Nov. 8, 1960 E. N. MEAKIN 2,958,900

PELLET MILL DIE ASSEMBLY

Filed June 23, 1955 4 Sheets-Sheet 1

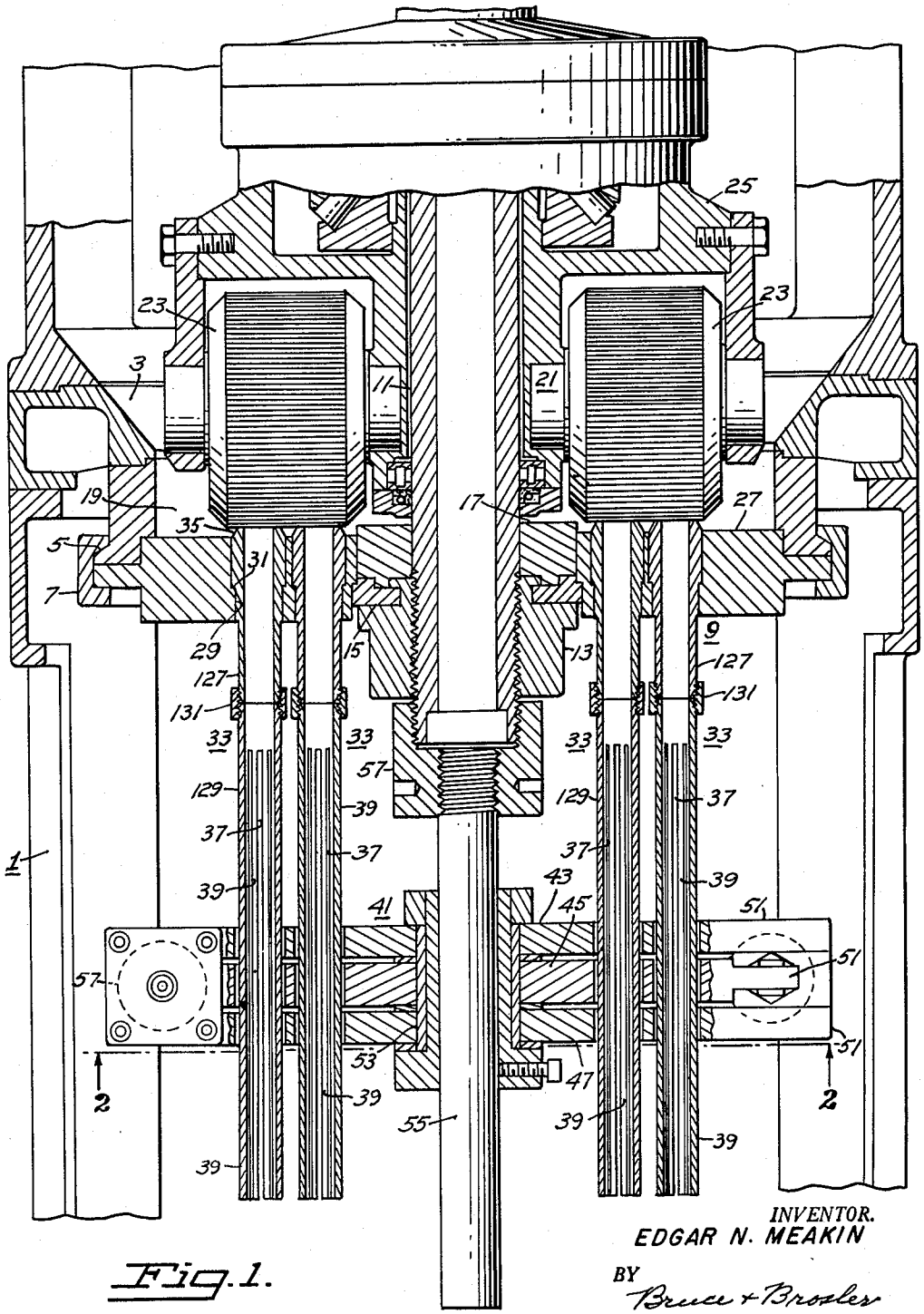


Fig. 1.

