May 26, 1959 M. M. RAYMER, SR., ET AL 2,888,155

MECHANISM FOR DISCHARGING MATERIAL FROM A RELATIVELY LOW PRESSURE ZONE TO A RELATIVELY HIGH PRESSURE ZONE

Filed Oct. 10, 1956 3 Sheets-Sheet 1

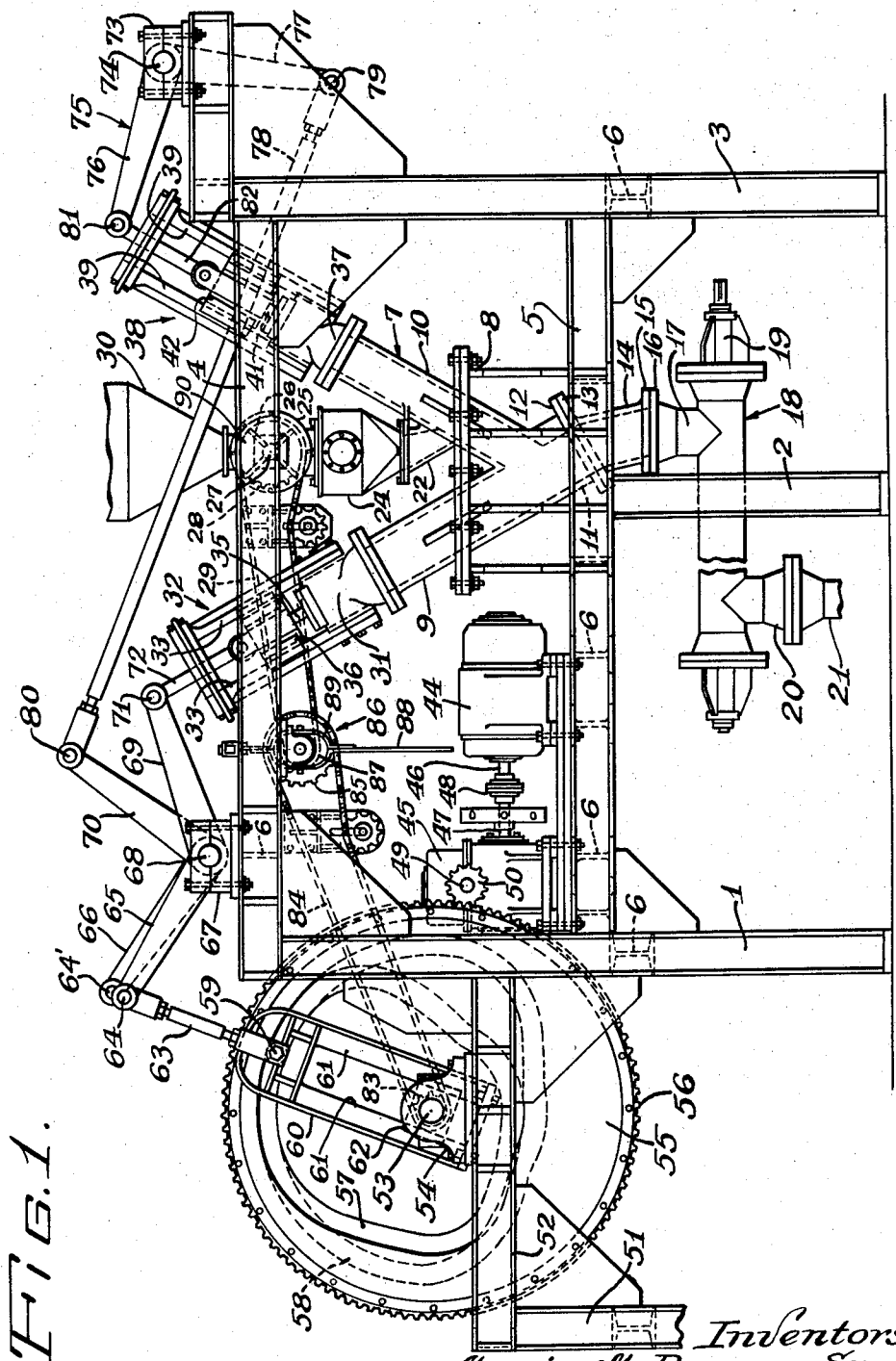


Fig. 1.

