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Oberley et al.

[11] **3,791,187**

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[54] COLLAPSIBLE FEED MECHANISM

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[52] **U.S. Cl.** **72/272**

[51] **Int. Cl.** **B21c 27/00**

[58] **Field of Search** 72/60, 272, 253, 271, 273; 92/166

[56] **References Cited**

UNITED STATES PATENTS

3,724,336	4/1973	Fuchs, Jr.	72/272
3,431,825	3/1969	Crawley et al.	92/165
1,856,440	5/1932	Spire	72/345

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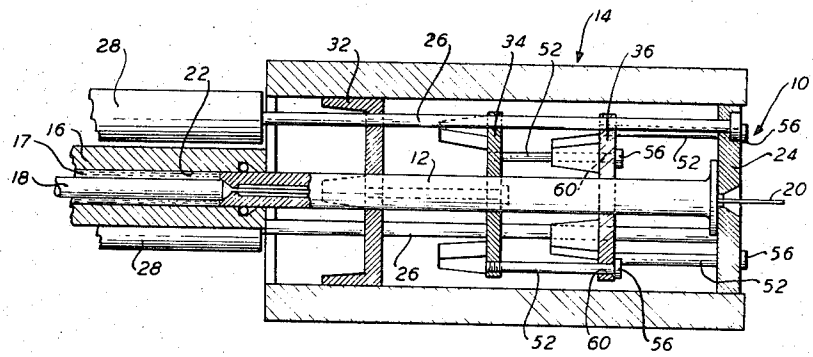
Attorney, Agent, or Firm—Popper, Bain, Bobis, Gilfillan & Rhodes

[57] **ABSTRACT**

Collapsible feed mechanism for providing radial support to a longitudinally extending member and for preventing bending and buckling of the longitudinally extending member during the axial advancement thereof while under an axial compressive load, such collapsible feed mechanism typically residing axially displaceably within an outer support structure, including a plurality of axially displaceable radial support members positioned around the longitudinally extending member and for providing the radial support thereto; each radial support member having an outer axial surface and an inner axial surface and the outer axial surface being greater in axial length than the inner axial surface; the outer axial surfaces of greater axial length for slidably engaging the outer support structure during the axial displacement of the radial support members and for preventing the tendency of the axially displaceable support members to rotate with respect to an axis perpendicular to the longitudinally extending member and bind during the axial displacement of the radial support members; and the inner axial surfaces for slidably engaging the longitudinally extending member during the axial displacement of the radial support members and for providing the radial support to the longitudinally extending member.

