July 22, 1969 W. K. HEILAND ETAL 3,456,576

AUTOMATIC EXPLOSIVE PUFFING APPARATUS

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Fig. 1

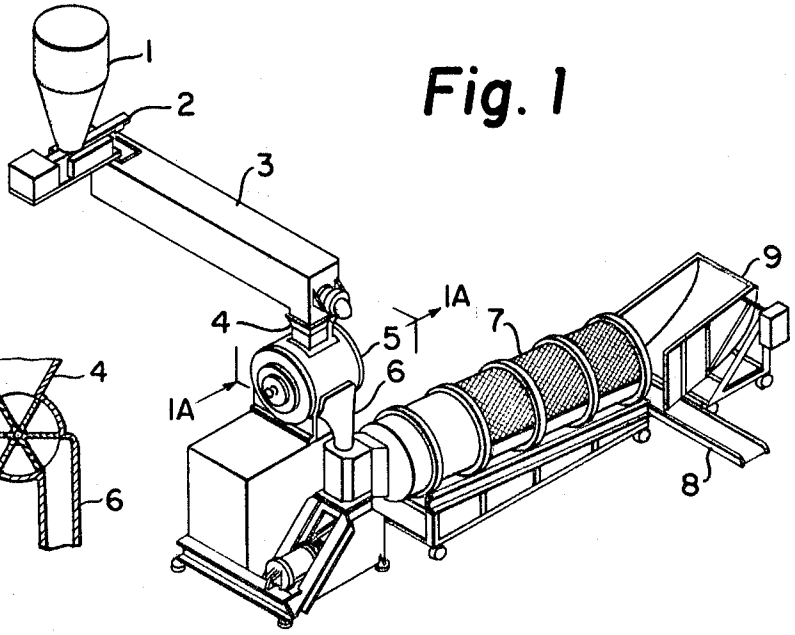

Fig. 1A

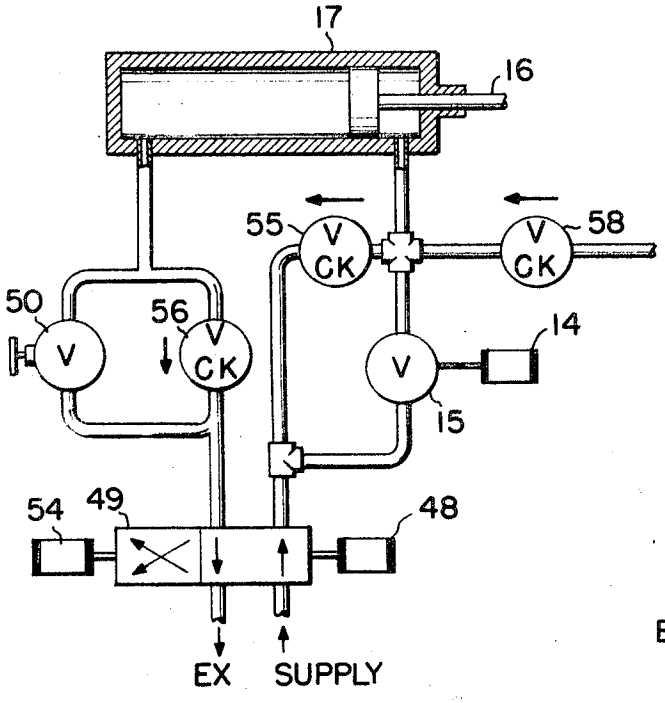

