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(71) Applicant: **Steel Casting Engineering, Ltd.**
**1434 West Taft Avenue**
**Orange California 92667 (US)**

(72) Inventor: **Ahrens, Max**
**4 Vista**
**Irvine California 92715 (US)**

**Haissig, Manfred**
**31 Roxhill**
**Irvine California 92714 (US)**

**Ahacic, Kozma**
**9 Ekallen**
**S-77300 Fagersta (SE)**

(74) Representative: **Jones, Michael Raymond et al**
**HASELTINE LAKE & CO. Hazlitt House 28 Southampton Buildings Chancery Lane**
**London WC2A 1AT (GB)**

## (54) Continuous casting billet shear.

(57) An improved billet shear for use in a horizontal continuous casting system comprises a pair of oppositely positioned hydraulic cylinders and a pair of inwardly facing shearing blades. The shearing blades are multi-faceted to produce simultaneous shearing of the casting and camming of the casting separations during the shearing process.

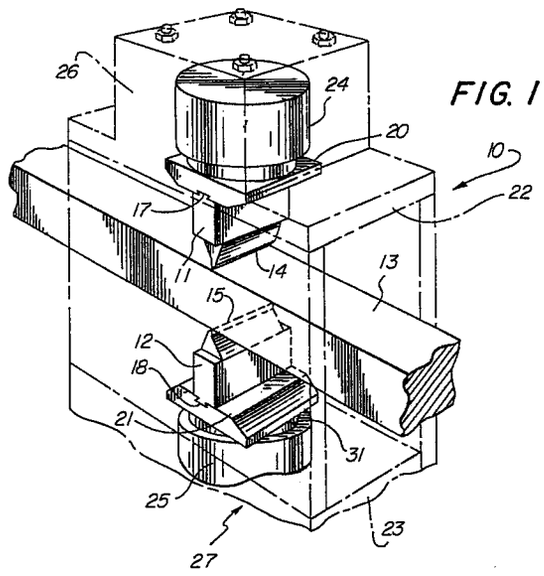


FIG. 1

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**Description**

# CONTINUOUS CASTING BILLET SHEAR

## Field of the Invention

This invention relates generally to continuous casting systems in which a single elongated casting is formed and particularly to horizontal continuous casting systems in which the elongated casting is periodically sheared into predetermined lengths during the continuous casting process.

## Background of the Invention

The continuous casting system provides a system of casting fabrication in which a supply of molten metal or molten alloy is heated and liquified within a furance-like structure called a tundish or heated outside the tundish and placed therein prior to casting. In most systems, the furnace includes a discharge orifice near the bottom of its internal cavity which is coupled by a throat to a cooled die or mold. The latter defines an elongated die passage suitable for the formation of an elongated casting which in turn defines an entrance opening and exit opening. In addition, cooling means are provided which generally circle or surround the die passage for the purpose of conducting sufficient heat from the molten metal within the die passage to solidify all or part of the molten metal therein to form a casting. In horizontal continuous casting systems, drive means are provided down stream of the mold and casting coolers which are operated upon the casting to periodically withdraw a portion of the casting from the die passage. This withdrawn portion is typically referred to as "casting stroke". The speed at which the casting is withdrawn from the cooled die is selected in accordance with the cooling capacity of the die and the characteristics of the casting. Because of the heat within the casting, the center of the casting remains molten or partially molten for a substantial length down the casting. At some point however, the entire casting becomes soldified and is moved by the casting drive mechanism along a succession of rollers generally referred to as the casting bed. Where the casting fabricated is a substantially thin casting, such as wire or small diametere rod, it may be desirable to wind the casting upon a large take-up roller at the end of the casting bed. However, where the casting formed is a rather large billet having sufficient diameter to make rolling of the casting prohibitive and undesirable, continuous casting systems generally provide a device as a billet shear which is operative upon the casting to periodically shear the casting into predetermined lengths thereby facilitating transportation and storage of the cast billet. The most commonly used billet shear comprises a pair of substantially flat hardened plates which are positioned one above and one below the casting at a selected point along the casting bed. Hydraulic means are operative upon the cutting plates to drive the cutting plates toward each other and into the casting. In most systems, the cutting plates are offset from each other and move in substantial alignment such that the billet cutting action occurs by virture of the inwardly facing corners of the cutting plates being driven through the casting.