3 Claims, 6 Drawing Figures



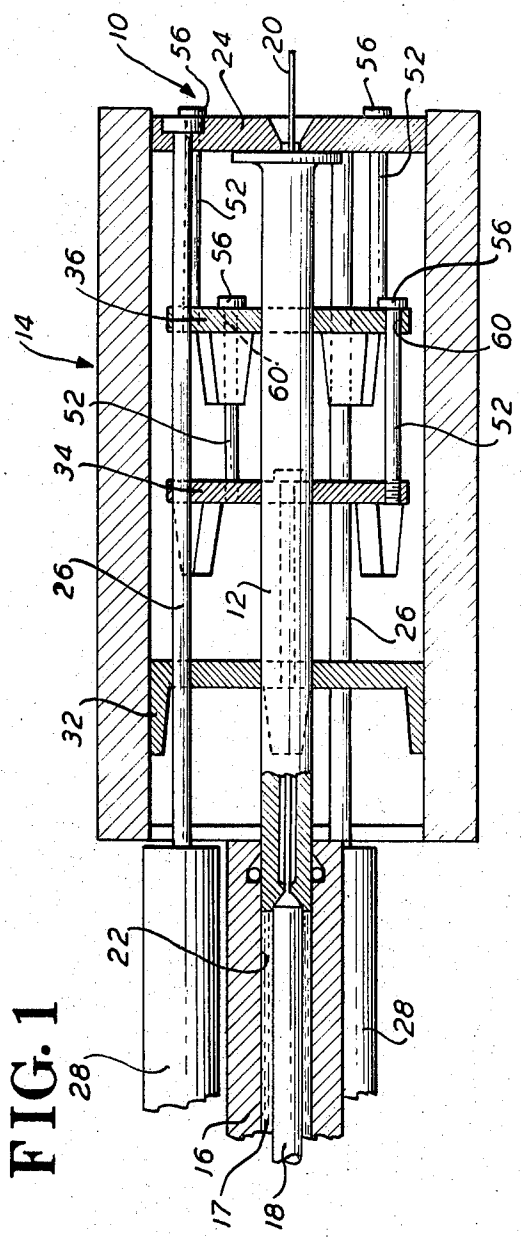

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FIG. 1

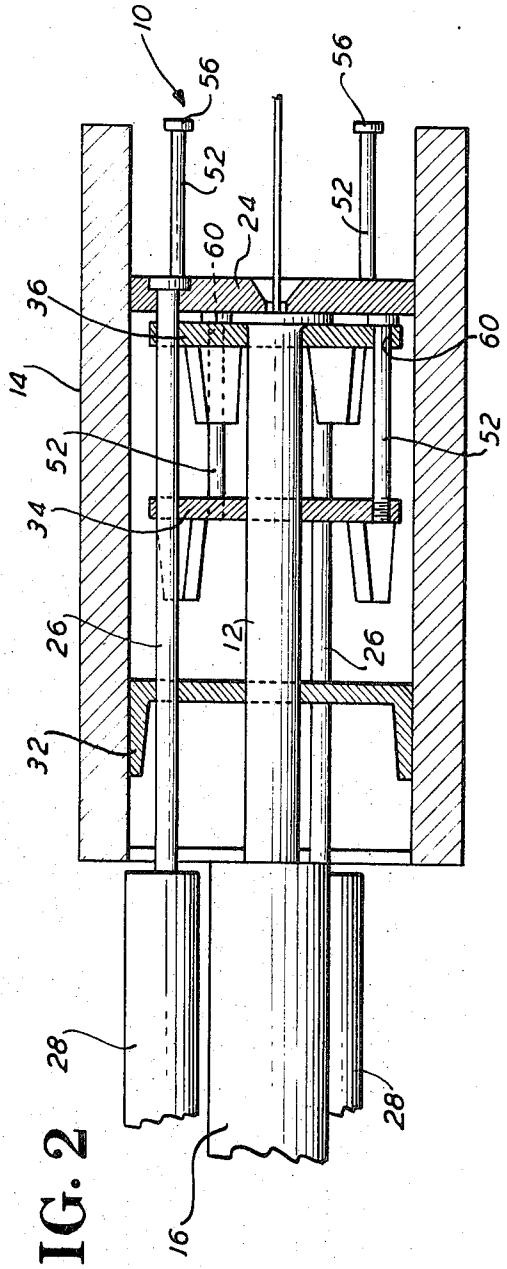
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FIG. 2