Fig. 4

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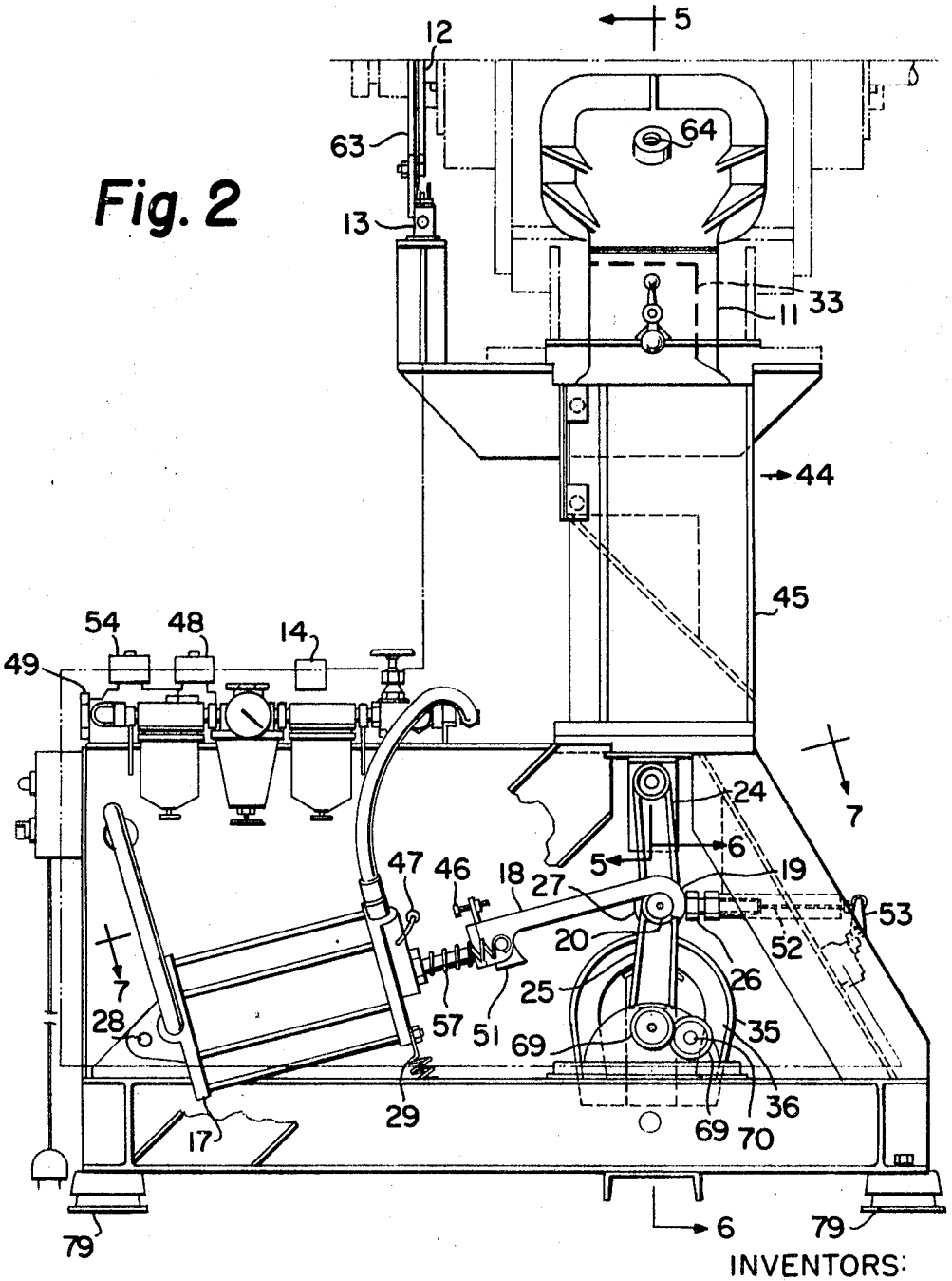
Fig. 2



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AUTOMATIC EXPLOSIVE PUFFING APPARATUS

