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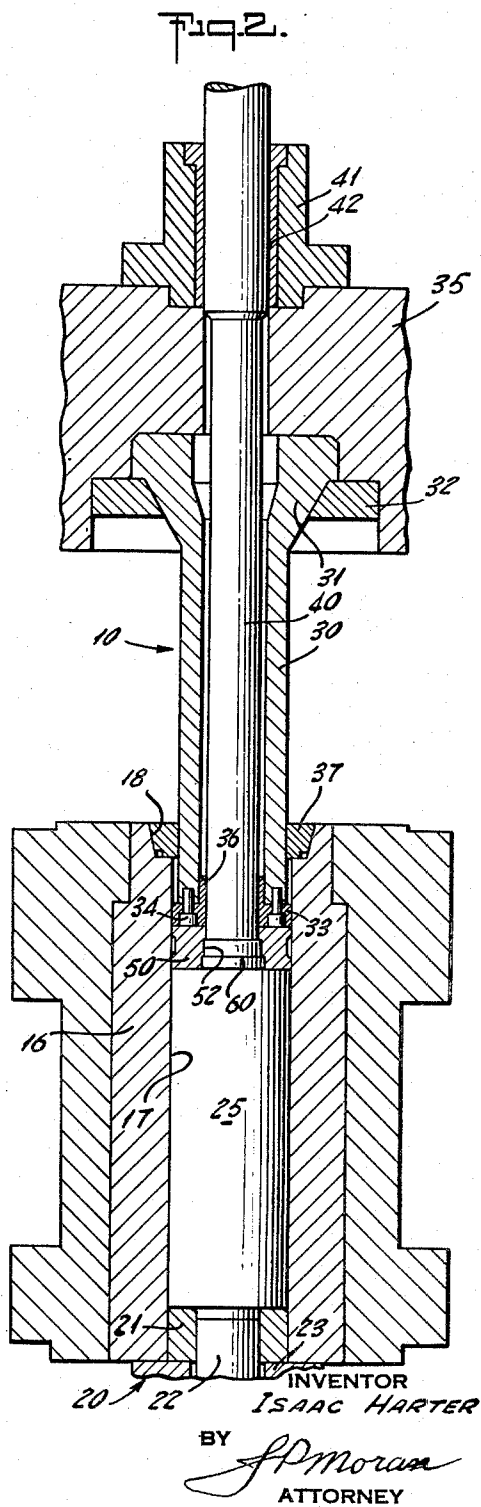
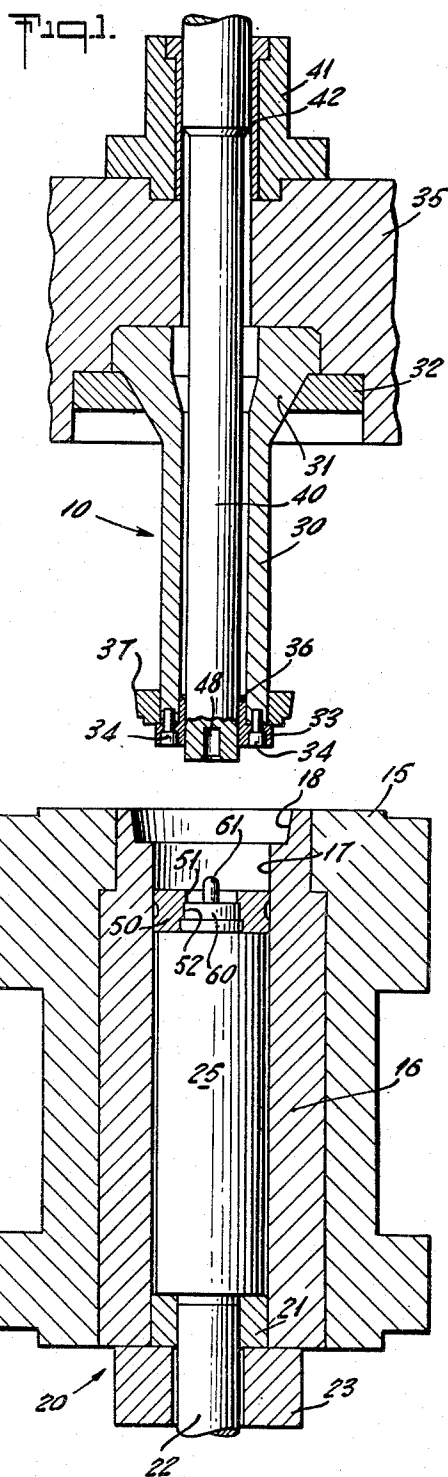
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MANDREL GUIDING ARRANGEMENT FOR BILLET PIERCING APPARATUS

