United States Patent

Duron et al.

[15] **3,670,516**

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[54] **MACHINE FOR MAKING DRY ICE PELLETS**

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[52] **U.S. Cl.** .... **62/35**, 18/12 RR, 100/DIG. 4, 107/14 F

[51] **Int. Cl.** **B29c 3/00**

[58] **Field of Search** .... 18/12 RR; 107/14 F; 100/DIG. 4; 62/35

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[57] **ABSTRACT**

A dry ice pellet machine having a snow horn for flashing liquid carbon dioxide into snow; an extruding ring die for receiving the snow and consisting of an internal ring gear with radial draw-holes in and between the gear teeth around the ring periphery; a concentrically pivoted carrier within the ring die having diametrically positioned gear pinions for planetary movement in meshing engagement with the ring gear, and alternatively, rolls on the carrier for traversing a corresponding surface of the ring die; a drive motor for rotating the carrier and causing collected snow to be entrained and forced by the rolls (meshing gears) into the draw-holes and extruded therefrom as ice pellets.

22 Claims, 6 Drawing Figures

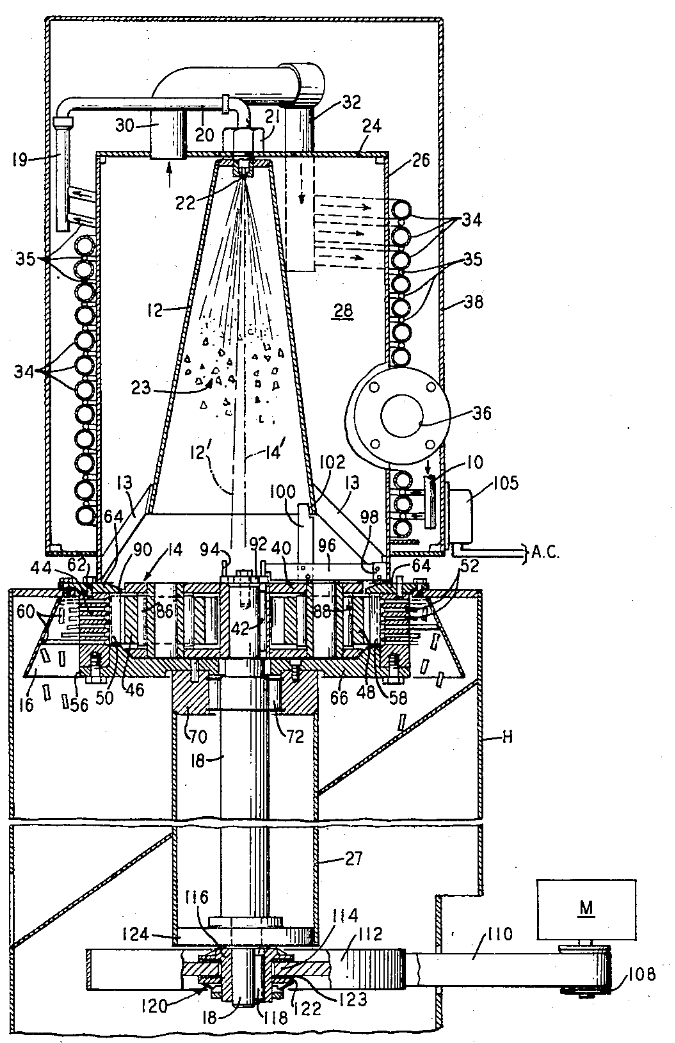

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FIG. 1

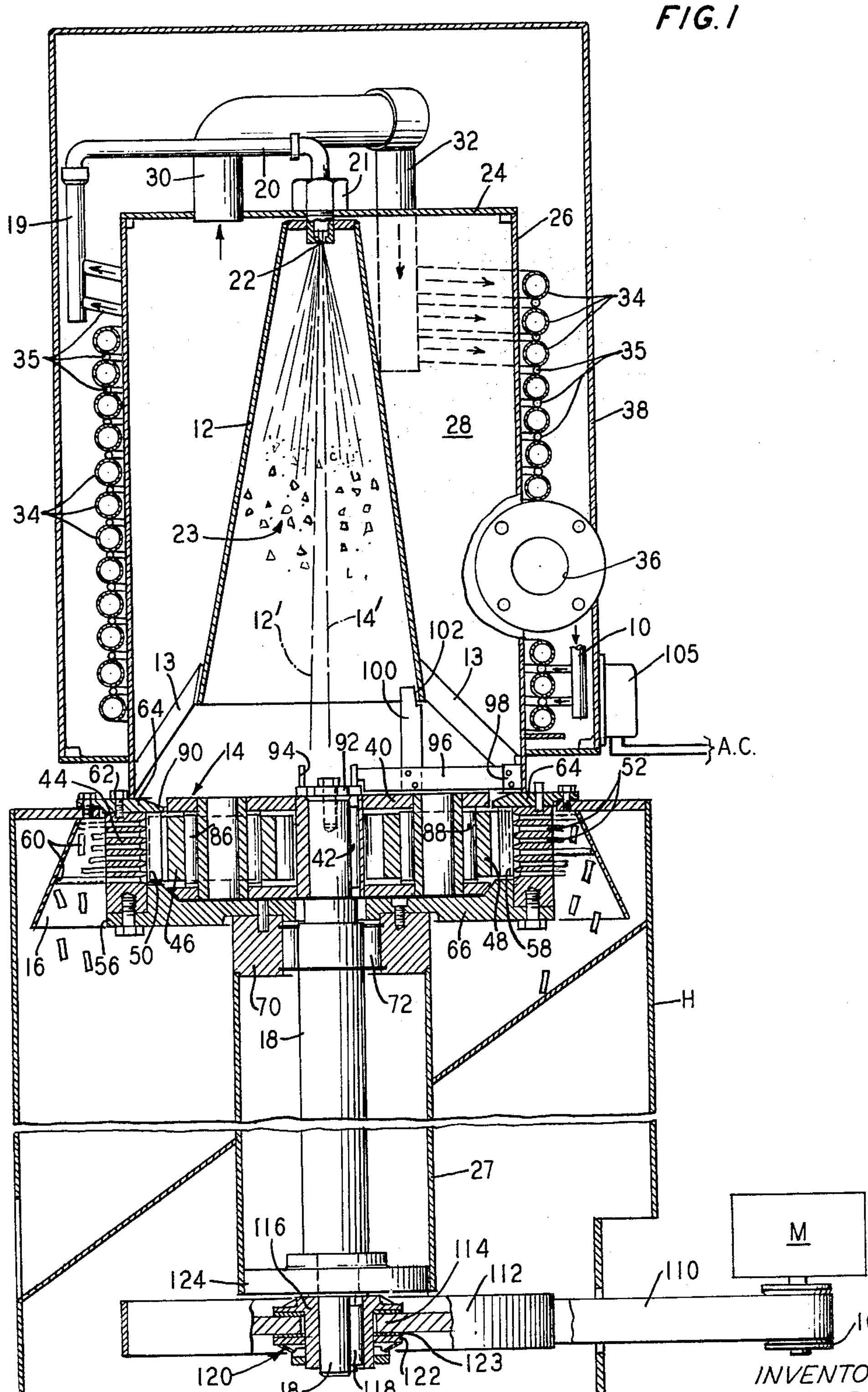

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FIG. 2

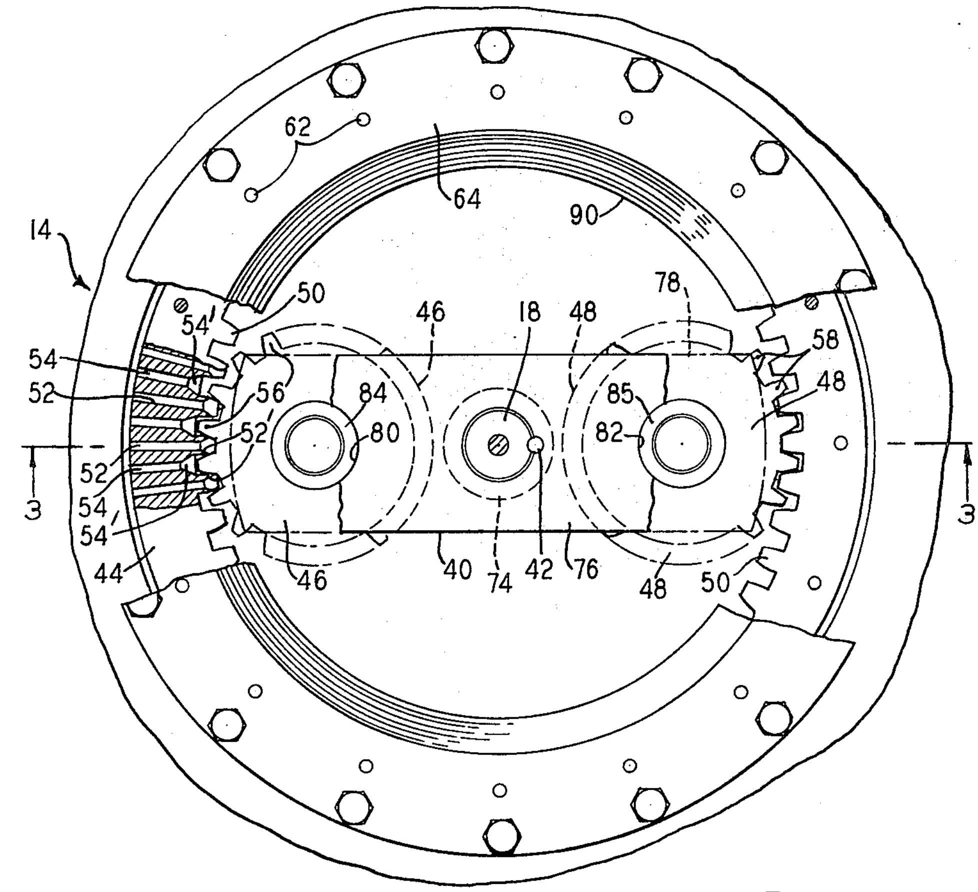

FIG. 3

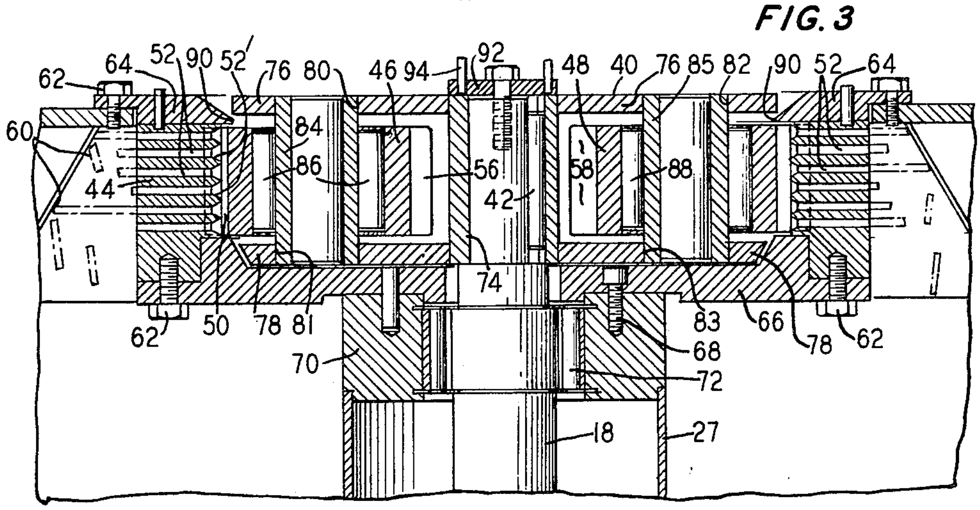

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FIG. 4

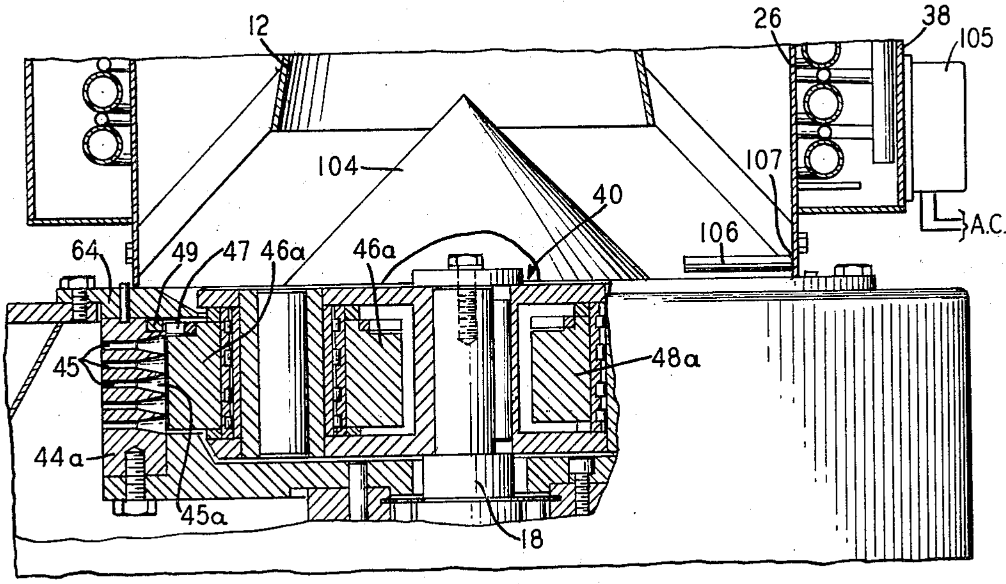
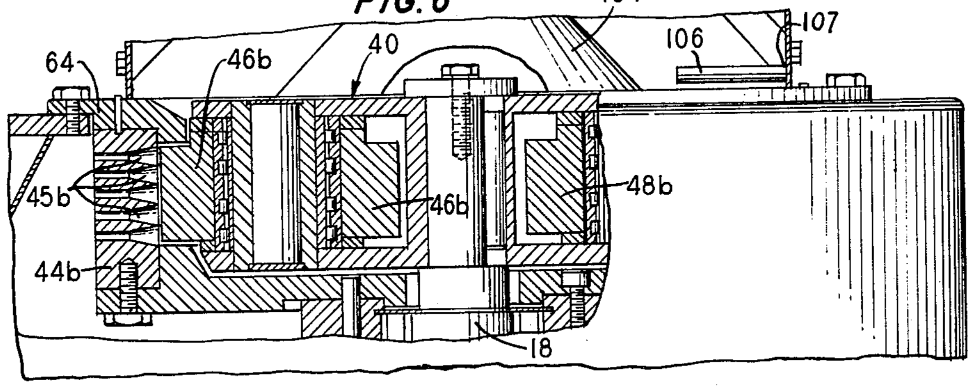