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Fig. 3

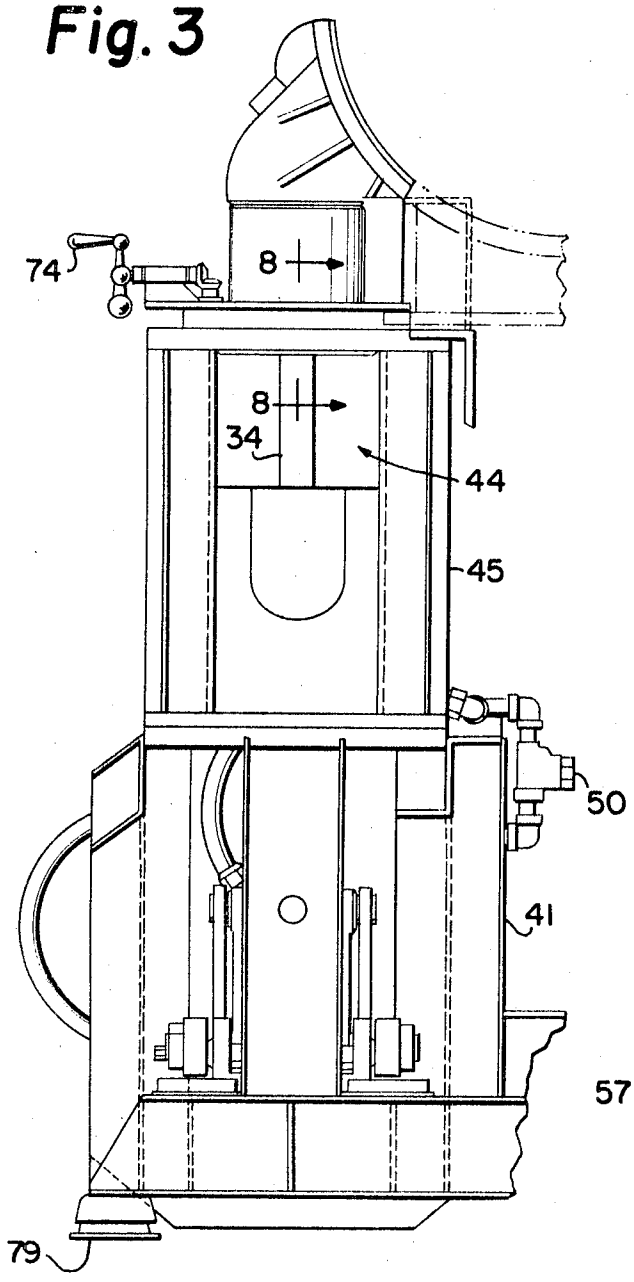
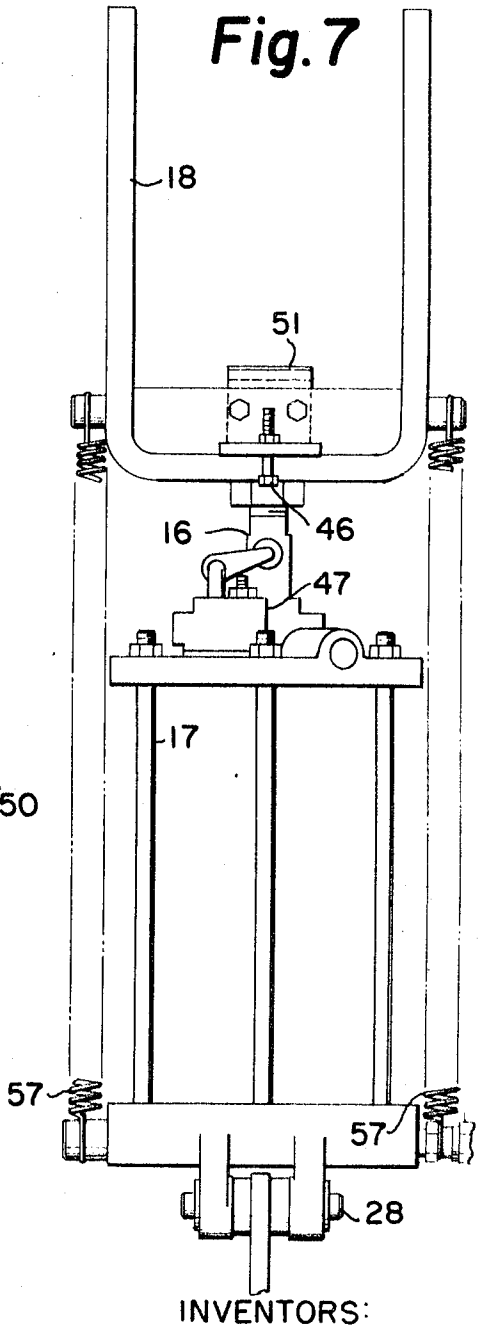


Fig. 7



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AUTOMATIC EXPLOSIVE PUFFING APPARATUS

