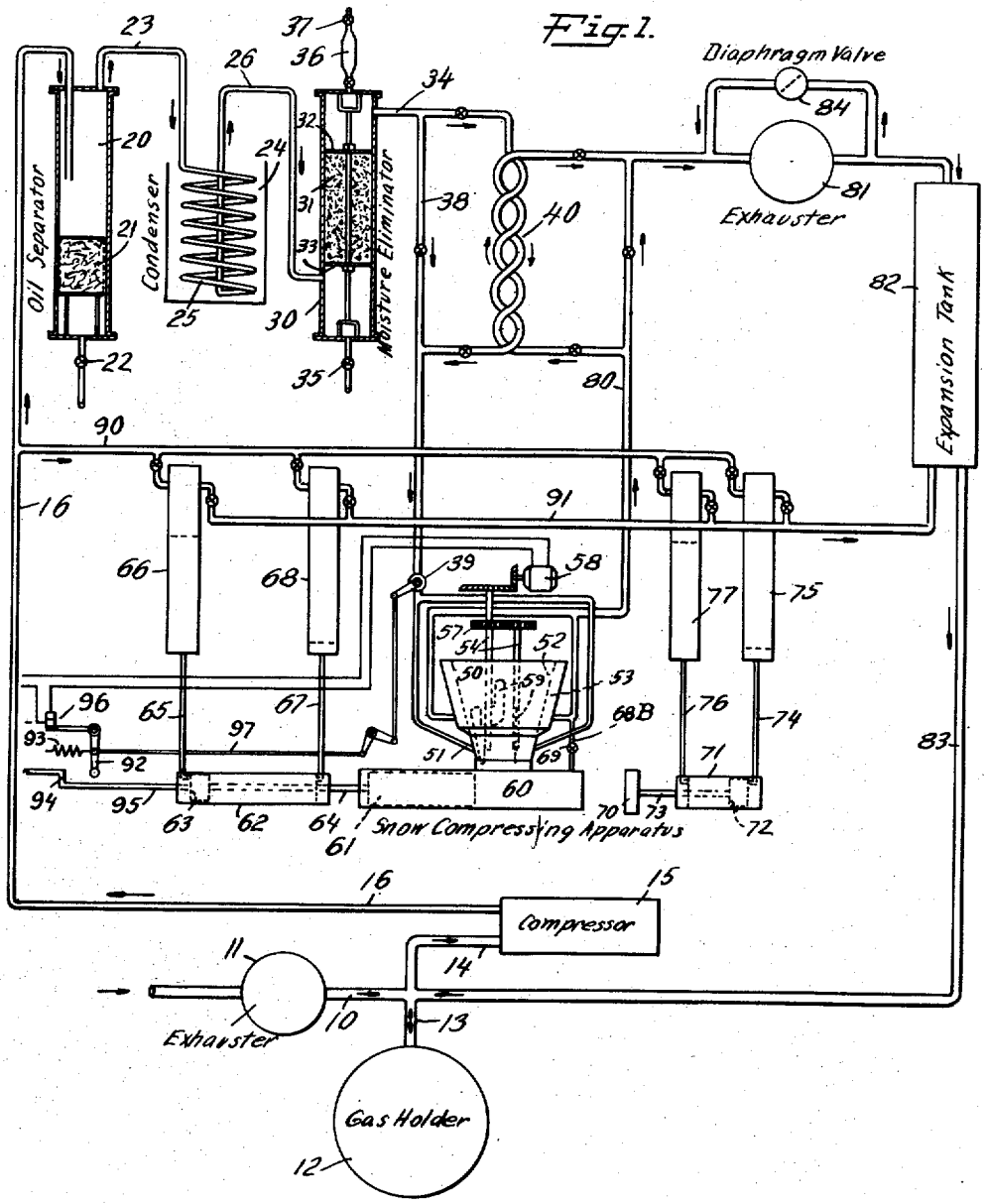
Dec. 24, 1935. H. W. COLE ET AL 2,025,698

GAS SOLIDIFYING APPARATUS

Filed May 22, 1928 3 Sheets-Sheet 1

Fig. 1.



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Filed May 22, 1928 3 Sheets-Sheet 2

Fig. 2.