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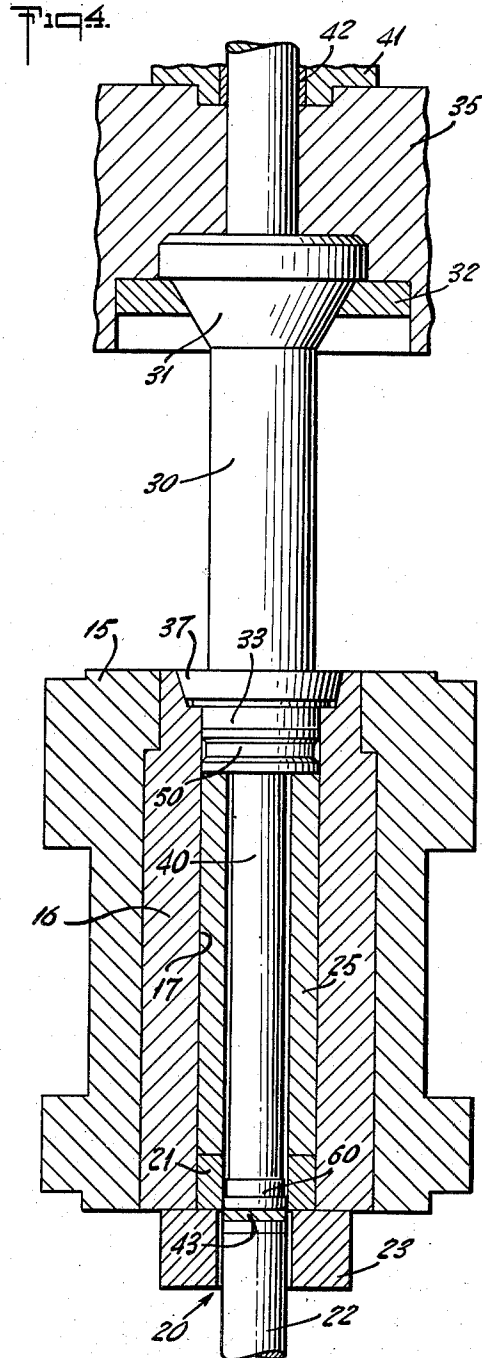
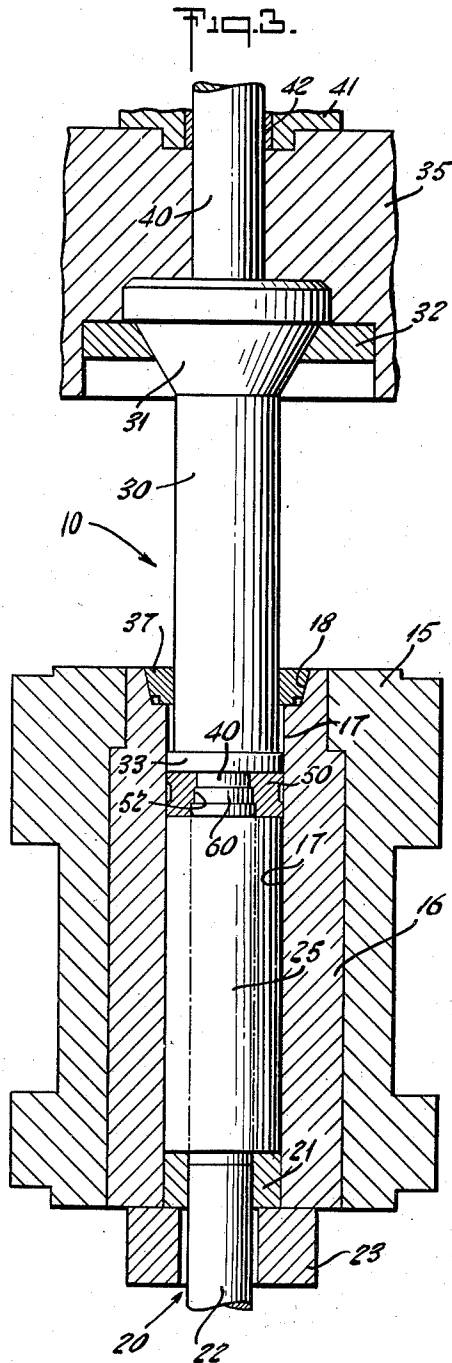
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2 Sheets-Sheet 2



