HYDROSTATICALLY OPERATED EXTRUDING MACHINE

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ABSTRACT

In a hydrostatically operating extruding machine which has a billet container having a cylindrical hollow, a die removably inserted in one end thereof, a die support suitably installed for bearing the die, a hydrostatic pressure generator associated with the billet container having a cylindrical hollow and a ram slidably inserted from a remote end thereof, the improvement comprising connecting means coaxially and sealingly securing the end of the hollow of the billet container opposite the die and the end of the hollow of the generator opposite the ram and having a hollow, a mandrel coaxially secured to the connecting means and extending through the hollow of the billet container and fluidly communicating with both the pressure generator and the billet container.

7 Claims, 10 Drawing Figures
HYDROSTATICALLY OPERATED EXTRUding MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to a hydrostatic extruding machine, and more particularly to a hydrostatically operated extruding machine of simple construction which is adapted for repeatedly extruding a long tube.

2. Description of the Prior Art

There presently exists several conventional types of hydrostatically operated machines for extruding tubes and the like. One of these is the so-called movable mandrel type shown in FIG. 1A of the drawing which has a container 1 for a billet 2, a die 2, a mandrel 3 with a collar head 3' and a ram 4. Since the front end of the mandrel of this type of machine is in contact with atmospheric pressure, a pressure equal to the product of the sectional area of the mandrel times the pressure in the billet container acts on the rear end of the billet as an axial force. Accordingly, the billet 2 is unstably deformed by the collar head 3' of the mandrel 3, strongly depressing the billet from the left side of the billet in the drawing, so that if the billet is very long, it is not only recognized that the billet may tend to buckle, but even more unfavorable is the prospect that as the mandrel 3 advances forwardly, the mandrel itself will gradually project a long way through the die 2 with the result that the friction with the tube being extruded is increased and thereby tends to produce a tube of an irregular thickness.

A second of these types, being an alternative form of the first type is shown in FIG. 1B. It has a mandrel 3 fixed to the end of a ram 4, and when it extrudes a long tube, though the billet 2 is not unstably deformed, the mandrel 3 is strongly depressed through the die 2 and is pushed forwardly against the ever present strong resistance of the billet 2, while simultaneously it is being subjected to the strong compressive axial force of the ram 4 from the left side of the drawing, with the result that it tends to buckle or to be deformed.

A third form of these prior art types, the so-called stationary mandrel type shown in FIG. 1C, has a billet container 1, a die 2, a mandrel 3 with a collar head 3' provided thereon, a ram 4, a tubular liner or container 5 provided between the die 2 and the head 3', and a billet a disposed in the container 5, said collar head 3' including a plurality of holes 6 for passing pressurized fluid therethrough.

As the ram 4 moves forwardly, pressurized fluid passes through the holes 6 into the container 5 so as to extrude the billet 2 through the die 2 to form a tube. With this construction, in order to hold the container 5 in the billet container 1 for holding the billet 2 corresponding to the quantity of long tube to be extruded so as to extrude a long tube, not only must the effective inner diameter or length of the billet container 1 be enlarged, but the peripheral surface of the collar head 3' must engage strictly with the inner surface of the billet container 1 for a broad axial range in order to prevent axial error of the mandrel 3.

The fourth of the former well-known types of hydrostatic extruders is shown in FIG. 1D and has a mandrel 3 provided through a ram plunger 4. In order to move the ram 4 with respect to the mandrel 3 while the mandrel 3 is held continuously in a proper position at the base of the die 2, a number of liquid-tight seals and complicated structure must be provided.

In general hydrostatic extrusion of metal, a liquid of high compression rate is used as the pressure medium. For this reason, various disadvantages are raised. For instance, particular traces tend to form on the surface of extruded products due to the occurrence of stick-slip phenomenon on the basis of the change of a frictional resistance between the die and billet. In addition, when the billet is completely extruded out from the billet container, the driving pressure medium retained in the billet container strongly discharges instantaneously therefrom with the result that the machine itself is damaged or the pressure medium may be wasted. In order to prevent the aforementioned stick-slip phenomenon, means for preventing it are provided, such as, for example, increasing the extruding speed or the amount of lubrication. Also, in order to prevent such strong discharge of the pressure medium, various stoppers or dampers are provided at the end of the billet, but these preventing means have not been found to be completely successful in positively preventing discharge of the pressure medium upon completion of the extrusion of the billet.

