

Oct. 16, 1934.

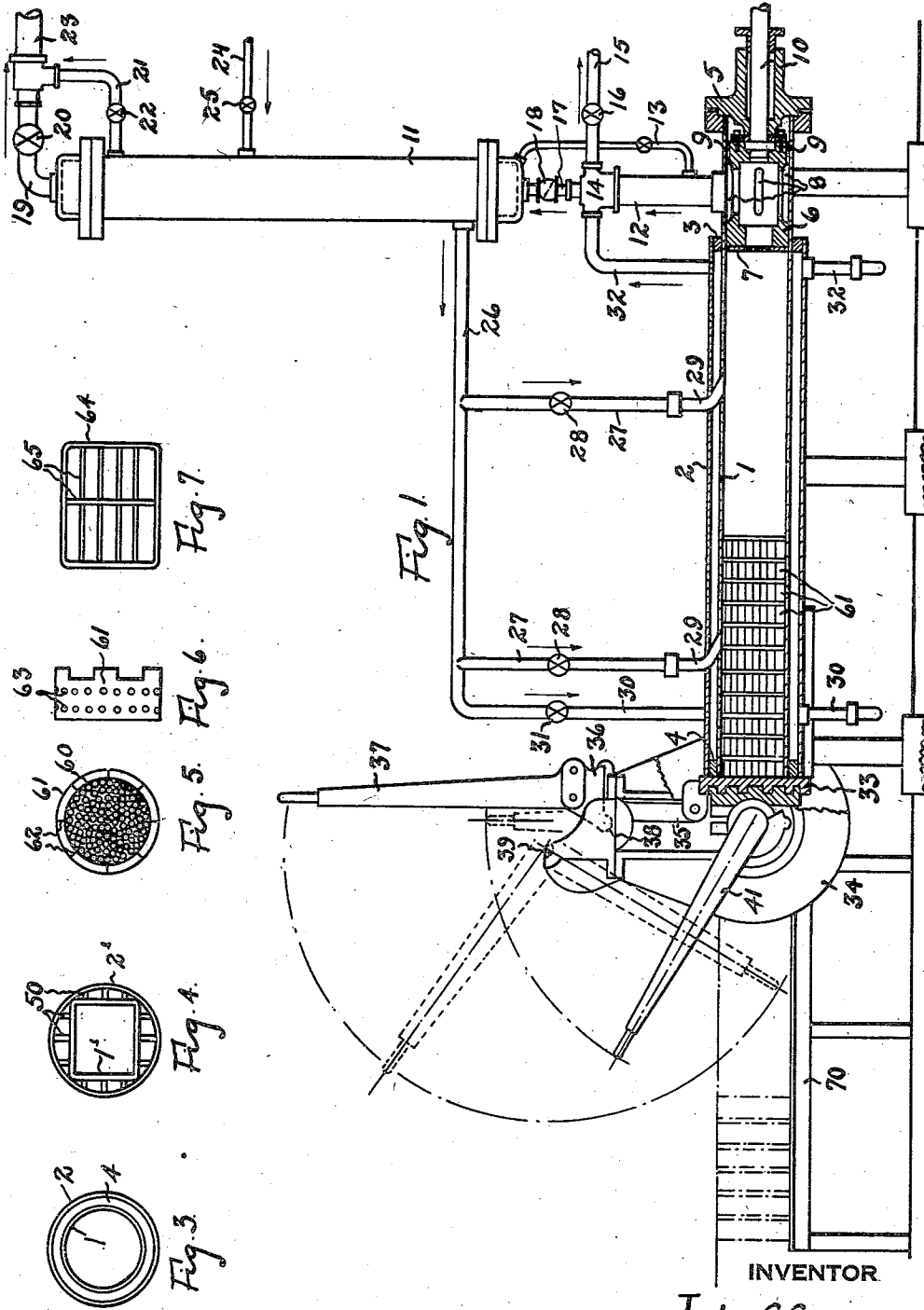
J. C. GOOSMANN

1,976,777

SOLID CARBON DIOXIDE MACHINE

Filed July 8, 1931

2 Sheets-Sheet 1



INVENTOR
Justus C. Goosmann
BY his ATTORNEYS. Darby & Darby.