FIG. 6



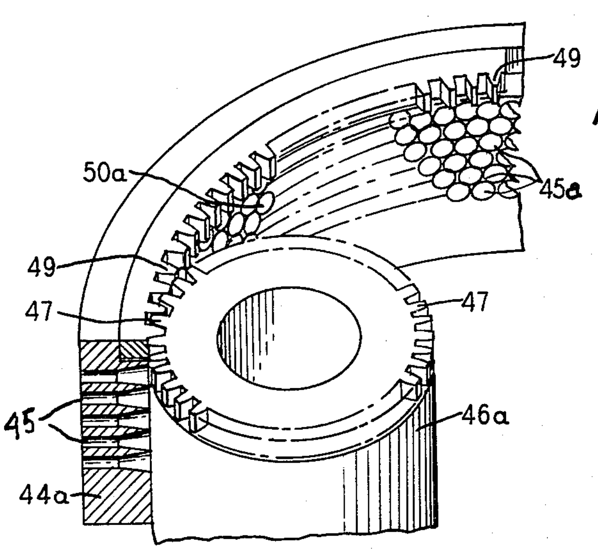


FIG. 5

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MACHINE FOR MAKING DRY ICE PELLETS

BACKGROUND OF THE INVENTION

The invention relates to the production of high density carbon dioxide (CO_2) ice, especially to production of the ice in small sticks or pellets for convenient and efficient flow-handling, ice packing for refrigerating food containers, etc., and general packaging and distribution. A known method of making CO_2 ice in moderate size pieces, as distinguished from block ice, comprises feeding CO_2 liquid to a cylinder where it is flashed to form CO_2 snow. The snow is then compressed by a piston or ram into a disc-like dry ice cake against a releasing gate or the like at the compression end of the cylinder. The gate is operated by manual or automatic means at the end of the compression or work stroke for ejecting the ice cake; the gate is then closed and the cycle repeated. Although this method produces dry ice in pieces much smaller than block ice, the disc-like cakes are still in most cases too large for efficient flow-handling and for convenient packing around refrigerated containers and the like. In such instances, the cake may be broken up into pieces that ordinarily vary in size down to powder. This is objectionable as pieces of fairly uniform size and contour are more desirable for facilitating handling, and for general use.

Various methods have been proposed for producing CO_2 ice in small pellet-like pieces, one method, for example, comprising forcing CO_2 slush ice into multiple sectionalized molds within a press, after which the molds containing ice pellets are removed as units for shipping and storage. In another method, compressed snow is divided into parallel streams within a press having a reciprocating piston, and the streams are converged and solidified under pressure against an extrusion plate having multiple draw holes for the pellets.

Insofar as is presently known, none of the proposed methods and apparatus for producing dry ice pellets have been found satisfactory in practice. The pellets in mold packages do not lend themselves to convenient general use, and proposed extruding presses tend to clog and back up ice at the extruding plate, thereby causing excessive stresses and pressures in the press and temporary shut-down of the equipment.

A practical disadvantage moreover, of most of the prior art ice machines is that the production process is cyclic, i.e. there is a periodic pause for recharging, etc., during which the output of the machine is either nil or greatly reduced.

The present invention is directed to overcoming the problems involved in the continuous production of high density CO_2 ice pellets by extruding press equipment and thereby increasing the rate of pellet production.

SUMMARY OF THE INVENTION

In accordance with the invention, carbon dioxide (herein sometimes termed "CO_2") in liquid form is flashed by conventional snow-horn means or the like, into snow, and the snow is deposited in a rotary-type extruder that consists of a fixed ring die and a centrally pivoted carrier with coacting rotary extruder elements. The extruder elements may take the form of either cylinder-like rolls or gear pinions that are caused successively to traverse draw-hole openings around the inner periphery of the ring die. Where pinions are used, the ring die constitutes an internal ring gear with draw holes in and between the teeth extending from the inner periphery radially through the ring. The gear pinions are mounted at diametrically opposite positions on the carrier within the ring gear for continuous meshing therewith in planetary motion so that the draw holes around the ring periphery come into successive alignment with the rotating pinions.

The flashed snow as it collects in the extruding region of the ring die is entrained by the pinions, compressed between the meshing gear teeth and extruded through the draw holes as CO_2 or "dry ice" pellets in a continuous extrusion process.

Where the carrier has extruder rolls of cylindrical form for example, the ring die surface at the inner periphery is circular and includes openings for the radial draw holes.

A principal object of the invention therefore is to provide an improved extruding machine of the rotary type that is capable of quantity production of dry ice pellets in a continuous non-cyclic operation.

Another and related object of the invention is to provide improved extruding apparatus having a ring die with internal planetary type rotating extruder elements, that is efficient and positive in its operation, readily adaptable for receiving the output of conventional CO_2 snow-making equipment for continuous production of dry ice pellets, and that is simple, rugged and inexpensive in construction and economical in operation.

Other objects, features and advantages will appear from the following description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view, mainly in section, of a rotary extruder embodying the invention for making CO_2 ice pellets;

FIG. 2 is an enlarged plan view, partly in section, of rotary extruding equipment shown generally in FIG. 1;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is an elevational view, partly in section, of a modified form of the rotary extruder;

FIG. 5 is an exploded view of the coacting extruder elements of FIG. 4; and

FIG. 6 is a sectional view similar to FIG. 4, illustrating a variation thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the essential combination of the CO_2 ice pellet making machine of the invention consists of a suitable source of liquid CO_2 generally indicated by a supply line manifold **10**, a snow horn **12** or equivalent, within which liquid CO_2 is flashed in conventional manner into snow, a rotary extruder with ring die at **14** for receiving the snow and converting it into high density ice pellets, the extruder having an exhaust chute **16** for directing the ice pellets into a container, storage bin or the like, a main drive shaft **18** for the rotating unit of the extruder, and an operating motor M connected through a suitable transmission system to the drive shaft.