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FIG. 3.

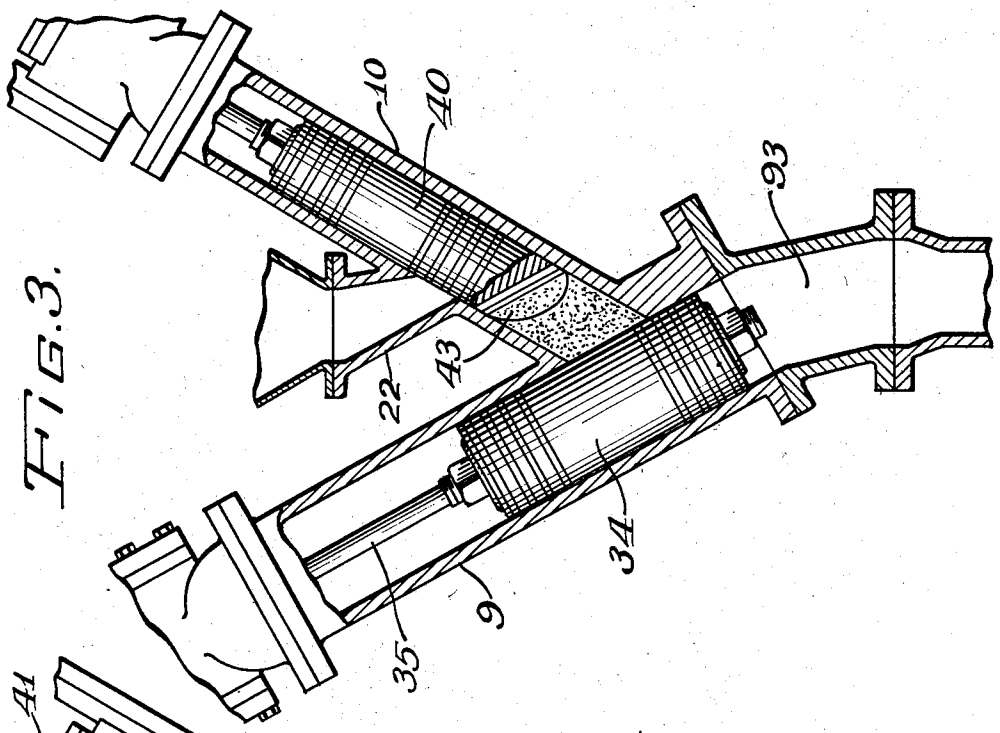
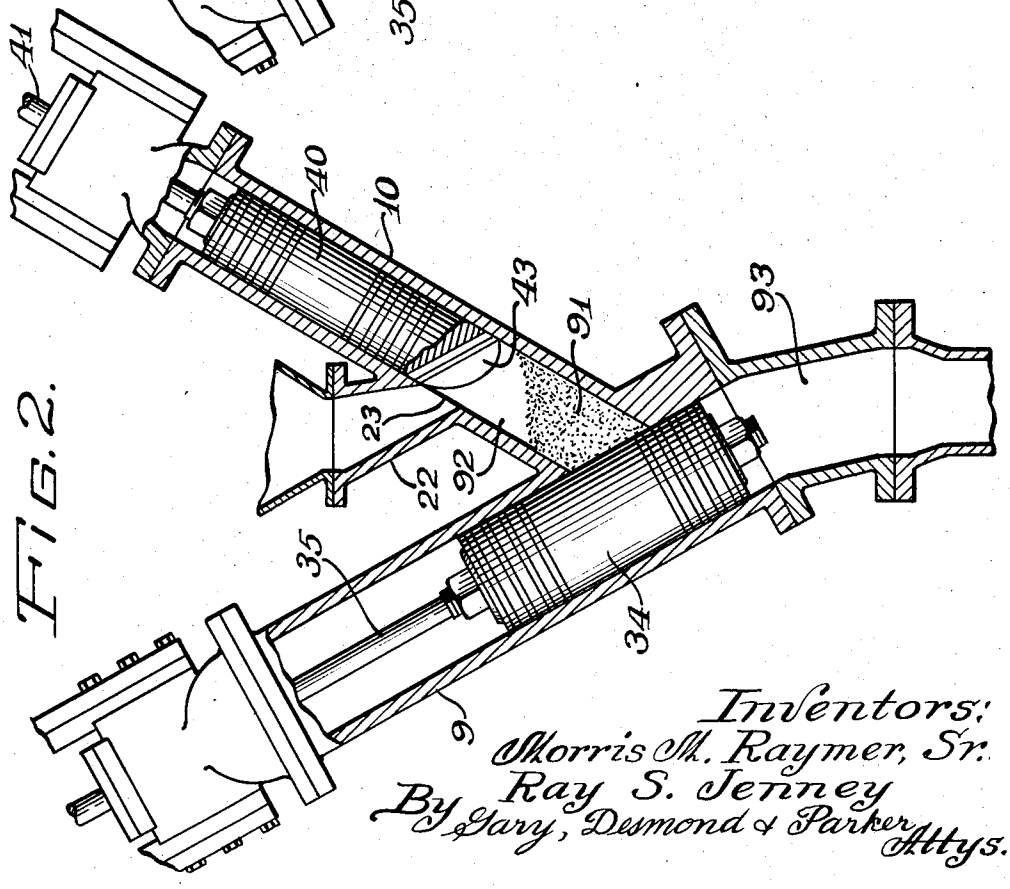