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Fig. 5

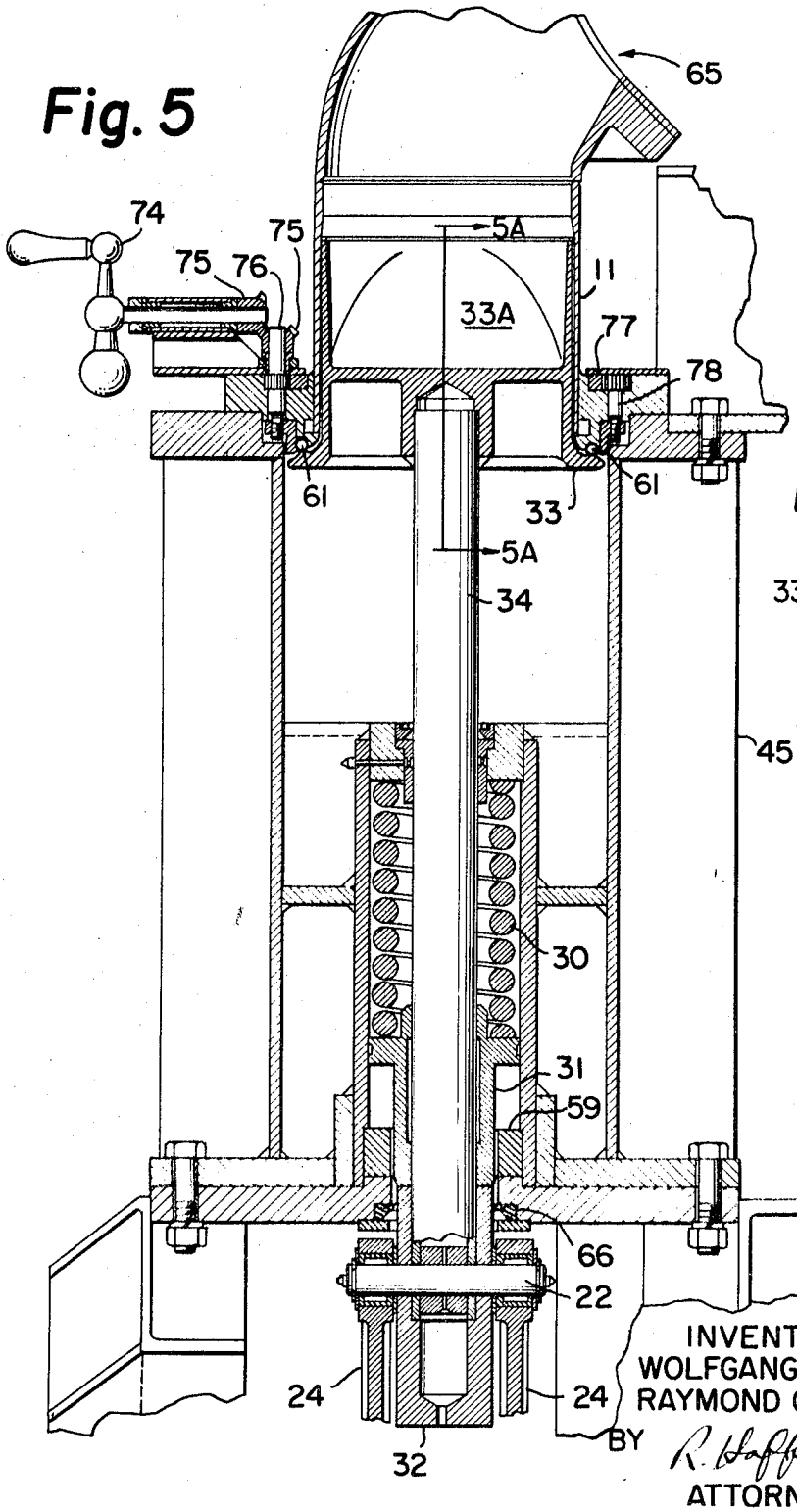
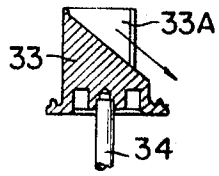


Fig. 5A



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AUTOMATIC EXPLOSIVE PUFFING APPARATUS

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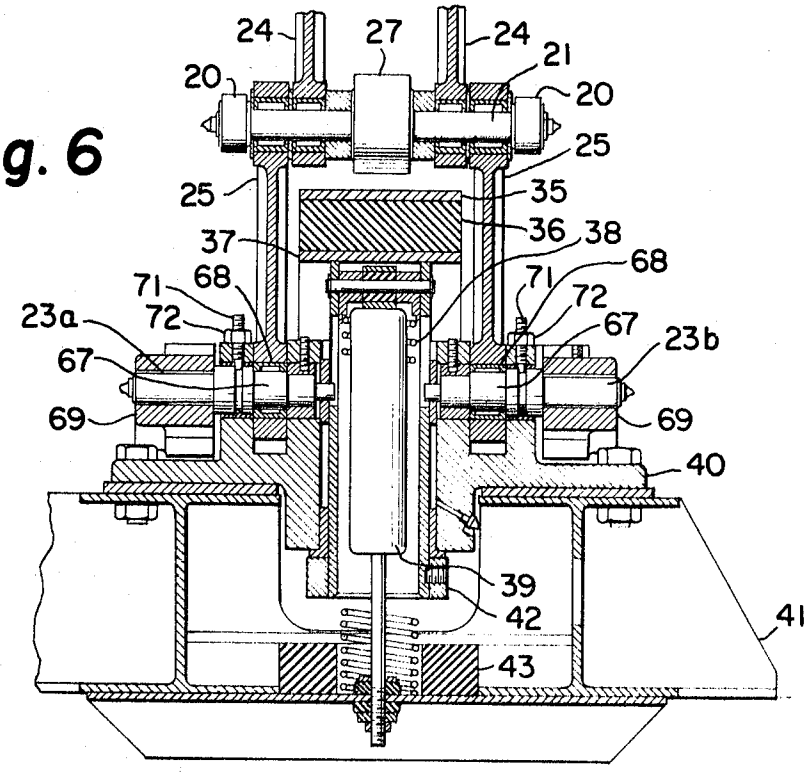
Fig. 6