In the snow-making process indicated above, the pressurized liquid CO_2 from the supply at **10** is continuously fed through conventional snow horn precooling coils **35** to the throat of the snow horn **12** that has a standard orifice-controlled discharge nozzle **22**. The liquid CO_2 is fed from the cooling coils to the discharge nozzle through a liquid receiving manifold **19**, feed line **20** and nozzle coupling **21**. Upon discharge from the nozzle, the CO_2 liquid is for the most part flashed as indicated at **23** into snow, the remainder being cold CO_2 gas. A cylindrical metal housing **26** made of stainless steel for example, encloses the snow horn and forms a so-called snow chamber **28** for collecting both the snow and excess gas. This housing has a cover **24** in which the coupling **21** is mounted for conveniently supporting the throat or inlet end of the horn **12**. The divergent or exhaust end of the horn is supported by peripherally spaced resilient struts **13** that are connected to the lower inner wall of the cylinder **26**. The cylindrical housing **26** itself is mounted above the extruder **14** that in turn, is supported by a centrally positioned tube-like bearing housing **27** for the drive shaft **18**, and also at its outer periphery by the main base housing H as further described below.

The function of the snow chamber **28** also includes the collection of excess CO_2 gas apart from the snow, for removal by venting for precooling purposes. To this end, the gas in chamber **28** (which is under positive gauge pressure in the normal operation of the snow horn) flows into a venting line **30** at the top of the chamber, and into a gas manifold **32**. From the manifold the cold gas is suitably directed to heat-transfer coils **34** that encircle the cylinder **26** for cooling the snow chamber and for subcooling the incoming liquid, thereby improving subsequent flashing efficiency of the snow horn. After passage through the cooling coils **34**, the gas is vented at **36** to an exterior recovery line for ultimate recycling in known manner as liquid CO .

The cylindrical housing for the snow chamber is provided with an outer insulating jacket or housing indicated at **38**.

The CO snow from the horn that collects in the lower part of the snow chamber, feeds directly by gravity into the extruder that is vertically beneath and in fact constitutes the bottom of the snow chamber. The extruder consists essentially of rotary extruder elements mounted on a central rotating carrier **40**, FIG. **2**, and a complementary fixed extruding die **44**. The die in the form of the invention shown by FIG. **1** constitutes an internal ring gear within which the carrier is concentrically pivoted. The carrier is keyed at **42** to the drive shaft **18** for rotation therewith, and has mounted thereon at opposite ends two gear pinions **46** and **48** that have planetary motion within the ring gear. Thus, the diametrically positioned pinions continually mesh with the internal teeth **50** of the ring gear as the carrier is rotated.

The ring gear in turn has at least two extruding die passages or draw-holes **52** and **54** per tooth pitch throughout the circumference of the ring die depending on the transverse width of the teeth and draw-hole diameters, i.e., there is a minimum of twice as many draw-holes as teeth in the extruding die. The number of draw-holes can be increased according to the transverse length of the extruding teeth as shown in FIG. 3. Specifically the draw-holes extend along radial lines transversely through the ring of the die, a draw-hole **52** extending from the top of a respective tooth **50**, and the adjacent draw-hole **54** extending from the foot line between the tooth and a following tooth, FIG. **2**. Accordingly, each such pair of draw-holes is within a span corresponding in length to a tooth pitch. For facilitating extrusion flow, the entrance end of each draw-hole is counter-bored as shown at **52** for the draw-holes **52**, and at **54** for the draw-holes **54**.

As indicated above, the gear pinions **46** and **48** have the same tooth pitch as the ring gear, and are symmetrically positioned at opposite ends of the pivoted carrier **40** for continuous and precise meshing with the die teeth **50**. Assuming clockwise rotation of the carrier as viewed in FIG. **2**, the respective pinion teeth **56** and **58** engage the fixed die teeth **50** to cause counterclockwise rotation of the pinion gears. Preferably, the mating tolerance or limit of backlash of the engaging gear teeth is approximately 0.010 to 0.015 in. so that positive and continuous rolling contact is for practical purposes, established between the coacting gear teeth surfaces.

As the snow chamber **28** is continuous with the lower fixed ring die **44**, the collected CO tends to settle within the ring, FIG. **1**, where it is first entrained by the gear pinions as the rotating carrier sweeps the circular area. During meshing of the snow-entraining teeth with the die teeth, the snow is tightly compressed as it is progressively forced into the respective "-valleys" between the pinion teeth and the die teeth. As the so-called rolling contact between a pair of engaging gear teeth continues, the snow is further compressed into ice and finally forced into a respective draw-hole, as for example a draw-hole **52**, during coincidence of the radial axis of the draw hole and the line of centers of the ring die and the corresponding pinion respectively. In other words, when the carrier center line is brought into coincidence with the longitudinal axis of a given draw-hole, the ice charge in question is entirely forced by the corresponding pinion gear into the aligned draw-hole, from which it is later extruded in cylindrical form as succeeding charges of compressed snow and ice are formed and forced into the draw-hole by successive passes of the pinions.