SUMMARY OF THE INVENTION

This invention contemplates the elimination of the aforementioned disadvantages of conventional extruding machines of tubes and the provision of a novel and improved hydrostatic extruding machine.

It is an object, therefore, of the present invention to provide a hydrostatically operated extruding machine of simple construction which may repeatedly extrude a long tube.

It is another object of this invention to provide a hydrostatically operated extruding machine in which a billet may be readily inserted.

It is a further object of the invention to provide an improved hydrostatic extruding machine which may prevent any strong discharge of the pressure medium upon completion of extrusion of a billet.

According to one aspect of the present invention, there is provided a hydrostatically operated extruding machine which has a billet container having a cylindrical hollow and a die removably inserted into one end of the hollow, with a die support installed therein for bearing the die, and a hydrostatic pressure generator having a cylindrical hollow and a ram slidably inserted from one end of the hollow thereof, the improvement of the machine comprising connecting means coaxially secured sealingly at one end to the end of the billet container hollow opposite the die and at the other end to the end of the pressure generator hollow opposite the ram, and including a hollow, and a mandrel coaxially secured to the connecting means through the hollow of the billet container and communicating with both the pressure generator and the billet container.

According to another aspect of the invention, there is provided a hydrostatic extruding machine which comprises in addition to the components contained in the machine described above, throttle means comprising a member facing the end of the mandrel in the pressure generator hollow having a first hole of smaller diameter than that of the mandrel passage and one or
more second holes having a larger diameter than that of the mandrel passage, a packing member of ring shape provided so that the first hole of the member communicates only with the passage of the mandrel upon a sudden decrease of hydrostatic pressure in the billet container, and a spring disposed between the end of the connecting means and the member for urging the member.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIGS. 1A through 1D are longitudinal sectional side views of the various types of conventional hydrostatically operated extruding machines of tubes hereinbefore described;

FIG. 2 is a longitudinal sectional side view of one embodiment of a hydrostatic extruding machine of elongated tubing constructed according to the present invention;

FIG. 3 is a longitudinal sectional side view of another embodiment of the extruding machine of this invention;

FIG. 4 is a longitudinal sectional side view of a further embodiment of the extruding machine of this invention;

FIG. 5 is a partially enlarged sectional view of the main part of the extruding machine shown in FIG. 4;

FIG. 6 is a graph of the relationship between the pressure being applied to the billet and the stroke of the billet; and

FIG. 7 is a partially enlarged sectional view of still another embodiment of the extruding machine of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to FIG. 2, which shows one embodiment of a hydrostatic extruding machine according to this invention.

