Sept. 11, 1962 B. T. SANDOR ETAL 3,052,923

PELLETING MACHINE

Filed March 28, 1960 3 Sheets-Sheet 1

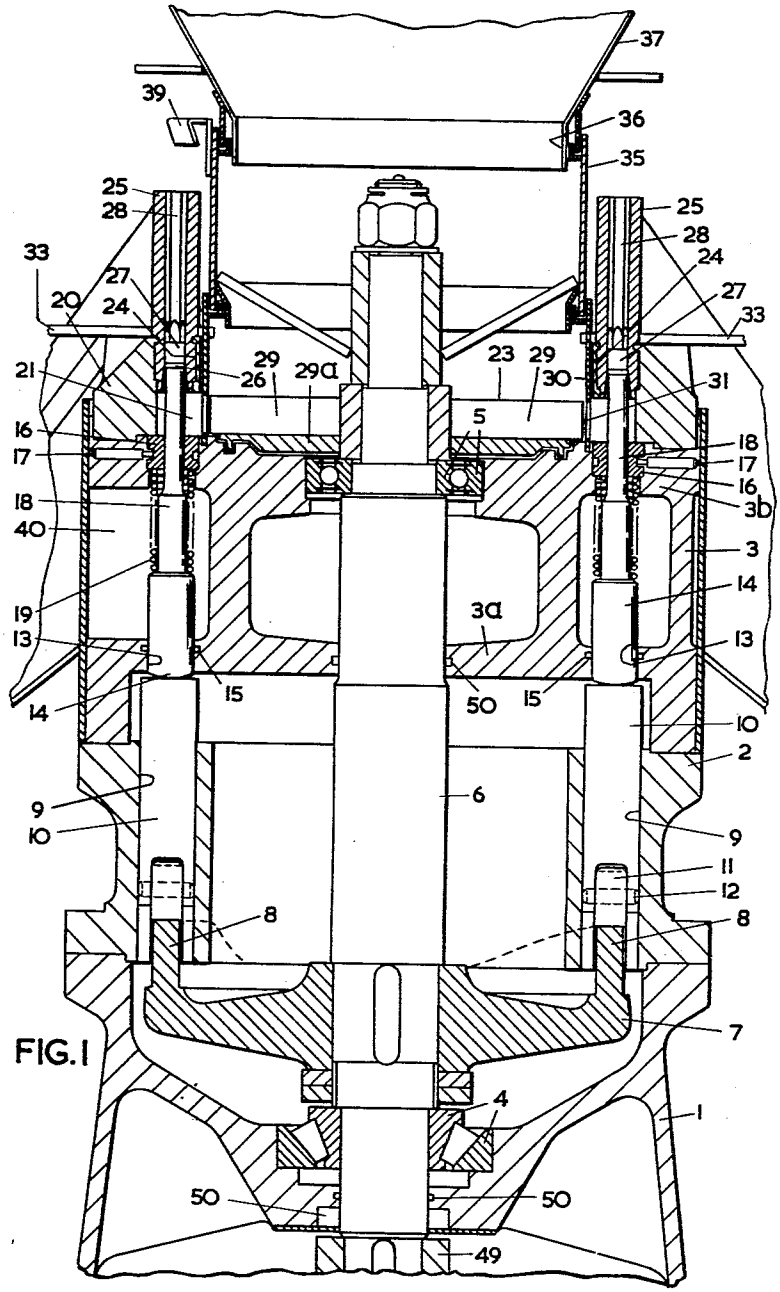


FIG. 1

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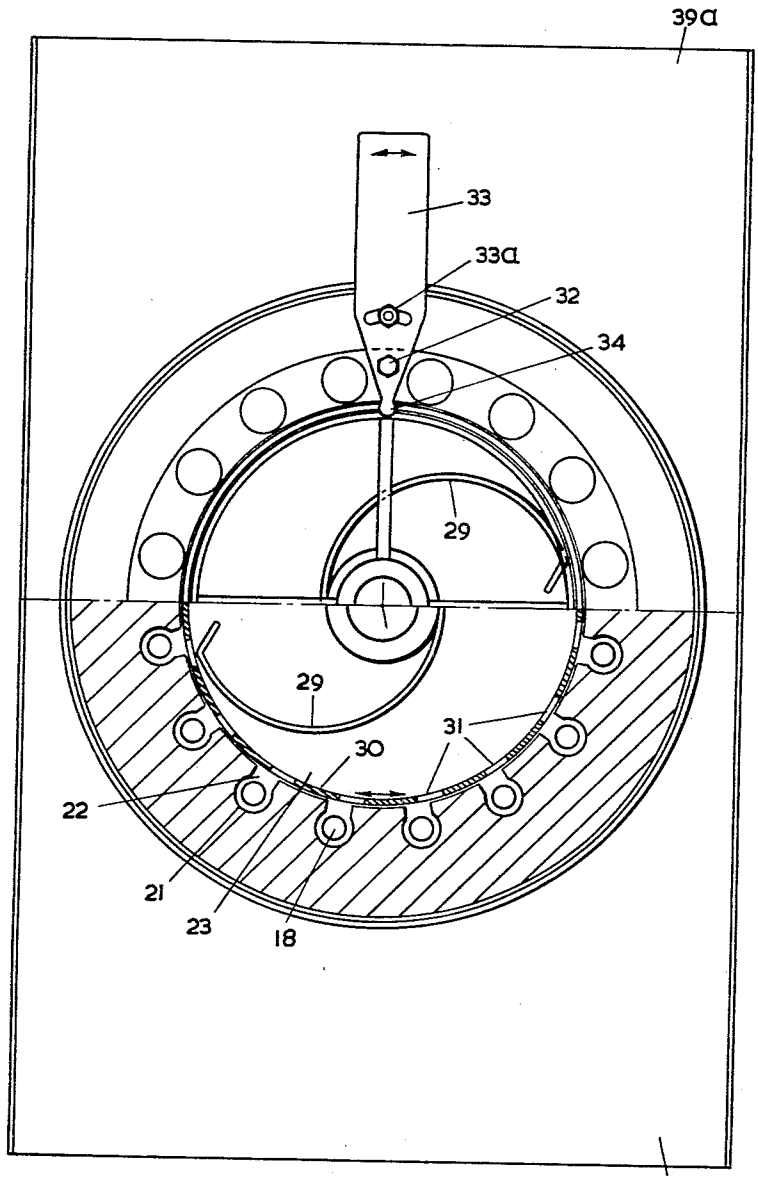


FIG.2

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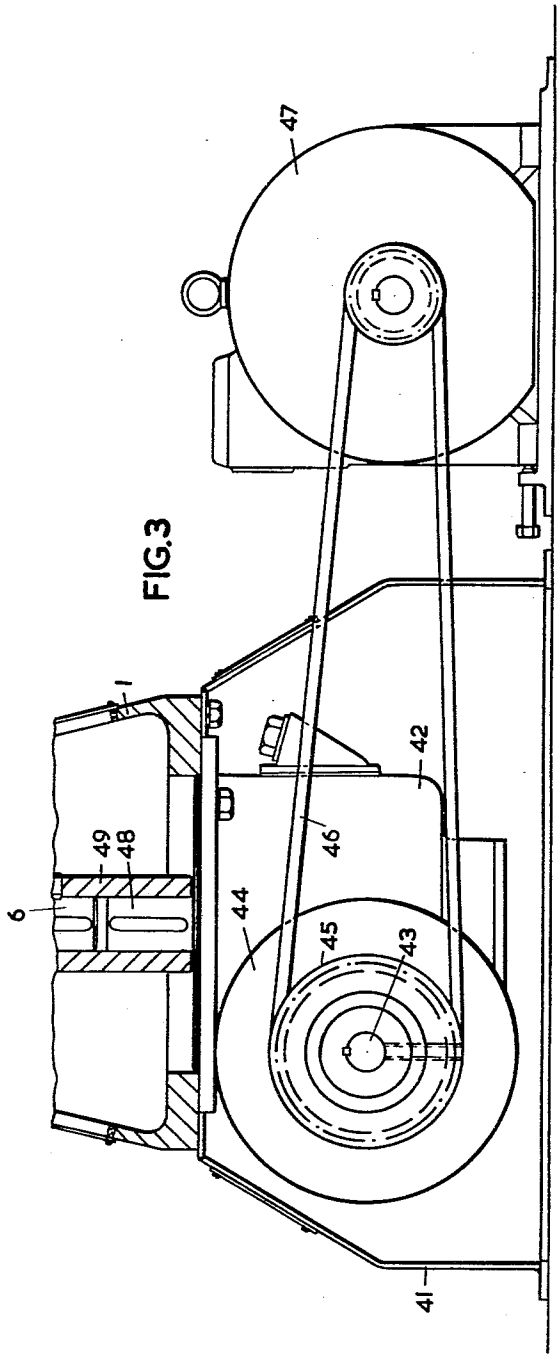


FIG.3

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3,052,923
PELLETING MACHINE

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1 Claim. (Cl. 18—20)

This invention relates to machines for the production of pellets, e.g. of animal foods, by compression or compression and extrusion.