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MANDREL GUIDING ARRANGEMENT FOR BILLET PIERCING APPARATUS

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2 Claims. (Cl. 78—9)

This invention relates to billet piercing apparatus and, more particularly, to an improved mandrel guiding arrangement for such piercing apparatus.

In the piercing of relatively elongated hot metal billets to form tubular members, one of the problems involved is that of maintaining the piercing mandrel accurately aligned with the desired center line of the resultant tubular member. If such alignment is not maintained throughout the piercing stroke of the mandrel, the tubing wall will not be of uniform thickness and the relative concentricity of the inner and outer surfaces of the tubing will not be within acceptable limits. In many applications, tubing having a substantial variation in its wall thickness cannot be used.

This problem of relative concentricity of the inner and outer surfaces of pierced tubular elements occurs relatively infrequently when the billet length to be pierced is relatively short or when the ratio of the pierced length to the diameter of the pierced hole is relatively small. In such cases, the ratio of the unsupported length of the piercing mandrel to the mandrel thickness is relatively small, so that the "slenderness ratio" of the mandrel is correspondingly small. This "slenderness ratio," which is a measure of the relative length and thickness of the mandrel, is the factor which exercises the most influence on the relative concentricity of the inner and outer surfaces of the pierced tubing.

If the slenderness ratio of the piercing mandrel is relatively high, as in the case of a relatively small diameter mandrel having a relatively long unsupported length, the mandrel, under the forces and stresses existent during the piercing stroke, may move substantially laterally or radially of the billet. Such forces and stresses may, under unusual circumstances, be sufficient to cause the mandrel to bend sufficiently to move in a curved path to the outer wall of the billet. It is therefore very important to reduce the free or unguided length of the piercing mandrel as much as possible.

In many piercing operations, the parameters of the press, or of the operating cycle, necessitate the unsupported and unguided mandrel length being substantially longer than the length of the pierced billet. Such a situation exists, for example, in piercing presses of the type in which the billet is pre-compressed to fill the container before the billet is pierced. A press of this type is generally vertically disposed and includes a vertically movable, relatively massive tubular ram coaxially reciprocable relative to the billet receiving passage of the container, and having an outer diameter equal to the passage diameter. The relatively small diameter billet piercing mandrel is coaxially telescoped through the ram and is projectable therefrom during the piercing stroke.

In the pre-compression stroke, the ram and mandrel are advanced as a unit, forming a solid cylindrical ram engaging the billet to compress the latter axially so that the hot metal is forced radially into firm contact with the cylindrical surface of the passage. The mandrel is then projected from the ram to pierce the billet. How-

ever, during such piercing stroke, the ram must rise with the upper end of the billet to allow upward flow of the billet metal as the piercing mandrel, moving downwardly through the billet, displaces the billet metal laterally. The displaced billet metal, being confined by back-up means on a back-up ram or mandrel at the bottom of the container passage, and by the side wall of the passage, can, of necessity, only flow upwardly.