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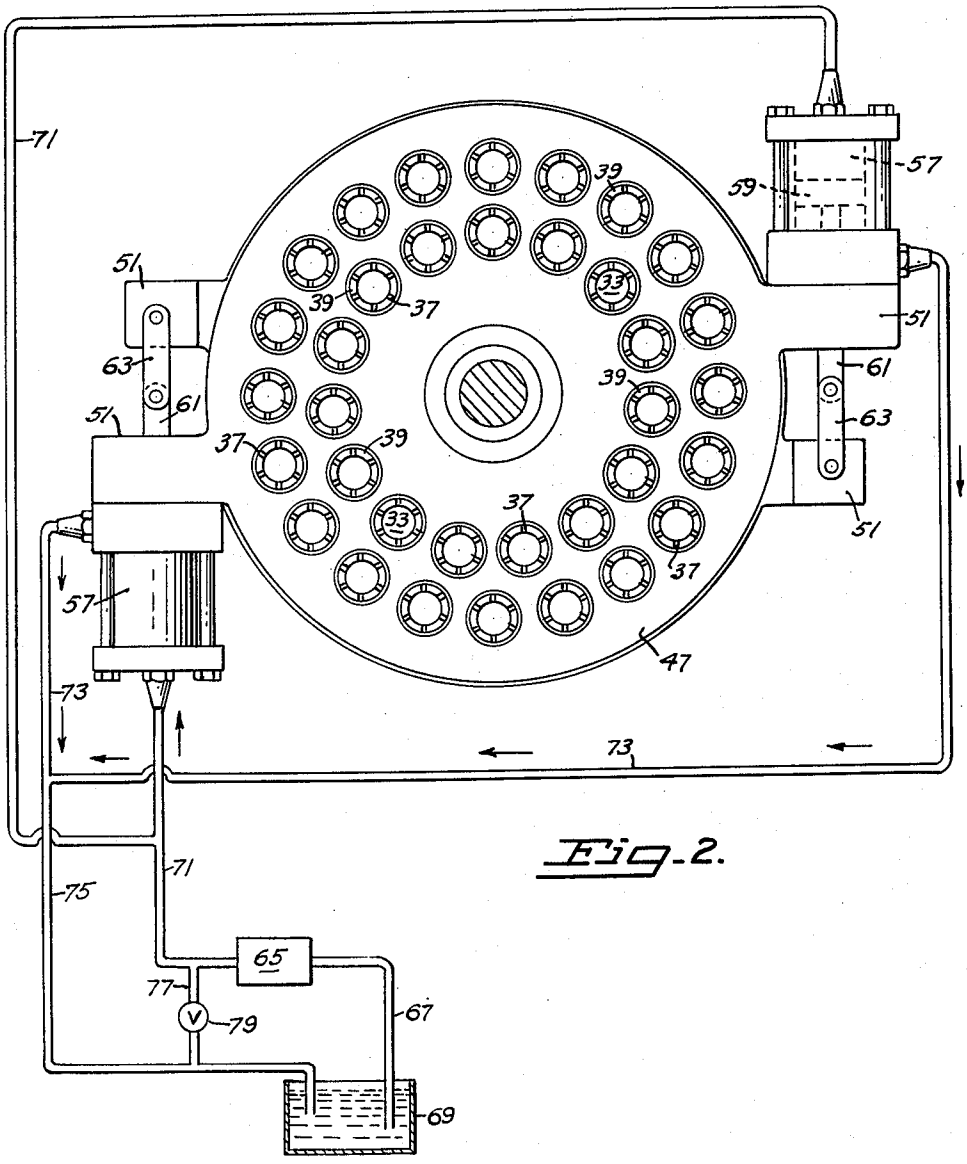


Fig. 2.