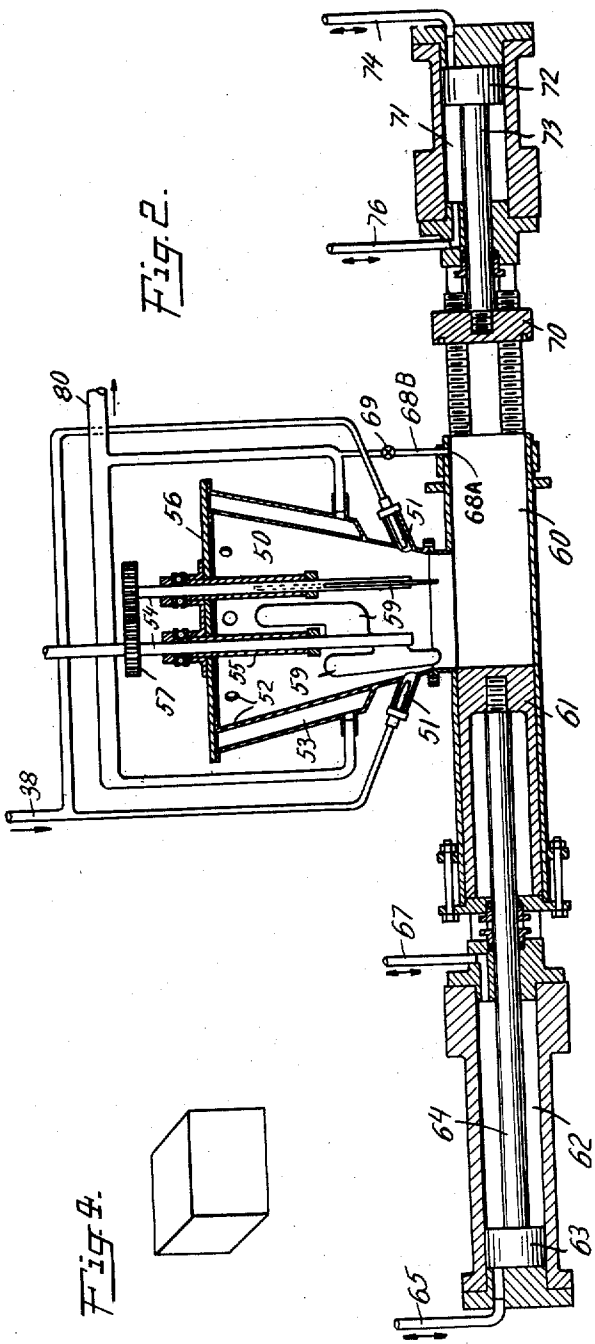


Fig. 3.

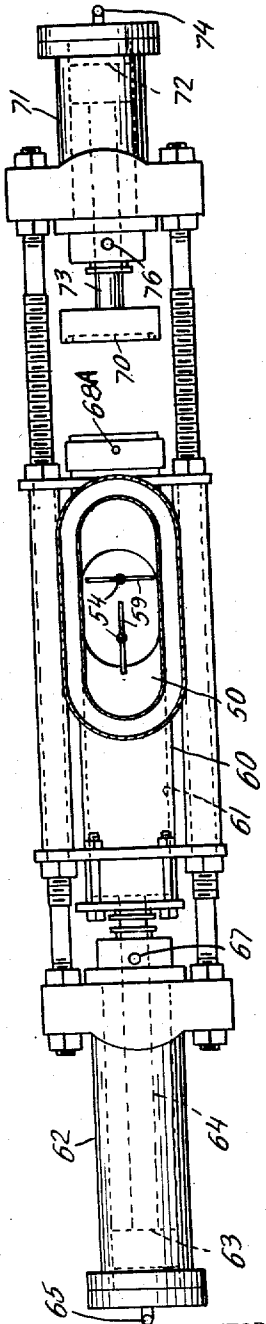


Fig. 4.

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Filed May 22, 1928 3 Sheets-Sheet 3

Fig. 5.

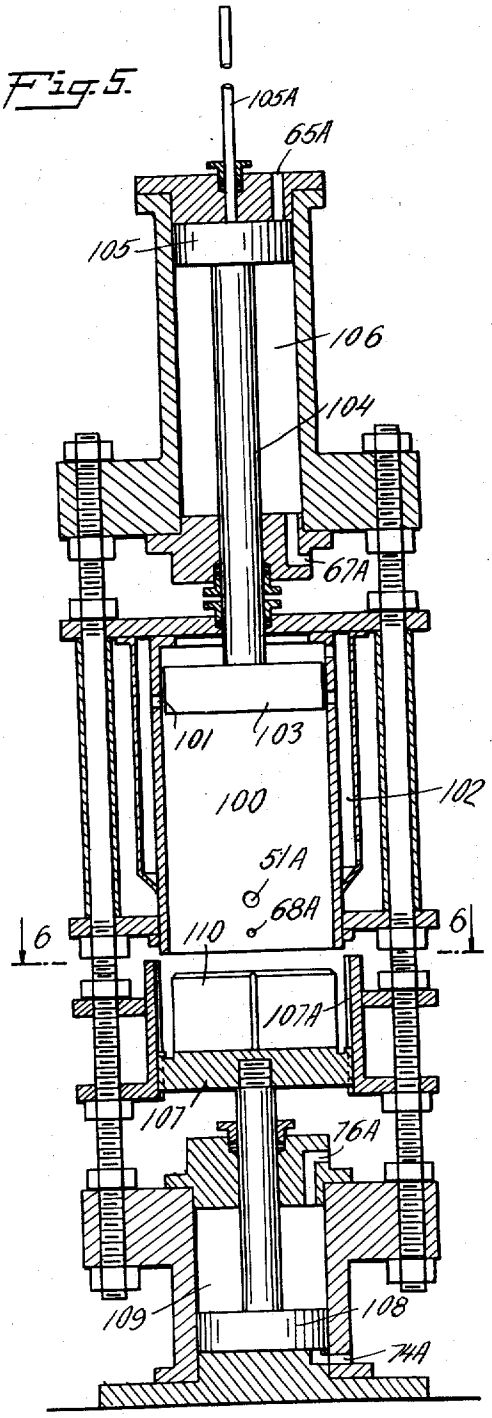


Fig. 6.