The extruding machine comprises a billet container 11 which includes a cylindrical hollow 12 formed axially therein, a die 13 removably inserted into one end of the hollow 12 of the billet container 11 for a billet a in a predetermined position for extruding the billet to form a tube, a die support 14 installed stably in a predetermined position for bearing the die 13, a hydrostatic pressure generator 15 which includes a cylindrical hollow 16 having a relatively large diameter and being axially aligned with the hollow 12 of container 11. A connector 17 disposed between the container 11 and generator 15 has one cylindrical end portion 18 sealingly inserted within the end of the cylindrical hollow 12 of the billet container 11 opposite the die 13 and an opposite cylindrical end portion 19 sealingly disposed within the adjacent end of the cylindrical hollow 16 of the pressure generator 15 through compression seals 20 and 21, respectively, and includes a cylindrical hollow or bore 22 coaxially formed therethrough which is flared conically outward as it approaches the generator side thereof. A mandrel 24 is removably and sealingly inserted with compression seals 25 through the hollow 22 of the connector 17 and coaxially through the hollow 12 of the billet container 11, respectively, and is provided with a hole or passage 23 formed in such a manner that the hole 23 opens at one end in the hollow 16 of the generator 15 and at the other end at the side of the mandrel 24 in the hollow 12 of the billet container 11, the forward end of the mandrel 24 facing the die 13 and projecting through the hollow 12 of the billet container 11, and a coil spring 26 disposed between the one end of the connector 17 in the billet container 11 and one end of the billet a for initially urging the billet a toward the die 13. This spring 26 is compressively inserted in advance within the hollow 12 of the billet container 11 over the mandrel 24 after the die support 14 and die 13 have been removed from the billet container 11, and thereafter the billet a is inserted over the mandrel 24 into the hollow 12, being brought into contact with the end of the spring 26 so that the latter may be compressed, whereupon they are stably supported by the die support 14 in their predetermined positions, respectively. A ram 27 is inserted into the other end of the hollow 16 of the pressure generator 15 for generating liquid or hydrostatic pressure to be transmitted through the holes 23 of the connector 17 onto the billet a so as to cause it to be extruded by a prime mover (not shown).

It should be understood from the foregoing description of the structure of the machine of this invention that since the inner diameter of the billet container may be formed smaller than that of the pressure generator and the length of the former may be longer than that of the generator, the stroke of the ram in the pressure generator is lessened so that a great deal of pressure medium may be fed into the billet container with the result that the machine may adopt long, thin billets for extruding long tubes.

Referring now to FIG. 3, which illustrates another embodiment of a hydrostatically operating extruding machine of this invention wherein like parts and components are designated by the same numerals as those shown in FIG. 2, there is shown a billet container 11 which includes a cylindrical hollow 12 formed axially therein, a die 13 removably inserted into one end of the hollow 12 of the billet container 11 for extruding a billet a positioned therein to form a tube, a die support 14 installed stably in a predetermined position outside container 11 for supporting the die 13, a hydrostatic pressure generator 15 which includes a cylindrical hollow 16 having a relatively large diameter and being axially aligned with the hollow 12 of container 11. A connector 17 disposed between the container 11 and generator 15 has one cylindrical end portion 18 sealingly inserted within the end of the cylindrical hollow 12 of the billet container 11 opposite the die 13 and an opposite cylindrical end portion 19 sealingly disposed within the adjacent end of the cylindrical hollow 16 of the pressure generator 15 through compression seals 20 and 21, respectively, and includes a cylindrical hollow or bore 22 coaxially formed therethrough which is flared conically outward as it approaches the generator side thereof. A mandrel 24 is removably and sealingly inserted with compression seals 25 through the hollow 22 of the connector 17 and coaxially through the hollow 12 of the billet container 11, respectively, and is provided with a hole or passage 23 formed in such a manner that the hole 23 opens at one end into the hollow 16 of the generator 15 and also opens at its other end from the side of the mandrel 24 into the hollow 12 of the billet container 11. The mandrel 24 is initially inserted into the hollows 22 and 12 of
the connector 17 and billet container 11, respectively, in such a manner that the forward end of the mandrel 24 projects within the hollow 12 of the billet container 11 and faces the die 13 inserted therein, and a coil spring 26 is disposed between the one end 18 of the connector 17 and one end of a billet a for initially urging the billet a toward the die 13. This spring 26 is compressively inserted in advance into the hollow 12 of the billet container 11 over the mandrel 24 after first removing the die support 14 and die 13 from the billet container 11, and thereafter the billet a is inserted over the mandrel 24 into the hollow 12, and the die 13 is then inserted into the hollow 12 in contact with the end of the billet a so that the spring 26 is compressed and they are stably maintained by the die support 14 in their respective predetermined positions. A ram 27 is inserted into the other end of the hollow 16 of the pressure generator 15 for generating liquid pressure to be transmitted through the hole 23 of the mandrel 24 onto the billet a so as to cause it to be extruded through operation of a prime mover, not shown.