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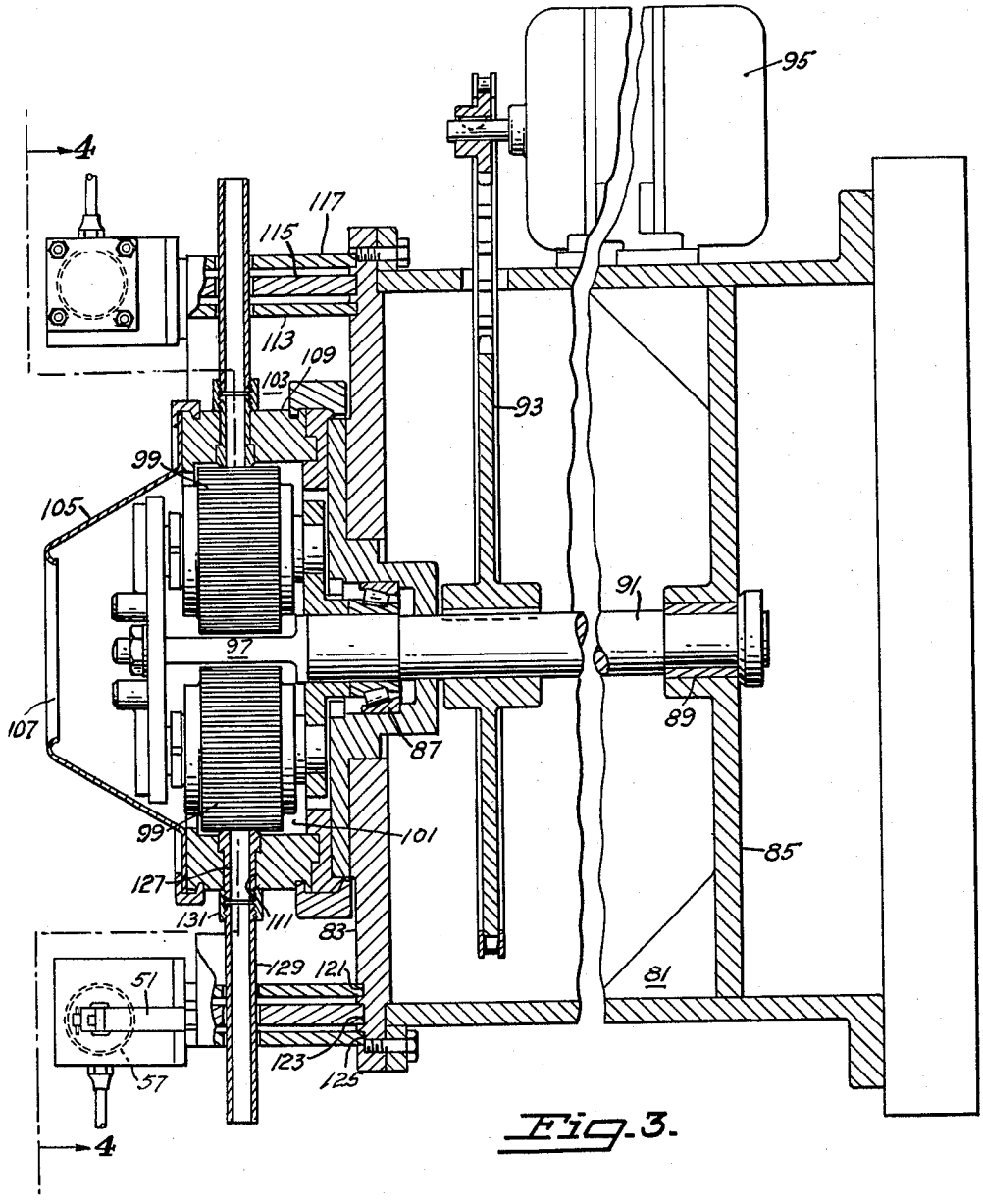


Fig. 3.