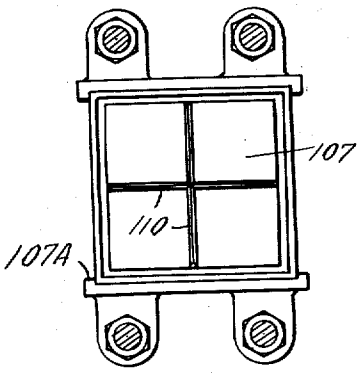
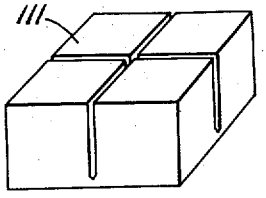


Fig. 7.



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UNITED STATES PATENT OFFICE

2,025,698

GAS SOLIDIFYING APPARATUS

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Application May 22, 1928, Serial No. 279,641

39 Claims. (Cl. 62—121)

This invention relates to improvements in gas soldifying apparatus, and has for its object to provide a simple efficient apparatus for solidifying gaseous matter by refrigeration and compression. Our apparatus is especially designed to make solid cakes of carbon dioxide and will be described as applied to that particular use.

One of the objects of this invention is to overcome the disadvantageous features of such apparatus as has been available for this specific purpose and to provide a machine which produces the desired product rapidly and economically.

Other objects will appear in the following specification.

Referring to the drawings, Fig. 1 is a diagrammatic representation of a system of refrigeration which embodies our invention;

Fig. 2 is a sectional elevation, and

Fig. 3 is a plan view, partly in section of certain parts of the apparatus which are shown in Fig. 1;

Fig. 4 is a perspective view of the product of the apparatus shown in Figs. 2 and 3;

Fig. 5 is a sectional elevation of a modified form of that part of the mechanism which is shown in Figs. 2 and 3;

Fig. 6 is a sectional plan view of the apparatus shown in Fig. 5, the section being taken on line 6—6 of the latter figure; and

Fig. 7 is an inverted perspective view of the product of the apparatus shown in Fig. 5.

In Fig. 1 the gas from any source is led to the solidifying plant through a pipe 10, being impelled by an exhauster 11, preferably of a motor-driven positive type. A gas holder 12 is connected by a pipe 13 with the supply pipe 10. As this is of the usual inverted bell-type, it serves to maintain a sufficient supply of gas and to maintain it at a practically constant pressure. While we do not claim as a part of our invention and have not shown the devices for accomplishing a convenient feature, it is usual to drive the exhauster 11 intermittently by an electric motor controlled by contacts on the gas holder 12. A revolution counter on the exhauster 11 may be used as a measuring or metering device.

The gas to be solidified is led through a pipe 14 into a compressor 15 from which it is discharged through a pipe 16 at a desired high pressure, for example, about 1200 lbs. per square inch.

A certain amount of oil is carried along from the compressor with the gas, often to an objectionable extent. It has been difficult to remove this oil. We discharge the gas heated by the compressor downwardly, into an oil separator 20 in the form of a vertically disposed cylinder.

In the lower part of this separator is a pervious mass of material, such for example as steel turnings. These are contained in and supported by a wire basket 21 in such a way as to leave a space under the mass. The oil is deposited in this pervious mass, which serves the further purpose of preventing the velocity of the gas from carrying the oil out from the top of the separator. 22 is a valve through which the oil may be drained. The gas is taken out from the top of the separator and led by a pipe 23 into a condenser.

The condenser comprises a receptacle 24, in which a circulation of cooling water is maintained in the usual manner, and a pipe coil 25. Here the compressed gas is liquefied.

From the condenser the liquefied gas is led by a pipe 26 to the lower portion of a moisture and air eliminator 30. This too comprises a vertically disposed cylindrical casing. In it a mass 31 of suitable material, such as carbon, is held between perforated headers 32 and 33, positioned to leave spaces below and above the permeable mass. The liquefied gas is admitted into the lower of these spaces and discharged through a pipe 34 from the upper space. The charcoal permits the liquefied gas to move upwardly but is sufficiently large in cross sectional area, greatly to reduce its velocity. Any water which has passed from the compressor and has been condensed will settle in the bottom of the eliminator as it is heavier than the liquefied gas, and can be withdrawn by opening valve 35.

Air or non-liquid gases accumulate in a chamber 36 at the top of the eliminator, from which they may be discharged through a valve 37.

The purified liquefied gas is then led to the chamber 50 into which it is discharged through nozzles 51, 51 (Fig. 2), its flow being controlled by an automatic valve 39. From the eliminator 30 to the nozzles, the liquefied gas passes through a direct path 38 or through a countercurrent heat exchanger 40, or partly through both. Valves are provided to control its path.