The object of the present invention is to provide an improved machine wherein a number of dies are utilised and have plungers operated in succession by a common actuating device, whereby a relatively high rate of output may be achieved with comparatively small bulk and low power consumption.

According to the present invention, such a machine comprises a plurality of dies, a corresponding number of reciprocable plungers associated one with each die for forcing material into the die, and a rotary plunger-actuating member adapted to move each plunger in a compression stroke at least twice per revolution of the actuating member. The dies are preferably bottomless dies through which the material is extruded forced at each stroke.

The plunger-actuating member may be a camming element having axially-acting cams, or a cam-shaft acting radially or otherwise. In a preferred form of the invention the plurality of dies are arranged about the axis of revolution of the plunger-actuating member and may have their own axes parallel or at right-angles or inclined thereto.

The plunger-actuating member may effect both the compression and return strokes of the plunger, but in a preferred embodiment the return stroke is effected by suitable spring-loading acting on the plungers.

For the precompression and feeding of material to the dies there may be provided a common charging gap or a number of charging pockets, adjacent the inlet end of each die, in which the associated plunger moves to force material from the gap or pocket towards the die at each compression stroke, means being arranged for compressing material into the gap or each such pocket prior to such stroke of the plunger. Such material-compressing means may comprise, for example, radially-acting blade impellers or axially-acting auger means.

In a preferred form, the impellers are attached to the shaft which operates the plunger-actuating member and the material is fed to the impellers from a hopper by gravity. The impellers force the material into the pockets so that the material becomes pre-compressed and forms a solid layer from which a constant quantity is punched out and delivered by the moving plunger at each compression stroke. The material flow from the hopper to the impellers may be adjustable or may be arranged in a self-sealing manner. The contents of the hopper may be kept in permanent motion by a stirrer, also attached to the rotating shaft.

It is desirable to be able to vary the amount of material fed to each die, rather than varying the length of the compression stroke. For this purpose we may provide shutter means for regulation of the amount of material forced into each pocket prior to each compression stroke. In a preferred embodiment the charging pockets are arranged at the periphery of, and open radially into, a cylindrical feed chamber in which coaxial radially-acting impellers rotate to compress material into the pockets. A cylindrical shutter having apertures corresponding to the number of pockets is positioned within the chamber and is angularly adjustable to vary the effective size of the pocket openings.

In another form the feed-regulating shutter is adjustable longitudinally to close or open the gap or pockets and control the quantity of material fed thereinto.

The machine may have stationary or rotating breaker means the latter being movable transversely to the path of the extruded rod of material for breaking or shearing off predetermined lengths thereof. The extruded rod of material tends to have weak sections at positions corresponding to each compression stroke, and preferably the breaker means are adjustable in spacing from the outlet of the die so as to permit breaking off, from the extruded rod, of lengths corresponding to a desired number of extrusion strokes, or adapted to cut off pellets by shearing off close to the die head.

Each die advantageously includes, when considered in the direction of the extrusion, a bore portion of reducing circular cross-section merging into a bore portion of constant circular cross-section, the latter then merging into a bore portion of constant polygonal cross-section. One or more of the dies may be multiple-outlet dies. The length of the die is preferably at least a multiple of the plunger stroke.

In order to reduce the power requirement of the extruding operation the dies and plungers may be made as follows:

(*a*) The included angle of the inlet if the die is 10° or less and the diameter of the plunger is at a maximum 15%–20% larger than the diameter of the first cylindrical portion of the die hole; or

(*b*) The plunger diameter is equal to the diameter of the first cylindrical portion of the die and the cross section of the cylindrical portion is subsequently reduced in one or more positions. In this case the plunger only enters the orifice of the die (having an approximately 5° included angle) and as a result of consecutive strokes a gradual compression takes place: first in longitudinal direction, then in radial direction also.

(*c*) The plunger diameter is smaller than the diameter of the first cylindrical portion of the die, which is only flared for easier penetration. Here again one or more cross section reductions can be made to obtain the required firmness of the pellet.

Instead of the cross-section reductions mentioned in (*a*), (*b*) and (*c*) above, or in addition thereto, the firmness of the pellet can also be increased by making the die longer or attaching thereto die extensions to suit the material to be pelleted.

A preferred form of die and plunger assembly comprises a chamber having first an orifice with an included angle of 4° to 6°, then a cylindrical portion the diameter of which is equal to the diameter of the co-acting plunger, then a hexagonal die portion (preferably broached), where the dimension of the hexagon across the corners is equal to the diameter of the cylindrical portion.

The cylindrical portion may be omitted altogether or made to a suitable length so as to suit the material to be compressed.