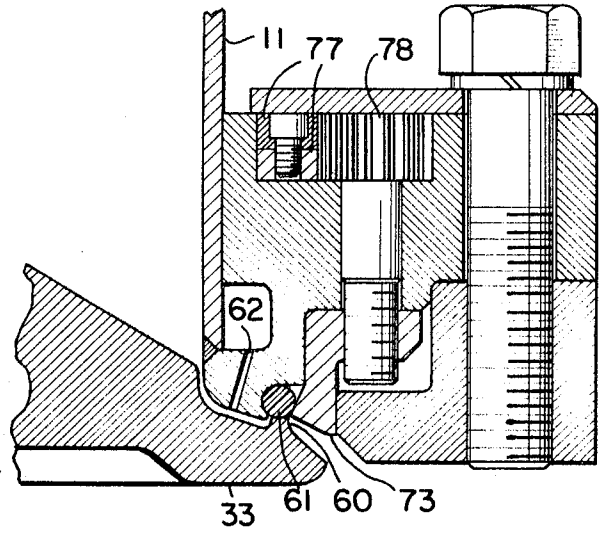


Fig. 8

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AUTOMATIC EXPLOSIVE PUFFING APPARATUS

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Int. Cl. A23l *1/18*
U.S. Cl. 99—238 5 Claims

ABSTRACT OF THE DISCLOSURE

An automatic puffing apparatus for explosive puffing of fruits and vegetables having a continuous product feed and receiver and an automatic but intermittent puffing operation. A non-hinged deeply recessed lid in combination with a heavy firing spring and the internal pressure in the puffing chamber provides extremely short opening times and a sideways discharge of puffed product.

This invention relates to apparatus for explosive puffing of various products. More particularly, it relates to apparatus for continuous explosive puffing of various products, especially comestibles.

Puffing process has long been applied in the preparation of products such as read-to-eat cereals and more recently in the preparation of quick cooking dehydrated fruits and vegetables. In such puffing process, the material is placed in a hollow pressure chamber, the chamber is sealed and heat and pressure are applied. Pressure may be applied either by external application of heat such as gas burners, electric heaters or steam jacket, and/or by injecting superheated steam into the chamber until the moisture in the material is slightly superheated with respect to atmospheric pressure. The chamber is subsequently rapidly opened discharging the material, while a small amount of the superheated moisture in the material flashes into steam, causing the material to puff.

Equipment in current operation for explosive puffing exists in the form of puffing guns of various designs. These puffing guns, however, suffer from many disadvantages. For example, differences in such variables as time, temperature and pressure which are prevalent, adversely affect product uniformity between batches; considerable time is lost during firing and reloading of puffing guns and; large individual charges require a spacious collection system.

One of the more serious draw-backs of puffing guns themselves, however, is their lid design. Conventionally, such lids are hinged and are dependent exclusively on the releasing of the internal pressure for opening. To withstand the internal pressure and to form a pressure tight seal with the pressure chamber, such lids are heavily constructed. Because of their heavy construction, the speed of the lids lags behind the speed of portions of the discharging material. As a result the product is damaged, as it impinges on the lid. Since the opening time of the lid determines the quality of the puff, and since in currently used apparatus the pressure for opening the lid is the same as the processing pressure, it is virtually impossible to increase the quality of the puff by decreasing the opening time of a given lid at established processing pressure.

It is therefore an object of this invention to provide apparatus for continuous puffing of various products, especially comestibles.

Another object is to provide apparatus for puffing various products, which said apparatus eliminate product damage resulting from product impinging on the lid of said apparatus.

These and other objects will become apparent from the description, claims and accompanying drawings which form a part of this application.