In the chamber 50 the liquefied gas expands into a gas, some of which solidifies as frozen snow-like crystals. These drop down into a compression chamber 60, toward which nozzles 51, 51 are directed and in which is a plunger 61. The other end of this compression chamber is closed by a movable head 70. The unfrozen gas escapes from chamber 50 through orifices 52 into a jacket 53, from which it is led by a pipe 80 to a

circulating exhauster 81, either directly or through the heat exchanger 40, or partly through both, as determined by the conditions of the valves shown. By adjusting the proportions of the high pressure liquefied gas and of the cold low pressure gas which pass through the heat exchanger, the temperature of the liquefied gas at the nozzles may be controlled.

The exhauster 81 drives the low pressure gas to an expansion tank 82 from which it is returned to the gas holder 12 by a pipe 83. The expansion tank serves as a cushion to prevent large pressure variations in the low pressure side of the system.

Around the exhauster 81 a by-pass is provided in which is a diaphragm valve 84 which may be set to maintain automatically a definite pressure condition within the interconnected chambers 50 and 60 and the lines and apparatus between them and the exhauster 81.

62 is a cylinder in which is a piston 63 having a rod 64 connected with plunger 61. One end of cylinder 62 is connected by a pipe 65 with a pressure tank 66 and its other end is connected by a pipe 67 with a pressure tank 68.

71 is a cylinder in which is a piston 72 having a rod 73 connected with head 70. One end of cylinder 71 is connected by a pipe 74 with a pressure tank 75 and its other end is connected by a pipe 76 with a pressure tank 77. These four pressure tanks contain water, glycerine, oil or other liquid, for actuating the pistons 63 and 72.

90 is a pipe leading from the pressure pipe 16 to the four pressure tanks and having valve controlled connections therewith above the liquid.

91 is an exhaust pipe leading from the four pressure tanks to the expansion tank 82 and having valve controlled connections with the pressure tanks above the water therein.

We will now describe the construction and operation of the apparatus shown in Figs. 2 and 3. The snow chamber 50 has parallel sides and its ends are curved. In it are two vertical shafts 54 which extend through sleeves 55 in the cover 56. These are geared at 57 to rotate in opposite directions and driven by an electric motor 58 (Fig. 1).

On the shafts are blades or scrapers 59 positioned 90° apart. As the gas solidifies, the movement of these blades agitates it and prevents it from accumulating in the chamber 50 or sticking to its sides, so that such of the gas as solidifies in the expansion chamber 50 falls by gravity into the compression chamber 60. When the plunger 61 is retracted, there is unobstructed communication between the chamber 50 and the compression chamber 60, and this communication is closed at its sides so that it is gas-tight.

High pressure non-liquefied gas admitted to the pressure tank 75 above the water therein, forces the water through pipe 74 into cylinder 71 at the right hand side of piston 72. At this time the space above the water in pressure tank 77 is in communication with the low pressure pipe 91 so that piston 72 moves the head 70 to the left to close the end of the compression chamber.

After a desired amount of solidified gas has accumulated in the compression chamber, the upper part of pressure tank 68 is connected to the low pressure pipe 91 and the upper part of pressure tank 66 is connected to the high pressure pipe 90. The water admitted to cylinder 62 through pipe 65 forces piston 63 and plunger 61 to the right. As plunger 61 advances, it first closes communication between the expansion chamber 50 and the compression chamber 60 and then compresses the solidified gas between itself and the head 70 into a solid cake.

During this part of the operation any unfrozen gas or air which might be entrapped with the solidified gas is forced through a pipe 68B and a check valve 69 into the low pressure pipe 80. This is an important feature of our invention as the entrapment of gas and air has heretofore made it difficult to produce solid cakes of desired form.

Now the hydraulic pressure back of piston 63 is released and the head 70 removed from the end of the compression chamber by proper manipulation of the gas connections between pressure tanks 75 and 77 and the pipes 90 and 91. Then the plunger 61 is caused to move further to the right to eject the cake.

In Fig. 1 there is shown an arrangement for automatically controlling the valve 39 and the circuit for motor 58. This comprises a bell crank lever 92 arranged to be moved in one direction by a spring 93 and in the other direction by an arm 94 projecting from a rod 95 connected with piston 63. When the latter moves plunger 61 far enough to cut off communication between chambers 50 and 60, the motor circuit is broken by the separation of contacts 96 and the valve 39 is closed by connections 97. When the plunger is moved back, the motor circuit closes and valve 39 opens.

The modified apparatus shown in Figs. 5 and 6 comprises a rectangular chamber 100 having orifices 101 communicating with an outer jacket 102. The nozzles are placed at 51A. 103 is a plunger connected by a rod 104 with a piston 105 in a cylinder 106. This plunger fits loosely in chamber 100 to permit gases to pass it as it descends. Ports 65A and 67A are provided for connection with the water pipes 65 and 67 respectively. The port 68A is for connection with the vent pipe 68B.

The lower end of the chamber 100 is arranged to be closed by a head 107 which is connected with a piston 108 in cylinder 109. This head runs in fixed guides 107A. The ports 74A and 76A are connected with water pipes 74 and 76.

110 is a cross-like metallic member removably seated on head 107.