The present invention is directed to novel means for providing guiding engagement for the mandrel at the top of the billet, so that the unsupported length of the mandrel is reduced to only that portion of the mandrel actually extending into or through the billet. As a specific example of the invention, such means may comprise a collar movably mounted on the billet and having a portion with an inner diameter equal to the mandrel diameter and a portion with an outer diameter equal to the diameter of the billet receiving passage of the container.

The piercing mandrel is preferably provided with a removable piercing point having a diameter slightly greater than that of the mandrel. This piercing point has a conforming fit within the mandrel guiding ring or collar. The piercing point and guiding ring, assembled as a unit, are placed in the container on top of the billet loaded therein before the container is moved into alignment with the ram and mandrel. As the ram and mandrel descend for the billet pre-compression stroke, an axial pin on the piercing point enters an axial aperture in the lower end of the mandrel, thereby centering the piercing point and guiding ring on the mandrel.

During the subsequent piercing stroke, the guiding ring, being movable on the piercing mandrel, rides up along the mandrel on top of the upwardly moving displaced billet metal. Due to its continual engagement with the mandrel and the container, the guiding ring provides continuous bracing for the mandrel, at the zone of the billet entry end, during the piercing stroke. Thereby, the unsupported length of the mandrel is reduced substantially, and is equal only to the length of the mandrel actually within the billet at any given moment. Consequently, the mandrel slenderness ratio is reduced, with marked improvement in the relative inner and outer concentricities of the pierced tubular member.

For an understanding of the invention principles, reference is made to the following description of a typical practical embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is an axial vertical sectional view of a portion of a piercing press having the invention mandrel guiding arrangement incorporated therein, showing the parts before the start of the pre-compression stroke;

Fig. 2 is a view similar to Fig. 1 illustrating the pre-compression stroke;

Fig. 3 is a view similar to Fig. 1 illustrating the start of the piercing stroke; and

Fig. 4 is a view similar to Fig. 1 illustrating the finish of the piercing stroke.

Referring to the drawings, a billet piercing press 10, of the billet pre-compression type, is illustrated as including a billet container 15 having a vertically disposed replaceable liner 16 therein formed with a cylindrical billet receiving passage 17. For a purpose to be described, the upper end of liner 16 is formed with an enlarged frustoconical recess 18. The lower end of billet passage 17 is closed by suitable back-up means generally indicated at 20. This back-up means may include a ring 21 movably disposed within the lower end of passage 17 and acting as a guiding means for a back-up mandrel 22. Ring 21 is supported on a member 23.

In practice, container 15 is mounted for lateral movement into and out of operative relation with the press

ram and mandrel for loading of a billet 25 thereinto and ejection of the pierced billet therefrom. When at the operative position, container 15 is axially aligned with a vertically movable ram 30 and a vertically movable piercing mandrel 40, the mandrel 40 being telescoped through ram 30 and having guiding engagement therein.

The ram 30 is a tubular member having an enlarged head 31 by means of which the ram is rigidly secured within the lower platen 35 of the press by means of a suitable clamping ring 32. This provides for ready interchangeability of rams to accommodate different diameter billets, the liner 16 of container 15 likewise being interchangeable for the same purpose. The lower end of ram 30 has a guiding collar 33 secured thereto by studs 34. This guiding collar has a tubular flange 36 projecting into ram 30 and acting as a guiding bushing for mandrel 40. The outer diameter of ring 33 is slightly greater than the outer diameter of ram 30 to serve as a retainer for a ram guiding ring 37 axially movable on ram 30. When ram 30 enters container passage 17, ring 37 has a conforming fit in enlarged recess 18 so that it forms a lateral brace for the ram, at the upper end of liner 16, during operation of ram 30 in passage 17.