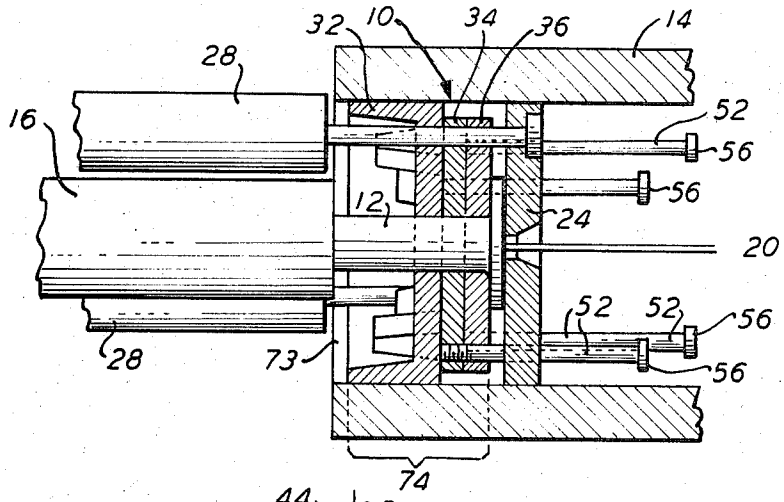

FIG. 3

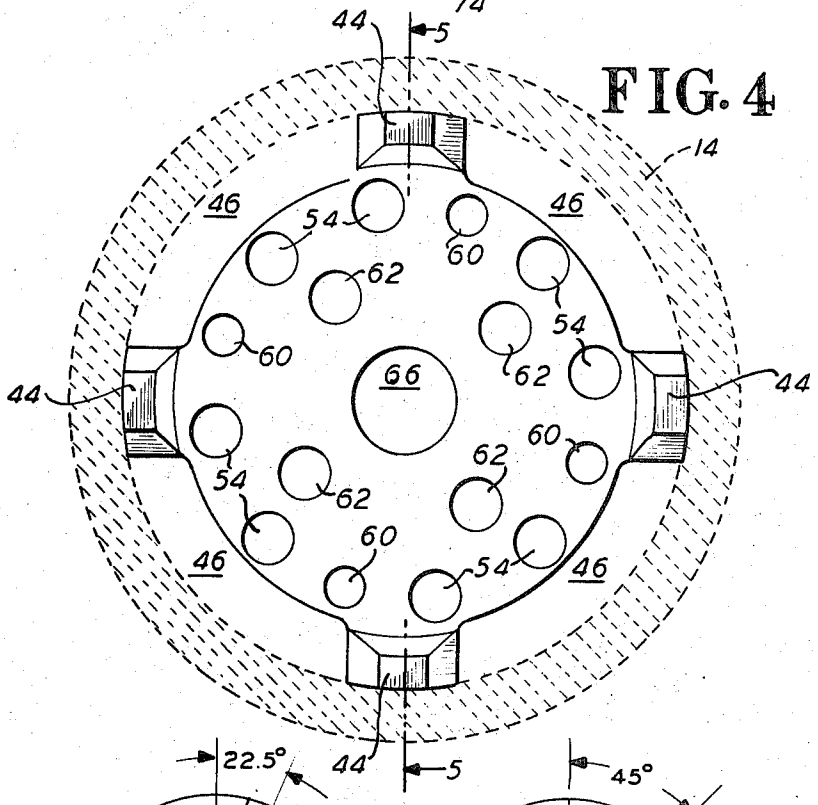

FIG. 4

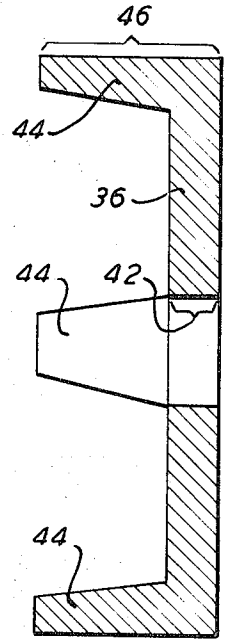

FIG. 5

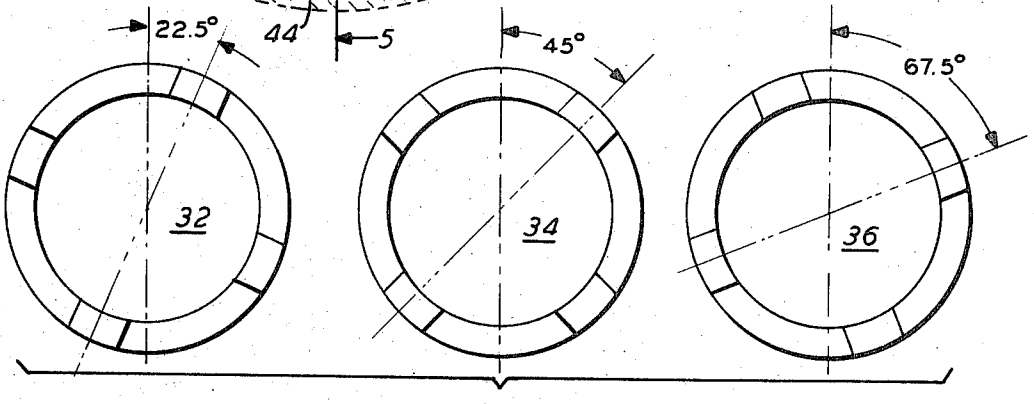

FIG. 6

COLLAPSIBLE FEED MECHANISM

BACKGROUND OF THE INVENTION

A problem which has faced those concerned with the extrusion art, as well as other arts wherein it is required to advance a longitudinally extending member such as a rod or rod-like member, and in particular a "slender column," subjected to a relatively high compressive axial load, has been the bending or buckling of the member. A further problem has been that of maintaining such a member in co-axial alignment with other structures during such advancement.

It is known to those skilled in the art that longitudinally extending members such as long, slender rods having a length to least radius of gyration ratio in excess of 80:1, are commonly referred to as "slender columns" and are particularly susceptible to bending and buckling when subjected to large, axially directed, compressive loads.

The susceptibility of rods in general and slender columns in particular to bending and buckling not only limits the capability of the rod or column to support axially directed compressive loads, but also causes misalignment and bending difficulties when it is necessary to pass a rod or slender column axially through one or more aligned orifices. For example, the extrusion of wire from a billet being subjected to high hydrostatic pressure in a fluid tight pressure vessel wherein the extrusion is accomplished by advancing a ram-mounted die upwardly of the billet into a bore in the vessel, ordinarily requires the use of a hollow die ram which is a rod, or rod-like member, falling within the definition of a slender column. The forces of extrusion are quite high, thus increasing the likelihood of bending or buckling. Further, the alignment of the die ram with the pressure vessel bore is very important in order to preclude binding which might interfere with advancement of the die at a constant or controlled rate. In this typical situation, therefore, great care must be taken to support the die ram radially during the axial advancement against any unacceptable bending or buckling, and to maintain the die ram in co-axial alignment with the pressure vessel.