One or more holes may be provided in the connector 17 in addition to the hole 23 of the mandrel 24 for passing pressurized fluid into the cylindrical hollow 12 of the billet container 11 for urging the billet.

It should be understood from the foregoing description that since the extruding machine of this invention may repeatedly hydrostatically extrude a billet so as to form a long tube while the mandrel thereof is held positively in a predetermined position because the connector coaxially connecting the billet container and the pressure generator serves also to positively hold the mandrel in a proper coaxial relation, the aforementioned disadvantages of conventional extruding machines may be eliminated and the billet may be easily inserted for every extrusion.

Referring now to FIGS. 4 and 5, another embodiment of the extruding machine of this invention is illustrated which features, in addition to the parts and components contained in the first embodiments, a throttle member in the form of a planar disc 29 being of a smaller diameter than the inner diameter of the cylindrical hollow 16 of the pressure generator 15 and disposed on the end of the mandrel 24 in the hollow 16 of the pressure generator, and including a passage or hole 30 of smaller diameter than the hole 23 of the mandrel 24 and being coaxially aligned with the hole 23 for throttling the passage of pressurized fluid from the pressure generator 15 into the billet container 11. There also is provided in the throttle member 29 a plurality of holes 31 formed in an annulus around the hole 30 and being of relatively larger diameter. The mandrel 24 has an outer annular groove 32 formed in the one end thereof facing the throttling disc 29 and an inner annular groove 34 formed on the same end thereof inside the radial extent of the plurality of holes 31 of the planar disc 29. A coil spring 33 is disposed in the outer annular groove 32 for urging the throttle member 29 therefrom in a normal operational state of the pressure generator 15 and a packing member of ring shape, such as an O-ring 35, is disposed in the inner groove 34 for sealing the passages 23 and 30 of the mandrel 24 and throttle member 29, respectively, when the face of the throttle member 29 is in contact therewith under the force of pressure within hollow 16 for throttling the passage of pressurized fluid through the mandrel into the billet container 11.

In a normal extruding operation of an extruding machine constructed in this fashion, the pressurized fluid generated by the pressure generator 15 is fed through the plurality of holes 30 and 31 and about the peripheral clearance between the periphery of the throttle member 29 and the inner surface of the cylindrical hollow 16 of the pressure generator 15, then through the passage 23 of the mandrel 24 into the billet container 11, the planar disc 29 being urged by the spring 33 so that it is separated from the face of the end of the mandrel 24. If the billet a in the container 11 is completely extruded out through the die 13, however, the extruding resistance is abruptly decreased, whereby the throttle member 29 is impinged upon the end surface of the mandrel 24 by the abrupt and instantaneous flow of pressurized fluid in the pressure generator 15 against the end surface thereof in opposition to the tension of the spring 33 so that the area inside the O-ring 35 between the throttle member 29 and the mandrel 24 is sealed by the O-ring 35 in contact therewith, with the result that while the pressurized fluid passes through the hole 30 of the disc 29, the larger portion of the pressurized fluid, or that previously passing through the holes 31 and the clearance between the periphery of the member 29 and the inner surface of the cylindrical hollow 16 of the pressure generator 15, is positively shut off from passing into the billet container by the O-ring 35.

Reference is now made to FIG. 6, which is a graph showing the relationship between the pressure P to be applied to the billet and the stroke S of the billet. In order to overcome the frictional resistances between the billet, the die and the mandrel immediately before the start of an extrusion by the machine, it is necessary to apply a higher pressure A than that indicated at B which is generally sufficient to conduct an extruding operation with the machine, as illustrated by a curve in the graph, and accordingly the mandrel has a tendency to be damaged at this time. Though the structure of the machine of this invention also is subject to such damage of the mandrel, the throttle member may prevent the mandrel from being taken out and also alleviates any possible danger owing to the instantaneous discharge of the pressure medium even if the mandrel is accidentally damaged.

It should be understood from the foregoing description that since this embodiment of the extruding machine of this invention comprises the throttle member for throttling or eliminating an abrupt and instantaneous discharge of pressurized fluid upon completion of extrusion of the billet from the billet container, it may simply and reliably prevent any high-rate or impact discharge of the pressurized fluid upon completion of the extrusion process of the billet.