The objects of this invention are accomplished: (1) by connecting a pressurized multiple-compartment continuous feeder valve equipped with pressurized discharge means between the conveyor which, transfers the product from the feed hopper, and the pressurized puffing chamber, (2) by providing the pressurized puffing chamber with a non-hinged lid which contains a deep recess and to which is attached a heavy compression spring to accelerate opening. This lid opens on a downward stroke like the piston of a combustion engine, and (3) by employing in combination a pressurized multiple-component continuous feeder valve and a pressurized puffing chamber containing a non-hinged lid. This combination is operative alone as well as when connected with existing apparatus.

The pressurized multiple-compartment continuous feeder valve which is comprised of a housing and several individual compartments therein, provides means for continuously heating and feeding product under pressure to the pressurized puffing chamber; these compartments rotate continuously through a circular path. For example, at one point on the circular path a compartment is aligned with the opening to the steam heated conveyor and is filled with the product to be processed. As one compartment rotates away from the opening, another compartment is aligned with the conveyor opening and is filled with the product. Simultaneously, the previously filled compartments are pressurized with superheated steam as they continue rotating toward the puffing device. When each compartment is aligned with the discharge device feed opening, it empties its contents into the pressurized puffing chamber. The puffing device makes an explosive discharge, closes the puffing chamber which is pressurized immediately and the product from the next compartment falls into it. From the time the compartment is filled with product, the product remains under pressure until such pressure is released by the opening of the lid of the pressurized puffing chamber.

In the instant invention, the lid is not hinged to the puffing chamber and makes its opening stroke straight downward like the piston of a combustion engine. The lid is constructed with a deep recess which causes the product to be discharged sideways, nearly horizontal, when the lid is opened. This side discharge feature directs the product into the collection system in a more easily controlled manner. This type lid is constructed with a piston type design and provides a more positive seal against the pressure chamber as the sealing surface of the lid engages the sealing ring on the pressure chamber over its entire circumference at the same time, while the sealing surface of the lid is washed clean of product remaining just before it closes. Attached to the lid is a heavy compression spring which is automatically cocked during lid closure. To open the lid, the stored energy in this spring is used to accelerate the lid downward through its first ⅓ length of travel. Without any assistance by the pressure in the pressure chamber, this spring alone provides opening times comparable to those experienced on puffing guns operating at average pressures. This feature makes possible the successful puffing of fragile materials such as blueberries and apples at very low pressures without an excessive amount of fragmenting of same by the lid and collecting system. For sturdier products, such as carrots and potatoes, this spring, augmented by the pressure in

the pressure chamber, provides extremely short opening times and a high quality puff.

Referring now to the drawings:

FIG. 1 is a diagrammatic drawing showing all equipment pertinent to the whole process.

FIG. 1A is a transverse section of the valve taken on plane 1A—1A of FIGURE 1.

FIG. 2 is a front elevation of the assembled invention.

FIG. 3 is a side elevation of the assembled invention looking at the discharge.

FIG. 4 is a schematic air diagram.

FIG. 5 is a view, mostly in cross section along line 5—5 of FIG. 2.

FIG. 5A is a fragmentary section of the discharge chamber taken on line 5A—5A of FIGURE 5, showing the direction of product discharge.

FIG. 6 is a view mostly in cross section along line 6—6 of FIG. 2.

FIG. 7 is a partial view in direction 7—7 showing the air cylinder and yoke.

FIG. 8 is a partial view, mostly in cross section along line 8—8 of FIG. 3.

FIG. 1 is a flow diagram showing the operation of the instant invention in combination with conventional apparatus: The material to be processed is removed from an input hopper (component #1) by a volumetric feeder (component #2) at a pre-set rate and dropped into a screw conveyor (component #3) which is comprised of a hollow, steam heated conveying screw and steam jacketed trough. Here, the product is preheated under atmospheric pressure and falls by gravity into an intermittent feeder (component #4), where the product is accumulating until a pocket of the pressurized conventional star valve (component #5) is in position for the drop. As each pocket of this star valve lines up with the feed opening, it is filled with preheated product and as it clears the feed opening, it is pressurized with superheated steam. As the star valve continues to rotate, the superheated steam heats the product until its moisture is slightly superheated with respect to atmospheric pressure. The product then transfers by gravity into the closed, prepressurized puffing device (component #6), and as soon as the pocket is in the proper position, the lid to the pressurized puffing chamber is opened downward by a heavy compression spring and the internal pressure of the puffing chamber. The deep recess in the lid causes the product to be discharged horizontally into a semi-perforated receiver (component #7), rotating synchronously with the star valve. This receiver makes one revolution per discharge at which time its solid half is on the bottom to prevent damage to the discharging product as the steam is allowed to escape upward through the perforated half. With the axis of the receiver sloping downward, the product is gently conveyed through the receiver length to a take-away conveyor (component #8). Part of the discharging product may have enough velocity to fly clear through the synchronously rotating receiver and pass the take-away belt. In such cases, the discharging product is finally stopped by a vibrating, progressively inclined arrester (component #9), which vibrates the product back to the take-away conveyor.