A collapsible feed mechanism for supporting slender columns in compression wherein the application is hydrostatic extrusion of billets is described in full in U.S. Pat. No. 3,548,625 to F. J. Fuchs, Jr. The slenderness ratio is minimized by a series of sliding die stem support spacers, or aligning plates, connected such that their maximum separation is limited to satisfy the slenderness ratio requirement of the slender column in the open position and the surfaces of each spacer will be in contact during the closed position. As is known in the art, it is desirable to limit the spacers'thicknesses to the smallest value possible primarily because the spacer thickness utilizes volume which in turn adds to the requirement for increased die stem or slender column length. If the spacers are too thin, there is a tendency for them to translate, or rotate, about an axis parallel to the vertical surface of the spacer and perpendicular to its center line or the centerline of the slender column. To avoid this tendency toward translation or rotation, it is a general rule of thumb that the axial spacer length or thickness should be approximately equal to its diameter. However, for those knowledgeable in the art, adaptation of this design parameter is highly undesirable, and in certain instances virtually intolerable, in that it unwantedly extends the length of the extrusion machine, the slender column or die stem (with the resulting adverse effect on alignment) equivalent to the sum of the thicknesses of the die stem spacers. An expedient known to the prior art for overcoming the resulting binding of the OD of the spacers against their retainer wall as well as the ID of the spacers against the die stem due to such rotational problem, is to fabricate curved surfaces onto the OD and ID of the spacers. Thus, any tendency to rotate will not create a binding or otherwise interfering condition. However, such expedient has not proven to be altogether satisfactory as such rounded surfaces can cause too much rotation and hence can result in lack of full radial support to the die ram.