While such billet shears having square cutting plates have been used with some success, they remain limited in the casting size which they can effectively shear. As a result, horizontal continuous casting systems forming large castings typically resort to the use of cutting torch mechanisms in places of the billet shear due to the prohibitive forces required by a billet shear for such castings.

There remains a need therefore in the art for an improved billet shear capable of effectively cutting large sized casting and configured to be used in a horizontal continuous casting environment.

## Summary of the Invention

Accordingly, it is a general object of the present invention to provide an improved horizontal continuous casting system. It is a more particular object of the present invention to provide an improved billet shear for use in a horizontal continuous casting system capable of shearing substantially larger diameter castings.

In accordance with the invention, there is provided a horizontal continuous casting billet shear having a pair of cutting blades and means situating the blades on opposite sides of a to-be-sheared casting billet. The blades each define an acute angled cutting edge having facets extending therefrom for a predetermined distance together with a pair of inclined camming surfaces joined to the cutting surfaces which function to provide cutting clearance for the shearing operation. Channel means are provided within the shearing blade supports for guiding the shearing blades and hydraulic means are operative upon the cutting blades to provide a shearing force.

## Brief Description of the Drawings

The features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings in the several figures of which like reference numerals identify like elements and in which:

Figure 1 is a simplified perspective view of an improved billet shear constructed in accordance with the present invention;

Figure 2 is a side view of an improved billet shear constructed in accordance with the present invention;

Figure 3 is a front view of an improved billet shear constructed in accordance with the present invention;

Figure 4 is a section view of the present invention billet shear taken along section lines 4-4 in Figure 3;

Figure 5 is a section view of the present invention billet shear taken along section lines

5-5 in Figure 4; and

Figures 6a and 6b are simplified illustrations of the shearing action of the present invention billet shear.

Description of the Preferred Embodiments

Figure 1 sets forth a perspective view of the shearing blades and hydraulic cylinder of the present invention billet shear together with a dashed line representation of the support mechanism. It should be understood that Figure 1 is a simplified pictorial view for use in obtaining a clear understanding of the basic operation of the present invention shear. It will be apparent to those skilled in the art, from examination of the remaining figures, that many structural details of the present invention billet shear have been omitted from Figure 1 for purposes of illustration. A pair of shearing blades 11 and 12 are positioned above and below a casting billet 13. Blade 11 defines a cutting edge 14 extending downwardly from the remainder of blade 11 while blade 12 defines an upwardly extending cutting edge 15. As will be apparent from examination of Figure 1 and the remaining figures, shearing blades 11 and 12 are substantially identical and are mirror images of each other in their orientation with respect to the vertical plane of blade motion described below in greater detail. An upper blade support 20 is attached to shearing blade 11 and defines a dove-tail union 17 which secures shearing blade 11 to blade support 20. An upper hydraulic cylinder 24 is positioned overlying blade support 20 and defines a conventional expansion-type hydraulic cylinder. Upper cylinder 24 further includes a piston 30 which couples hydraulic cylinder 24 to blade support 20. In accordance with conventional hydraulic press fabrication techniques, cylinder 24 includes the conventional means utilized in coverting a source of pressurized hydraulic fluid to an expandable cylinder. Similarly, balde support 21, having shearing blade 12 secured thereto by a dove-tail union 18, rests upon a similar hydraulic cylinder 25 having a similar construction to hydraulic cylinder 24 and defining a piston 31. In similar fashion to hydraulic cylinder 24, hydraulic cylinder 25 includes conventional hydraulically operable means for coverting a source of pressurized hydraulic fluid to an expandable hydraulic press function. Casting 13, which comprises the to-be-sheared horizontally continuously cast billet, extends between shearing blades 11 and 12.