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PELLET MILL DIE ASSEMBLY

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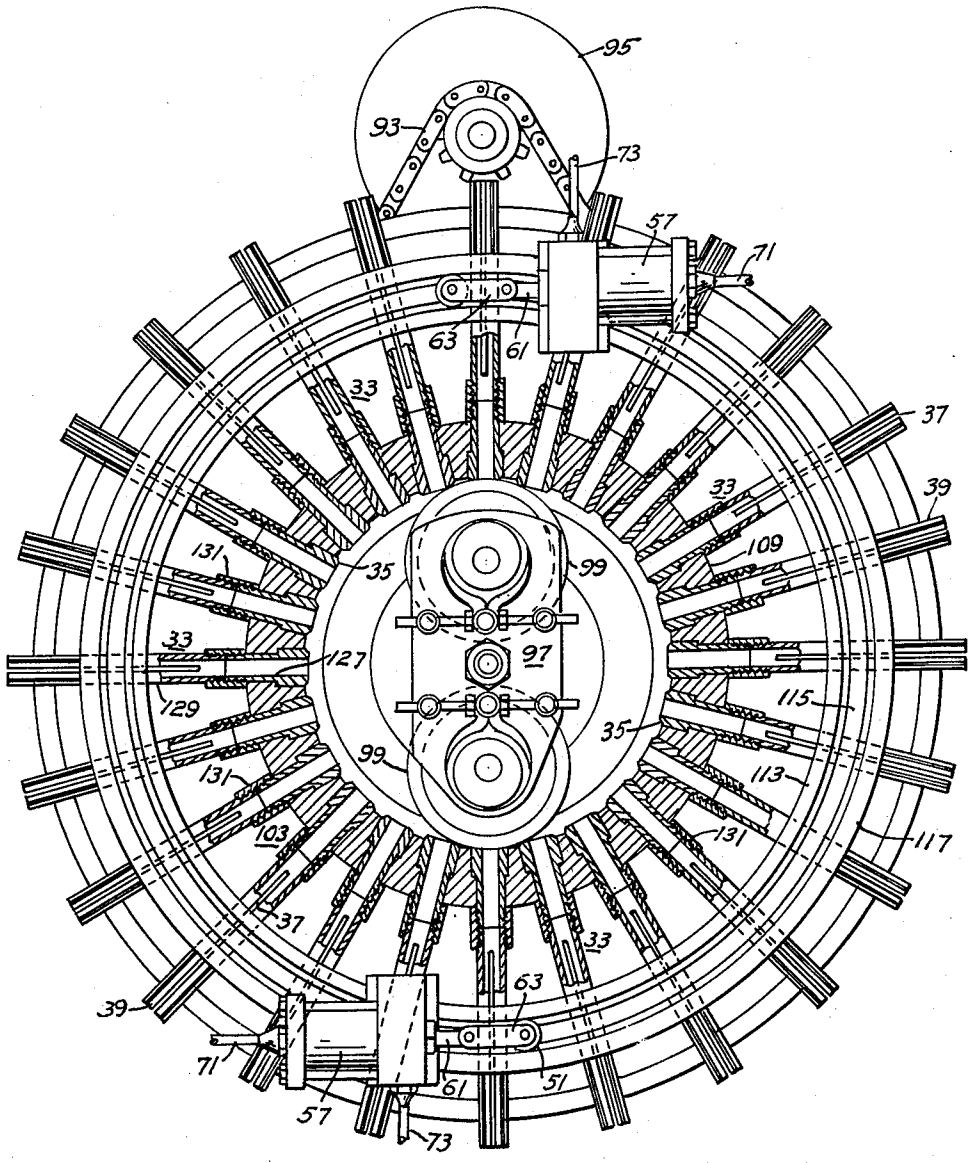


Fig. 4.

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PELLET MILL DIE ASSEMBLY

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7 Claims. (Cl. 18—12)

The present invention relates to pellet mills and more particularly to the die structure of such mills.

Pellet mills are employed in the forming of pellets from materials which may vary widely in particle size, moisture content, oil content, fibre content, particle dispersion and the like, all of which have a marked effect on the successful and efficient production of a firm pellet. This problem is partially solved by designing the dies to have special structural characteristics such as thickness, hole size and shape, taper entrance, or combinations thereof, suitable for the extrusion of particular materials.

