which consists in the cylinder 40 surrounding the compression cylinder 1 and immersed in a non-volatile liquid contained

within an outer cylinder 2, the cylinder 40 being so secured and disposed as to effect the circulation of the said liquid, and a movable piston within the compression cylinder 1, and means for operating it, substantially as described.

4. In a refrigerating apparatus, the combination of the outer cylinder 2, having the downwardly extending sheath 37 containing packing, a pump cylinder 1 open at the top and disposed within the said outer cylinder, a plunger movable in the pump cylinder, a piston rod 12 secured to the plunger and passing through the said sheath, and a liquid surrounding the lower edge of the sheath and cooling and sealing the same, substantially as described.

5. The combination of the pump cylinder 1, having the plunger 5 movable therein, a piston rod 12 hollow for a portion of its length secured to said plunger with a hollow and perforated valve stem 13 within the piston rod, and valve 14 operated by the said plunger, substantially as described.

6. The combination of the pump cylinder 1, having the plunger 5 movable therein, a piston rod 12 hollow for a portion of its length secured to said plunger, a hollow perforated valve stem 13 within the piston rod, and valve 14 operated by the said plunger, the said valve having a downwardly extending spindle 16, nuts 20 on its spindle, and means for arresting the upward motion of the valve, substantially as described.

7. The combination of the pump cylinder 1, having the plunger 5 movable therein, a piston rod 12 hollow for a portion of its length secured to said plunger with the hollow perforated valve stem 13 within the piston rod, a valve 14 operated by the said plunger, downwardly extending spindle 16 on the valve, nuts 20 on the spindle, means for arresting the upward motion of the valve, the chamber 18 with perforations 22 secured to the bottom of the pump cylinder, and another chamber 23 secured to the bottom of the pump cylinder and surrounding the chamber, substantially as described.

8. The combination of the pump cylinder 1, having the plunger 5 movable therein, a piston rod 12 secured to said plunger and hollow for a portion of its length with the hollow perforated valve stem 13 within the piston rod, and valve 14 secured to said valve stem, the valve being operated by the said plunger, a downwardly extending spindle 16 on the valve, nuts 20 on the spindle, means for arresting the upward motion of the valve, a chamber 18 with perforations secured to the bottom of the pump cylinder, another chamber 23 secured to the bottom of the pump cylinder and surrounding the chamber 18, an auxiliary cylinder 40 disposed about the pump cylinder 1, and a pipe coil 25 disposed about the pump cylinder and between it and the auxiliary cylinder, substantially as described.

9. The combination of the pump cylinder 1, having the plunger 5 movable therein, a centrally disposed ring 11 on said plunger, packing 15 in said ring and means for compressing the same, a piston rod 12 hollow for a portion of its length secured to said ring, valves and ports in said plunger with the valve 14 seated in the bottom of said pump cylinder 1 and a hollow valve stem 13 with perforations 21 passing through the packing 15 in the said plunger, substantially as described.

10. The combination of the pump cylinder 1, having the plunger 5 movable therein, a centrally disposed ring 11 on said plunger, packing 15 in said ring and means for compressing the same, a piston rod 12 hollow for a portion of its length secured to said ring, valves and ports in said plunger, the valve 14 seated in the bottom of said pump cylinder 1, a hollow valve stem 13 with perforations 21 passing through the packing 15 in said plunger, the valve 14 having a downwardly extending spindle 16, nuts 20 on the said spindle, and means for arresting the upward motion of the valve, substantially as described.

11. The combination of the pump cylinder 1, having the plunger 5 movable therein, a centrally disposed ring 11 on said plunger, packing 15 in said ring and means for compressing the same, a piston rod 12 hollow for a portion of its length secured to said ring, valves and ports in said plunger, with the valve 14 seated in the bottom of said pump cylinder 1, and a hollow valve stem 13 with perforations 21 passing through the packing 15 in the said plunger, a downwardly extending spindle 16 on the valve 14, nuts 20 on the spindle, a chamber 18 with perforations 22 secured to the bottom of the pump cylinder, the spindle of the valve 14 passing through said chamber 18 the bottom of which arrests the upward motion of the valve, and another chamber 23 secured to the bottom of the pump cylinder and surrounding the chamber 18, substantially as described.

12. The combination of the pump cylinder 1, having the plunger 5 movable therein, a centrally disposed ring 11 on said plunger, packing 15 in said ring and means for compressing the same, a piston rod 12 hollow for a portion of its length secured to said ring, valves and ports in said plunger, the valve 14 seated in the bottom of said pump cylinder 1, a hollow valve stem 13 with perforations 21 passing through the packing 15 in the said plunger, the valve 14 being provided with a downwardly extending spindle 16, nuts 20 on the spindle, a chamber 18 with perforations 22 secured to the bottom of the pump cylinder, the spindle of the valve passing through this chamber the bottom of which arrests the upward motion of the valve, and another chamber 23 secured to the bottom of the pump cylinder and surrounding the chamber 18, an outer closed cylinder 2 in which the pump

cylinder is located, a downwardly extending sheath 37, through which the piston rod 12 passes, and a liquid 39 surrounding the sheath and pump cylinder, substantially as described.