In operation, when the appropriate point of elongated billet 13 is positioned underlying shearing blades 11 and 12, hydraulic means (not shown) pump hydraulic fluid into hydraulic cylinders 24 and 25 by means shown below in greater detail, causing shearing blade 11 to be driven downwardly against casting 13 and shearing blade 12 to be driven upwardly against the under side of casting 13.

With temporary reference to Figures 6a and 6b, the cutting action of shearing blades 11 and 12 may be discussed. Figure 6a shows the configuration of shearing blades 11 and 12 as the initial shearing action takes place and as shearing blades 11 and 12 are driven into casting or billet 13. Shearing blade 11 defines a cutting edge 14 and a inclined facet 33 extending upwardly therefrom at an acute angle. An additional facet 34 extends upwardly from facet 33 at a more inclined angle and as set forth below, provides a camming surface which aids the shearing action of the present invention billet shear. A vertical facet 35 extends upwardly from cutting edge 14 while an inclined facet 36 extends upwardly from facet 35 and forms a second camming surface for shearing blade 11.

Similarly, shearing blade 12 defines an inclined surface 40 extending from cutting edge 15 and a camming facet 41 extending from facet 40. The latter defines a camming surface similar to surface 34 of shearing blade 11. Shearing blade 12 further defines a vertical facet 42 extending downwardly from cutting edge 15 and a camming facet 43 which extends downwardly from vertical facet 42. As can be seen by examination of Figure 6a and as mentioned above, shearing blades 11 and 12 are substantially identical in structure and are oppositely oriented with respect to each other. As should also be noted from Figure 6a by means set forth below in greater detail, shearing blades 11 and 12 are positioned in a common vertical plane substantially orthoginal to billet 13 and aligned such that cutting edges 14 and 15 are positioned in parallel and generally aligned with each other in a common vertical plane. Furthermore, it should be noted that facets 35 and 42 are positioned in a common vertical plane corresponding to the plane of motion of shearing blades 11 and 12.

Figure 6b sets forth a illustration of the positions of shearing blades 11 and 12 as they appear at the conclusion of the shearing stroke of hydraulic cylinders 24 and 25. It should be noted that billet 13 is completely sheared at this point and defines a plurality of inclined surfaces 44, 45, 46 and 47. It should be further noted that surfaces 25 and 42 of shearing blades 11 and 12 respectively are in substantial contact and further that cutting edges 14 and 15 overlap each other insuring that billet 13 is completely severed by the shearing action. Inclined surfaces 44 through 47 are produced in billet 13 by the incline of surfaces 34 and 36 of blade 11 and surfaces 41 and 43 of blade 12. In accordance with an important aspect of the present invention, incline surfaces 34, 36, 41 and 43 of shearing blades 11 and 12 provide a camming action against billet 13 during the cutting process which in turn insures proper clearance of the material of billet 13 during the shearing process and facilitates the shearing operation of blades 11 and 12. In accordance with an important aspect of the present invention, the cutting edge 14 and 15 are more easily driven into casting 13 than the conventional square faced cutting plates utilized in prior art shears.

Figure 2 sets forth a side view of the present invention billet shear supported upon a casting bed 60 which, in accordance with coventional fabrication techniques, extends horizontally substantially in parallel with the path traveled by casting 13. Casting bed 60 further defines a rail 61 and a rail 59 (better seen in Figure 3). Billet shear 10 comprises a pair of oppositely positioned frame members 22 and 23