The cylindrical extrusions consist of high-density CO ice that can readily be broken into short pellets for convenient handline. For example, the ice exhaust chute **16**, FIG. **1**, can be formed as an annular baffle plate that is inclined at a suitable angle with respect to the draw hole outlets for causing the extruded ice cylinders to break up into small lengths as they meet the baffle, as indicated at **60**.

In a practical example, the draw holes were made for one-fourth in. diameter pellets, and the ring die was sufficiently wide (transverse direction) for accommodating transverse rows of six draw-holes, FIGS. **1** and **3**, thereby providing a total of 12 draw-holes per tooth pitch of the ring die. It will be apparent that the number of draw-holes for increasing the production of pellets can be increased by increasing the transverse dimensions of the ring die and pinion gears respectively; also, it will be apparent that the tooth height and the ratios of tooth pitch circumference indicated in the drawings are for purposes of illustration only. According to extrusion stresses, depending on rate of production and other mechanical factors, the gear teeth can be strengthened as required by increasing the tooth base width (and hence the tooth pitch) for a given tooth height, or, simply by reducing the tooth height.

The extruder **14** as described above, is suitably mounted in a generally vertical arrangement between the snow chamber **28** and the main base housing H. The ring die **44** is bolted at **62** between an annular retaining ring **64** (on which is mounted the upper cylindrical housing **26** for the snow chamber) and a fixed die supporting plate **66**. This plate is in turn centrally positioned by and bolted at **68** to the upper part of the cylindrical bearing housing **27** for the drive shaft. Specifically, the housing **27** has secured thereto at its upper end an annular bearing support **70** to which the die plate **66** is bolted in centered relationship. A main bearing **72** of standard type for the shaft journal is mounted within the support **70**.

Referring specifically to the carrier mounting for the rotary elements, FIGS. **2** and **3**, the carrier **40** consists of a central hub **74** (that is keyed as mentioned above to the upper end of the drive shaft at **42**) and a pair of parallel spaced arms **76** and **78** that are integrally secured to the hub and extend equal distances therefrom for diametrically positioning the gear pinions **46** and **48** with respect to the ring die **44**. The corresponding ends of the arms at diametrically spaced points on the pinion carrier are provided with aligned holes at **80, 81** and at **82, 83**, in which are mounted tightly fitted bushings **84** and **85** for positioning the pinions **46** and **48** respectively. Suitable heavy duty bearings **86** and **88** respectively, FIG. **3**, are positioned between the bushings and the bearing surfaces of the corresponding pinions.

In another mode of the invention illustrated by FIGS. **4** to **6**, the dry ice pellets are extruded at the ring die generally as described above, except that extrusion is achieved by relatively movable portions of substantially cylindrical surfaces, rather than by meshing gears. To this end, referring first to FIGS. **4** and **5**, the inner periphery of the ring die **44*a*** has a generally circular or cylinder-like contour with closely spaced draw holes **45** throughout. For facilitating extrusion flow into the draw holes, the hole openings each have a counter-sink **45*a*** which overlap, so that the die entrance **50*a*** has a hexagonal or "honey-comb" appearance as indicated in FIG. **5**.

The coacting rotary extruder elements constitute cylinders or rolls **46*a*** and **48*a*** that can be mounted within the carrier **40** in the same manner as the pinions **46** and **48**. In FIGS. **4** and **5**, each roll has at its upper edge gear teeth **47** for meshing with aligned corresponding teeth **49** on the ring die, thereby obtaining uniform rotation in relation to carrier rotation. The coacting roll and die surfaces are preferably spaced for slight tolerance, rather than in metal-to-metal contact. The snow as it settles into the die is entrained by the advancing rolls, compressed, and forced into the draw holes for extrusion, generally as described above.

FIG. 6 illustrates a rugged and simple form of roll-type extruder wherein the rolls **46*b*** and **48*b*** are idler-mounted on the carrier for free rotation with respect to the ring die **44*b***. With this arrangement there is no problem of overstressing gear teeth, and transient load peaks are more easily handled by not forcing rotation of the rolls at the respective draw holes **45*b***.

In operation, snow or ice may tend to accumulate or "ball" on the upper side flat surfaces of the rolls or pinions near the periphery. This is readily prevented by extending at **90** the inner edge of the upper die retaining ring **64** in overhanging relation to the roll or pinion as indicated in FIGS. 1 and 3 for scraping clear such accumulations as the carrier rotates beneath. Also, the tendency of snow from the horn 12 to settle in the hub areas of the pinion carrier rather than outwardly toward the ring die can be at least partly offset by deflecting slightly the longitudinal axis or center line 12′ of the horn with respect to the carrier axis of rotation 14′.

