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3,177,821

DIE STRUCTURE FOR WAFERING MACHINE

Original Filed Jan. 2, 1962

FIG. 1

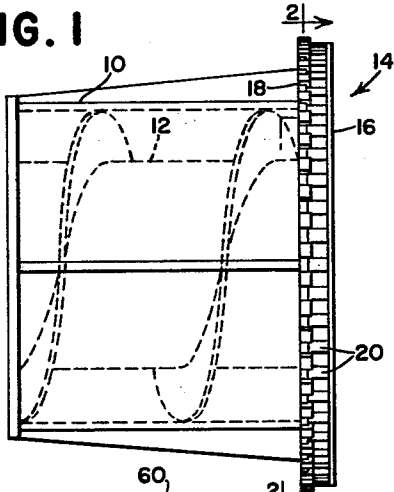


FIG. 2

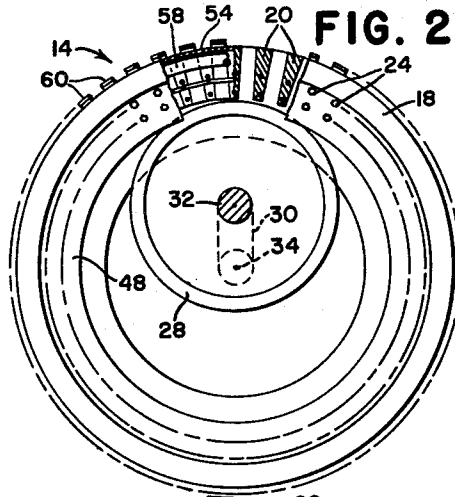


FIG. 4

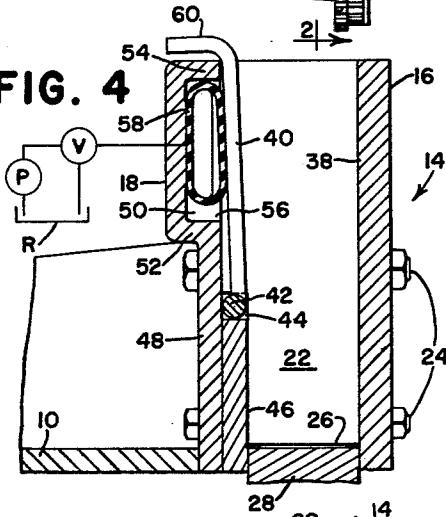


FIG. 5

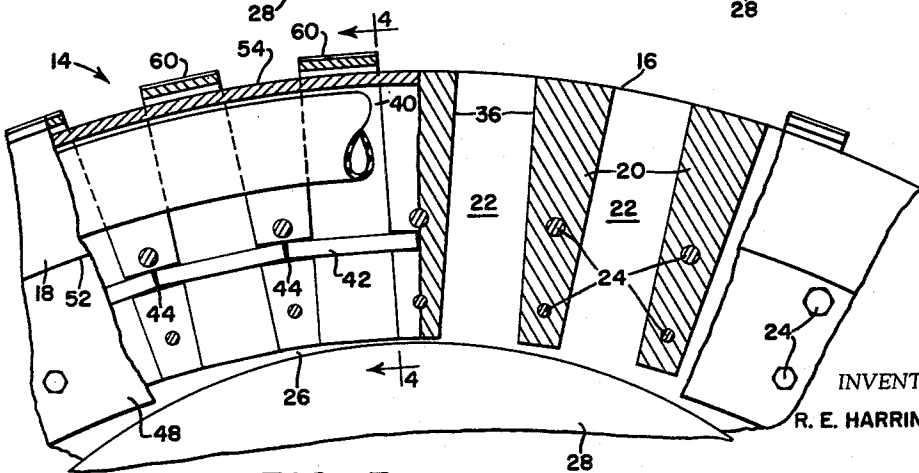
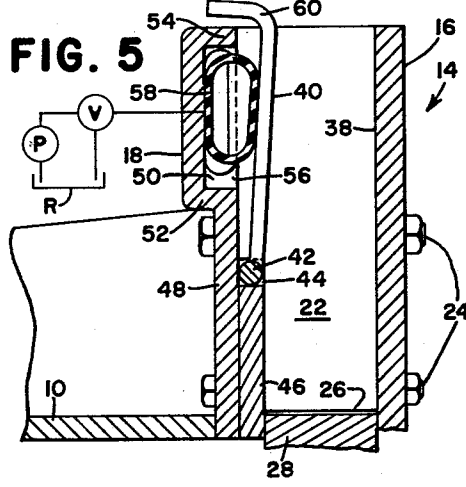