13. The combination of the pump cylinder 1, having a plunger 5 movable therein, a centrally disposed ring 11 on said plunger, packing 15 in said ring and means for compressing the same, a piston rod 12 hollow for a portion of its length secured to said ring, valves and ports in said plunger with the valve 14 seated in the bottom of said pump cylinder 1, a hollow valve stem 13 with perforations 21 passing through the packing 15 in the said plunger, the valve 14 being provided with a downwardly extending spindle 16, nuts 20 on the spindle, a chamber 18 with perforations 22 secured to the bottom of the pump cylinder, the spindle of the valve passing through this chamber the bottom of which arrests the upward motion of the valve, and another chamber 23 secured to the bottom of the pump cylinder and surrounding the chamber 18, an outer closed cylinder 2 in which the cylinder 1 is located, a downwardly extending sheath 37, through which the piston rod 12 passes, a liquid 39 surrounding the sheath and pump cylinder, an auxiliary cylinder 40 disposed between the outer cylinder 2 and pump cylinder 1, and a pipe coil 25 disposed between the pump cylinder 1 and the auxiliary cylinder 40, substantially as described.

14. In a refrigerating apparatus a pump cylinder, a plunger movable in said cylinder, and having a centrally disposed stuffing box, a hollow piston rod secured in said stuffing box in combination with a valve seated in the bottom of the pump cylinder, a perforated and hollow valve rod secured to said valve and passing through the said stuffing box into the hollow piston rod said valve being operated by the motion of the plunger, substantially as described.

15. The improvement in cold producing apparatus, which consists in an outer cylinder with closed ends, containing a pump adapted to receive and compress within said cylinder a liquefiable gas, and containing cooling pipes conducting cold water around said pump, the said pipe being immersed in a non-volatile liquid, with suitable openings in and connections with the said cylinder for operating the pump and admitting and discharging the gas or refrigerating agent and the non-volatile liquid, substantially as described.

16. The combination of the outer cylinder 2, pump cylinder 1, open at the top and disposed within the outer cylinder a plunger 5 movable within the pump cylinder, a piston rod 12 and means for actuating the same secured to the plunger, an auxiliary cylinder 40 disposed between the outer and pump cylinders and a cooling coil 25 between the auxiliary and pump cylinders one end of the coil coming from a suitable source of supply and the other end leading to a drain, substantially as described.

17. The combination of the outer cylinder 2, pump cylinder 1 open at the top and disposed within the outer cylinder, a plunger 5 movable within the pump cylinder, a piston rod 12 and means for actuating the same secured to the plunger, an auxiliary cylinder 40 disposed between the outer and pump cylinders, a cooling coil 25 between the auxiliary and pump cylinders one end of the coil coming from a suitable source of supply and the other leading to a drain; deflector plates 42, 43, extending down into the outer cylinder and a pipe 54 leading from said outer cylinder, substantially as described.

18. The combination of the outer cylinder 2, a pump cylinder 1 open at the top and disposed within the outer cylinder, a plunger 5 movable within the pump cylinder, a piston rod 12 and means for actuating the same secured to the plunger, an auxiliary cylinder 40 disposed between the outer and pump cylinders and having an upwardly projecting conical top 41, and a cooling coil 25 between the auxiliary and pump cylinders and located below the conical top and the auxiliary cylinder the ends 26, 27, of the cooling coil passing out through the shells of the auxiliary and outer cylinders the ends 26 being provided with a valve 28, substantially as described.

19. The combination of the outer cylinder 2, deflector plates 42, 43, secured to the outer cylinder and extending downwardly therein, a pipe 54 leading from the outer cylinder opposite the deflector plates, a pump cylinder 1, open at the top and disposed within the outer cylinder, a plunger 5 movable within the pump cylinder, a piston rod 12 and means for actuating the same secured to the plunger, and auxiliary cylinder 40 disposed between the outer and pump cylinders and having an upwardly projecting conical top 41 and a cooling coil 25 between the auxiliary and pump cylinders, and located below the conical top of the auxiliary cylinder, the ends 26, 27, of the cooling coil passing out through the shells of the auxiliary and outer cylinders, the ends 26 being provided with a valve 28, substantially as described.

20. An outer cylinder for a gas compressor, comprising the cylinder 2 having the downwardly extending and elongated sheath 37 secured in the upper head 32, packing and means for compressing the same 38 in the upper end, like devices 39 in the lower end of the sheath, a lower head or bottom 3 having the valve seat and port 17, a casing 18 screwed to the head 3 having openings 22, a casing 23 screwed to the head 3, and surrounding the casing 18, and a pipe 24 leading from the casing 23, substantially as described.

21. An outer cylinder for a gas compressor, comprising the cylinder 2, having the down-

wardly extending and elongated sheath 37 secured in the upper head 32, packing and means for compressing the same 38 in the upper end, and like devices 39 in the lower end of the sheath, the lower head or bottom 3 having the valve seats and ports 17, a casing 18 screwed to the head 3 having openings 22, a casing 23, screwed to the head 3 and surrounding the casing 18 a pipe 24 leading from the casing 23, a pipe 30 leading into the outer cylinder 2, a temperature casing 35 adapted to hold a thermometer extending into the outer cylinder 2, a pipe 90 leading from near its bottom and a cock 91 leading from the bottom of the casing 23, substantially as described.

Signed at the city, county, and State of New York this 20th day of June, 1891.

EDWARD D. KENDALL.

Witnesses:
M. E. STODDARD,
H. DURBIN.