FIG. 2.



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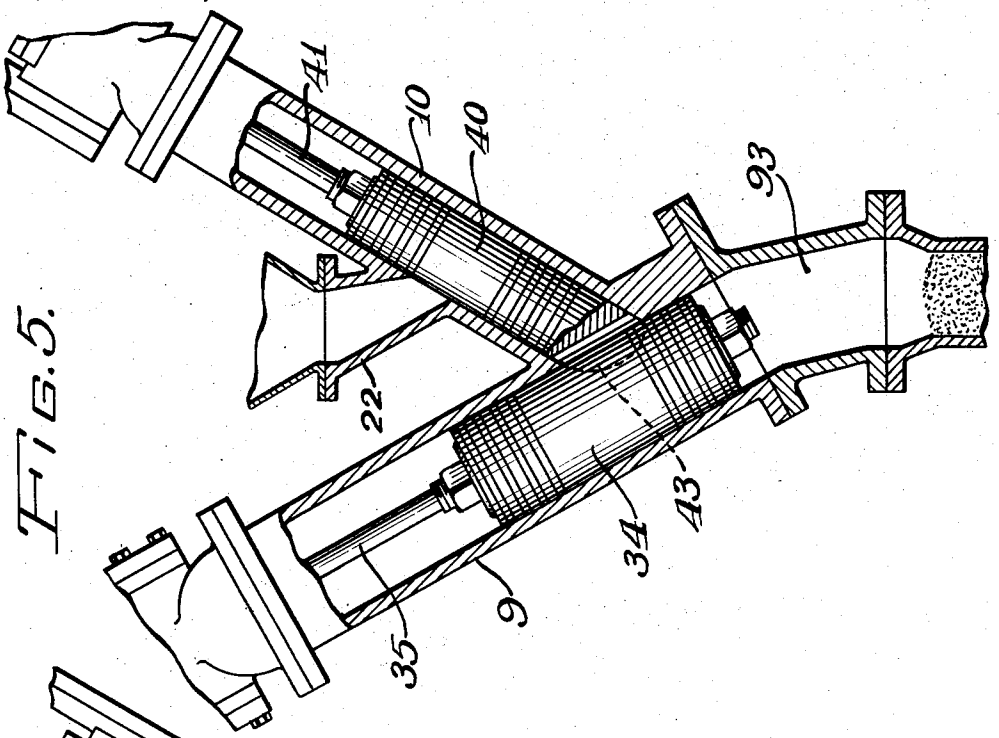


FIG. 5.