Suitable means, not shown, such as one or more hydraulic actuators, are provided to force platen 35, and thus ram 30, downwardly relative to container 15. The upper end of platen 35 has a tubular guide 41 mounted thereon in which is a bushing 42 engaging a mandrel holder which supports mandrel 40, thus providing a second guide for the mandrel spaced axially from the guiding ring 33 at the lower end of ram 30. Other actuating means, preferably hydraulic, are provided for effecting movement of mandrel 40 relative to ram 30 and platen 35 during the piercing operation. As these means form no part of the present invention, they have not been illustrated. The lower end of mandrel 40 is provided with a short axial recess or passage 48 for a purpose to be described.

As previously explained, the first stroke of the press during a cycle is a pre-compression stroke to expand billet 25 to fill liner 16. The billet has a smaller diameter than the liner for ease in charging the billet into the container. Prior to charging the container, a suitable lubricant is applied either to the billet or to the container to facilitate movement of the hot metal during the pre-compression and piercing strokes. This lubricant may, for example, be a vitreous material such as a glass.

During the pre-compression stroke, the mandrel and ram are forced downwardly as a unit to form a solid cylindrical member engaging the upper end of the billet, and the billet is compressed and radially expanded to fill the container passage. During the piercing stroke, the ram 30 rides upwardly on top of the billet, which expands upwardly due to upward flow of metal around the mandrel 40 during the piercing stroke. The present invention provides novel means for providing lateral support for the mandrel at the upper end of billet 25 throughout the piercing stroke, thus reducing the unsupported length of the mandrel to that portion of the mandrel axially within billet 25.

Referring to Figs. 1 and 2, mandrel 40 is provided with a collar 50 movable axially therealong and having an inner diameter, at its upper end 51, fitting the mandrel closely, and an outer diameter fitting passage 17 closely. Due to the relative inner and outer diameters of guiding ring 50, mandrel 40 is thus braced laterally from the wall of passage 17 throughout the piercing stroke, and at a zone at the upper end of billet 25. To retain this ring 50 on mandrel 40, the mandrel is provided with a removable piercing point 60 provided with a stepped circumferential periphery having a conforming fit in the correspondingly stepped inner surface 52 of ring 50. Piercing point 60 is further provided with a pin 61 projecting axially from its upper end and conformingly engageable in recess 48 in the lower end of mandrel 40.

Referring more particularly to Fig. 1, after billet 25 is charged into container passage 17, ring 50 and piercing point 60, assembled as a unit, are positioned on top of the billet, preferably with the interposition of lubricant between the upper end of the billet and the unit. As ram 30 and mandrel 40 conjointly descend during the pre-compression stroke, pin 61 engages in recess 48 to center ring 50 and point 60 on the mandrel 40. The relative axial relation of parts is such that, as piercing point 60 has its upper surface engaged with the lower end of mandrel 40, the upper surface of ring 50 is engaged by the lower surface of ring 33 on ram 30, thus providing a flush lower surface for the press parts during the pre-compression stroke. As ram 30 and mandrel 40 enter the container passage, ram guiding ring 37 seats in recess 18, as best seen in Fig. 2. During downward movement of the ram and mandrel, ring 37 acts as a lateral brace for these parts during the pre-compression stroke which reduces the length of billet 25 and increases its diameter so that the billet is firmly engaged with the wall of passage 17.

At the finish of the pre-compression stroke, as illustrated in Fig. 3, mandrel guiding ring 50 remains on top of the compressed billet 25, having firm engagement with the outer surface of mandrel 40 and the surface of passage 17. As mandrel 40 is now forced downwardly through billet 25 to pierce the same, the displaced metal of the billet, flowing upwardly through passage 17 around mandrel 40 and its point 60, moves ring 50 upwardly, the ring always remaining engaged, by gravity, with the upper end of the metal or billet 25. Thus, during the piercing stroke, the mandrel 40 is always laterally braced at a zone adjacent the upper end of the billet 25. Consequently, the laterally unsupported length of the mandrel is only equal to the length of the mandrel axially extending in or through the billet. Thereby, the slenderness ratio of the mandrel 40 is maintained at the minimum possible value, with consequent notable increase in the relative concentricity of the inner and outer diameters of the pierced billet.