Oct. 16, 1934.

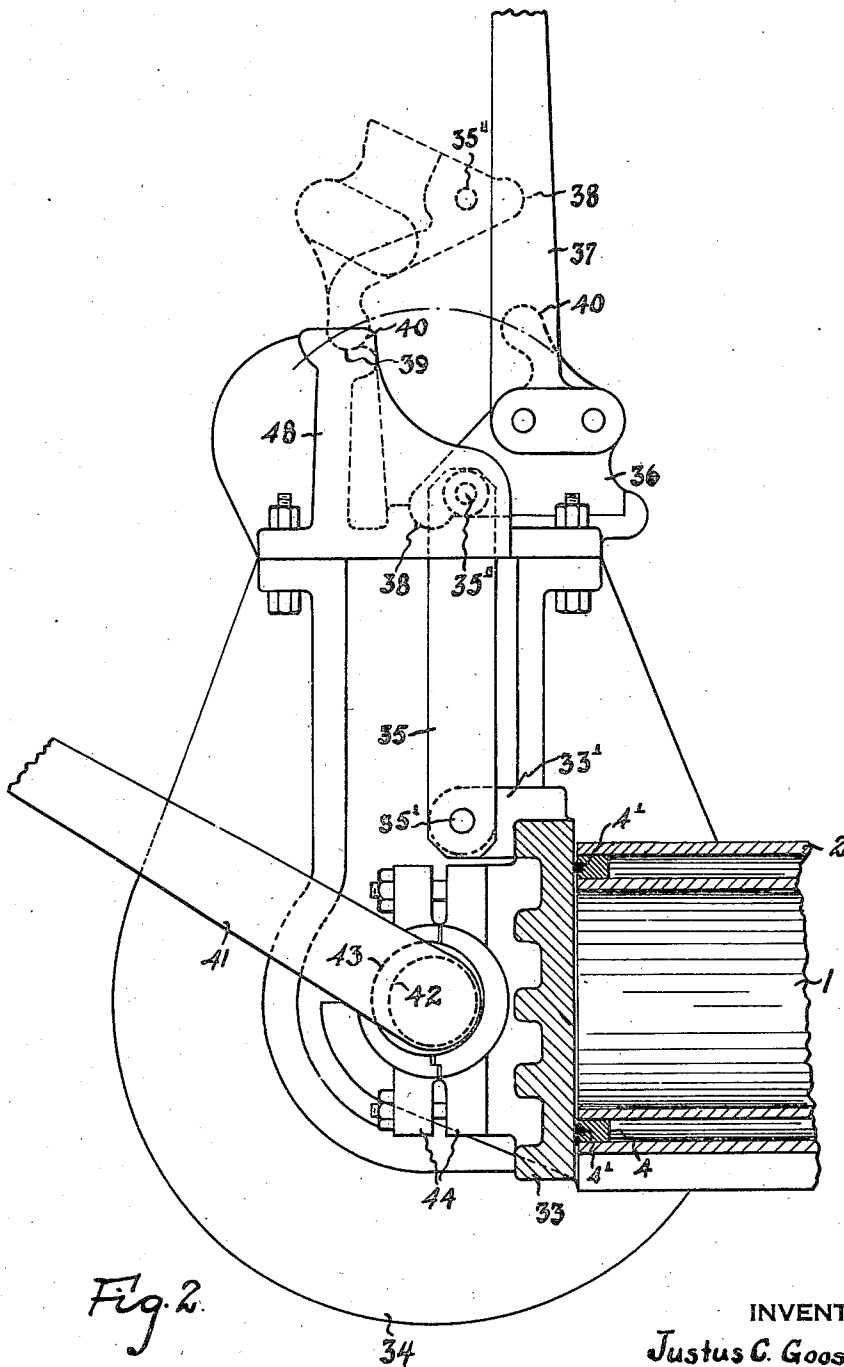
J. C. GOOSMANN

1,976,777

SOLID CARBON DIOXIDE MACHINE

Filed July 8, 1931

2 Sheets-Sheet 2



INVENTOR

Justus C. Goosmann

BY his ATTORNEYS... Dady & Dady.