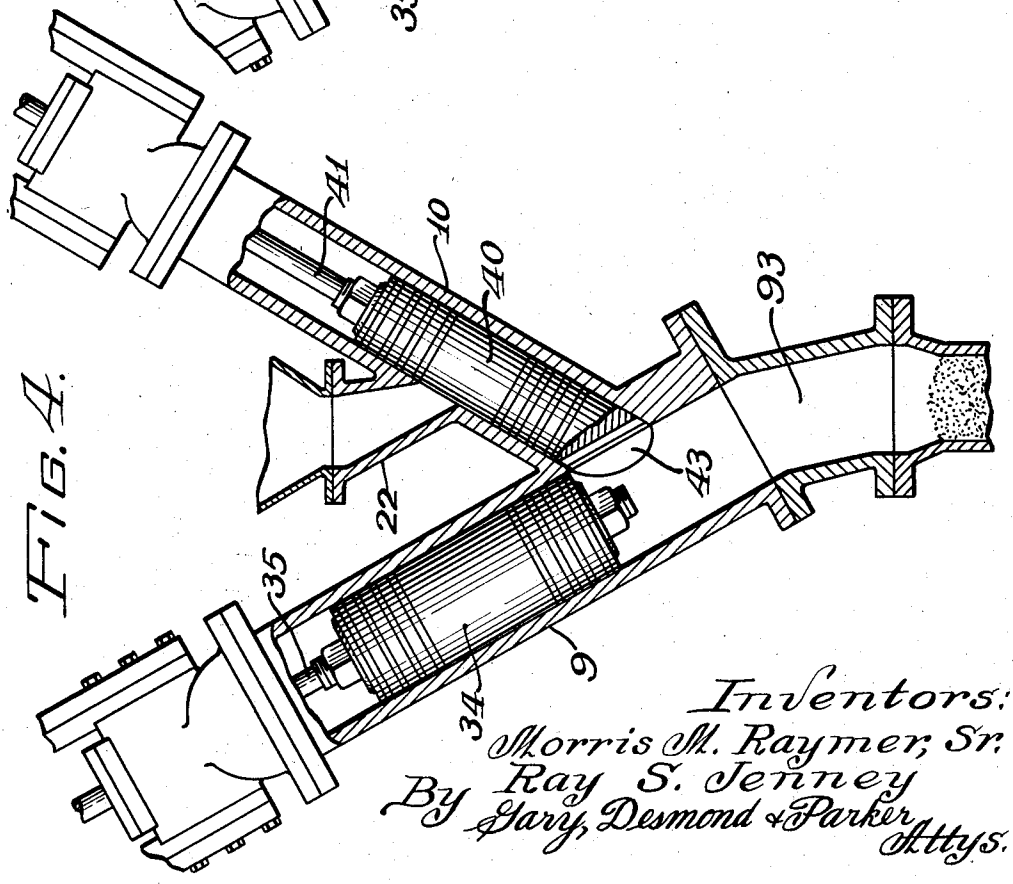


FIG. 4.

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MECHANISM FOR DISCHARGING MATERIAL FROM A RELATIVELY LOW PRESSURE ZONE TO A RELATIVELY HIGH PRESSURE ZONE

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8 Claims. (Cl. 214—17)

This invention relates to improvements in a machine for continuously transferring materials from a relatively low pressure zone to a relatively high pressure and high temperature zone without bleeding the high pressure from the high pressure and high temperature zone and without disrupting or displacing the material being fed from the low pressure zone by the escape of steam from the high pressure and high temperature zone.

In the act of continuously puffing ready-to-eat cereals or other cellular organic material, it is necessary to convey products to be puffed or exploded from a zone maintained at atmospheric pressure to a zone held at high steam pressures in the neighborhood of 80 to 190 pounds per square inch, gauge. After a conditioning period in the high pressure and high temperature zone, the materials are suddenly released from the zone and are thus exploded or puffed.

One of the difficulties involved in the operation hereinbefore described resides in introducing the materials from a zone at atmospheric pressure to the high pressure and high temperature conditioning zone and heretofore no suitable apparatus has been available for this operation.

The present invention contemplates apparatus by which relatively discrete materials such as wheat or the like may be fed from a zone of atmospheric pressure to a high pressure and high temperature zone, the device being characterized by its simplicity in structure and operation.