FIG. 3

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DIE STRUCTURE FOR WAFERING MACHINE
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 Continuation of application Ser. No. 163,530, Jan. 2, 1962. This application Feb. 19, 1964, Ser. No. 346,387
 7 Claims. (Cl. 107-14)

This invention relates to a wafering machine and more particularly to improved die structure therefor. This application is a continuation of Serial No. 163,530, filed January 2, 1962, now abandoned.

The term "wafering machine" has come to be applied to machines for forming wafers or pellets from agricultural forage products such as hay, grasses, straw, etc., as distinguished from the conventional pellet mill which is designed to handle relatively dry and granular or pulverulent material. In a pellet mill, the die is usually a forging or casting having a plurality of rows of relatively small die openings through which the granular material is extruded. Although a wafering machine operates broadly on the principle of extruding material through die openings, the very nature of the material dictates a different type of die and accordingly different design considerations are involved. These factors are due largely to the nature of the crop, which varies in moisture content from field to field and from windrow to windrow in the same field and very often from one part of the same windrow to another. Accordingly, the material will vary in density as it is extruded and some wafers are apt to be considerably more dense than others. To compensate for this difference in density, it is desirable to provide the die openings with means for varying the enclosed taper thereof, and also involved in this is the basic consideration that the die differs from a pelleting machine die in that it normally comprises only a single row of die cells or openings arranged as an annulus, and these openings are capable of producing wafers or pellets of a highly compacted nature having dimensional characteristics on the order of 2 x 2 x 2 inches. For the purpose of accomplishing such adjustment of the taper of the die cells, the die structure is provided so that each die cell has an adjustable wall, which in itself is broadly known to those versed in the art. However, various problems arise in the provision of means for adjusting the walls and according to the present invention, a novel solution is offered.

It is therefore the principal object of the present invention to provide an improved die structure of the character indicated. More specifically, it is an object to provide means for adjusting the movable walls of the die cells. It is a significant object to provide this means in the form of a fluid-expandable and -exhaustible element, preferably in the form of an endless annular member concentric with the die annulus and having portions thereof acting respectively on the movable walls for the several die openings. It is still further an object of the invention to provide a die structure that may be economically constructed and maintained.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention will become apparent as the preferred embodiment thereof is disclosed in detail in the ensuing description and accompanying sheet of drawings, the figures of which are described below.

FIG. 1 is a side view of a representative wafering apparatus.

FIG. 2 is a section as seen substantially on the line 2-2 of FIG. 1.

FIG. 3 is an enlarged fragmentary view illustrating that portion of FIG. 2 shown in section.

FIG. 4 is a section on the line 4-4 of FIG. 3, drawn to an enlarged scale.

FIG. 5 is a section similar to FIG. 4 but showing the adjustable wall in an inwardly adjusted position.

In a typical wafering machine, of which FIG. 1 is representative of a part, the basic structure includes a cylindrical housing 10 which carries coaxially therein a rotatable auger 12 for feeding material axially to the interior of a die structure 14. This die structure is in the form of an annulus having first and second closely coaxially spaced apart radial side means 16 and 18, the former preferably in the form of a ring-like plate and the latter in the form of a composite structure, the details of which will be described below. Rigidly disposed between these plate means are die blocks or spacers 20 arranged in uniformly circumferentially spaced relation to provide a like plurality of die cells 22 which radiate relative to the center of the annulus. The components of the die structure are rigidly secured together as by a plurality of bolts 24 arranged in two concentric circles and passing through the blocks and side means. This structure is in turn rigidly secured to the auger casing or housing 10 in any suitable manner.