In FIG. 7, there is shown a partially enlarged sectional view of still another embodiment of an extruding machine constructed according to this invention, wherein a coaxially positioned connector 17 sealingly secures the billet container 11 and the pressure generator 15 by inserting one cylindrical end portion 18 thereof into one end of the cylindrical hollow 12 of the billet container 11 and another cylindrical end portion 19 into the adjacent end of the cylindrical hollow of the
generator through the use of a packing member of ring shape, such as an O-ring, in the former and a compression seal in the latter. An axial hole or passage is formed through the connector and a partially threaded cylindrical recess is formed coaxially therein on the side adjacent the billet container. A conical seat is formed on the bottom of the recess and a mandrel is removably positioned in the recess with threads on the end thereof meshing with the threaded recess of the connector. The mandrel body sealingly engages the O-ring to close off the recess at the rear end of the mandrel and is provided with a through hole or passage formed in such a manner that the hole opens at one end at the front end of the hole of the connector so as to permit fluid communication therebetween and also opens at the other end on the side of the mandrel in the hollow of the billet container. The mandrel is readily screwed into the recess of the connector from the side of the billet container and includes a conical projection at one end for sealingly engaging the conical seat of the connector.

Obviously many modifications and variations of this invention are possible in light of the above teachings. It is to be understood, therefore, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a hydrostatically operated extruding machine characterized by a billet container having a cylindrical hollow, a die removably positioned in one end of said billet container hollow, a die support disposed at said one end of said billet container for bearing said die, a hydrostatic pressure generator independent of said billet container having a cylindrical hollow and a ram plunger slidably disposed in one end of said pressure generator hollow, the improvement comprising: connecting means disposed between said billet container and said pressure generator sealingly securing the same in coaxial relation, said connecting means having one end thereof secured within the end of the hollow of said billet container opposite said die and another end secured within the end of the hollow of said generator opposite said ram; and a mandrel coaxially secured to said connecting means through said billet container hollow being non-movable with respect to said die and having passage means therethrough fluidly communicating with both said pressure generator hollow and said billet container hollow.

2. In a hydrostatically operated extruding machine as set forth in claim 1, wherein said mandrel is removably secured to said connecting means in sealed relation therewith.

3. In a hydrostatically operating extruding machine as set forth in claim 1, the improvement further comprising: throttle means comprising a member disposed in the hollow of said generator; said member having a first hole of smaller diameter that of the fluid communicating passage of said mandrel and at least one other hole having a larger diameter than that of the fluid communicating passage of said mandrel; packing means for permitting communication of said first hole only of said throttle member with the passage of said mandrel responsive to sudden decrease of hydrostatic pressure within said billet container; and a spring disposed between said another end of said connecting means and said throttle member for normally urging said member toward said one end of said pressure generator.

4. The hydrostatically extruding machine set forth in claim 3, wherein said first hole of said throttle member is disposed at the center thereof; and said packing means is disposed intermediate said first hole and said at least one other hole.

5. The hydrostatically operated extruding machine set forth in claim 4, wherein said at least one other hole in said throttle member is a plurality of holes disposed in an annular array about said first hole; and said packing means is a ring-shaped member disposed between said first hole and said plurality of other holes.

6. The hydrostatically operated extruding machine set forth in claim 5, wherein said fluid communicating passage of said mandrel comprises a hole opening at one end into said pressure generator hollow and at its other end from the side of said mandrel into said billet container hollow.

7. The hydrostatically operated extruding machine as set forth in claim 3, wherein said connecting means comprises a passage coaxially formed therethrough, a partially threaded cylindrical recess formed coaxially in the end thereof secured within said billet container, and a conical seat formed in the bottom of said recess; and said mandrel comprises a threaded end portion for meshing with said threaded recess of said connector and a conical projection on said threaded end portion which upon being inserted into said recess of said connector engages said conical seat of said connector.