Other objects, advantages and features of the present invention will be apparent from the accompanying drawings and following detailed description.

In the drawings,

Fig. 1 is a side elevational view of a machine embodying the concepts of the present invention.

Figs. 2, 3, 4 and 5 are enlarged detailed sectional views of the operative cylinders and pistons employed in the device, the views illustrating the different positions of the parts in sequential phases of one complete cycle of operation.

Referring in detail to the drawings, **1**, **2** and **3** comprise vertical frame members which are longitudinally bridged by frame members **4** and **5** and transversely bridged by frame members **6**. A substantially Y-shaped cylinder structure **7** is carried upon a sub-frame structure **8** which, in turn, is supported on frame members **5** and **6**. The Y-shaped cylinder structure **7** is of hollow construction and comprises an ejection cylinder **9** and a feed cylinder **10**, which comprise arms of the Y and a relatively short continuation **11** of ejection cylinder **9**, which, in effect, constitutes the staff portion of the Y structure. The lower end of the continuation **11** carries a flange **12** which may be connected to flange **13** of discharge nipple **14**. The opposite end of the discharge nipple **14** carries a flange **15** which connects with flange **16** of an inlet pipe **17**, said inlet pipe constituting the inlet to a conventional high pressure conditioning chamber **18**.

In one use of the present invention the invention may be employed in conjunction with the puffing of cereal products. In this operation, the material to be puffed is passed from a zone of atmospheric pressure to a high pressure and high temperature zone wherein the material may be subjected to relatively high steam pressure for a predetermined period to cook the material and to pressurize the internal portions of the material. Such a conditioning zone is illustrated at **18** in Fig. 1 wherein the material fed through pipe **17** passes into the chamber **18** and is passed therethrough by a screw conveyor (not shown) carried and operated by shaft **19**. At the end of the chamber **18** the material may be discharged through outlet pipe **20** and may, if desired, be fed to inlet pipe **21** of another chamber (not shown) similar to chamber **18**.

A feed spout **22** is mounted upon feed cylinder **10** and, if desired, may be formed integral with the cylinder, the interior of the spout **22** connecting with the interior of the feed cylinder through opening **23**. A sub-hopper **24** may connect with spout **22** at its discharge end and at its feed end said sub-hopper connects with a proportioning valve **25**. The proportioning valve comprises a rotatable cruciform rotor **26** which may be mounted upon a shaft **27** which projects outwardly from the body of the valve. A sprocket wheel **28** is mounted upon shaft **27** and a sprocket chain **29** trained around wheel **28** functions to rotate the rotor **26**. A hopper **30** connects with the inlet side of the proportioning valve **24** and functions to deliver material to be ultimately transferred to the conditioning chamber, to the valve. The material in hopper **30** is normally at relatively low or atmospheric pressure and said material stays at that pressure during its passage through the proportioning valve, the sub-hopper **24** and spout **22**.

A head **31** is mounted upon the cylinder **9**, said head carrying a crosshead **32** having oppositely disposed guides **33**. A piston **34** (Figs. 2 to 4) is slidably positioned within the cylinder **9**, said piston being carried upon piston rod **35**. A guide block **36** is secured to the piston rod exteriorly of the cylinder and is disposed in association with the guides **33** for reciprocal movement.

Similarly a head **37** is mounted upon feed cylinder **10**, said head carrying a crosshead **38** having oppositely disposed guides **39**. A piston **40** is slidably positioned in the cylinder **10** and is carried upon piston rod **41** which exteriorly of the cylinder is secured to a guide block **42** which is slidably associated with the guides **39** of the crosshead **38**.