SUMMARY

In accordance with the present invention the above-noted prior art problems are overcome by providing a collapsible feed mechanism for providing radial support to a longitudinally extending member, which mechanism includes aligning members or radial support members structured in such a manner that they have sufficient axial length or thickness to avoid the tendency to rotate or translate and bind and at the same time will nestle or collapse in such a manner that in the fully collapsed or nestled position they will occupy a minimum volume or axial length or at least a volume no greater than that known to the collapsible feed mechanisms of the prior art.

DESCRIPTION OF THE DRAWINGS

FIGS. **1, 2** and **3** are diagrammatic presentations of a collapsible feed mechanism of the present invention showing various conditions of expansion and contraction;

FIGS. **4** and **5** are enlarged schematic views showing detailed structural configuration of a radial support member of the collapsible feed mechanism of the present invention; and

FIG. **6** is a multiple view FIG. showing the relative angular displacement of the radial support members of the collapsible feed mechanism of the present invention.

DESCRIPTION OF THE INVENTION

Referring to FIGS. **1–3**, there is shown a collapsible feed mechanism embodying the present invention and indicated by general numerical designation **10**. In the diagrammatic presentation of the present invention, the collapsible feed mechanism **10** is for providing radial support to a longitudinally extending member, such as die ram **12**, during the axial advancement of the die ram while under an axial compressive load. The collapsible feed mechanism **10** resides axially, displaceably within a suitable outer support structure identified by general numerical designation **14**.

More particularly, the collapsible feed mechanism **10** is for providing radial support to the die ram **12** during its axial advancement into a pressure vessel **16** to hydrostatically extrude a metal billet **18** into, for example, wire **20** in the manner known to those skilled in the hydrostatic extrusion art. Further, the collapsible feed mechanism **10** is for also maintaining the die ram **12** in co-axial alignment with the bore **22** of the pressure vessel **16** during the axial advancement of the die ram into

the bore **16.** More particularly with regard to the hydrostatic extrusion of the billet **18,** the die ram **12** is suitably secured to a drive plate **24** to which are suitably connected a plurality of drive rods **26.** Each drive rod is suitably connected to a piston (not shown) mounted for reciprocable movement in a power cylinder **28.** Upon the advancement of the drive rods to the left, the drive rods in turn transmit leftward movement to the drive plate **24** which in turn axially displaces the die ram **12** into the pressure vessel **14** to extrude the billet **18,** and in doing so, places the die ram **12** under a heavy axial compressive load.

Referring still to FIGS. **1–3,** and referring more particularly to the structure of the collapsible feed mechanism of the present invention, the collapsible feed mechanism **10** includes a plurality of axially displaceable radial support members **32, 34** and **36** which reside axially displaceably in the outer support structure **14.**

Each radial support member, such as for example representative radial support member as shown in FIGS. **4** and **5,** is provided with an inner axial surface **42** for slidably engaging the die ram **12** during its axial displacement to hydrostatically extrude the billet **18** of FIGS. **1–3.** The inner axial surface **42** is provided with an axial length equal to the thickness or width of the radial support. In addition, the representative radial support member is provided at its outer radial portion with a plurality of angularly displaced, axially extending pad members **44.** Each pad member is provided with a radially outer, axially extending surface **46** (FIG. **5**) and it will be noted that radially outer axially extending surface **46** is greater in axial length than the inner axially extending surface **42.** Further, it will be noted that the surfaces **46** of each radial support member provide, in combination, an interrupted annular surface.