Various comestibles and other products have been explosively puffed in the above described apparatus. Such products include both fragile and sturdy products such as carrots, potatoes, cellery, apples, rutabages, beets, turnips, blueberries. Damage-free puffed products have been repeatedly obtained.

A further and more detailed illustration of the instant invention is demonstrated when a product, such as one of those named above, reaches the pressurized puffing chamber. Referring now mostly to FIGS. 2, 3, 4 and 5, after the heated product reaches the pressurized puffing chamber, theinstant invention operates as follows: Cam disc **12** located on star valve shaft (component #5) actuates limit switch **13** energizing solenoid **14** which opens valve **15** to admit compressed air to the rod **16** end side of air cylinder **17**. Fastened to the rod end **16** of air cylinder **17** is a yoke **18** having two hooked ends **19** which at this time are engaged with two outboard roller bearings **20** on the knee joint shaft **21**. At this time, the center line of knee joint shaft **21** is located a small distance to the right of a straight line between upper **22** and lower **23** pivot pins which are connected to each other by a pair of upper **24** and lower **25** links as in FIG. 2 and FIG. 6. Right side movement of knee joint shaft **21** is limited by adjustable stop **26** and knee joint shaft center roller **27**. Pivot mounting **28** of air cylinder **17**, gravity and extension spring **29** cause the yoke **18** to remain in contact with outboard rollers **20**, as the compressed air retracts rod end **16** moving knee joint shaft **21** to the left. As the knee joint shaft **21** moves past the connecting line of pivots **22** and **23**, the whole knee joint mechanism becomes unlocked. The pull of yoke ends **19** on rollers **20** and the steadily increasing force components of compression spring **30** (FIG. 5), transmitting its force through floating sleeve **31**, anvil **32** to upper pivot pin **22** and the pressure in chamber **11** acting on lid **33**, through lid shaft **34**, transmitting its force to upper pivot pin **22** causing knee joint **21** to swing counter clockwise around lower pivot pin **23**. Rollers **20** move ahead to the moving hooked ends **19** of yoke **18**. As the knee joint **21** moves through this arc, the upper pivot pin **22** with anvil **32**, lid **33** and lid shaft **34** move straight downward until this movement is gradually stopped by the arrester mechanism as the anvil **32** makes contact with Teflon heat shield **35** (FIGS. 2 and 6), supported by a horse-shoe-shaped rubber bumper **36**, spring housing **37**, compression spring **38** and automotive shock absorber **39**, all of which are mounted in an arrester housing **40**, bolted to the lower frame **41**. The downward movement is finally stopped when lower end of spring housing **37** and collar **42** contact rubber stop **43**. In the meantime, the product in chamber **11** is explosively discharged through discharge opening **44** (FIG. 3) of intermediate housing **45** as the lid **33** makes its down stroke. Spring **38** returns spring housing **37**, rubber bumper **36** and heat shield **35**. At the same time, anvil **32**, and with it lid **33** and lid shaft **34** are raised a small amount. In the meantime, retraction of air cylinder rod **16** has come to an end as an adjustable stop screw **46** on yoke **18** tripped limit switch **47** mounted on the face of air cylinder **17** causing solenoid **48** (FIG. 4) to become energized, shifting 4-way valve **49** to the right and compressed air is admitted to the bottom end of air cylinder **17**, while the rod end side is now exhausting to the atmosphere, causing the rod **16** and with it yoke **18** to move out starting from position depicted in FIG. 7. This forward movement, controlled by flow control valve **50**, cocks the knee joint mechanism as the bumper **51** contacts roller **27** in center of knee joint shaft **21** and moves it on an arc around lower pivot **23** until this movement is stopped by adjustable stop **26**. Through the hollow center of this stop **26**, a pin **52** extends by a small amount into the pass of roller **27** which, as the knee joint snaps past dead center, is fired to the right, tripping limit switch **53**. Limit switch **53** in turn energizes solenoid **54** causing 4-way valve **49** to shift to position shown in FIG. 4. Check valve **55** and the closed valve **15** prevent compressed air from entering the rod end **16** side of air cylinder **17**. With the bottom side of air cylinder **17** connected to the exhaust part of valve **49** through flow control valve **50** and check valve **56**, two extension springs **57**, mounted one on each side of the yoke **18** and air cylinder **17** retract the cylinder rod **16** and yoke **18** slowly as make-up air is allowed to enter the rod end side of air cylinder through check valve **58**. Piston rod **16** and yoke **18** rolling on rollers **20** are retracted by springs **57** until hooked ends **19** of yoke **18** snug-up on rollers **20**. Earlier, during cocking of the knee joint mechanism, upper pivot **22**, (FIG. 5), anvil **32**,