This apparatus is operated in the manner previously described. 105A is an indicator rod by means of which the movement of the piston 105 and plunger 103 may be observed. When the cake of ice is formed, the member 110 will be embedded in it. It can be removed to form the multiple block shown at 111 in Fig. 7 or the four parts of the block may be broken apart on the planes formed by this member. This obviously has the advantage of forming several blocks at once.

We realize that other forms of apparatus than those shown in order to illustrate our invention can be used without departing from its spirit and scope and intend no limitations other than those imposed by the following claims.

What we claim is:

1. Gas solidifying apparatus including an expansion chamber, a compression chamber below and in gas-tight communication with the expansion chamber, stirring means in the expansion chamber above said communication, means for expanding a liquefied gas to produce an accumulation of solidified gas in the compression chamber, a plunger arranged to close the communication between said chambers and to compress

the solidified gas, and a movable head against which the solidified gas is compressed.

2. A gas solidifying system including a gas compressor, a condenser, a closed chamber, means for supplying liquefied gas to said chamber for expansion to form an accumulation of solidified gas in the chamber, a gas return line having an exhauster therein for leading the unsolidified portion of the expanded gas from the chamber back to the gas compressor, and means in said gas return line for maintaining a definite pressure condition in said chamber.

3. A gas solidifying system including a gas compressor, a condenser, a closed chamber, means for supplying liquefied gas to said chamber for expansion to form an accumulation of solidified gas in the chamber, a gas return line for conducting the unsolidified portion of the expanded gas from the chamber back to the compressor, means in said gas return line controlling the flow of gas there-through, an expansion chamber in said return line, a by-pass around the gas flow controlling means in said line, and means for regulating said by-pass to thereby maintain a definite pressure condition in said chamber.

4. A solidified gas producing and compressing apparatus including a closed compression chamber, means for supplying a liquefied gas to said chamber to form an accumulation of solidified gas in the chamber, a plunger for compressing the solidified gas, a head against which said solidified gas is compressed, and hydraulic means for moving the plunger and the head.

5. A gas solidifying apparatus including a gas compressor, means for liquefying the compressed gas, a compression chamber, means for supplying liquefied gas for expansion to form an accumulation of solidified gas in the chamber, means for compacting the solidified gas in the compression chamber, a return line for conducting the unsolidified portion of the expanded gas from the compression chamber back to the gas compressor, a heat exchanger, and adjustable means for passing desired portions of the liquefied gas and of the expanded gas from the compression chamber through the heat exchanger.

6. In apparatus of the class described, a chamber, a conduit for supplying liquefied gas to said chamber for expansion in the chamber, means for conducting expansion gases from the chamber, a heat exchanger interrelating said liquid supply conduit and said gas conducting means, by-passes around the heat exchanger for the liquefied gas and for the expansion gas, and means for regulating the flow of said fluids through the heat exchanger.

7. A refrigerating system including a closed chamber, means for supplying liquefied gas to said chamber, adjustable means for controlling the temperature of the entering liquefied gas, and adjustable means for maintaining a desired pressure in said chamber.

8. A gas solidifying and compressing apparatus, including a chamber, means for supplying liquefied gas to said chamber to form an accumulation of solidified gas in the chamber, a plunger in the chamber, a head closing an end of said chamber, means for actuating the plunger to compress solidified gas in the chamber against said head, and means for moving the head to permit the removal of the compressed solidified gas.

9. Gas solidifying and compressing apparatus, including a source of liquefied gas, an expansion chamber, a compression chamber below and in gas-tight unobstructed communication with the expansion chamber, means for supplying liquefied gas from said source to produce an accumulation of solidified gas in the compression chamber, a plunger arranged to close the communication between said chambers and to compress the solidified gas, and a movable member arranged to form the closure for the compression chamber against which the solidified gas is compressed.

10. A gas solidifying and compressing apparatus including a compression chamber, means for supplying liquefied gas to produce an accumulation of solidified gas in the chamber, a plunger for compressing the solidified gas, a movable head arranged to form the closure of the compression chamber against which the solidified gas is compressed, and means controlled by the movement of the plunger for controlling said liquefied gas supplying means.

11. A gas solidifying apparatus including a closed chamber, means for supplying liquefied gas to said chamber to convert a portion of the liquefied gas into a solid and a portion into a gas, a conduit for withdrawing said gas from the chamber, and means in the conduit for maintaining a definite pressure in the chamber.

12. A gas solidifying apparatus including a closed chamber, means for supplying liquefied gas to said chamber for expansion to convert a portion of the liquefied gas into a solid and a portion into a gas, a conduit for withdrawing gas from the chamber, and adjustable means in the conduit for maintaining a definite pressure in the chamber.

13. Gas solidifying apparatus including a closed chamber, means for supplying liquefied gas to said chamber for expansion to form an accumulation of solidified gas in the chamber, adjustable means for controlling the temperature of the entering liquefied gas, adjustable means for maintaining a desired pressure in said chamber, and means for compressing the solidified gas in the chamber.

14. A gas solidifying apparatus including a compression chamber closed to atmosphere, means for supplying a liquefied gas to form an accumulation of solidified gas in the chamber, means for maintaining a definite pressure in said chamber, and means for compressing the solidified gas in the chamber.