together with a channel frame 28 coupled therebetween. Channel frame 28 and upper frame 22 and lower frame 23 form a compact rigid structure which encircles casting bed 60 and rails 61 and 59 as well as casting 13. As set forth above, upper frame 22 supports a hydraulic cylinder 24 constructed in accordance with presently known conventional hydraulic cylinder techniques. A quartet of fasteners 50, 51, 52, and 53 are secured to frame 22 and extend upwardly therefrom and from an attachment to upper housing 26. Upper housing 26, fasteners 50 through 53 and upper frame 22 cooperate to captivate hydraulic cylinder 24 and secure it to channel frame 28. Similarly, lower frame 23 defines a quartet of fasteners 55 through 58 which extend downwardly therefrom and which are secured to lower housing 27. In further similarity, hydraulic cylinder 25 is captivated between lower frame 23 and lower housing 27 by fasteners 55 through 58. As a result, the present invention billet shear comprises, to the point thus far described, an extremely rigid structure having a pair of oppositely posed upper and lower hydraulic cylinders. In accordance with an important aspect of the present invention, channel frame 28 defines a channel 70 therein which receives the end portions of shearing blades 11 and 12 and which provides a channel guide for the motion thereof in the vertical plane. Correspondingly, a second blade channel 72 (better seen in Figure 4) which corresponds in position and structure to channel 70, receives the other end of shearing blades 11 and 12. Channels 70 and 72 cooperate to restrict shearing blades 11 and 12 to vertical motion in a single plane under the forces imparted by hydraulic cylinders 24 and 25. Simply stated, channels 70 and 72 insure that shearing blades 11 and 12 operate in a common vertical plane and provide the relative motions depicted in Figures 6a and 6b described above during the present invention shearing process.

Billet shear 10 further includes a wheel support 63 on one side of channel frame 28 and a wheel support 73 (better seen in Figure 3) on the other side of channel frame 28. A pair of conventional axels 68 and 69 extend outwardly from channel frame 28 on one side and pass through wheel support 63 while a similar set of axels 71 and 74 extend outwardly from the other side of channel frame 28 and are secured to wheel support 73. A quartet of rolling wheels 64 through 67 are supported up axels 68, 69, 71 and 74 and are aligned with and ride upon rails 61 and 59 of casting bed 60. As a result, billet shear 10 is rollingly supported upon rails 61 and 59 and is moveable with respect thereto in accordance with an important aspect of the present invention.

With reference again to Figure 6a, it should be noted taht upon the initiation of the shearing operation produced by expansion of hydraulic cylinders 24 and 25, shearing blades 11 and 12 extend into and begin to pierce or sever billet 13. As will be apparent to those skilled in the art, once shearing blades 11 and 12 begin severing beillet 13 they are captivated by the material of billet 13 which, because of the above-described motion thereof, imparts a latteral force to shearing blades 11 and 12. Accordingly, billet shear 10, being entirely supported upon rails 61 and 59 of casting bed 60 begins moving in the direction of travel of billet 13 as cylinders 24 and 25 continue to drive shearing blades 11 and 12 through casting 13. The inward motion of shearing continues as the extension of hydraulic cylinder 24 and 25 drives shearing blades 11 and 12 deeper into billet 13. During the time shearing blades 11 and 12 are in the process of cutting through billet 13, billet shear 10 moves downward (to the right in Figure 2) along the directio of travel of billet 13 until the completion of the shearing operation ash shown in Figure 6b. Thereupon, blades 11 and 12 are withdrawn to the retracted position shown in Figure 2 and casting 13 continues traveling through the passage within billet shear 10. In addition, means are provided for returning billet shear 10 to the initial position (to the left in Figure 2) where billet shear 10 awaits the next initiation of a shearing operation.

Figure 4 sets forth a section view of the present invention billet shear taken along section lines 4-4 in Figure 3. As can be seen, hydraulic cylinders 24 and 25 are supported respectively above and below casting 13. Hydraulic cylinder 24 defines a piston 30 which is coupled to a blade support 20 while hydraulic cylinder 25 includes a piston 31 coupled to blade support 21. Blades 11 and 12 are shown positioned in their retracted position within channel 72. Casting 13 extends through billet shear 10 and is supported therein by a pair of cooled guides 80 and 81 below and above casting 13 respectively. Cooled guide 80 defines a transverse bearing surface 82 at the downstream side of billet shear 10 while cooled guide 81 defines a transverse bearing surface 83 at the upstream side of billet shear 10. In accordance with an important aspect of the present invention, bearing surfaces 82 and 83 support casting 13 during the shearing operation and assist in compensating for the twisting forces imparted to billet 13 by the shearing operation.