As thus seen in FIG. 3, each die block 20 is of wedge-shaped section as seen in a radial plane, having its narrower or reduced end disposed inwardly, and all of these ends lie generally on the same circle or annulus so as to afford an annular track 26 over which the periphery of a press wheel 28 rides. This wheel is disposed eccentrically within the annulus, being journaled on the pin of a crankshaft 30, the pin of the crankshaft being designated at 32 and the main bearing or axis being shown at 34. This bearing may be supported in any suitable manner in the basic support structure that carries the housing 10, auger 12 and die 14, and its axis is of course coincident with the axis of the annulus and of the auger casing 10. Representative structure is shown in assignee's copending application Ser. No. 162,670, filed December 28, 1961. In the structure chosen for purpose of illustration, the crankshaft turns in a clockwise direction as seen in FIGS. 2 and 3, and the wheel 28 will of course turn in a counterclockwise direction as it rolls around the track 26. Material fed to the interior of the annulus will be received by the track ahead of the orbiting press wheel and the accumulated material will be compacted into the die cells 22 and ultimately extruded therefrom in wafer form having the dimensional characteristics noted above. The outer ends of the blocks 20 lie also generally on a circle which is concentric with the track or annular row of die block inner ends, thus giving the die structure or annulus 14 what may be regarded as inner and outer peripheries. Of course, in practice, it is more economical to machine or otherwise form the ends of the die blocks so that they are flat or straight rather than arcuate, and the circle referred to will not be a perfect circle. However, this is a detail without significance. Also in this respect, it should be observed that the annulus could be rotatable while the center of the press wheel 28 is stationary, a structure that is not unknown. See for example U.S. Patent No. 1,868,370. Another variation exists in an instance in which two annuli, both similar to the annulus 14, are placed edge to edge and rotated relative to each other, in which case, the bite formed between the meeting peripheries of the annuli is a material-receiving zone and the material will be extruded radially inwardly. These variations are mentioned merely for the purpose of environment only and to demonstrate that the present invention is not limited to a wafering machine in which the wafers are extruded radially outwardly.

Because of the shapes of the die blocks and of the associated side means 16 and 18, each die cell 22 is of rectangular cross-section, and two circumferentially opposed walls thereof are provided respectively by opposed faces 36 of a pair of neighboring die blocks. A third wall is

afforded by the interior surface of the plate means 16, as at 38 (FIGS. 4 and 5). The fourth wall for a die cell 22 is provided by a movable plate-like element 40, which is axially opposite the wall portion provided at 38. The same characteristic exists of course throughout the annulus 14. The element 40 is pivoted at its radially inner end at 42, the pivot comprising a pintle having a circumferential length greater than the circumferential width of the element 40 so that it has opposite ends projecting to be received in notches 44 in neighboring die blocks (FIG. 3). Hence, each element 40 is movable back and forth toward its opposite wall 38, swinging about the pivot 42. Just below the pivots 42, the annulus is provided with a ring-like filler 46 which in effect provides a fixed inner continuation of the elements and the inside diameter of which is comparable to that of the opposite side plate 16 so that the track is afforded at 26 for the press wheel 28.

The side means 18 includes, in addition to the elements 40 and filler 46 an outer ring-like plate 48 which is shaped at its radially outer periphery to afford an annular recess 50. Portions of the member or ring 48 that define the recess 50 include a radially inward shoulder 52 and a radially outer peripheral lip or flange 54, both of which axially abut the proximate faces or sides of the die blocks 20. The recess 50 in the main opens axially inwardly but it is of course interrupted by the blocks 20 so that at circumferentially spaced portions thereof it opens respectively toward the die cells 22 at 56. The circumferentially spaced intervals at which the openings 56 occur will of course register respectively with the die cells 22 and will also register with the elements 40 so that means carried in the recess 50 will be capacitated to act on the elements.

In the present case, this means takes the form of a fluid-expandable and -contractible tube 58, preferably of rubber or rubber-like material and also endless. The initial size of the tube 58 is such that it is readily incorporated in the recess 56 prior to assembly of the annulus. The tube in its contracted or fluid-exhausted form is shown in FIG. 4. Any suitable fluid circuit may be utilized for introducing fluid to and exhausting fluid from the tube 58, such circuit being shown schematically as including a valve V supplied by a pump P in association with reservoir R to which valve V has a return line. Valve V may be manually operated or may incorporate a relief valve set at a predetermined pressure on the basis of the desired pressure to be maintained in tube 58. Each element 40 has at its radially outer end an outturned lip 60 which overlies the flange 54 for purposes of substantially closing the outer end of the structure when the elements 40 are moved inwardly, as in FIG. 5.