15. A gas solidifying apparatus including a compression chamber closed to atmosphere, means for supplying a liquefied gas to form an accumulation of solidified gas in the chamber, adjustable means for maintaining a definite pressure in said chamber, and means for compressing the solidified gas in the chamber.

16. Gas solidifying and compressing apparatus, including a compression chamber, means for supplying a liquefied gas to said chamber for expansion to form a portion thereof into a solid and a portion into gas, a conduit for withdrawing gas from said chamber, a plunger for compressing the solidified gas in the chamber, a head against which said solidified gas is compressed by said plunger, a vent connected to the space in which the solidified gas is compressed, to prevent entrapment of gas between the plunger and the head, and means for conducting gas from said vent back to said conduit.

17. In apparatus for forming a liquefied gas into a solid mass, the combination of means for expanding the liquefied gas to form solid parti-

cles, means for compressing the particles into a solid mass, and rotatable means to feed said particles to said compressing means.

18. In gas solidifying and compressing apparatus, the combination with an open ended chamber, and means for supplying liquefied gas to said chamber to form particles of solidified gas in the chamber, of means for compressing said particles into a compacted mass, means for closing said chamber at its open end during the compressing operation, and means for moving said closing means after the compressing operation for removal of the compacted mass, said compressing means being adapted to then eject the compacted mass.

19. In gas solidifying and compressing apparatus, the combination with an open ended chamber and means for supplying liquefied gas to said chamber to form particles of solidified gas in the chamber, of means for compressing said solidified gas particles into a compacted mass, a cylinder and piston, and means operated thereby for closing said chamber during the compressing operation.

20. The method of making carbon dioxide snow from liquid carbon dioxide by releasing it from critical pressure, which method includes cooling the liquid; permitting free, sudden expansion of said liquid by discharge through a nozzle; depositing the snow by maintaining the gaseous and solid products of the expansion in a relatively large volume chamber in the intensely cold atmosphere produced by such expansion, and while in such atmosphere, breaking up the deposited snow, collecting the broken snow and compressing it to solid form.

21. The method of making carbon dioxide snow from liquid carbon dioxide by releasing it from critical pressure, which method includes permitting rapid expansion of the liquid by discharge from a pipe, depositing the resultant snow by maintaining the gaseous and solid products of the expansion in a relatively large volume chamber in the intensely cold atmosphere produced by such expansion, and while in such atmosphere, dislodging and collecting the deposited snow for the purposes described.

22. Gas solidifying and compressing apparatus including a source of liquefied gas, an expansion chamber, a compression chamber below and in gas-tight unobstructed communication with the expansion chamber, means for supplying the liquefied gas to the chamber for expansion to produce an accumulation of solidified gas in the compression chamber, in combination with means for closing communication between the chambers and compressing the solidified gas in said compression chamber.

23. A gas solidifying and compressing apparatus including a closed compression chamber, means for supplying a liquefied gas to said compression chamber to form an accumulation of solidified gas in the chamber, a plunger for compressing the solidified gas, a movable abutment element against which said solidified gas is compressed, and a power cylinder for actuating the plunger.

24. Gas solidifying and compressing apparatus, including an expansion chamber, a compression chamber in gas-tight unobstructed communication with the expansion chamber, means for supplying a liquefied gas to produce an accumulation of solidified gas in the compression chamber, a plunger arranged to close the communication between said chambers and to compress the solidified gas, and a movable element forming an end of the compression chamber and against which the solidified gas is compressed.

25. Gas solidifying and compressing apparatus including means providing a gas solidification chamber and a solidified gas compression chamber in direct communication with each other, means for supplying a liquefied gas to said solidification chamber to form solidified gas which is adapted to move into said compression chamber, means for compressing the solidified gas in said compression chamber, and a head against which said solidified gas is compressed by said compressing means, said means being adapted to eject a compressed mass of solidified gas through an opening in the compression chamber closed by said head, and to close said solidification chamber off from said compression chamber.

26. In a gas solidifying apparatus, the combination of an expansion chamber, means for supplying liquefied gas to said chamber for expansion to form solidified gas, a solidified gas receiving chamber below and in gas-tight and unobstructed communication with said expansion chamber, movable means for closing the communication between said chambers, and a movable member for closing an opening of said receiving chamber, through which opening solidified gas may be removed from said receiving chamber.

27. Gas solidifying and compressing apparatus including a source of liquefied carbon dioxide, an expansion chamber, a compression chamber below and in gas-tight, unobstructed communication with the expansion chamber, means for supplying liquefied gas to produce an accumulation of solidified gas in the compression chamber, a plunger arranged to close the communication between said chambers and to compress the solidified gas in the compression chamber, and a movable member arranged to form a closure for the compression chamber, against which the solidified gas is compressed by said plunger.

28. Gas solidifying and compressing apparatus including a compression chamber, means for suppling a liquefied gas for expansion to produce an accumulation of solidified gas in the compression chamber, a plunger arranged to compress the solidified gas in said compression chamber, a movable head arranged to form a closure for the compression chamber against which the solidified gas is compressed, and means for controlling the gas pressure in said compression chamber.