The well-known tendency of the snow to stick along the inside wall of the snow horn can also be counteracted by advantageous use of the extruder drive means. By way of example, a mechanical horn vibrator operable by the drive shaft may consist of a star-wheel, or as shown, a disc 92 having peripherally spaced pegs 94, secured to the end of the drive shaft. A spring steel strip 96, FIG. 1, secured at 98 to the snow chamber housing 26 extends laterally over the pinion carrier so that the free end of the strip tends to position itself a short distance within the peg circle. The spring strip has a transverse vertical extension 100 with a notched portion 102 at its upper end that is positioned next to the lower edge of the horn. Accordingly, rotation of the disc 92 as the extruder is operated, results in flexing and releasing of the spring strip 96 in snap action that in turn causes the vertical extension 100 to engage the horn in percussion-like manner. The vibration of the horn structure so produced is sufficient to keep it clear of sticking snow.

In an alternative arrangement shown by FIG. 4, the snow from the symmetrically positioned horn is deflected and distributed generally in a radial direction toward the ring die by a cone 104 that is centered beneath the horn and seated on the carrier. For spreading and leveling the deflected snow at the base of the cone for uniform feed into the extruder, a leveler strip 106 is connected to the cylinder 26 at 107 so as to extend above and across the dished inner edge of the retaining ring 64, FIGS. 2 and 3, and the annular region at the die entrance. This region which is open (except for the carrier) therefore receives uniform snow feed as leveling proceeds.

For preventing formation of voids and ensuring settling of accumulated snow in the snow chamber and horn above the extruder, the entire upper assembly unit including the horn and cylinder 26 can be vibrated by mounting an electric vibrator of conventional type on the side wall of housing 38 for example, as indicated at 105, FIGS. 1 and 4, thereby freeing the horn of sticking snow, as well as causing piled-up low mass snow at the bottom of the snow chamber to settle evenly around the base of the cone. This insures more uniform feed by the leveler 106 into the extruder. The unit vibrator 105 may if desired also be used along with the horn vibrator arrangement of FIG. 1.

The remaining mechanical arrangements and structures for a commercial machine are of but general interest for an understanding of the invention and therefore can be described briefly. The motive means for rotating the drive shaft 18 is not limited to any specific arrangement. In the preferred embodiment, an electric motor M vertically mounted at the base of the machine is connected through its shaft pulley 108 and belt-drive transmission 110 to a large diameter drive pulley 112 operatively connected to the lower end of the drive shaft. The hub 114 of the drive pulley has a free fit on a centering bushing 116 that in turn is keyed to the lower end of the drive shaft at 118.

For avoiding damage under excess load conditions, the drive connection between the power pulley 112 and the drive shaft 18 (at the keyed bushing 116) includes a springloaded clutch 120 of conventional type having a clutch disc 122 splined to the bushing 116 for engagement with the mating clutch surface 123 of the pulley 112.

Accordingly, a high mechanical ratio can be used between the motor shaft pulley 108 and the extruder shaft for safely producing the required force at the carrier 40 for the snow compressing and ice extruding operations described above. The drive shaft has a second main bearing 124 that is suitably mounted within the cylindrical bearing housing 27 at its lower end. The lower end of the drive shaft may be supported if desired by a vertical thrust bearing (not shown) suitably mounted in a structural steel base on which the main base enclosing housing H is fastened.

Summarizing the advantages of the invention, it is seen that a large quantity of high-density, dry ice pellets can be continuously produced by the rotary extruder described above. There is no operating cycle involved in the sense that a periodic pause is required during production of the ice pellets; also volume production is essentially limited only by the output of the snow horn or other CO_2 snow-making equipment, the physical dimensions of the extruding elements (and draw-holes) and the power of the drive motor.

Having set forth the invention in what is considered to be the best embodiment thereof, it will be understood that changes may be made in the system and apparatus as above set forth without departing from the spirit of the invention or exceeding the scope thereof as defined in the following claims.

We claim:

1. A carbon dioxide pellet machine for producing carbon dioxide ice pellets comprising, housing means at least partly defining a snow chamber, carbon dioxide snow generating means at least partly within said snow chamber to direct snow generally vertically downwardly, said snow generating means including nozzle means and means to supply liquid carbon dioxide to said nozzle means under pressure, further means to remove carbon dioxide vapor from said snow chamber, extrusion means at least partly defining the bottom of the snow chamber, said extrusion means including an extruding die formed as a ring, said ring die being horizontally positioned for receiving by vertical gravity feed carbon dioxide snow within the circumscribed ring area said ring die having draw holes extending therethrough around the ring periphery, rotary extruder elements mounted for planetary motion within the ring die for successive traversing of the die draw holes, and power means for driving the rotary elements around the inner periphery of the extruding die for causing snow settling within the ring area to be entrained and compressed between the rotary elements and die, and extruded through the draw holes as ice pellets.

2. An ice pellet machine as specified in claim 1 wherein the extruder elements are rotatably mounted at diametrically opposite positions on carrier means that in turn, is pivoted for movement about the center of the ring die and connected to the power means.

3. An ice pellet machine as specified in claim 2 wherein the die is formed as an internal ring gear with the draw hole openings extending from the gear teeth side of the die, and the extruder elements are gear pinions that rotate about the ring gear center in planetary motion and mesh with the die teeth for entraining and extruding snow at the draw holes.