UNITED STATES PATENT OFFICE

1,976,777

SOLID CARBON DIOXIDE MACHINE

Justus C. Goosmann, Mount Vernon, N. Y., assignor, by mesne assignments, to Adico Development Corporation

Application July 8, 1931, Serial No. 549,498

7 Claims. (Cl. 62—121)

This invention relates to improvements in apparatus for making solid carbon dioxide either in the form of large blocks or in the form of small blocks, pencils, pellets and the like.

One of the objects of this invention is the provision of a novel method of forming solid carbon dioxide.

A further object of this invention involves the method and apparatus by means of which liquid carbon dioxide is delivered into a compression chamber at the triple point pressure, wherein it exists simultaneously in the solid, liquid and gaseous condition.

A still further object of this invention involves the method of directly solidifying the slush present at the triple point condition by reducing the pressure thereon or by first mechanically compressing the slush and then reducing the pressure thereon.

A still further object of the invention is to provide an apparatus for carrying out this method to form the slush into relatively large blocks or in smaller pieces of any desired size and configuration.

Another object of this invention is the provision of a machine for carrying out this method, employing a novel form of gate structure for closing the cylinder of the machine while in use.

Another object of this invention involves the construction and shape of the solidifying chamber to insure sufficient strength under the pressures and temperatures encountered.

These and many other objects as will appear from the following disclosure are secured by means of this invention.

This invention resides substantially in the combination, construction, arrangement, relative location of parts, steps, series of steps, and the product in accordance with the following disclosure.

Referring to the drawings:

Fig. 1 is a longitudinal cross sectional view through the machine of this invention with some parts in elevation and some parts broken away.

Fig. 2 is an enlarged detail view of the gate structure partly in section and partly in elevation.

Fig. 3 is an end view of the cylinder construction;

Fig. 4 is an end view of a modified form of cylinder construction;

Figs. 5 and 6 are end and side views of one form of mold which may be inserted within the cylinder to form carbon dioxide pencils;

Fig. 7 is an end view of a modified form of mold which is insertable into a cylinder of the form shown in Fig. 4.

The general object of this invention is to provide a novel method of making solid carbon dioxide from carbon dioxide slush, as well as the apparatus for carrying out the method. The carbon dioxide liquid is introduced into the solidifying chamber of the machine at the so-called triple point so that it exists therein under a condition of solid liquid and gas. The slush consists of a mixture of liquid and solid and the portions of the two of course vary with the chamber and pressure conditions within the chamber. If desired the density of the finished mass may be increased by mechanically compressing the slush mixture before reducing the gas pressure in the chamber. If a less dense mass is desired the mechanical compression is done away with and the pressure on the slush is collapsed to permit direct solidification thereof. Where it is desired to produce solid carbon dioxide in the form of smaller pieces than normally employed the slush may be allowed to flow into a mold within the chamber so that when the slush is solidified the result is a plurality of smaller pieces of a shape depending upon the mold shape.

Referring to the drawings in detail the nature of the invention will be better understood. One form of machine as disclosed for purposes of illustration is shown in Fig. 1 as comprising two concentric cylinders 1 and 2 held in spaced relation by means of closure rings 3 and 4 to provide a double wall vessel as shown. As illustrated these cylinders are of circular cross-section (see Fig. 3). As is well known the circular cross section is the best from the viewpoint of strength, which is of considerable importance in a machine of this type in view of the high pressures and low temperatures to which the machine is subjected. If desired the cylinder construction may be like that of Fig. 4, wherein the outer cylinder 2' is circular as before to give strength, and the inner cylinder 1' has a rectangular cross section. The inner cylinder contacts with the outer cylinder at its four corners and is pressed against the outer cylinder by means of fins or webs 50. As before, a closed chamber is provided between the inner and outer cylinders for a purpose to be described later.