Figure 5 sets forth a section view of the present invention billet shear taken along section lines 5-5 in Figure 4. In accordance with an important aspect of the invention, blade channel 70 comprises a pair of trapezoidal wedge blocks 90 and 91 secured to channel frame 28 by a pair of conventional fasteners 94 and 95 respectively. Similarly, channel 72 comprises a pair of trapezoidal cross-section blocks 92 and 93 secured to channel frame 28 by a pair of conventional fasteners 96 and 97 respectively. In accordance with an important aspect of the present invention, wedge shaped blocks 90 through 93 are moveable with respect to channel frame 28 to provide adjustment of the channel thus formed which guides shearing blades 11 and 12.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

## Claims

1. For use in a horizontal continuous casting process in which an elongated billet is continuously formed and caused to be moved along an extended casting bed, an improved billet shear comprising;
a housing having means supporting said housing in proximity to said billet at a predetermined point along the travel path of the billet;
first and second hydraulic cylinders supported within said housing above and below said billet;
a pair of shearing blades attached to such hydraulic cylinders having respective cutting edges positioned above and below said billet;
said cutting blades defining a multi-faceted cross-section having a pair of oppositely positioned camming surfaces extending outwardly from said cutting edge; and
means operative upon said hydraulic cylinders to cause said cylinders to drive said shearing blades through said billet and produce shearing thereof.