Fig. 4 illustrates the parts at the end of the piercing stroke. The metal of billet 25 has flown upwardly through passage 17. As piercing point 60 nears the lower end of the billet 25, back-up mandrel 22 is withdrawn downwardly so that the point 60 may force the "discard" 43 of billet 25 out of passage 17. At this time, point 60 is engaged in guiding ring 21 of back-up mandrel 22. The mandrel and ram are now withdrawn to the position of Fig. 1, leaving point 60 resting within ring 21 and ring 50 resting on top of the pierced billet 25. Ram 22 is further withdrawn to allow point 60 and the discard to fall out of the container into suitable means from which the point is recovered for reuse. The container 15 is moved out of the press and an ejecting ram forces the pierced billet 25 upwardly out of passage 17, carrying ring 50 with it. The ring 50 is recovered for cleaning and reuse.

It will thus be noted that the invention mandrel guiding arrangement provides rigid lateral bracing for the mandrel at the upper end of the billet during the entire piercing stroke, thus reducing the unsupported length of the mandrel by a substantial amount and to a value equal only to the length of billet 25.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Billet piercing apparatus comprising, in combination, a vertically disposed container having a cylindrical passage arranged to have a billet disposed therein of smaller diameter than the passage, said passage having an enlarged peripheral seat surrounding its upper end; a tubular ram axially aligned with said passage and ver-

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tically reciprocable axially relative thereto, the outer diameter of said ram being substantially equal to the diameter of said passage; mechanism operable to force said ram against the upper end of a hot billet disposed in said passage to pre-compress the billet to engage the passage surface; a cylindrical mandrel concentrically telescoped through said ram and projectable therefrom axially through said passage; said ram having guiding engagement with the portion of the mandrel disposed therethrough; mechanism operable to pierce said mandrel axially through a heated billet in said passage; said ram, during such piercing, riding upwardly on the upper end of the billet due to flow of displaced hot billet metal upwardly along said passage as the mandrel pierces the billet; a first annular collar slidably mounted on said ram and conformingly engageable in said seat to guide said ram during movement of the latter along said passage; means on the end of said ram retaining said annular collar on said ram; and mandrel guiding means comprising an annular collar movably mounted on said mandrel beyond said ram and having an inner diameter substantially equal to the mandrel diameter and an outer diameter substantially equal to the passage diameter; said collar engaging the upper end of the billet to guide the mandrel in its passage through the billet; said mandrel cooperating with said ram, during the pre-compression stroke, to provide a continuous surface engaging the upper end of the billet.

2. In combination with billet piercing apparatus of the type including a vertically disposed container having a cylindrical passage arranged to have a billet disposed therein of smaller diameter than the passage; said passage having an enlarged peripheral seat surrounding its upper end; a tubular ram axially aligned with said passage and vertically reciprocable axially relative thereto, the outer diameter of said ram being substantially equal to the diameter of said passage, mechanism operable to force said ram against the upper end of a hot billet disposed in said passage to pre-compress the billet to

engage the passage surface, and a cylindrical mandrel concentrically telescoped through said ram and projectable therefrom axially through said passage, said ram having guiding engagement with the portion of the mandrel disposed therethrough and said mandrel cooperating with said ram, during the pre-compression stroke, to provide a continuous surface engaging the upper end of the billet, mechanism operable to pierce said mandrel axially through a heated billet in said passage, said ram, during such piercing, riding upwardly on the upper end of the billet due to flow of displaced hot billet metal upwardly along said passage as the mandrel pierces the billet; a first annular collar slidably mounted on said ram and conformingly engageable in said seat to guide said ram during movement of the latter along said passage; means on the end of said ram retaining said annular collar on said ram; mandrel guiding means comprising an annular collar movably mounted on said mandrel beyond said ram and having an inner diameter substantially equal to the mandrel diameter and an outer diameter substantially equal to the passage diameter; said collar engaging the upper end of the billet to guide the mandrel in its passage through the billet.

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