As shown in Fig. 1 the inner cylinder 1 extends beyond the outer cylinder 2 and is closed by means of a suitable closure plate 5. Within the cylinder is disposed a slidable piston 6 which is

hollow and has its forward end closed by means of a perforated plate 7. A series of ports 8 are provided in the walls of the piston and its rear portion is provided with longitudinal grooves 9 on its surface. The piston rod 10 passing through a suitable packing gland is provided for operating the piston. A pipe 12 is connected to the projecting end of cylinder 1, and is connected by means of a suitable T to pipes 32 and 15. Pipe 32 is connected to the space between the cylinders 1 and 2 and pipe 15 provided with a control valve 16 extends to any suitable receptacle such as a gasometer to which the gas formed within the inner cylinder may be delivered. T 14 is connected by means of pipe 17 through a check valve 18 to the upper casing 11 of a heat exchanger of any suitable structure. Check valve 18 prevents escape of gas from casing 11 into pipes 17, 12 and 15, and cylinder 1 when the pressure in the cylinder is dropped to effect solidification and when the machine is being emptied. The upper end of the casing 11 is connected by pipe 19 through a pressure control valve 20 to the pipe 23, which pipe likewise extends to a suitable receptacle. Pipe 23 is connected to the casing 11 of the heat exchanger through pipe 21 and the valve 22. The heat exchanger is of the well known type in which the casing 11 is provided with a series of pipes extending therethrough in communication with the ends of the cylinders, but not in communication with the space within the cylinder. The carbon dioxide liquid supply line is shown at 24 provided with a valve 25. Thus the liquid carbon dioxide is delivered into the casing 11 around the pipes which extend therethrough so that the space within the pipes is not in communication with the space surrounding them and within the casing 11. The casing 11 is connected by a liquid supply pipe 26 to the inner cylinder 1 through the branch pipes 27, control valves 28, and liquid discharge nozzles 29. Pipe 26 is also connected by means of pipe 30 to the space between the two cylinders at the end opposite to the point of connection of pipe 32. Pipe 30 is also provided with a control valve 31.

As shown more clearly in Fig. 2, the closure ring 4 is provided with a suitable gasket or seat 4' against which the closure gate 33 presses to seal the inner cylinder. The gate 33 is arranged so that it may be tightly pressed against its seat and moved out of place when desired. Mounted in any suitable manner on each side of the open end of the chamber are two vertical U-shaped brackets 34. Only one of these brackets is shown in the drawings, but they extend parallel to each other and are mounted on each side of the cylinder. At the top of the gate is provided a lug which is pivotally connected at 35' with a link 35. The upper end of the link 35 is pivotally connected at 35' to the lower end 36 of a hand operated lever 37. Mounted on the top of the brackets are the removable saddles 48 on which the lower end of the lever 37 seats, as shown. The lower end 36 of the lever is provided with two ball shaped extensions 38 and 40. The extension 38 seats in a socket on the saddle as shown. The ball 40 seats in another socket 39 formed in the saddle when the lever 37 is pivoted to the left (Fig. 2). The gate 33 is provided with spaced journals 44 between which a shaft 42 extends. This shaft is provided with two spaced eccentrics 43 which rotate in bearings in the brackets 34.

A hand lever 41 is connected to the shaft 42. Fig. 2 shows the gate closed and pressed on its seat. To release the gate arm 41 is swung in a

clockwise direction. This rotates shaft 42 and carries with it the eccentrics 43. These eccentrics react on their seats in the brackets 34 forcibly pulling the gate 33 to the left a short distance equal to the throw of the cams. This provides a structure by means of which a considerable pull may be exerted on the gate to break it away from the seat if it is sealed there by the frozen solid carbon dioxide. Lever 37 is then pulled to the left starting the gate 33 upwardly in a vertical direction. Tremendous leverage can be produced by this structure because of the length of lever 37 and the shortness of the lever arm between the point 35' and the center of rotation of the ball 38 in its socket. Thus the gate may be started upwardly. As the lever 37 is further moved to the left the ball 40 engages the seat 39 on the saddle, increasing the length of the lever arm between the pivot point 35' and the center of rotation of the ball 40. Thus after the gate is fastened and started it may be pulled upwardly through this construction to the point where it completely opens the cylinder 1. Of course the pulling members 44, the shaft 42, the eccentrics 43 and the lever 44 all form a unitary structure which moves upwardly with the link 35.

