

Aug. 1, 1939.

E. T. MEAKIN

2,167,900

MILL

Filed June 12, 1935

2 Sheets-Sheet 1

FIG. 1

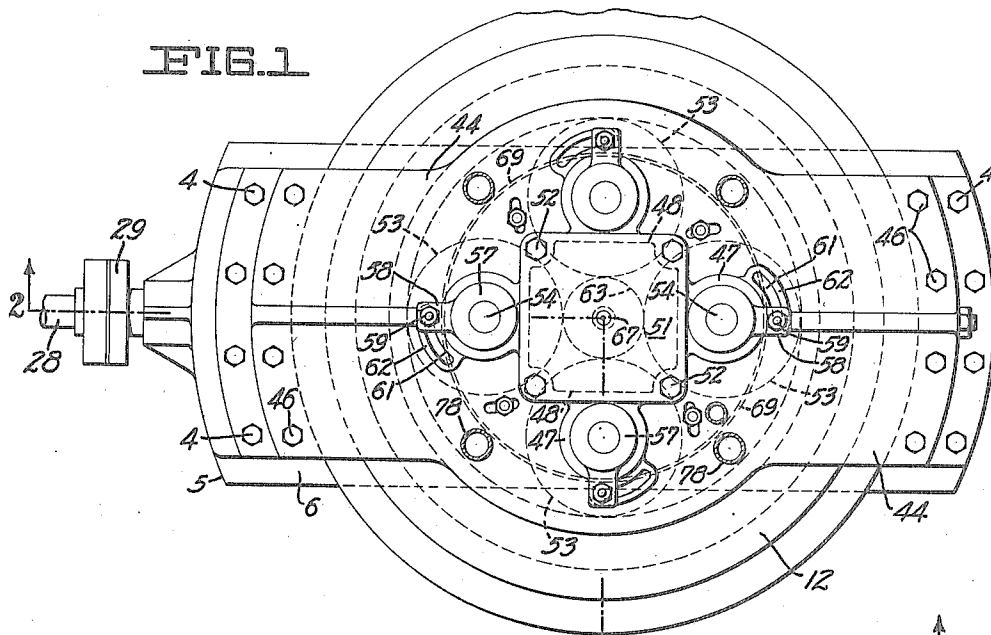
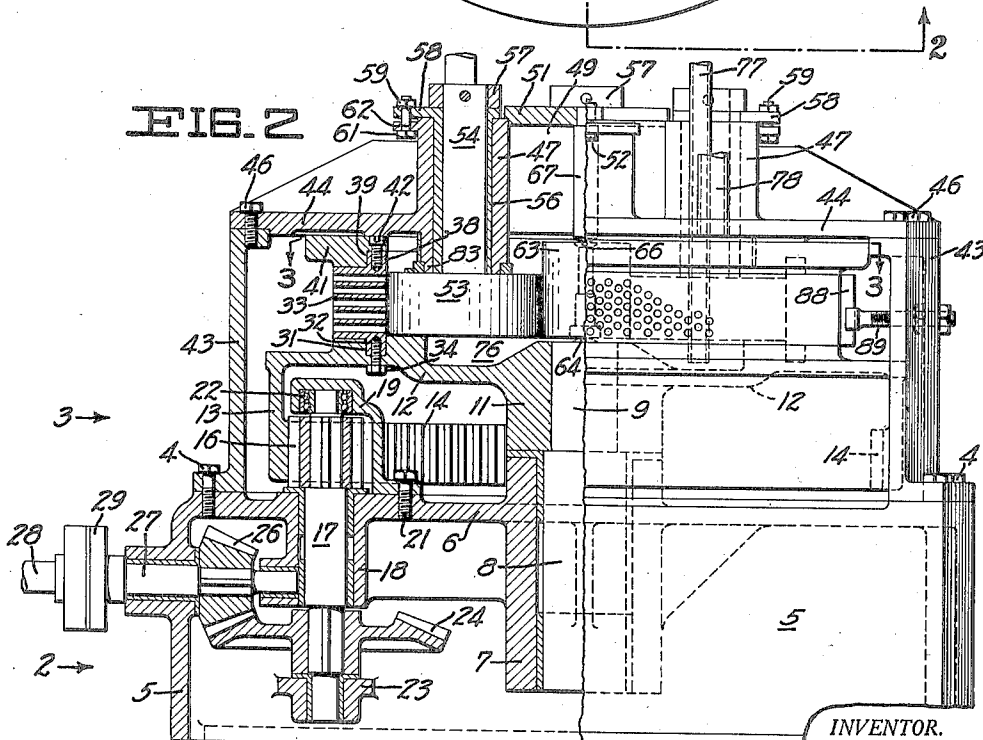