FIG. 1

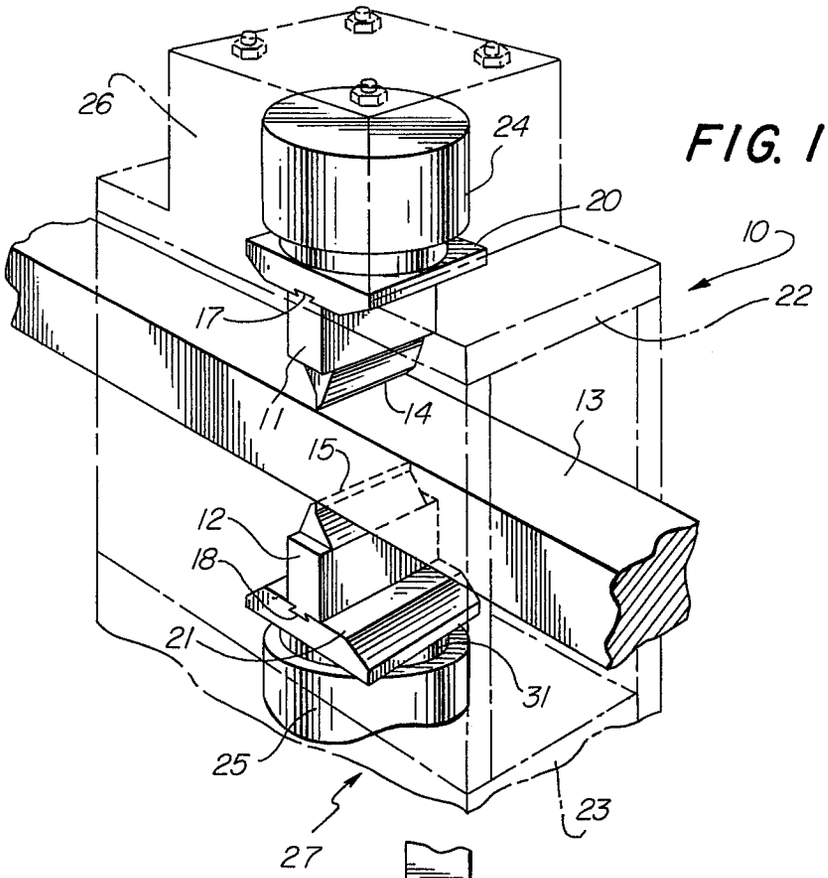


FIG. 6A

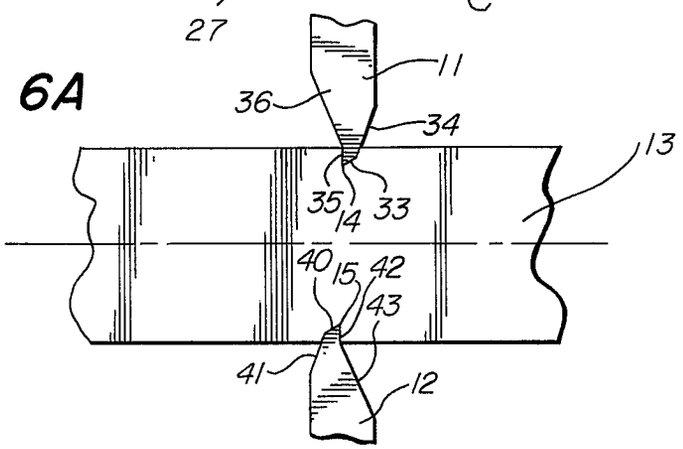


FIG. 6B

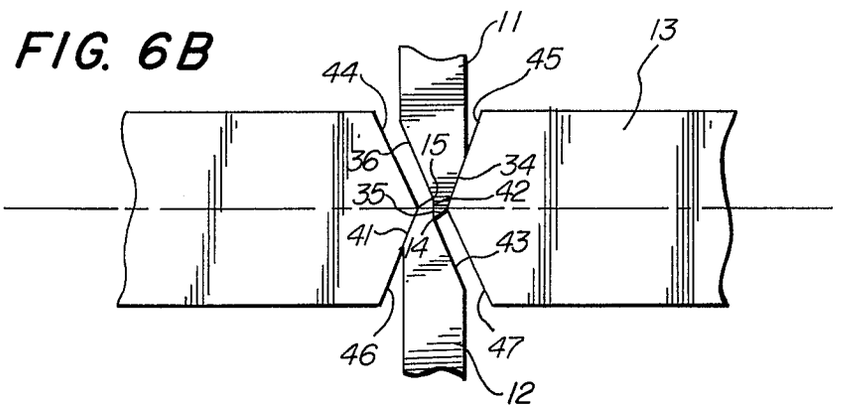

FIG. 3

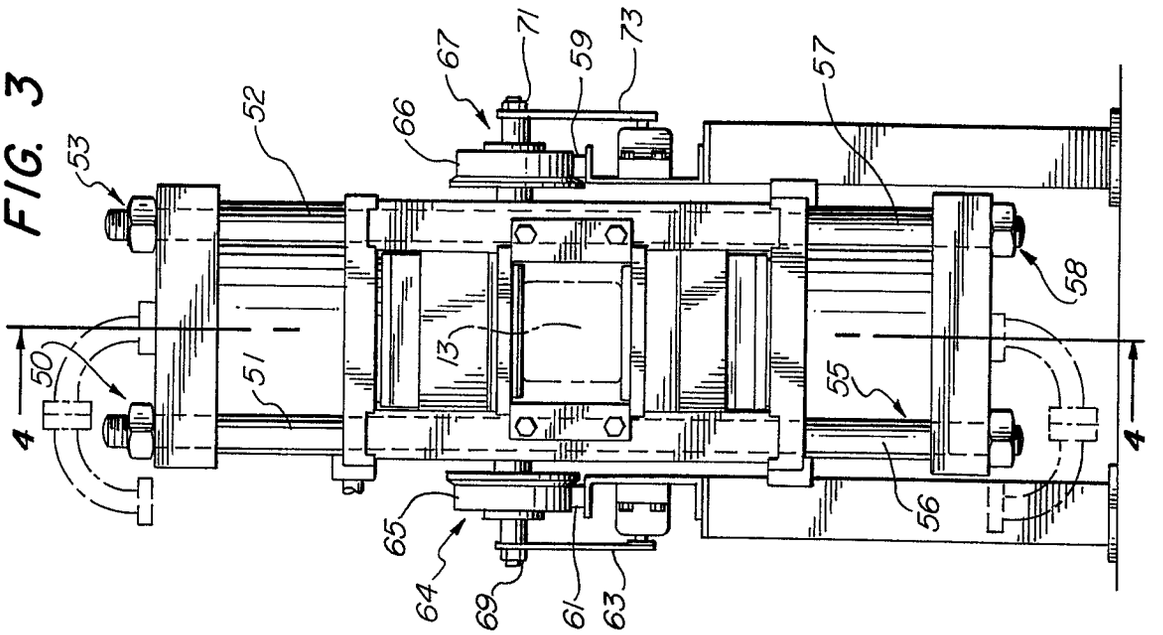