In the operation of the device valve 16 is closed. The valves 20 and 22 may be of any well known construction such as a diaphragm valve which operate to maintain a pressure behind them depending upon their adjustment. As soon as the pressure exceeds a predetermined value the diaphragm valve opens to permit gas to pass therethrough. Valves 25, 28 and 31 are then opened and liquid carbon dioxide is delivered from pipe 24 through casing 11 around the cooling pipes extending therethrough to pipe 26. From pipe 26 it is delivered to and discharged from the nozzles 29 into the inner casing 1. At the same time sufficient liquid may be discharged through the branch 30 into the space between the cylinders to provide gas for two purposes. First of all the gas delivered between the two cylinders is of such a pressure as to balance the pressure on the inner cylinder 1, and to transmit it to the outer cylinder 2, thus insuring a structure which will withstand the pressures involved. At the same time the gas formed by the discharge of liquid into the space between the cylinders is further cooled, thereby helping to maintain the proper temperature conditions within the inner cylinder. The discharge of liquid into cylinder 1 is carried out under the proper temperature and pressure conditions so that the carbon dioxide within the inner cylinder is at the triple point condition. Thus the inner cylinder will have carbon dioxide in the solid, liquid and gaseous state. When a sufficient amount of material has been delivered into the inner cylinders the valves 28 may be closed. The gas may escape from the cylinder 1 through the perforated plate 7, the hollow piston 6, pipe 12, pipe 17, valve 18, through the pipes in casing 11, and to pipe 23 through the connection 19 of the valve 20. The gas formed within the casing 11 around the pipes from the liquid delivered into the casing may be discharged through the branch 21 into the pipe 23. Any excess gas pressure in the space between cylinders 1 and 2 may also discharge into the pipes of the heat exchanger through the branch 32. The pressure conditions within cylinder 1 and the space between cylinders 1 and 2 may be controlled as already stated by the diaphragm pressure control valves 20 and 22, which may be set to maintain conditions within the cylinder 1 at the triple point.

If it is desired to increase the density of the slush in cylinder 1, this can be accomplished by forcing piston 6 to the left to compress the mixture to the desired density. Any gas may escape through the piston as before, and when the piston moves to the left of the connection 12, the gas may still escape through the grooves 9 to the right of the piston. If it is not desired to first mechanically compress the slush the operation of the piston can be dispensed with. The consistency of the slush can be varied by controlling the temperature and pressure conditions of the liquid delivered to cylinder 1, so that the proportion of solid and liquid can be varied. To completely solidify the slush valve 16 is opened, thereby completely releasing the pressure within cylinder 1. The slush then solidifies with the formation of some gas which escapes through and past the piston to pipe 12, and thence to pipe 15, and back to the gasometer under atmospheric pressure conditions. At the same time the gas between the cylinders may also escape through pipe 32. Gate 33 is then opened as described before and the piston employed to eject the solid carbon dioxide onto the table 70.

If desired, instead of making the large blocks of solid carbon dioxide, molds of the forms shown in Figs. 5 and 6 in the case of a cylindrical cylinder, or the mold shown in Fig. 7 in the case of a square cylinder are introduced in the desired number into the chamber as shown in Fig. 1. The slush is then allowed to flow into these molds. It is pointed out in connection with the mold such as shown in Fig. 5 that the space between the inner and outer walls 60 and 61 will also be packed with slush so that that slush in connection with the fins 62 serves to prevent rupture of the molds. The solidified carbon dioxide between the walls 60 and 61 also serves the purpose of preventing shrinkage of the small pellets in the mold during shipment and thereby serving to refrigerate the interior of the mold and its contents. After solidification of the carbon dioxide these molds may be ejected and shipped in this form to the place of use. The gas delivered from the chamber into pipe 12 and into the heat exchanger will be a substantially wet vapor, and being very cold will sub-cool the incoming liquid through pipe 24, thereby effecting a heat economy. The warmed dry vapors which may be termed superheated are delivered through pipe 23 for accumulation and reuse. If desired pipe 13 may be used to supply gas under pressure into cylinder 1 for ejecting the block of solid carbon dioxide from the cylinder instead of ejecting it with the piston.