Upon axial displacement of the radial support members **32, 34** and **36,** the inner axial surfaces **42** slidably engage and provide radial support to the axially advanced or displaced die stem **12.** The radially outer axially extending surfaces **46,** of greater axial length, slidably engage the inner surface of the outer support structure **14,** and, the axially extending surfaces **46** of greater axial length avoid or preclude any tendency of the radial support members **32, 34** and **36** to rotate or translate with respect to an axis perpendicular to the die ram **12** thereby preventing or precluding any binding of the radial support members during their axial advancement to provide radial support to the advancing die ram **12.** More specifically, it will be noted and understood, that the radially outer axially extending surfaces **46,** as may be best seen in FIG. **5,** are of greater axial length than the width or thickness of the radial support members, and hence, provide a much greater inhibiting influence for preventing the tendency of the radial support members to rotate and bind than were the radially outer axially extending surfaces **46** to be merely equal to the thickness or width of the radial support members.

As noted above, another primary consideration with collapsible feed mechanism is that they be able to be collapsed in a minimum volume, or minimum axial length, so as to permit, for example, the die ram **12,** and associated extrusion structure, to be of minimum axial length because, as may be best seen in FIG. **3,** the die ram **12** for complete advancement into the pressure vessel **16** must be of an axial length which includes the collapsed axial length of the collapsible feed mechanism **10.** Accordingly, the collapsible feed mechanism **10** of the present invention, in addition to precluding the tendency of the radial support members **10** to rotate or translate about the die ram **12,** is also structured so as to permit the radial support members **32, 34** and **36** to be collapsed or nestled into a minimum axial length.

More specifically, and as may be seen in FIGS. **1–3,** and in particular FIG. **6,** the radial support members **32, 34** and **36** are displaced angularly with respect to each other a predetermined number of degrees, so as to in turn displace the respective pad members **44** of each radial support member with respect to the respective pad members **44** of the other radial support members of the plurality. By being so angularly displaced, and since the pad members **44** of the radial support members extend radially outwardly beyond the body of their respective radial support member, as may be best seen in FIG. **4,** interrupted annular space **46** is provided between the annular body of the radial support member and the outer support structure **14** for permitting the axially extending pad members **44** to be extended beyond the next adjacent radial support member upon the collapse of the collapsible feed mechanism **10,** as may be best seen in FIG. **3.** More specifically, it will be noted and understood that the spaces **46** surrounding radial support member **32** accommodate the pads **44** formed on radial support members **34** and **36,** and that the spaces **46** surrounding radial support member **34** accommodate the pad members **44** formed on radial support member **36.**

Further, it will be understood by those skilled in the collapsible feed mechanism art, that, as in the collapsible feed mechanism in the aforementioned patent to F. J. Fuchs, Jr., the radial support members **32, 34** and **36** of the present invention are provided with means for axially positioning the radial support members at predetermined points along the die ram **12** upon the retraction or expansion of the collapsible feed mechanism, namely, and as is also known to those skilled in the art, the collapsible feed mechanism **10** of the present invention is provided with lost motion mechanism including a plurality of headed bolts **52** (FIGS. **1, 2** and **3**) and apertures **54** and **60** (FIGS. **4**) in which the bolts **52** slidably reside and extend therethrough; further, it will be understood that only certain of the bolts **52** of the plurality are shown in FIGS. **1–3** for purposes of simplifying the drawings and clarity of presentation. More specifically, as shown in FIGS. **1–3,** bolts **52** interconnect radial support members **34** and **36,** the bolts **52** being threadedly secured in radial support member **34** and extending slidably and loosely through apertures **60** formed in radial support member **36** with the heads of the bolts **56** residing on the opposite side of radial support member **36.** Apertures **60** are larger in diameter than the bolts **52** thereby permitting the free passage of the bolts therethrough, but are smaller in diameter than the diameter of the bolt heads **56** thereby preventing passage of the bolt heads therethrough. Similarly, it will be understood that radial support member **36** and drive plate **24** are interconnected by headed bolts **52** and apertures **60,** and further similarly, it will be understood that although not shown, radial support members **32** and **34** are provided with bolts **52** and apertures **60.** Further, and with particular regard to the apertures, the structural details of a representa-