lid **33** and lid shaft **34** moved upward until upper end of anvil **32** contacted floating sleeve **31**, lifting it off bumper **59** and in turn compressing spring **30** as the lid **33** closed with its annular sealing surface **60** against sealing ring **61** of pressure chamber **11**. Just before the lid **33** closes, a plurality of fine jets **62** (FIG. 8) of superheated steam wash off any product remaining on sealing surface **60**. The instant the lid **33** is closed a quick opening steam valve (not shown) activated by a second cam disc **63** located on the star valve shaft admits superheated steam through port **64** into chamber **11**, pressurizing same prior to the next compartment of the star opening to the pressure chamber **11**. Thus, as soon as this next compartment starts to open into the feed opening **65** of chamber **11**, internal pressures of compartment and chamber **11** are identical as the product drops by gravity into chamber **11**, the compartment of which is designated by **33A** in FIGURES 5 and 5A.

To prevent impact loads on floating sleeve **31** (FIG. 5) and other vital parts, the floating sleeve is air cushioned before it hits bumper **59** by means of shaft seal **66** closing against the lower, cylindrical portion of floating sleeve **31**.

To provide a positive sealing of lid **33** against sealing ring **61**, through the full range of manufacturing tolerances, the lower pivot **23** (FIG. 6) of the knee joint mechanism is adjustable. To accommodate a central arrangement of the arrester mechanism, the lower pivot **23** consists of two pins **23***a* and **23***b*. Rotatably secured to an eccentric portion **67** of pins **23** are the lower links **25** of the knee joint mechanism by means of needle bearings **68**. Spur gears **69** on both pins **23** and on both ends of jack shaft **70** (FIG. 2) secure the lower pins **23** to each other and when jack shaft **70** is rotated by means of flats on its protruding end, both lower links **25** are raised or lowered together. After the correct position of the lower pins **23** toward positive sealing of lid **33** against sealing ring **61** is established, both lower pins **23** are locked in place by tightening set screws **71** which in turn are secured from becoming loose through tightening of nuts **72** against arrester housing **40**. To facilitate removal and installation of sealing ring **61** (FIGS. 5 and 8), its retaining groove is only partly machined into chamber **11**. The outer part of the retaining groove is formed by a ring **73** which, through crank **74**, miter gears **75**, drive pinion **76**, split ring gear **77** and driven pinions **78** can be lowered. To prevent any hard shock from being transmitted to the floor, the entire apparatus is bolted to the floor by means of four shock mounts **79**.

We claim:

1. The combination of a pressurized feeder valve and a pressurized puffing chamber with a non-hinged lid to which is connected a compression spring which upon release opens said non-hinged lid; said feeder valve discharging pressurized product into said non-hinged pressurized chamber.

2. In an apparatus for explosive puffing of comestibles and other products, the improvement consisting of the combination of a pressurized feeder valve and a pressurized puffing chamber with a non-hinged lid, said non-hinged lid containing a recess for side-way discharge of puffed product, said non-hinged lid being connected to a compression spring which when released opens said lid in a downward manner.

3. In an apparatus for the explosive puffing of comestibles and other products, the improvement comprising a pressurized puffing chamber having a non-hinged lid and a compression spring connected to said lid acting with the internal pressure in the puffing chamber, said compression spring acting in combination with said internal pressure to maximize the opening speed of the non-hinged lid.

4. The pressurized puffing chamber of claim **3** wherein said non-hinged lid contains a recess for side-way discharging of puffed product upon opening.

5. An automatic puffing apparatus for explosive puffing of fruits and vegetables having a continuous product feed and receiver and an automatic but intermittent puffing operation, the puffing chamber of said apparatus being provided with a non-hinged deeply recessed lid, said lid being connected to a heavy compression spring which exerts its force on the lid in the same direction as that of the force exerted by the internal pressure in said puffing chamber, said lid and spring in combination with the internal pressure in the puffing chamber providing extremely short opening times at low pressures for discharge of puffed product.

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U.S. Cl. X.R.

99—81; 146—223