However, even such a die is not the complete answer, for a particular material for which a die was initially designed, may and often will change even from hour to hour in its characteristics and to an extent which will cause production of soft or otherwise poor pellets. The preparation of separate dies to take care of such variations and the necessary interchanging thereof in the press to meet the changing conditions, obviously, is impractical.

Among the objects of the present invention are:

(1) To provide a novel and improved die assembly for a pellet mill;

(2) To provide a novel and improved die assembly for a pellet mill capable of being adjusted to adapt the same to extrusion of materials varying somewhat in character;

(3) To provide a novel and improved die assembly which will enable the production of a firm pellet at good capacity despite variations in the material being extruded therethrough.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same taken in conjunction with the accompanying drawings, wherein

Figure 1 is a fragmentary view in section, of a pellet mill of the flat die type and depicting the die assembly of the present invention as incorporated therein;

Figure 2 is a plan view of the die assembly of Figure 1;

Figure 3 is a view, partly in section, through a pellet mill of the ring die type, and depicting the die assembly of the present invention as adapted for this type of mill; and

Figure 4 is a view taken in the plane 4—4 of Figure 3.

Referring to the drawings for the details of apparatus for the carrying out of my invention, the pellet mill, in general, may comprise a base frame 1 supporting an inwardly and downwardly sloping circular bowl 3 having an out-turned lower edge 5 from which a die clamp 7 such as illustrated and described in Meakin Patents Nos. 2,075,450 of March 30, 1937, and 2,124,744 of July 26, 1938, is suspended to engage and support the outer edge of a die assembly 9.

A centrally mounted sleeve 11, supported in any conventional manner in the upper portion of the mill, carries at its lower end, as by a nut 13 with a peripheral recess therein, the segments of a split ring 15 which offers support to the inner edge of the die assembly.

A die block 17 carried on the nut, forms with the die assembly, the floor of a compression chamber 19, into which the loose pellet material is fed for extrusion through the die assembly.

Extrusion of the pellet material is accomplished through the use of compression means 21 involving a pair of compression rollers 23 journalled in a spider 25 adapted for rotation about the sleeve as an axis.

The upper structure of the mill, which for simplicity's sake, has not been illustrated, may be of any desired construction, such for example as is illustrated in the patent to Edgar T. Meakin No. 2,065,141 of Dec. 22, 1936, or in the patent to Edgar N. Meakin No. 2,075,450 of March 30, 1937. Such structure, however, is incidental to the present invention.

The die assembly 9 of the present invention, as adapted for a machine of the flat die type described above, involves a die plate 27 in the form of a ring, having a plurality of extrusion tube receiving holes 29 therein, each such hole being counter bored from the compression side of the plate to provide an enlarged entrance terminating at a shoulder 31.

Such holes are adapted to permit the assembly in the die plate, of a plurality of extrusion tubes 33 each having an enlargement at the upper end to form a head 35 adapted to fit the counter bore and seat upon the shoulder 31, whereby to withstand the extrusion pressures developed. Preferably the heads extend slightly above the surface of the die plate to assure good pressure engagement with the shoulders 31.

For about two thirds of the length of each tube, as measured from the discharge end thereof, the tube is provided with a plurality of slits 37 extending longitudinally thereof, leaving a plurality of longitudinal tube sections 39 flexibly suspended at the upper ends thereof from the unslitted portion of the tube, thereby permitting these sections to be drawn inwardly toward the center axis of the tube until they contact each other, or expanded outwardly therefrom. Each tube thereby becomes adjustable along the slitted portion thereof, between limits, which in one case will define a tube having its discharge end tapered and in the other case, resulting in a tube having its discharge end flared.

The tendency for the tubes to expand will be attributed to the expansion pressure of the material being extruded through the tubes. Consequenlty, to provide for adjustability of the tubes within the limits discussed, necessitates only the provision of means 41 for constricting such tubes to any degree desired within the aforementioned limits. The ultimate adjustment of the tubes, therefore, will constitute a compromise between the expansive forces of the material being forced through the tubes and the constricting forces caused to be exerted in opposition thereto.