4. An ice pellet machine as specified in claim 3 wherein gear teeth of the extruding die have draw holes that extend through the centers respectively of the teeth.

5. An ice pellet machine as specified in claim 3 wherein each tooth pitch throughout the periphery of the ring gear spans at least two peripherally spaced draw holes.

6. An ice pellet machine as specified in claim 5 wherein one draw hole of each tooth pitch extends from the top of the corresponding tooth to the exterior periphery of the ring gear, and the other peripherally spaced draw hole extends from the foot line of the tooth through the ring gear, whereby a snow charge carried between two adjacent pinion teeth is delivered to the first-named draw hole for extrusion therethrough and a following snow charge for the other draw hole is forced into the space between the corresponding die teeth by an adjacent pinion tooth.

7. An ice pellet machine as specified in claim 2 wherein the extruder elements are cylinder-like rolls that successively traverse the draw holes at the inner periphery of the ring die.

8. An ice pellet machine as specified in claim 7 wherein the rolls have gear teeth apart from the roll extruder surfaces, that engage corresponding teeth at the inner periphery of the ring die for causing positive rotation of the rolls in synchronism with the rotation of the carrier.

9. An ice pellet machine as specified in claim 7 wherein the rolls are mounted for free rotation.

10. An ice pellet machine as specified in claim 1 wherein liquid carbon dioxide is continuously flashed within a snow horn into said snow chamber, the horn having its exhaust opening opposite and over the extruding die for deposit of snow within the circumscribed ring area of the die.

11. An ice pellet machine as specified in claim 10 wherein a deflector is located between the horn exhaust and central ring area for radially directing the snow toward the ring die.

12. An ice pellet machine as specified in claim 11 wherein the deflector is a cone having its apex centrally of the horn exhaust and its base over the central ring area.

13. An ice pellet machine as specified in claim 10 wherein the snow horn and extruding die are mounted on common supporting structure and vibrator means is operatively connected to the structure for loosening collected snow within the horn and above the ring die area.

14. An ice pellet machine as specified in claim 10 wherein the horn is engaged by a vibrator operated by the power means, the vibrator including a percussion element for successively engaging the horn for freeing snow sticking to the inner surface thereof.

15. An ice pellet machine as specified in claim 10 wherein the longitudinal axis of the snow horn is deflected by a small angle from the projected axis of rotation of the extruder means for eccentric deposition of snow with respect to the extruder axis.

16. An ice pellet machine as specified in claim 10 wherein a flat ring dished at its inner periphery is mounted above and closely overhangs the inner side of the ring die and the traversing rotary extruder elements for guiding snow thereto, and a radially positioned snow leveler overhangs the dished ring.

17. An ice pellet machine as specified in claim 1, further including electrically powered means to prevent the sticking and accumulation of snow within the snow chamber.

18. An ice pellet machine as specified in claim 10 wherein the liquid carbon dioxide is directed through precooling coils surrounding the snow chamber prior to flashing in the snow horn, and excess carbon dioxide gas in the snow chamber is vented from the chamber for passing through precooling coils also surrounding the chamber.

19. A dry ice pellet machine comprising, housing means at least partly defining a snow chamber, carbon dioxide snow generating means at least partly within said chamber to direct snow into an extrusion means, said snow generating means including nozzle means and means to supply liquid carbon dioxide to said nozzle means under pressure, further means to remove carbon dioxide vapor from said snow chamber, said extrusion means at least partly defining the lower part of the snow chamber, said extrusion means including an annular extruding die positioned to receive the descending snow particles within its annular extent, said die having draw holes extending therethrough around the die periphery, rotary extruder elements mounted on a carrier for planetary motion within the annular die for successive traversing of the die draw holes, and power means for rotating the carrier for driving the rotary elements around the inner periphery of the extruding die for causing snow settling within the die area to be entrained and compressed between the rotary elements and die and extruded through the draw holes as ice pellets.

20. A dry ice pellet machine as defined in claim 19 wherein said snow generating means further includes a snow horn, and electrically powered means to counteract the tendency of the carbon dioxide snow to stick to the interior of the snow horn.

21. A carbon dioxide pellet machine for producing carbon dioxide ice pellets comprising, housing means at least partly defining a snow chamber, a frusto conical snow horn mounted in said chamber and being substantially vertically arranged with its wider end at the bottom, nozzle means at the upper end of the horn, means to supply liquid carbon dioxide to said nozzle means, means to remove carbon dioxide vapor from said chamber, extrusion means below said snow horn to receive the snow generated therein, said extrusion means including an extrusion ring die having an inner diameter greater than the diameter of the wider end of the snow horn so that the snow is deposited within the ring die, said ring die having draw holes extending therethrough around the ring periphery, extruder elements mounted within the ring die for successive traversing of the die draw holes, power means for driving the extruder elements for causing snow to be compressed by the extruder elements and extruded through the draw holes as ice pellets.

22. A pellet machine as set forth in claim 21 further including electrically powered means to free the snow horn from sticking snow.

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