29. A gas solidifying and compressing apparatus including a closed compression chamber, means for supplying a liquefied gas to said compression chamber to form an accumulation of solidified gas in the chamber, a plunger for compressing the solidified gas, a movable abutment element against which said solidified gas is compressed, and means for actuating the plunger to compress the solidified gas against said abutment element.

30. In gas solidifying and pressing apparatus, a normally closed and gas-tight pressing chamber having a movable closure member for opening and closing the chamber, fluid pressure means for moving said closure member to chamber closing position and for maintaining the member in closed position against pressures within the chamber, means for supplying said chamber with a mass of solidified gas, a pressing plunger reciprocal in said chamber and formed for passage of gas therepast as the plunger is moved in

the chamber, fluid pressure means for moving said plunger to press a mass of solidified gas in said chamber when said closure member is in chamber closing position, and said closure member, upon completion of the pressing operation, being movable to chamber opening position for removal of the pressed solid from the chamber.

31. In a gas solidifying and block forming apparatus, a normally closed and gas-tight solidification and block pressing chamber, means for supplying a liquefied gas to said chamber when the chamber is closed for expansion to convert a portion of the liquid to a solid and a portion to a gas, means for withdrawing the unsolidified gas from the chamber during accumulation of a mass of solidified gas in the chamber, a pressing plunger in the chamber movable to press an accumulated mass of solidified gas into a block, said plunger normally inactive during expansion of the liquefied gas and accumulation of the solidified gas in the chamber, means for actuating the plunger to press an accumulated mass of the solidified gas in the chamber into a dense, block of solidified gas, and means for opening said chamber after completion of the block by said pressing plunger for removal of the block from the chamber.

32. In gas solidifying and pressing apparatus, a gas solidifying and pressing chamber having a discharge opening, a closure member for said chamber opening, said member movable to and from position closing said opening to seal the chamber gas-tight, means for moving said closure member and for maintaining the same in chamber sealing position against opening under the action of pressures within the chamber, means for supplying gas in fluid form to the chamber when the latter is sealed by said closure member for conversion of a portion of the gas into a solid and a portion to a gas, means for withdrawing the unsolidified gas from the chamber, a pressing plunger in the chamber movable to press a mass of the solidified gas collected in the chamber against said closure member under sufficient pressure to compress the solidified mass into a dense block.

33. In a gas solidifying and pressing apparatus, a solidifying and pressing chamber having one end thereof open, a closure head movable to close the open end of said chamber and to seal the chamber from the atmosphere, means for moving said closure head to and from chamber closing position and for maintaining said head in chamber closing position against pressures within the chamber, a pressing plunger reciprocal in said chamber for pressing a mass of solidified gas in the chamber into a block against said closure head while the latter is held in chamber closing position by said means, said plunger formed for passage of gas therepast as the plunger is moved in the chamber, means for forcing said plunger into block pressing engagement with a mass of solidified gas in the chamber, and said closure head being movable to position opening the end of the chamber upon completion of the block pressing for removal of the block through the chamber open end.

34. In a gas solidifying and pressing apparatus, a vertically disposed closed top and open bottom gas solidifying and pressing chamber, a vertically disposed fluid pressure cylinder below said chamber having a vertically reciprocal plunger therein, a chamber closing head mounted on the upper end of said pressure cylinder and vertically movable therewith between raised position closing the open bottom of the chamber and sealing the chamber from the atmosphere, and lowered position opening the bottom of the chamber, a pressing plunger vertically reciprocal in said chamber for pressing a mass of solidified gas in the chamber into a block against said bottom closure head when the latter is in raised chamber closing position, fluid pressure means for operating said pressing plunger, means for supplying gas in fluid form to the chamber for expansion to convert a portion thereof to a solid and a portion to a gas when the closure head is in chamber sealing position and the pressing plunger is in raised inactive position in the chamber, means for withdrawing the gas from the chamber during formation of the solid mass, and said closing head upon completion of a block by said pressing plunger being movable downwardly from closing position with the block supported on the head to remove the block from the chamber.

35. In a solidified gas pressing apparatus, the combination of a pressing chamber having an open end, a closure head for the open end of the chamber for closing the chamber and sealing the same from the atmosphere, said chamber and closure head being relatively movable to position the head in chamber closing position and in chamber opening position removed from the chamber, means for relatively moving the chamber and head to and from chamber closing position and for maintaining the head closed against pressures within the chamber, means for expanding compressed gas in the chamber when closed by said head to form a mass of solidified gas in the chamber, a pressing plunger in the chamber operable to press a mass of solidified gas formed therein into a block against said closure member when the latter is held in chamber closing position, and means for operating said plunger.

36. In gas solidifying and pressing apparatus, a gas solidifying and pressing chamber having one end thereof open, a closure head movable between position closing the open end of the chamber to seal the chamber from atmosphere, and position removed from and opening the chamber end for discharge of material therefrom, means for moving said closure head between chamber opening and closing positions and for maintaining the head under sufficient pressure when in closed position to overcome pressures within the chamber acting to force the head to open position, a pressing plunger reciprocal in the chamber toward and from said closure head and in normal inactive position disposed in the chamber spaced from said head, means for supplying a compressed gas to said chamber when the closure head is in chamber closing position and the pressing plunger is in normal inactive position to convert a portion of said gas into solidified form in the chamber between the plunger and pressing head, means for withdrawing the unsolidified gas from the chamber during formation of the solidified gas therein, and means for forcing said pressing plunger toward a mass of solidified gas to press such mass into a block against the closure head, said closure head being movable after completion of the block pressing by said plunger to position removed from the chamber for unobstructed removal of the block from the chamber.