Such constricting means in the preferred embodiment of the invention under consideration may take the form of a plurality of axially aligned disc elements 43, 45, 47 . . . etc., each having holes therethrough laid out on a pattern corresponding to that of the die plate, with each hole of sufficient diameter to loosely receive one of the tubes.

At diametrically opposite points of each disc element, extends a lug 51. These plates, preferably three in number, are horizontally mounted on a bearing 53 which in turn is affixed to a rod extension 55 depending from the sleeve 11 to which it is threadedly secured by a suitable adaptor nut 57.

Of these three disc elements, the outer ones 43 and 47 are connected together as a unit by a pair of hydraulic cylinders 57 each affixed to a pair of corresponding lugs of these elements. Each of these cylinders includes a piston 59 and associated piston rod 61 extending

through the attached end of the cylinder, intermediate the lugs of that pair to which the cylinder is affixed.

The intermediate disc element which may be somewhat thicker than the others, is so adjusted angularly with respect to the outer ones as to position each of its associated lugs in a position facing the piston rod of one of the cylinders, to which rod it is coupled by a link **63**.

From this arrangement, it will be apparent that movements of the pistons will cause the outer disc elements to rotate angularly relative to the intermediate element and that by suitable control of such movements, the constricting disc elements may be caused to exert a constricting force against the split tubes.

Such control may be effected hydraulically by including the cylinders in a hydraulic circuit, the simplest form of which may involve a pump **65** having its intake or suction line **67** connected to a supply tank **69** of liquid such as oil, and its discharge line **71** connected to the input end of each of the cylinders, while an exhaust line **73** extends from the opposite end of each of the cylinders to a return line **75** leading to the supply tank. A bypass **77** about the pump, includes a spring loaded valve **79** which will cause the pump to exert a fixed pressure against the pistons in the system so long as the overall load on the pump, including the spring loading of the valve remain constant. By utilizing a spring loaded valve which is adjustable, the degree to which the tubes may be constricted while material is being extruded therethrough may be altered to realize a desired condition in the pelleted material discharging from such tubes.

Other means may be relied on for altering the pressures and obtaining a change in the constricting forces applied to the tubes by the disc elements, and while the hydraulic system specifically illustrated is of a simple type requiring manual control of the pressure adjustments, it is contemplated that automatic means may be utilized which would respond to variations in expanding pressures attributable to any changes in the physical characteristics of the material being extruded.

Further, while the previous embodiment of the invention has been illustrated and described in connection with a flat plate type of pellet mill, the invention is also applicable to pellet mills of the ring die type illustrated in Figure 3, for example.

Such type of mill, in general, involves a casing **81** having a front wall **83** and a rear wall **85**, each of which carries a bearing **87**, **89** respectively, with such bearings in alignment to receive a driven shaft **91** which carries a sprocket **93** for chain connection to a source of power in the form of an electric motor **95**, for example, mounted on top of the casing. The shaft extends to the front of the front wall, and at that end carries extrusion means **97** which includes a pair of extrusion rollers **99**.

The extrusion means is enclosed within an extrusion chamber **101**, comprising in part, a ring die assembly **103** mounted along one edge, to the front wall of the machine casing, while to the front edge of the die assembly is affixed a conical shaped front wall **105** in the center of which is an opening **107** for the introduction of the pelleting material to the extrusion chamber.

Here again the specific construction of the mill may vary widely within the realm of the prior art, inasmuch as the invention is directed particularly to the die assembly.

In this embodiment of the invention, the die assembly includes a die plate in the form of a ring **109** having a pattern of extrusion tube receiving holes **111** distributed thereabouts with the inner end of such holes counter bored to receive the head ends of the extrusion tubes.

The extrusion tube constricting elements in this embodiment will take the form of a plurality of concentric rings **113**, **115**, **117** . . . etc., preferably three in number, these being slidably supported in concentric grooves **121**, **123**, **125** . . . etc., formed in the front wall of the casing, in concentric relationship to the die plate; and are provided with radially aligned holes corresponding to the pattern of holes in the die plate, to receive the extrusion tubes which extend radially outward from the die plate. Constricting of the tubes is accomplished by a relative angular shift between the intermediate ring **115** and the adjacent rings **113** and **117** to either side thereof.