tive radial support member, e.g. radial support member **36**, is shown in FIG. **4**. The radial support member **36** is provided with a plurality of smaller apertures **60**, mentioned above, for permitting free passage therethrough of the bolts **52** and for preventing passage therethrough of the bolt heads **56**, and is further provided with a plurality of apertures **54** for permitting the free passage therethrough of the bolts and bolt heads, and in particular the bolt heads, of the bolts **52** interconnecting radial support members **32** and **34** upon the collapse of the feed mechanism as shown in FIG. **3**. Also, radial support member **36** is provided with a plurality of apertures **62** for permitting the free passage therethrough of the drive rods **26**. Further, radial support member **36** is provided with a centrally formed aperture **66** for closely, but slidably, permitting the passage therethrough of die ram **12**; it being understood, of course, that aperture **36** is defined by the inner axial surfaces **42** of the radial support members.

Similarly, it will be understood that radial support member **34** and drive plate **24** are provided with smaller apertures **60**, larger apertures **54**, apertures **62** and aperture **60**, but that drive plate **32** is only provided with apertures **62** and **66**.

OPERATION

With regard to the operation of the collapsible feed mechanism of the present invention, it will be assumed that the structural members occupy the position shown in FIG. **1** and that it is desired to extrude the billet **18** into wire **20**.

The power cylinders **28** will be actuated by suitable means, not shown, to impart leftward movement to the drive rods **26**, which, in turn, impart leftward movement to the drive plate **24** which, in turn, advances the die ram **12** leftwardly into the pressure vessel **16** to hydrostatically extrude the metal billet **18** into wire **20**; it being understood that such leftward movement or axial advancement of the die ram **12** into the vessel **16** places the die ram under a large axial compressive load. During the leftward movement of the drive plate **24** from the position shown in FIG. **1** to the position shown in FIG. **2**, no movement will be imparted to the radial support members **32**, **34** and **36**, the headed bolts interconnecting radial support member **36** and the drive plate passing freely through the apertures formed in the drive plate and in which the headed bolts reside. Upon the drive plate **24** reaching the position shown in FIG. **2**, the drive plate engages radial support member **36** and axially displaces the radial support member leftwardly as viewed in FIG. **2**. The radial support member **36** under the influence of leftwardly moving drive plate **24**, is displaced leftwardly until it engages radial support member **34** which radial support member **34** is in turn advanced or displaced axially leftwardly until it engages radial support member **32** to axially displace radial support member **32** leftwardly until it engages the annular stop member **73** shown in FIG. **3**. During the leftward axial displacement of the radial support member **36** until it engages radial support member **34**, it will be understood that the headed bolts **52** interconnecting radial support member **34** with radial support member **36** pass freely through the apertures **60** formed in radial support member **36** and that such bolts and their heads pass through apertures **54** formed in the drive plate **24**. Similarly, it will be understood that during the leftward axial displacement of the drive plate **24**, radial support member **36** and radial support member **34**, leftwardly into engagement with radial support member **32**, that the headed bolts interconnecting radial support member **32** with radial support member **34** pass freely through the apertures **60** formed in radial support member **34** and that such bolts and their heads pass freely through larger apertures **54** formed in radial support members **34** and **36** and drive plate **24**.

Referring now specifically to FIG. **3**, it will be noted that the collapsible feed mechanism **10** of the present invention collapses into an axial volume or axial length indicated by bracket **74** which is less than the combined axial lengths **46** of the axially extending pad members **44** provided on the three radial support members **32**, **34** and **36**, or stated differently, the collapsed axial length **74** is less than three axial lengths **46**. Such shortened collapsed lengths of the collapsible feed mechanism **10**, as noted above, is due to the angular displacement of the radial support members **32**, **34** and **36**, which provide the interrupted annular spaces **46** for accommodating or receiving the pad members **44**.