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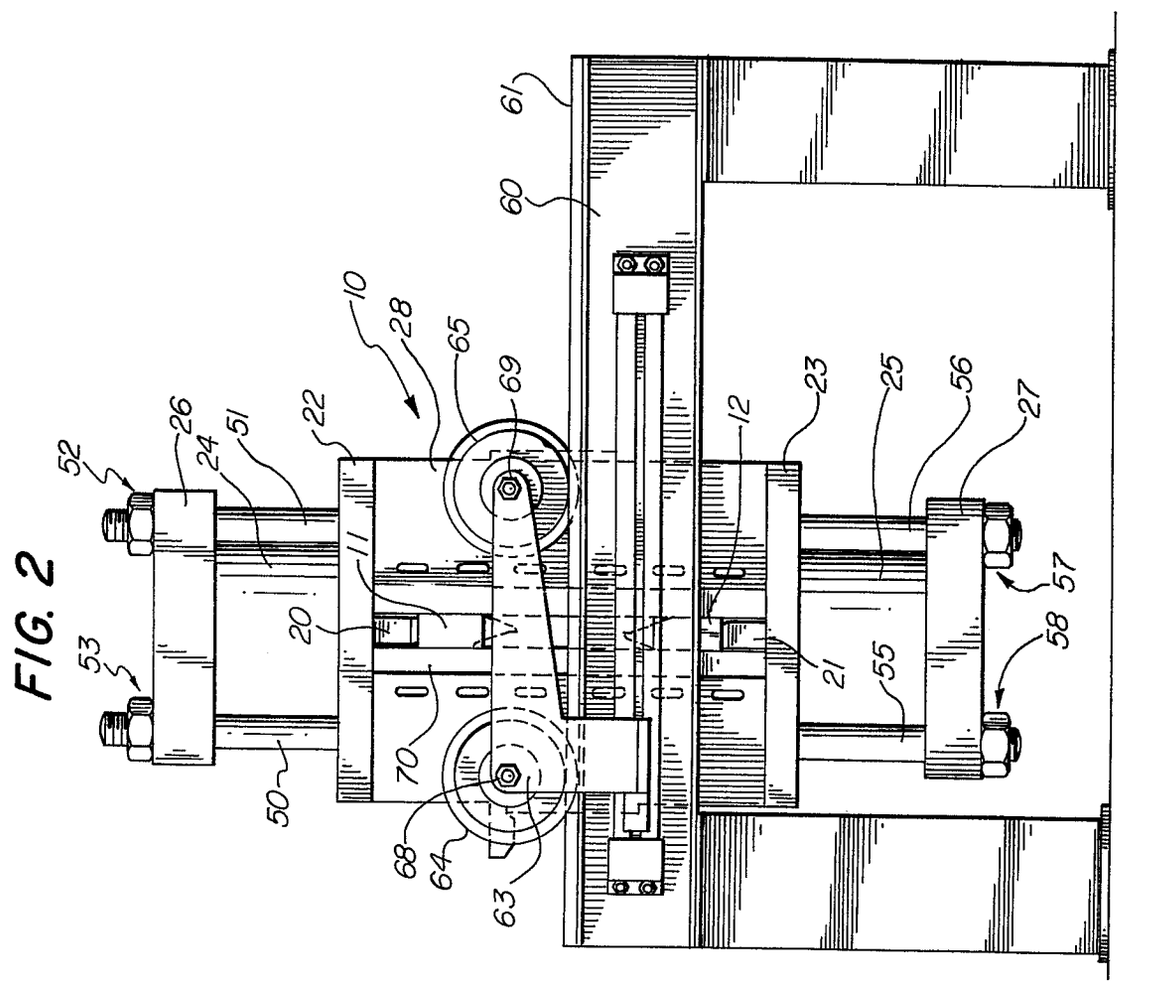
FIG. 2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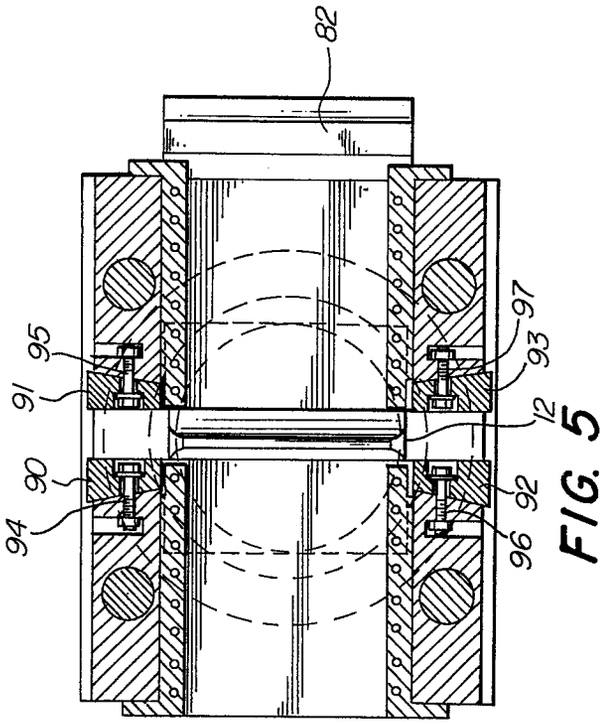
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FIG. 5