Such adjustment may be accomplished in a manner similar to the first embodiment, by the mounting of diametrically disposed cylinders to the innermost and outermost rings **113**, **117**, and linking the piston rod of each of said cylinders to the intermediate ring **115**, and operating the same hydraulically in the manner previously described in connection with the first embodiment.

While each of the extrusion tubes may be formed integrally throughout, I prefer to form the same of two sections, that is an upper section **127** which is assembled in the die plate, and a lower section **129** which is slitted from one end. The remaining ends of the two sections have coupling threads and are assembled by means of an internally threaded sleeve **131**. The advantage of this resides in the fact that the die plate mounted section may be standardized as to length, while the split portion may be made to different lengths, so as to give to the assembled tube, characteristics which are best suited to the material to be extruded.

It will be apparent from the foregoing description of my invention, that the same will fulfill the objects thereof, and while I have disclosed the same in its preferred form and in considerable detail, the invention as thus illustrated and described is subject to alteration and modification without departing from the underlying principles involved, and I accordingly do not wish to be limited in my protection as to the specific details as illustrated and described, except as may be necessitated by the appended claims.

I claim:

1. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein, a plurality of extrusion tubes extending through said holes and supported by said die plate, each of said extrusion tubes having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously.

2. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein, a plurality of extrusion tubes extending through said holes and supported by said die plate, each of said extrusion tubes having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously, said means including a plurality of constricting elements, and means for simultaneously moving said constricting elements in relatively opposite directions.

3. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein, a plurality of extrusion tubes extending through said holes and supported by said die plate, each of said extrusion tubes having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously, said means including adjacently disposed constricting elements, each having a plurality of holes through which the slitted portions of said tubes pass, and means symmetrically coupled to said constricting elements for moving said elements in relatively opposite directions to impose constricting force on said extrusion tubes simultaneously.

4. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein, a plurality of extrusion tubes extending through said holes and supported by said die

plate, each of said extrusion tubes having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously, said means including adjacently disposed constricting elements, each having a plurality of holes through which the slitted portions of said tubes pass, and means coupled to said constricting elements for angularly rotating said elements in relatively opposite directions to impose constricting force on said extrusion tubes simultaneously.

5. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein and a counterbore at each hole, a plurality of extrusion tubes each having a head end adapted to fit a counterbore, said tubes extending through said holes and with their head ends in said counterbore, each of said extrusion tubes also having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously, said means including a plurality of adjacently disposed constricting elements, each having a plurality of holes through which the slitted portions of said tubes pass, and means coupled to said constricting elements for moving said elements in relatively opposite directions to impose constricting force on said extrusion tubes simultaneously.

6. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein and a counterbore at each hole, a plurality of extrusion tubes each having a head end adapted to fit a counterbore, said tubes extending through said holes and with their head ends in said counterbores, each of said extrusion tubes also having a plurality of slits extending longitudinally thereof from its discharge

end, and means for adjustably constricting said extrusion tubes simultaneously, said means including a plurality of adjacently disposed disc elements, each having a plurality of holes through which the slitted portions of said tubes pass, and hydraulic means coupled to said disc elements at diametrically located positions for angularly rotating adjacent ones of said disc elements in relatively opposite directions to impose constricting force on said extrusion tubes simultaneously.

7. A die assembly for a pellet mill or the like comprising a die plate having a plurality of extrusion tube receiving holes therein, a plurality of extrusion tubes extending through said holes and supported by said die plate, each of said extrusion tubes including an upper cylindrical section and a lower cylindrical section coupled thereto and having a plurality of slits extending longitudinally thereof from its discharge end, and means for adjustably constricting said extrusion tubes simultaneously, said means including a plurality of adjacently disposed constricting elements, each having a plurality of holes through which the slitted portions of said tubes pass, and means coupled to said constricting elements for angularly rotating adjacent ones of said elements in relatively opposite directions to impose constricting force on said extrusion tubes simultaneously.

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