As the primary purpose of pelleting is not so much complete compression as the provision of a tough "skin" (to avoid dusting and to enable easy handling), the shape alteration within the die, e.g. from cylindrical or other polygonal shape, will fulfil the primary purpose better and with much less power than if the tough "skin" is produced by radial compression of a pre-compressed cylinder or cone, to a cylinder of smaller diameter. Shape alteration allows gradual compression in longitudinal direction and flattening the outside material layer so as to produce a tough skin with less power.

It is also possible to produce at each stroke a number of smaller cross-section pellets by forming the die in such a way that after the initial compression of the material in the orifice the material is then forced through a plurality

of holes so that a number of small cross-section rods would emerge from each die, and preferably sheared off at suitable lengths.

In order that the nature of the invention may be readily ascertained, an embodiment of extrusion pelleting machine in accordance therewith is hereinafter particularly described with reference to the figures of the accompanying drawings, wherein:

FIG. 1 is a central vertical section of the entire machine, with the exception of a conventional speed-reduction gear box and drive motor shown in FIG. 3.

FIG. 2 is a horizontal section on the line II—II of FIG. 1 to show impeller and feed regulating mechanism.

FIG. 3 is a sectional view of the gear box and driving motor.

The machine comprises a general body structure consisting of a coupling housing **1** disposed on a gear-box structure housing a conventional speed-reduction gear-box having belt drive from an electric motor, a tappet housing **2** with cam followers, a plunger housing **3** and a die housing **20** carrying die sets and housing impeller means for feeding the die sets. A feed hopper is attached to the die housing, and breaker means are attached to a revolving sleeve on a mainshaft.

The coupling housing **1** and plunger housing **3** house respectively a lower conical roller thrust bearing **4** and upper ball bearing **5** for a vertical main shaft **6** which is driven at reduced speed via the gear box situated in the base (see FIG. 3). On the shaft **6** is keyed a cam disc **7** having two axially-acting cams **8**. The shape of the cams is preferably such that there is a slow rise during the compression stroke, so that shock effect is minimised, and a relatively rapid drop down for the return stroke occurring under spring-action.

In the tappet housing **2** of the body are provided sixteen cylindrical bores **9** symmetrically arranged with their axes on a circle coaxial with the shaft **6**. In each bore **9** is disposed a cam follower or tappet **10** engaging with the cams of the cam disc **7** through a roller **11** carried on a transverse journal **12**.

In the lower wall **3***a* and upper wall **3***b* of the plunger housing **3** are provided aligned pairs of bores. In the lower bores **13** are disposed the lower parts **14** of the plungers sealed by oil rings **15**. The upper bores are provided with collars **16** retained by grubscrews **17** and receiving the upper parts **18** of the plungers. Compression springs **19** are seated about the plungers to act between the collars **16** and the parts **14** of the plungers, to urge the plungers into retracted position.

On the plunger housing **3** is disposed a die housing **20** in which is provided a symmetrically arranged circle of sixteen pockets **21** (see FIG. 2) each aligned with and of somewhat greater diameter than the associated plunger **18**. These pockets have an inward radial aperture **22** opening into a feed chamber **23** within the die housing. Into threaded bores **24** of the die housing, aligned with the pockets **21**, are screwed dies **25**. Each die has, taken from bottom to top, a frusto-conical portion **26** of reducing cross-section followed by a cylindrical portion **27**, followed by a hexagonal portion **28** into which the cylindrical portion merges.

Within the feed chamber **23** of the die housing **20** is disposed an impeller assembly consisting of two curved blades **29** mounted on a disc **29***a* carried by the main shaft **6** and turning in anti-clockwise direction in FIG. 2. The action of these blades is to force material lying in the chamber **23**, through the openings **22** into the pockets **21**. A labyrinth seal is arranged between the underside of disc **29***a* and the top wall **3***b*.

To permit adjustment of the amount of material fed into the pockets **21** there is provided, in the cylindrical chamber **23**, a cylindrical feed-regulating shutter sleeve **30** having a plurality of apertures **31** corresponding to the openings **22**. In the die housing is provided a pivot **32** about which there can rock, in the horizontal plane, a regulating handle **33** which engages by a lug **34** into an opening of the sleeve **30**, according to the position of the adjustment of the handle **33**, the apertures **31** of the sleeve will be positioned wholly or only partially in front of the associated openings **22**, thereby regulating the amount of material fed through by the impeller blades **29** at each time of passing.

On the upper end of the main shaft **6** there is secured a cylindrical breaker sleeve **35** which engages slidably about the lower end wall **36** of a stationary feed hopper **37**. On the sleeve breaker **35** are carried a number of breaker blades **39** arranged to move across the outlet of each die **25**, at a pre-arranged height above the top end of the latter.