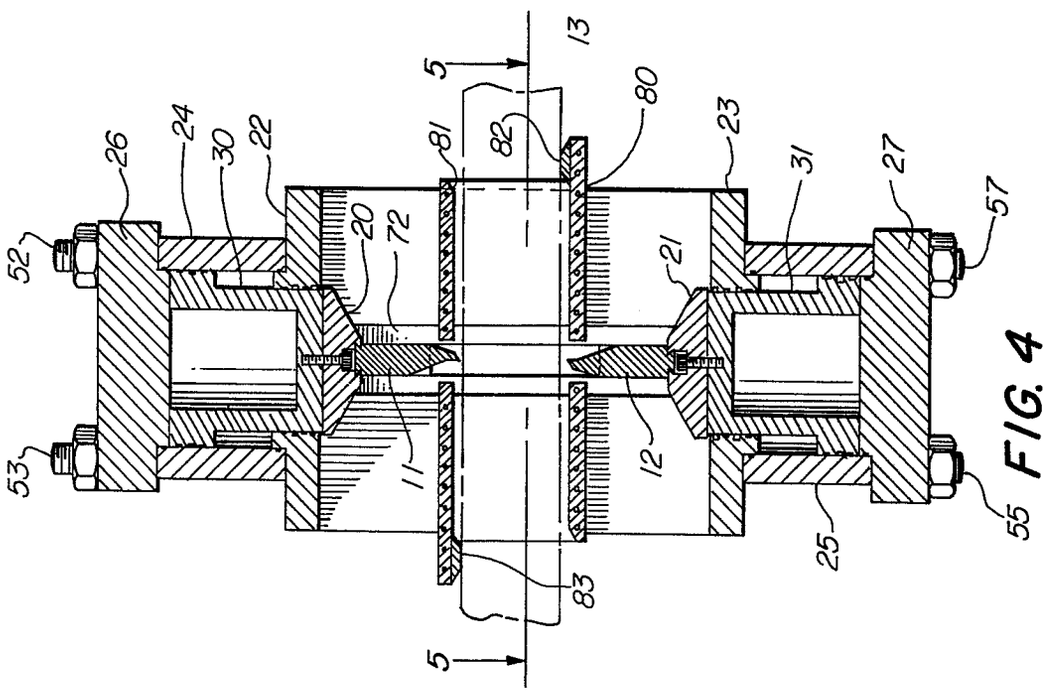
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FIG. 4