As will be hereinafter more full described the piston **34** in the ejection cylinder **9** reciprocates in said cylinder in timed relationship with respect to the reciprocation of the piston **40** in the cylinder **10**. At one phase of the operation of the machine, that is when piston **34** is in its outermost position and piston **40** is also in its outermost position within the respective cylinders, the end portion of the piston **40** comprises in effect a portion of the inner surface of the cylinder **9**. Accordingly, referring particularly to Figs. 2, 3, 4 and 5 the end of piston **40** is inclined to the axis of the piston at an angle equal to the inclination of the axis of the piston **34** with respect to the axis of the piston **40**. In addition, the inclined end portion of piston **40** is concavely arcuately formed as indicated at **43** in Figs. 2, 3, 4 and 5 whereby the tapered, concave end of the piston **40** may conform and may be disposed in registration with a portion of the peripheral wall of the cylinder **34**. The position of the parts shown in Figs. 4 and 5 indicate the position of the pistons **40** and **34** when the inclined arcuate portion **43** is in registration with the inner wall of the cylinder **9**.

Referring again to Fig. 1, an electric motor **44** is mounted upon the frame members **5** and **6**. A conventional gear-reducing mechanism **45** is also mounted upon said frame members and the motor shaft **46** is coupled to the input shaft **47** of the gear reducer **45** by a conventional

coupling 48. The gear reducer mechanism 45 also has an output shaft 49 upon which a pinion 50 is mounted.

Adjacent the frame of the machine proper, hereinbefore described, a sub-frame is positioned, the sub-frame comprising vertical frame members 51 and cross frame members 52. A cam shaft 53 is journaled in oppositely disposed bearings 54, only one of which is shown, said bearings being carried upon frame members 52. A cam 55 is carried upon the cam shaft 53, and the periphery of the cam 55 carries an external ring gear 56 which meshes with the gear reducer pinion 50. Hence, when motor 44 is actuated the cam 55 is rotated.

The cam 55 is a double-faced cam having an endless cam slot 57 on one face and an endless cam slot 58 upon the opposite face. A cam follower roller 59 is positioned in the cam slot 57, said roller being journaled in a frame 60 which, as will be hereinafter more fully described, moves in a substantially reciprocatory manner transversely to the axis of cam shaft 53. The cam frame 60 in addition to carrying the roller 59 carries opposite guides 61 which are slidably guided in a guide block 62 which is freely rotatable upon shaft 53. The arrangement is such that when cam 55 rotates, the frame 60 is caused to slide upon the guide block 62, guides 61 constraining the frame to move in a substantially reciprocal manner.

A similar arrangement is disposed upon the opposite side of the cam 55 and the cam roller, corresponding to the roller 59, operates in the cam slot 58. The frame which corresponds to the frame 60 is thus moved in a fashion similar to the frame 60, the movement, however, being determined by the contour of the cam slot 58.

A connecting rod 63 is rigidly secured to frame 60 and at its opposite end is pivotally connected, as at 64 to a crank 65. In similar fashion a connecting rod (not shown) is connected to the frame (not shown) on the opposite side of the cam 55 corresponding to frame 60 and the opposite end of said connecting rod is pivotally connected, as at 64', to crank arm 66. A pair of spaced bearing blocks 67 are mounted upon frame members 4 and said bearing blocks function as bearings for shaft 68 upon which both arms 65 and 66 are freely pivotally mounted.

The crank arm 65 is rigidly connected to an angular crank arm 69 whereby the crank arms 65 and 69 comprise a conventional bell crank lever. In similar fashion a crank arm 70 is rigidly connected to the crank arm 66 thereby forming another bell crank lever which is associated with the mechanism appurtenant to cam slot 58.

Crank arm 69 at its end is pivotally connected, as at 71, to a connecting rod 72 which is pivotally connected to the end of piston rod 35. Thus, when cam 55 is rotated, and the follower frame 60 is moved, the bell crank lever comprising the crank arms 65 and 69 are rocked about shaft 68 and by means of the connecting rod 72 the piston 34 is reciprocated within the ejection cylinder 9.

A pair of spaced bearing blocks 73 are also mounted upon the frame and function as bearings for shaft 74. A bell crank lever 75 comprising crank arms 76 and 77 is loosely journaled on shaft 74. A connecting rod 78 is pivotally connected, as at 79, to the end of the crank arm 77 and at its opposite end said connecting rod is pivotally connected as at 80 to the end of crank arm 70. The arrangement is such that when the cam 55 is rotated, the frame, corresponding to frame 60 and which is associated with the cam slot 58, rocks the crank arm 66 which in turn manipulates the linkage comprising crank arm 70, connecting rod 78 and bell crank lever 75. The end of crank arm 76 comprising a portion of bell crank lever 75 is pivotally connected, as at 81, to connecting link 82 which in turn is pivotally connected to piston rod 41. In this fashion rotation of cam 55 functions to cause reciprocation of the piston 40 within the feed cylinder 10.