One of the important features of this invention is that the liquid carbon dioxide is delivered into the inner cylinder at temperatures and pressures in the neighborhood of the so-called triple point condition so that a slush is formed therein comprising a mixture of solid and liquid carbon dioxide.

The consistency of the slush may be varied by pressure variation. When the pressure is carried below the triple point pressure snow formation increases and liquid formation decreases. On the other hand, when the pressure exceeds the triple point pressure the ratio of liquid to solid increases. Thus the characteristics of the slush may be varied by controlling the pressure within cylinder 1. In addition the density of the finished product may be varied by mechanically increasing the pressure on the slush as already pointed out.

From the above description it will be apparent that this invention resides in certain principles of construction and operation which may be carried out in other ways by those skilled in the art without departure from the spirit and scope of the invention. I, therefore, do not desire to be strictly limited to this illustrated disclosure, but prefer to be limited by the scope of the appended claims.

What I seek to secure by United States Letters Patent is:

1. A device of the type described comprising a chamber closed at one end and provided with a movable piston, a removable closure plate for the other end of the chamber, means for moving the closure plate into and out of closing relation, an outer casing surrounding the inner casing and connected thereto to form a closed double wall structure, the closed double walls being isolated from the inner chamber, means for delivering liquid carbon dioxide into the inner chamber, means for delivering carbon dioxide into the space between the double walls, means for maintaining a desired pressure in the inner chamber, and means for withdrawing the carbon dioxide from between the double walls.

2. In a device of the type described the combination comprising an open ended cylinder, a closure plate for closing the open end of the cylinder, means for imparting movement to the closure plate in a direction parallel to the axis of the chamber and for locking it in closed position, and means for imparting movement to the closure plate in a direction at right angles to the axis of the chamber.

3. A machine of the type described comprising a cylinder of suitable cross section closed at one end, a removable closure plate for the other end, means for moving the closure plate a short distance away from and into contact with the end of the cylinder and for locking it under pressure against the end of the cylinder, and means for raising the closure plate out of alignment with the end of the cylinder.

4. In a machine of the type described the combination comprising two concentric walls the outer wall being of cylindrical cross section and the inner wall being of rectangular cross section, and web members uniting the two sections into a unitary structure, to provide a strong double walled casing for withstanding considerable internal pressure.

5. A machine of the type described comprising two concentric casings united to form an inner chamber and an outer space isolated therefrom, means for closing the inner chamber, a piston in the inner chamber, means for delivering liquid carbon dioxide to the inner chamber, means for delivering carbon dioxide to the outer space, and means for withdrawing carbon dioxide in the form of gas from the inner chamber and the outer space at different pressures, and means for exposing the inner chamber to atmospheric pressure conditions.

6. In a device of the type described the combination comprising an open ended cylinder, a closure plate for the cylinder, a power device for moving the closure plate in a direction at right angles to the plane at the end of the cylinder and for locking it firmly against the end of the cylinder, and means for moving the closure plate in a plane parallel to the end of the cylinder to move it completely out of alignment therewith.

7. A machine of the type described comprising two telescoped walls united to form a closed space between them, one end of the inner wall being closed, means for closing the open end of the inner wall to provide a closed chamber including a movable closure plate, means for holding the closure plate in chamber forming relation with the inner wall, means for delivering liquid carbon dioxide into the chamber and the space, a discharge connection for said chamber, and means for maintaining a desired pressure in the chamber. 80

JUSTUS C. GOOSMANN.

10

85

15

90

20

95

25

100

30

105

35

110

40

115

45

120

50

125

55

130

60

135

65

140

70

145

75

150