Referring to FIG. 3 which shows the downward continuation of the machine of FIG. 1, a base structure **41** houses a speed reduction gear box **42** having a high speed input shaft **43** carrying a flywheel **44** and a pulley **45** driven by a belt **46** from an electric motor **47**. The slow-speed output shaft **48** of the gear box is connected, to the main shaft **6**, by a releasable coupling **49** which could be a flexible coupling.

Oil seals **50** are provided at various points in the machine.

The operation of the machine is as follows:

Material to be pelleted is fed into the hopper **37** and falls down through the rotary breaker sleeve **35** into the feed chamber **23**. Suitable labyrinth seals, are arranged between the upper edge of the breaker sleeve **35** and the hopper, and between the lower edge of the breaker sleeve **35** and the feed-regulating sleeve **30**. The main shaft **6** is assumed to be rotating under drive from the electric motor via the speed-reduction gear box, e.g. at say 62 revolutions per minute. The rotation of the impeller blades **29** with respect to the stationary die housing **20** causes material to be forced through the openings **22** into the pockets **21** at a rate determined by the relative position of the apertures **31**, as adjusted by the handle **33** secured in the selected position by a nut **33***a*. Two such handles **33** are arranged at 180°.

As the main shaft **6** rotates, it carries round the cam disc **7** and the two cams **8** thereon act against the cam followers or tappets **10** through their rollers **11**. Each cam follower or tappet **10** forces upwardly its associated plunger and the upper part **18** of the plunger picks up the material in the pocket **21** and rams it into and through the conical portion **26** of the die. As the plunger reciprocates, the material is forced through the cylindrical portion **27** of the die and then through the hexagonal portion **28** thereof.

The total length of the dies **25** is a multiple of the total stroke of the plungers, so that after some initial strokes the pellet material commences to emerge from the die as a solid rod having weak sections at the lengths produced by individual strokes. According to the adjustment in height of the breakers **39**, the pellet material is broken off in lengths corresponding to one, two, three or more strokes.

As the pellets are broken off, they fall onto one or other of two chutes **39***a* and pass into any suitable receptacle, or onto a conveyor, or bagging means. The size of the pellets is e.g. ½" across the corners of the hexagon, so that they are suitable for feeding cattle and pigs. For feeding poultry, multiple dies may be used in place of the die **25**, for producing 7 small diameter pellets at each stroke. It is possible to produce say in eight positions larger pellets and in eight positions smaller pellets simultaneously to bag them off separately.

As there are two cams **8** on the cam disc **7**, so that each plunger **18** is operated twice per revolution, and using sixteen plungers and a main shaft **6** rotating at 62 r.p.m., the output of pellets of single-stroke length would be 119,040 per hour.

The action of the plungers on the precompressed material in the pockets **21** is to produce firstly a general longi-

tudinal compression. Thereafter as the material passes from the cylindrical part of the die to the hexagonal part, the faceting effect produces a tough skin on the pellet rod.

The whole of the top portion of the coupling housing **1**, the tappet housing **2**, and lower part of the plunger housing **3** containing the thrust mechanism can be oil-filled, and any oil which may seep through the oil seals **15** merely accumulates in an escape chamber **40** instead of reaching the die pocket. Similarly, any material which may pass downwardly from the die pockets past the collars **16** is again trapped in the escape chamber **40** and can be removed.

The die housing can be removed as a whole for easy access or to permit replacement with a housing having different dies. After removing the die housing and unscrewing the screws **17**, the collars **16**, plungers **18** and spring **19** can be removed for servicing.

By removing the plunger housing **3**, the tappets **10** can also be removed.

We claim:

A machine for the production of pellets, comprising:

a body structure having a plurality of bores;

a plurality of dies mounted on said structure and aligned in spaced relationship with said bores to define charging chamber means;

compressing means in said body structure for compressing material into said charging chamber means;

a plurality of plungers, slidable one in each bore, for forcing material from said charging chamber means into the associated die;

a rotary actuating member journaled in said body structure and coacting with said plungers to move each plunger in a compression stroke at least twice per revolution of said actuating member;

said compressing means being operated to compress material into the charging chamber means prior to each compression stroke of the plunger;

shutter means movably disposed in said body structure adjacent said charging chamber means and between said chamber means and said material compressing means, thereby to control the quantity of material fed to the charging chamber means prior to each compression stroke; and wherein

charging chamber means consist of a pocket aligned with each die and opening radially inwards to a feed chamber, said shutter means being cylindrical and rotatable and having apertures corresponding to the openings of the pockets.

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