The movements of frame 60 and the corresponding frame on the opposite side of cam 55 are a compound movement of radial reciprocatory movement with respect to the shaft 53 and circular movement about shaft 53. This latter movement is brought about by the angularity produced by the rocking of crank arms 65 and 66. The rocking movement of the frames about shaft 53 are accommodated by the relationship of the blocks 62 upon the shaft 53.

A sprocket wheel 83 is mounted upon cam shaft 53 and a sprocket chain 84 is trained around said wheel. The sprocket chain 84 is also trained around sprocket wheel 85 comprising a portion of a conventional clutch 86. Sprocket wheel 85 comprises the driving element of the clutch 86 and sprocket chain 29, trained around proportioning valve sprocket wheel 28, is trained around a driven sprocket 87, also comprising a portion of clutch 86. A control lever 88 terminates in a yoke 89 whereby the driving and driven elements of the clutch 86 may be engaged and disengaged.

By virtue of the endless character of the cam slots 57 and 58, the motion imparted to pistons 34 and 40 is cyclic. Figs. 2, 3, 4 and 5 illustrate a cycle of movement of said pistons. Referring particularly to Fig. 2, at the commencement of the cycle, piston 34 is at the commencement of its stroke. The port 23 thus affords communication between spout 22 and cylinder 10. The movement of the proportioning valve is timed with the movement of the pistons 34 and 40 and, hence, the contents of one compartment 90 of the proportioning valve has been discharged from the valve, through subhopper 24, spout 22 and the material falls by gravity to the position shown at 91 in Fig. 2. The desired timing of the proportioning valve may be secured initially by the appropriate manipulation of clutch 86. At the phase of operation illustrated in Fig. 2, the zone 92 is at relatively low pressure, for instance, atmospheric pressure, and the zone 93 may be at relatively high pressure and high temperature, for instance, 80 to 190 pounds per square inch, gauge.

Fig. 3 illustrates the next phase of operation. In this phase, the piston 40 moves outwardly and blocks communication through port 23. The cam slot 58 is so contoured that at this phase a dwell is provided whereby piston 40 remains momentarily stationary in the position illustrated in Fig. 3.

In the next phase of operation, illustrated in Fig. 4, piston 34 moves inwardly and as soon as said piston passes the chamber 92, piston 40 will have completed its dwell and will again move outwardly, discharging the material 91, now under the high pressure of zone 93, into the vacated end of cylinder 9. When piston 40 reaches the position shown in Fig. 4, cam slot 58 provides another dwell, holding the inclined, arcuate end 43 of piston 40 in registration with the inner wall of cylinder 9. While piston 40 is thus held, the next phase takes place, illustrated in Fig. 5.

In this phase, piston 34 moves outwardly to the position shown in Fig. 5 and, in doing so, ejects any material remaining in the vacated end of cylinder 9 into the nipple 14 and inlet 17 of the conditioning chamber. In addition, piston 34 blocks communication between zones 92 and 93. Piston 40 then moves inwardly to its initial position, shown in Fig. 2, and inasmuch as the clearance space between piston 34 and the tapered, arcuate end 43 of piston 40 was substantially negligible the low pressure condition of zone 92 is substantially unchanged.

The cycle is thus repeated with the discharge of each compartment 90 of the proportion valve rotor.

It is to be understood that many unpatentable modifications and variations may be made by anyone skilled in the art and, hence, it is not intended that the present invention be limited to the exact details shown and described except as necessitated by the appended claims.

We claim as our invention:

1. A device for feeding discrete material from a zone

of relatively low pressure to a zone of relatively high pressure which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure, a feed cylinder connected at one end to an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylinder, means for feeding discrete material at said relatively low pressure from said spout to said feed cylinder, a piston reciprocally movable in said feed cylinder to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston in said ejection cylinder reciprocally movable past the connection between the ejection cylinder and the feed cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure, and means for moving said pistons in timed relationship to each other.

2. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure and high temperature, a feed cylinder connected at one end to an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylinder, rotary proportioning means for feeding discrete material at said relatively low pressure from said spout to said feed cylinder, a piston in said feed cylinder to open and close communication between said spout and said feed cylinder reciprocally movable past the connection between the spout and feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston reciprocally movable in said ejection cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for rotating said proportioning means and moving said pistons in timed relationship to one another.

3. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure and high temperature, a feed cylinder connected at one end to an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylinder, rotary proportioning means for feeding discrete material in increments at said relatively low pressure from said spout to said feed cylinder, a piston in said feed cylinder reciprocally movable past the connection between said spout and said feed cylinder to open and close communication between said spout and said feed cylinder and to move an increment of material fed to said feed cylinder from said spout to said ejection cylinder, a piston in said ejection cylinder reciprocally movable past the connection between the feed cylinder and the ejection cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject said last-mentioned increment of material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for rotating said proportioning means and moving said pistons in timed relationship to one another.

4. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, a generally vertically disposed ejection cylinder opening at its lower end into a zone of relatively high pressure and high temperature, a generally vertically disposed feed cylinder connected at its lower end to an

intermediate portion of said ejection cylinder, said two cylinders being connected at an angle to each other, a generally vertically disposed material inlet spout connected to an intermediate portion of said feed cylinder, means for feeding discrete material at said relatively low pressure to said spout whereby said material passes by gravity to said feed cylinder, a piston reciprocally movable in said feed cylinder periodically to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston reciprocally movable in said ejection cylinder periodically to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for moving said pistons in timed relationship to each other.

5. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, a generally vertically disposed ejection cylinder opening at its lower end into a zone of relatively high pressure and high temperature, a generally vertically disposed feed cylinder connected at its lower end to an intermediate portion of said ejection cylinder, said two cylinders being connected at an angle to each other, a generally vertically disposed material inlet spout connected to an intermediate portion of said feed cylinder, means for feeding discrete material at said relatively low pressure to said spout whereby said material passes by gravity to said feed cylinder, a piston reciprocally movable in said feed cylinder periodically to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston reciprocally movable in said ejection cylinder periodically to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and cam and lever means for moving said pistons in timed relationship to each other.

6. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure and high temperature, a feed cylinder intersecting at one end with an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylinder, means for feeding discrete material at said relatively low pressure from said spout to said feed cylinder, a piston reciprocally movable in said feed cylinder to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, the end of said cylinder substantially conforming in contour with the trace of the feed cylinder upon said ejection cylinder where they intersect, a piston reciprocally movable in said ejection cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for moving said pistons in timed relationship to each other.

7. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure and high temperature, a feed cylinder connected at one end to an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylin-

der, means for feeding discrete material at said relatively low pressure from said spout to said feed cylinder, a piston reciprocally movable in said feed cylinder to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston reciprocally movable in said ejection cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for moving said pistons in timed relationship to each other, said means comprising a pair of cams, followers for said cams, and lever means connecting a respective follower to said pistons.

8. A device for feeding discrete material from a zone of relatively low pressure to a zone of relatively high pressure and high temperature which comprises in combination, an ejection cylinder opening at one end into a zone of relatively high pressure and high temperature, a feed cylinder connected at one end to an intermediate portion of said ejection cylinder, a material inlet spout connected to an intermediate portion of said feed cylinder, a hopper for said material, the material in said hopper being a relatively low pressure, a rotary quadrant

proportioning valve connected to said hopper, means connecting the proportioning valve to said material inlet spout to pass material to said feed cylinder, a piston reciprocally movable in said feed cylinder to open and close communication between said spout and said feed cylinder and to move material fed to said feed cylinder from said spout to said ejection cylinder, a piston reciprocally movable in said ejection cylinder to open and close communication between said ejection cylinder and said feed cylinder and eject material received in said ejection cylinder from said feed cylinder to said zone of relatively high pressure and high temperature, and means for rotating said quadrant proportioning valve and moving said pistons in timed relationship to one another.

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