FIG. 2



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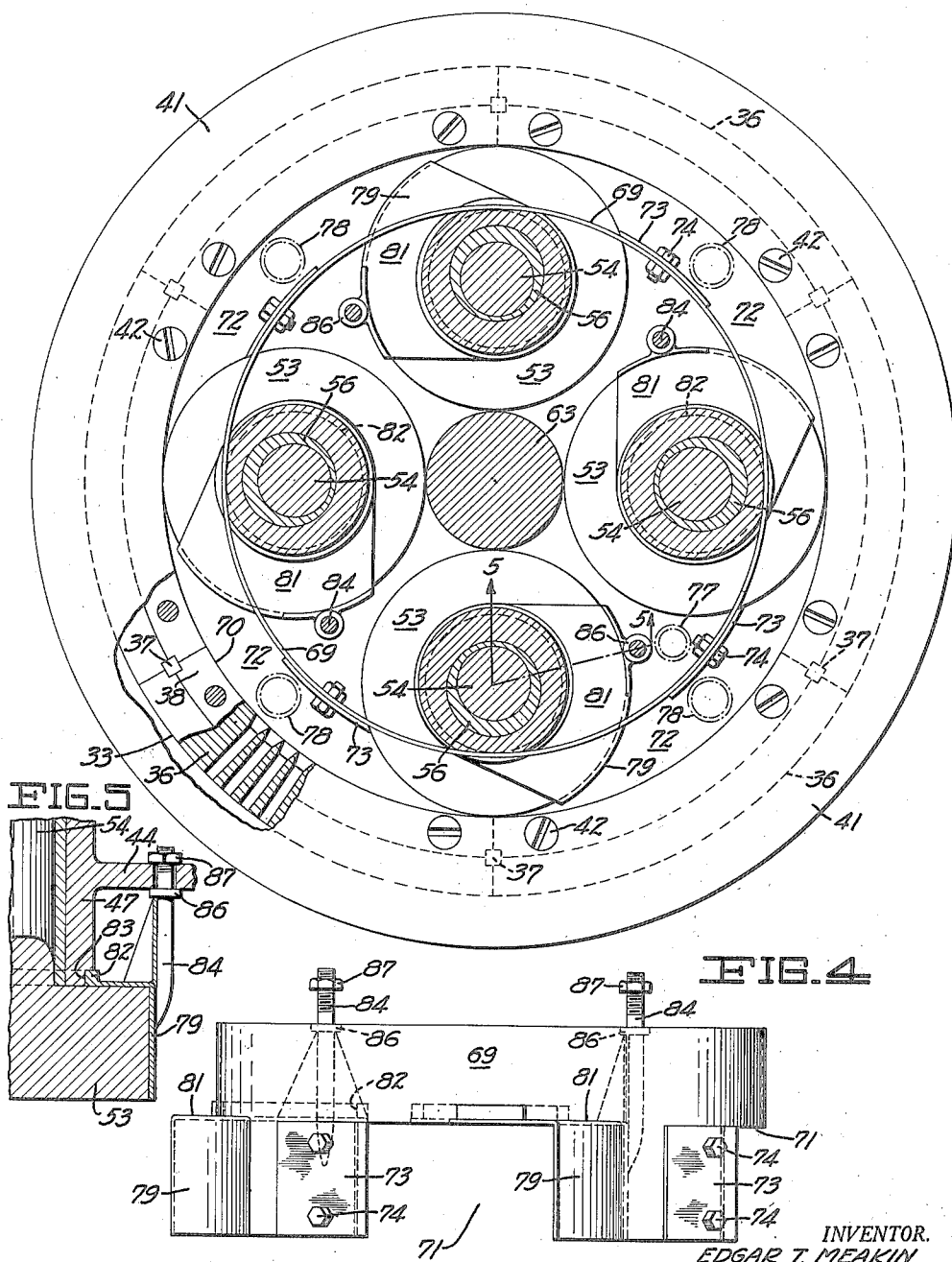
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2 Sheets-Sheet 2