Upon the completion of the extrusion of the billet **18** into wire **20**, the power cylinders are operated to move the drive rods **26** rightwardly to return the die ram **12** and drive plate **24** to their initial positions shown in FIG. **1**. During such return of the die ram **12** and drive plate **24**, the lost motion linkage positions the radial support members at the spaced points along the die ram **12** as shown in FIG. **1**. More particularly, upon the initial rightward movement of the drive plate **24**, only the drive plate **24** is moved rightwardly with the radial support members **32**, **34** and **36** remaining in their leftward position shown in FIG. **3**. The drive plate **24** moves rightwardly until it engages the heads **56** of the bolts **52** interconnecting the drive plate and radial support member **36** whereupon rightward movement or axial displacement is imparted to the radial support member **36**. The radial support members **32** and **34** remain in their leftward position shown in FIG. **3** until the radial support member **36** engages the heads **56** of the bolts **52** interconnecting radial support members **34** and **36** whereupon rightward movement or axial displacement is imparted to the radial support member **34**. Similarly, radial support member **32** remains in its leftward position shown in FIG. **3** until radial support member **34** engages the heads **56** of the bolts **52** interconnecting radial support members **32** and **34**. Upon the drive rods **26** having restored the drive plate **24** to its initial position shown in FIG. **1**, the lost motion linkage including the bolts **52** and apertures **54** and **60** will have positioned the radial support members **32**, **34** and **36** at their initial axial positions along the die ram **12** as shown in FIG. **1**.

It will be understood by those skilled in the art that the lost motion linkage instead of employing bolts threaded into the radial support members could employ bolts having heads on each end and residing slidably in smaller apertures **60** formed in the radial support members interconnected by the belts.

It will be further understood by those skilled in the art that many modifications and variations may be made in the collapsible feed mechanism of the present invention without departing from the spirit and scope thereof.

What is claimed is:

1. Collapsible feed mechanism for providing radial support to a longitudinally extending member having a longitudinal axis and for preventing bending and buckling of said longitudinally extending member during the axial advancement thereof while under an axial compressive load, and said collapsible feed mechanism for residing axially displaceably within an outer support structure, comprising:

a plurality of successively axially aligned and axially displaceable radial support members positioned around said longitudinally extending member and for providing said radial support thereto;

each of said radial support members provided with an inner axial surface for slidably engaging said longitudinally extending member during the axial displacement of said radial support members, said inner axial surface having an axial length;

each of said radial support members provided at its outer radial portion with a plurality of angularly displaced, axially extending pad members having interruptions therebetween to provide space to receive the axially extending pad members of the preceding radial support members, and each of said pad members provided with a radially outer, axially extending surface greater in axial length than said axial length of said inner axial surface, and said radially outer, axially extending surfaces of said greater axial length for slidably engaging said outer support structure during the axial displacement of said radial support members and for preventing the tendency of said radial support members to be displaced from a substantially normal plane with respect to said longitudinal axis of said longitudinally extending member and bind during the axial displacement of said radial support members; and

said axially extending pad members provided on each radial support member extending radially outwardly from each support member and said axially extending pad members provided on each radial support member being displaced angularly with respect to the axially extending pad members provided on the other radial support members of said plurality whereby upon the axial displacement of said radial support members said plurality of pad members on each successive support member extending into and being received by said interruptions provided between the pad members of the next successive support members thereby permitting adjacent ones of said radial support members to engage each other and collapse said feed mechanism in axial space less than the combined axial lengths of the axially extending pad members provided on said respective radial support members.

2. Collapsible feed mechanism according to claim 1, further including means for axially positioning said radial support members at spaced points along said longitudinally extending member upon the expansion of said feed mechanism.

3. Collapsible feed mechanism according to claim 2 wherein said axially positioning means comprises lost motion linkage.

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