37. A gas solidifying and pressing apparatus, including, a closed expansion chamber, a compression chamber in gas-tight, unobstructed communication with the expansion chamber, means for expanding a compressed gas to produce an

accumulation of solidified gas in the compression chamber, a plunger arranged to compress the solidified gas, and a movable head arranged to form the closure for the compression chamber to seal such chamber from the atmosphere and against which the solidified gas is compressed by said plunger.

38. The method of producing blocks of solidified gas which includes the steps of, supplying a liquefied gas to a closed chamber that is sealed from the atmosphere and converting a portion of the liquefied gas to a solid and a portion thereof to a gas in the chamber by expansion, maintaining the chamber volume constant while expanding the liquefied gas and accumulating a mass of the solidified gas therein, withdrawing the unsolidified gas from the chamber during formation and accumulation of the solidified gas in the chamber, shutting off the supply of liquefied gas to the chamber to stop production of solid and gas therein after a desired mass of the solid has been accumulated in the chamber, mechanically applying pressure to the mass of solidified gas in the chamber while the chamber is closed to press the mass into a dense block of solidified gas, and finally opening the chamber to atmosphere and removing the completed block therefrom.

39. The method of producing blocks of solid carbon dioxide from liquid carbon dioxide, which method includes supplying liquid carbon dioxide to a chamber that is closed to atmosphere and converting the liquid to solid and gaseous carbon dioxide in such closed chamber by expansion of the liquid carbon dioxide, collecting the solid carbon dioxide in the chamber while withdrawing the gaseous carbon dioxide from the chamber, maintaining a definite pressure in the closed chamber during formation and collection of the solid carbon dioxide therein, shutting off the supply of liquid carbon dioxide to the chamber after a desired mass of solid has been collected in the chamber, then pressing the mass of solid to a dense block of solid carbon dioxide in the chamber, and finally opening the chamber and removing the block therefrom.

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DISCLAIMER

2,025,698.—*Harry W. Cole*, New Rochelle, and *Malcolm W. McLaren*, Jackson Heights, N. Y. GAS SOLIDIFYING APPARATUS. Patent dated Dec. 24, 1935. Disclaimer filed Jan. 14, 1947, by the inventors and the assignee, *International Carbonic Engineering Company*.

Hereby enter this disclaimer to claims 4, 8, 14, 15, 18, 19, 23, 28, 29, 30, 31, 32, 33, 35, 36, 38 and 39 of said patent.

[*Official Gazette February 18, 1947.*]

accumulation of solidified gas in the compression chamber, a plunger arranged to compress the solidified gas, and a movable head arranged to form the closure for the compression chamber to seal such chamber from the atmosphere and against which the solidified gas is compressed by said plunger.

38. The method of producing blocks of solidified gas which includes the steps of, supplying a liquefied gas to a closed chamber that is sealed from the atmosphere and converting a portion of the liquefied gas to a solid and a portion thereof to a gas in the chamber by expansion, maintaining the chamber volume constant while expanding the liquefied gas and accumulating a mass of the solidified gas therein, withdrawing the unsolidified gas from the chamber during formation and accumulation of the solidified gas in the chamber, shutting off the supply of liquefied gas to the chamber to stop production of solid and gas therein after a desired mass of the solid has been accumulated in the chamber, mechanically applying pressure to the mass of solidified gas in the chamber while the chamber is closed to press the mass into a dense block of solidified gas, and finally opening the chamber to atmosphere and removing the completed block therefrom.

39. The method of producing blocks of solid carbon dioxide from liquid carbon dioxide, which method includes supplying liquid carbon dioxide to a chamber that is closed to atmosphere and converting the liquid to solid and gaseous carbon dioxide in such closed chamber by expansion of the liquid carbon dioxide, collecting the solid carbon dioxide in the chamber while withdrawing the gaseous carbon dioxide from the chamber, maintaining a definite pressure in the closed chamber during formation and collection of the solid carbon dioxide therein, shutting off the supply of liquid carbon dioxide to the chamber after a desired mass of solid has been collected in the chamber, then pressing the mass of solid to a dense block of solid carbon dioxide in the chamber, and finally opening the chamber and removing the block therefrom.

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DISCLAIMER

2,025,698.—*Harry W. Cole*, New Rochelle, and *Malcolm W. McLaren*, Jackson Heights, N. Y. GAS SOLIDIFYING APPARATUS. Patent dated Dec. 24, 1935. Disclaimer filed Jan. 14, 1947, by the inventors and the assignee, *International Carbonic Engineering Company*.

Hereby enter this disclaimer to claims 4, 8, 14, 15, 18, 19, 23, 28, 29, 30, 31, 32, 33, 35, 36, 38 and 39 of said patent.

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