FIG. 3



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UNITED STATES PATENT OFFICE

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MILL

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In Great Britain December 5, 1934

26 Claims. (Cl. 107—8)

My invention relates to a mill and more particularly to a pellet mill of the extrusion type, adapted to compress and force moldable materials through a perforated die and to sever the strings of extruded material into pellets of suitable size.

The principal object of my invention is to provide a compact and durable machine for forming pellets from moldable material.

Other objects of my invention are: To provide a mill of the class described, having a large capacity and which can be economically manufactured; to provide a pellet mill wherein materials may be compressed and rolled through a perforated die ring and thereafter cut off to form pellets; to provide a pellet mill in which the use of a costly thrust bearing structure for the transmittal of extension thrust stresses is obviated; to provide in a device of the class described means for neutralizing the thrust stresses occasioned during extrusion; to provide a pellet mill in which failure of parts is greatly reduced and to provide a pellet mill of simple construction.

The invention possesses numerous additional objects and advantages, some of which, together with the foregoing, will become apparent upon perusal of the following description of my invention. It is to be understood, however, that I do not limit myself to this disclosure of the species of my invention, as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawings:

Figure 1 is a plan view of a pellet mill incorporating my invention.

Figure 2 is a vertical elevational view, partly in section, of the apparatus of Figure 1, the plane in which the view is taken being indicated by the line 2—2 of Figure 1.

Figure 3 is a horizontal sectional view taken in a plane indicated by the line 3—3 of Figure 2.

Figure 4 is an elevational view of the hopper ring.

Figure 5 is a fractional vertical sectional view of the plow and its supporting structure, the plane in which the view is taken being indicated by the line 5—5 of Figure 3.

In terms of broad inclusion, my invention comprises a perforated die ring and means for compressing and forcing materials through the perforations thereof to effect consolidation, said means preferably comprising rollers disposed adjacent the inner face of the die ring and operative to effect extrusion of material fed thereto upon relative movement therebetween. Means is provided for neutralizing the thrust stress upon

the rollers occasioned during extrusion, said means preferably comprising a radial thrust member interposed between the adjacent peripheries of said rollers. In causing relative movement between the die ring and rollers, I prefer to employ means for rotating the die ring, although it is obvious that the die ring could be held stationary and the rollers moved about the face thereof without departing from the spirit of my invention.

Suitable plows are mounted adjacent the converging surfaces of the die ring and rollers for spreading the material uniformly over the face of the die ring; and the rollers are mounted for bodily adjustment relative to the face of the die if adjustment thereof becomes necessary because of wear.

Means is also provided for maintaining the contacting surfaces of the rollers and thrust member free of material, said means preferably comprising a wall adapted to confine the material within a definite area adjacent the die ring pending extrusion; and knives are provided for severing the strings of extruded material into pellets of desired length.

With reference to the preferred embodiment of my invention, I have chosen, for the purpose of illustration, the mill shown in the drawings. In this case the machine comprises a housing or frame, preferably of cast construction, having a lower section, generally indicated by the numeral 2, and an upper section, generally indicated by the numeral 3, said sections being suitably secured together by means of the bolts 4.

The lower sections 2 of the housing is provided with side walls 5 and a top 6, the latter having a centrally positioned hub 7 forming a bearing within which a vertically positioned rotor shaft 8 is journaled. The upper end of shaft 8 is provided with a portion 9 of reduced diameter on which is journaled hub 11 of an annular shaped and horizontally positioned rotor 12.