In operation, and assuming that the tube 58 is in its condition shown in FIG. 4, material extruded radially outwardly through the die cells 22 will have density and compression characteristics determined of course by the cross-sectional size of the die cells. If the material is relatively light and dry and has low frictional characteristics, the wafers of course will be consequently of relatively low density. In order to increase the density of the wafers, fluid is supplied to the tube 58 which of course acts on the elements 40 to move the elements toward their opposite wall portions 38, respectively. Although the tube will be confined at circumferentially spaced portions or intervals thereof by the sides of the die blocks, further circumferentially spaced portions thereof will be exposed through the openings 56 from the recess 50 to act on the elements. The amount of fluid supplied to the tube 58 will of course determine the radial expansion thereof and that in turn will determine the amount of movement of the elements 40. Since the tube is continuous, it will act in parallel on all elements 40 and therefore the pressure within the tube 58 will equal that of the die cell in which the compaction pressures are highest. Consequently, if material in one die cell is relatively heavy and that in another cell is relatively light, the pressure will be that of the cell having the heavy

material, causing therefore a greater outward (left) movement of the element 40 in the cell having the heavy material and consequently a greater inward (right) movement of the element 40 in the cell through which the lighter material is passing. This will contribute to the production of wafers of substantially uniform density, as distinguished from a situation in which the elements 40 were to be controlled individually. The broad principle of such system forms the subject matter of assignee's co-pending application Ser. No. 66,874, filed November 2, 1960.

As will be seen, the structure is relatively simple in design and has relatively few parts. Therefore, it is easy to maintain in the field and normally functions to produce good quality wafers.

Features and advantages other than those enumerated will readily occur to those versed in the art, as will many modifications and alterations in the preferred embodiment disclosed, all of which may be achieved without departure from the spirit and scope of the invention.

What is claimed is:

1. Die structure for a wafering machine, including: an annulus having first and second closely coaxially spaced apart radial side means and a plurality of uniformly circumferentially spaced generally radial spacers to provide a like plurality of die cells respectively having radially opposite inlet and outlet ends; said second side means including a circumferential set of axially movable, radial plate-like elements arranged respectively in the cells as side walls thereof axially opposite to radial portions of the first side means between the spacers; said second means further including an annular recess disposed axially outwardly of the elements and spacers and opening axially inwardly at circumferentially spaced intervals to said elements; a fluid-expandable and -contractible tube disposed in and extending throughout said recess and axially engageable at circumferentially spaced portions thereof with said elements at said intervals; and means for supplying fluid to and exhausting fluid from the tube to vary the axial dimension of the tube at said circumferentially spaced portions thereof for changing the positions of said elements axially as respects the aforesaid radial portions of the first side means and consequently to vary the cross-sectional areas of the die cells.

2. The invention defined in claim 1, in which: said elements are hinged to the annulus respectively on axes arranged in a circumferential series generally concentric with the annulus and lying intermediate said rows of inlet and outlet ends, and each element has a free end at the outlet end of its cell.

3. The invention defined in claim 2, in which: each element has at its free end an axially outwardly directed lip overhanging the second side means.

4. The invention defined in claim 1, in which: said recess, at circumferentially spaced portions thereof respectively in register with said elements, opens radially at the outlet ends of the cells, and said elements respectively have axially outwardly directed means therein at said outlet ends and overhanging and covering said recess portions, said covering means having such axial length as to retain covering relation to said recess portions during movement of the elements.

5. The invention defined in claim 1, in which: said tube is endless.

6. Die structure for a wafering machine, including: an annulus having first and second closely coaxially spaced apart radial side means and a plurality of uniformly circumferentially spaced generally radial spacers to provide a like plurality of die cells respectively having radially opposite inlet and outlet ends; said second side means including a circumferential set of axially movable, plate-like elements arranged respectively in the cells as side walls thereof axially opposite to radial portions of the first side means between the spacers; said second means further including an annular support disposed

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axially outwardly of the elements; a fluid-expandable and -contractible tube carried by and extending coextensively with said support and axially engagable at circumferentially spaced portions thereof with said elements; and means for supplying fluid to and exhausting fluid from the tube to vary the axial dimension of the tube at said circumferentially spaced portions thereof for changing the positions of said elements axially as respects the aforesaid radial portions of the first side means and consequently to vary the cross-sectional areas of the die cells.

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7. The invention defined in claim 6, in which: said elements are individually hinged to the annulus and each element has a free end at one end of its cell.

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WALTER A. SCHEEL, *Primary Examiner*.