Rotor 12 is preferably formed with a downturned peripheral flange 13 having gear teeth 14 formed on its inner face to provide a ring gear with which a drive pinion 16 is adapted to mesh. This pinion is secured to a vertically positioned shaft 17 which is journaled for rotation in a hub 18 formed in the top 6 of the lower section 2 of the housing. A bracket 19 secured by bolts 21 to the top 6 carries a roller bearing 22 within which the upper end of shaft 17 is journaled and serves to provide a support for the shaft adjacent the drive pinion 16. The lower end of shaft 17 is also journaled for support in a bracket 23 formed on

the walls 5 of the lower section of the housing. To the shaft 17 is secured a bevel gear 24 meshing with a pinion 26 mounted on a horizontal shaft 27 projecting through one of the side walls 5 of the housing and in which it is journaled; and such shaft is driven by a power driven shaft 28 through a flexible coupling 29.

The top face of rotor 12 is provided, adjacent the outer periphery thereof, with an annular groove 31 in which an annular flange 32 formed on the lower end of a radially perforated die ring 33 is secured by means of the bolts 34.

The die ring is preferably formed of a plurality of arcuate sections 36 (see Figure 3), the abutting ends of which are splined together with keys 37 to maintain the sections in proper alignment. It is obvious that should any portion of the die ring become worn or broken or the apertures thereof clogged with material or foreign matter, then the section in which said defect occurs may be readily removed and a new section substituted. Heretofore it has been necessary to remove and replace the entire die in the event of breakage and since the die is the most costly part of the mill, the expense of die replacement has presented a considerable problem. In this connection it will be appreciated that the segmentation of the die ring eliminates many of the problems and difficulties of die ring manufacture, particularly with reference to the formation of the radially disposed perforations. Each segment or section is of such shape and size that it can be readily and economically produced, and the assembly of the segmented ring in the mill, as well as its removal in whole or in part therefrom for repair or replacement, may be easily and speedily accomplished. Costs of manufacture and operation are therefore materially reduced while at the same time maximum efficiency is maintained.

The upper end of die ring 33 is formed with an annular flange 38 which is adapted to seat in an annular recess 39 formed in a locking ring 41. Ring 41 is removably secured to the die ring by means of the set screws 42 and serves to maintain the arcuate sections 36 in ring alignment. It should be further noted that the die ring is firmly and uniformly secured, by reason of its upper flange seating in the recess 39 of the locking ring and its lower flange seating in the groove 31 of the rotor, against radial deformation or displacement resulting from radial thrust stress occurring during extrusion; and that the rotor and ring structure form a bowl.

The upper section 3 of the housing is provided with side walls 43 and a top plate 44 suitably secured together by means of bolts 46. This top plate is provided with a plurality of spaced hubs 47, preferably four in number, which project upwardly from the upper face of the top plate 44 and downwardly from the lower face thereof into the bowl and adjacent the inner face of the die ring. The upper portions of said hubs are supported and joined together by means of connecting webs 48 which serve to form, in conjunction with the hubs, a substantially tubular chamber 49 communicating with the interior of the housing. A removable cover plate 51 secured by means of the bolts 52 threaded in the webs 48 provides a closure for the outer end of the tubular chamber.

Means is provided for effecting extrusion of material through the perforations of the die ring and preferably comprises a plurality of rollers 53 spaced about the inner face thereof and pref-

erably in contact therewith. Each of the rollers is provided with a shaft 54 and the same is journaled for rotation in hub 47 which forms a bearing therefor. A bushing 56 is provided for the bearing and a lock washer 57 keyed or otherwise suitably secured adjacent the upper end of the shaft is supplied for maintaining the associated elements in place.

As a result of long continued operation and the presence of abrasive matter in the material, the faces of the die ring and rollers may become worn to such an extent that an appreciable space develops therebetween. For this reason it is desirable that provision be made whereby each roller may be moved into bodily contact with the die face. To accomplish this result, therefore, I form the bushing 56 eccentric with respect to roller shaft 54 and provide on the upper end thereof an outwardly extending lug 58 suitably apertured to receive a bolt 59 which projects through an arcuate slot 61 formed in an outwardly projecting stationary ear 62 of hub 47. It is obvious that by rotating the eccentric bushing on its axis the shaft and consequently the roller will be moved relative to the die face and proper adjustment effected and thereafter maintained by locking the lug 58 of the bushing to the ear 62 of the hub by means of the bolt 59.

In effecting extrusion of material through the apertures of the die ring, the rollers are subjected to tremendous thrust stresses and, unless compensated for, will produce extreme wear and strain upon the roller mounting. For the purpose of overcoming this difficulty, I provide means for neutralizing the thrust stresses upon the rollers occasioned during extrusion. This means preferably comprises a radial thrust roller 63 interposed between the adjacent peripheries of the rollers 53. The thrust roller rides between the button 64, formed on the end portion 9 of the rotor shaft, and the button 66 forming the lower end of a rod 67, the upper end of which intersects cover plate 51. It is to be noted that when so mounted, axial movement of the thrust roller is prevented. It will also be seen that the thrust stresses on the rollers occasioned during extrusion will be neutralized and any appreciable strain upon the roller mounting will be obviated. In the event the peripheries of the rollers 53 are worn down through use or are moved out of contact with the periphery of the thrust roller 63, such thrust roller may be withdrawn through the chamber 49 by simply removing the cover plate 51 and a new thrust roller of proper diameter substituted.

It is desirable to maintain the thrust surfaces of the rollers 53 and thrust roller 63 free of material in order to prevent jamming. While scrapers could be mounted adjacent the converging surfaces of such rollers for such purpose, I prefer to maintain the material in a definite area adjacent the face of the die ring pending extrusion. This means preferably comprises an annular hopper ring 69 spaced from the inner face of the die ring and forming therewith an annular chamber 70, the bottom end of which is closed by the rotor 12 and the top end by the top plate 44. Said hopper ring is provided with cut-out portions 71 through which the peripheries of the rollers 53 project for engagement with the inner face of the die ring, thereby dividing the lower portion of the chamber 70 into compartments 72. Suitable scrapers 73 removably secured by bolts 74 to the outer periphery of the hopper ring, adjacent the cut-out portions 71, are provided

for removing from the peripheries of the rollers 53 any material which might adhere thereto during extrusion. It is obvious that any material scraped from the peripheries of the rollers will be retained within the annular chamber 70. However, should any material escape inwardly past the hopper ring, I provide a depressed annular chamber or sump 76 in the face of the rotor 12 for its collection, and a suction pipe 77 projecting through the top plate 44 of the housing and into the sump for the removal thereof.

Means comprising feeder pipes 78 projecting through the top plate 44 into each of the compartments 72 of the chamber 70 is provided for conveying material thereto for purposes of extrusion. Means are also provided for spreading the material so fed to the chamber in a layer of uniform thickness upon the face of the die ring immediately in advance of the converging surfaces of the rollers and die ring, including a plow 79 for each roller. With reference to Figures 3, 4 and 5, the plow is of arcuate shape and conforms to the curvature of the roller. Each plow is provided along its upper edge with an inwardly projecting support member 81 having a flanged aperture 82 adapted to encircle the reduced end portion 83 of the hub 47. Since the plow is subjected to considerable strain to effect spreading of the material, an additional support is provided which includes an upright arm 84 fixedly secured along the lower portion thereof to the outer face of the plow and extending upwardly through the top plate 44 of the housing to which it is firmly clamped by the fixed collar 86 and nut 87.

Suitable knives 88 are provided for severing the extruded strings of material into pellets of desired length. Each knife is provided with a handle 89 which is removably secured in any suitable and well known manner, to the side wall 43 of the housing adjacent the outer face of the die ring.

I claim:

1. In a device of the class described, a perforated die ring, means for supporting said die ring, a roller disposed adjacent one face of said die ring for compressing and forcing material through the perforations thereof upon relative movement between said die ring and said roller, means for causing said relative movement, and means interposed between said die ring and said roller for neutralizing the thrust on said roller occasioned during extrusion.

2. In a device of the class described, a perforated die ring, means for supporting said die ring, a roller disposed adjacent one face of said die ring for compressing and forcing material through the perforations thereof upon rotation of said die ring, means for rotating said die ring, and means disposed for engagement with the periphery of said roller for neutralizing the thrust stress thereon occasioned during extrusion.

3. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers each disposed adjacent one face of said die ring for compressing and forcing material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and means cooperating with all of said rollers for neutralizing the thrust stress thereon occasioned during extrusion.

4. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers each disposed adjacent

the inner face of said die ring for compressing and forcing material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and unitary means cooperating with said rollers for neutralizing the thrust stress thereon occasioned during extrusion.

5. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of spaced rollers each disposed for engagement with the inner face of said die ring and adapted to compress and force material through the perforations thereof upon rotation of said die ring, means for rotating said die ring, and thrust absorbing means cooperating with all of said rollers for neutralizing the radial thrust stress thereon occasioned during extrusion.

6. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of compression rollers each disposed for engagement with the inner face of said die ring for effecting extrusion of material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and a thrust roller interposed between the adjacent peripheries of said compression rollers for simultaneously neutralizing the thrust stresses thereon occasioned during extrusion.

7. In a device of the class described, a perforated die ring, rollers disposed for engagement with one face of said die ring and adapted to compress and force material through the perforations thereof upon rotation of said die ring, means for rotating said die ring, a thrust member cooperating with opposed pairs of said rollers for neutralizing the thrust stress thereon occasioned during extrusion, and means separating the material to be extruded from the cooperating portions of said roller and said thrust member.

8. In a device of the class described, a perforated die ring, means for supporting said die ring, a wall spaced from one face of said die ring to provide a chamber adjacent said face, compression means projecting into said chamber through an aperture in said wall and adapted to compress and force material through the perforations of said die ring upon rotation thereof, and means for rotating said die ring.

9. In a device of the class described, a perforated die ring, means for supporting said die ring, a wall spaced from the inner face of said die ring and forming an annular chamber therewith, a plurality of spaced rollers projecting into said chamber through said wall and dividing said chamber into a plurality of compartments, said rollers being adapted to converge upon the face of said die ring for compressing and forcing materials through the perforations thereof upon rotation of said die ring, means for feeding material to each of said compartments, and means for rotating said die ring.

10. In a device of the class described, a housing, a rotor mounted for rotation on said housing, a perforated die ring connected to said rotor, a plurality of spaced rollers supported by said housing and adjacent the inner face of said die ring for compressing and forcing material through the perforations thereof, a radial thrust member interposed between the adjacent peripheries of said rollers for transmitting thrust stresses therebetween, and means for rotating said die ring.

11. In a device of the class described, a housing, a rotor mounted for rotation on said housing, 75

a perforated die ring disposed on said rotor, a roller supported by said housing and adjacent one face of said die ring for extruding material through the perforations of said die ring upon rotation thereof, means for neutralizing the thrust stress on said roller occasioned during extrusion, and means for adjusting the extrusion roller radially to accommodate wear between the extrusion surfaces of said roller and said die ring.

12. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed for engagement with the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, means disposed between pairs of said rollers for neutralizing the radial thrust stress thereon occasioned during extrusion, and adjustable means interposed between the converging surfaces of said die ring and said rollers for regulating the quantity of material forced through said die ring.

13. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed for engagement with the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, means disposed between pairs of said rollers for neutralizing the radial thrust stress thereon occasioned during extrusion, and adjustable means interposed between the converging surfaces of said die ring and said rollers for regulating the quantity of material forced through said die ring, said means comprising an arcuate member overlying a portion of the periphery of each roller and having an edge disposed adjacent the periphery of said die ring.

14. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed for engagement with the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, means disposed between pairs of said rollers for neutralizing the radial thrust stress thereon occasioned during extrusion, means for regulating the quantity of material upon the face of the die ring prior to extrusion, said means comprising an arcuate member overlying a portion of the periphery of each roller and having an edge disposed adjacent the periphery of said die ring, and means for adjustably fixing the position of the edge of said member relative to said periphery of the die ring.

15. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed for engagement with the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, an arcuate member disposed adjacent the inner periphery of said die ring and between the peripheries of adjacent rollers to provide, between each pair of rollers and the die ring, an arcuate chamber for the reception of material to be extruded, and rotatable means associated with each roller for radially adjusting the position thereof relative to the periphery of said die ring.

16. In a device of the class described, a per-

forated die ring, means for supporting said die ring, a plurality of rollers disposed for engagement with the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, an arcuate member disposed adjacent the inner periphery of said die ring and between the peripheries of adjacent rollers to provide, between each pair of rollers and the die ring, an arcuate chamber for the reception of material to be extruded, means disposed between pairs of said rollers for absorbing the radial thrust thereof occasioned by extrusion, and rotatable means associated with each roller for radially adjusting the positions thereof to and from the periphery of said die ring.

17. In a device of the class described, a housing, a perforated die ring rotatably mounted on said housing, a plurality of shafts journaled in said housing, a roller carried by each of said shafts and disposed for engagement with the inner periphery of said die ring, said rollers being adapted to compress and force material through the perforations of said die ring upon rotation thereof, means for rotating said die ring, an arcuate member disposed adjacent the inner periphery of said die ring and between the peripheries of adjacent rollers to provide, between each pair of rollers and the die ring, an arcuate chamber for the reception of material to be extruded, means disposed between pairs of said rollers for neutralizing the thrust stress thereon occasioned during extrusion, a rotatable eccentric sleeve surrounding each of said roller shafts for varying, upon rotation of said sleeves, the radial position of said rollers, with the reference to the periphery of said die ring, and means for securing said sleeves to said housing for preventing rotation of said sleeves.

18. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers, each disposed adjacent the inner face of said die ring for compressing and forcing material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and floating means cooperating with said rollers for neutralizing the thrust stress thereon occasioned during extrusion.

19. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of spaced rollers, each disposed for engagement with the inner face of said die ring and adapted to compress and force material through the perforations thereof upon rotation of said die ring, means for rotating said die ring, and thrust absorbing means rotatable by and cooperative with said rollers for neutralizing the radial thrust stress thereon occasioned during extrusion.

20. In a device of the class described, a housing, a perforated die ring mounted for rotation in said housing, a plurality of spaced rollers, each independently supported by said housing and each disposed adjacent one face of said die ring for compressing and forcing material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and means supported by said rollers and cooperative therewith for simultaneously neutralizing the thrust stress thereon occasioned by extrusion.

21. In a device of the class described, a hori-

zontally positioned perforated die ring, a wall spaced from the inner face of said die ring and forming an annular chamber therewith for the reception of material to be acted upon, a roller disposed for engagement with the inner face of said die ring for extruding said material through the perforations thereof upon rotation of said die ring, a rotor connected to said die ring and forming a bottom closure for said chamber, said rotor having a sump for the collection of material escaping from said chamber, means for rotating said rotor and said die ring, and means opening within said sump and through which the collected material may be withdrawn.

22. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed adjacent the inner periphery of said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, and means disposed adjacent the inner periphery of said die ring and between the peripheries of adjacent rollers to provide, between each pair of rollers and the die ring, a chamber for the reception of material to be extruded.

23. In a device of the class described, a perforated die ring, means for supporting said die ring, a plurality of rollers disposed within the area confined by said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, a shaft for each of said rollers, and a member positioned adjacent an end of said rollers and having openings therein within which said shafts are disposed.

24. In apparatus of the class described, an an-

nular die ring, a plurality of rollers adapted for cooperable engagement with the inner surface of said die ring, all of said rollers being capable of adjustment with respect to said die ring, and means disposed adjacent to each roller for directing the material to be extruded toward the inner surface of said die ring and the outer peripheral surface of the respective roller.

25. In a device of the class described, a horizontally positioned perforated die ring, means for supporting said die ring, a plurality of rollers disposed within the area confined by said die ring and adapted to compress and force material through the perforations thereof upon relative movement between said die ring and said rollers, means for causing said relative movement, a shaft for each of said rollers, a member positioned adjacent an end of said rollers and having openings therein within which said shafts are disposed, and means cooperative with said shafts for radially adjusting the position of the rollers relative to the inner face of said die ring.

26. In apparatus of the class described, a plurality of rollers, means for supporting said rollers, an annular die ring surrounding all of said rollers and having its inner surface adapted for contact with the outer peripheral surface of each of the rollers, means for adjusting the position of the rollers with respect to the inner surface of the die ring, means for directing the materials to be processed toward the outer peripheral surface of each of the rollers whereby, upon relative rotational movement between said roller and die ring, the materials being processed will be forced through the die ring, means for effecting said relative rotational movement between said die ring and said rollers, and means for severing the material as it comes out of said die ring.

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