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(71) Applicant: **MORGAN CONSTRUCTION COMPANY**
**Worcester Massachusetts 01605 (US)**

(72) Inventors:
- **Shore, Terence Michael**
  **Princetown, MA 01541 (US)**
- **Puchovsky, Melicher**
  **Dudley, MA 01571 (US)**

(74) Representative: **Barnard, Eric Edward**
**BROOKES & MARTIN**
**High Holborn House**
**52/54 High Holborn**
**London WC1V 6SE (GB)**

## (54) Rolling mill slitting apparatus

(57) An apparatus is disclosed for subdividing an elongated product (P) moving axially along a pass line (L). The apparatus comprises at least one pair of rotatably driven slitting discs (38,40) arranged in a coplanar relationship on opposite sides of the pass line (L), with their rotational axes (A) being offset one from the other in the direction of product movement.

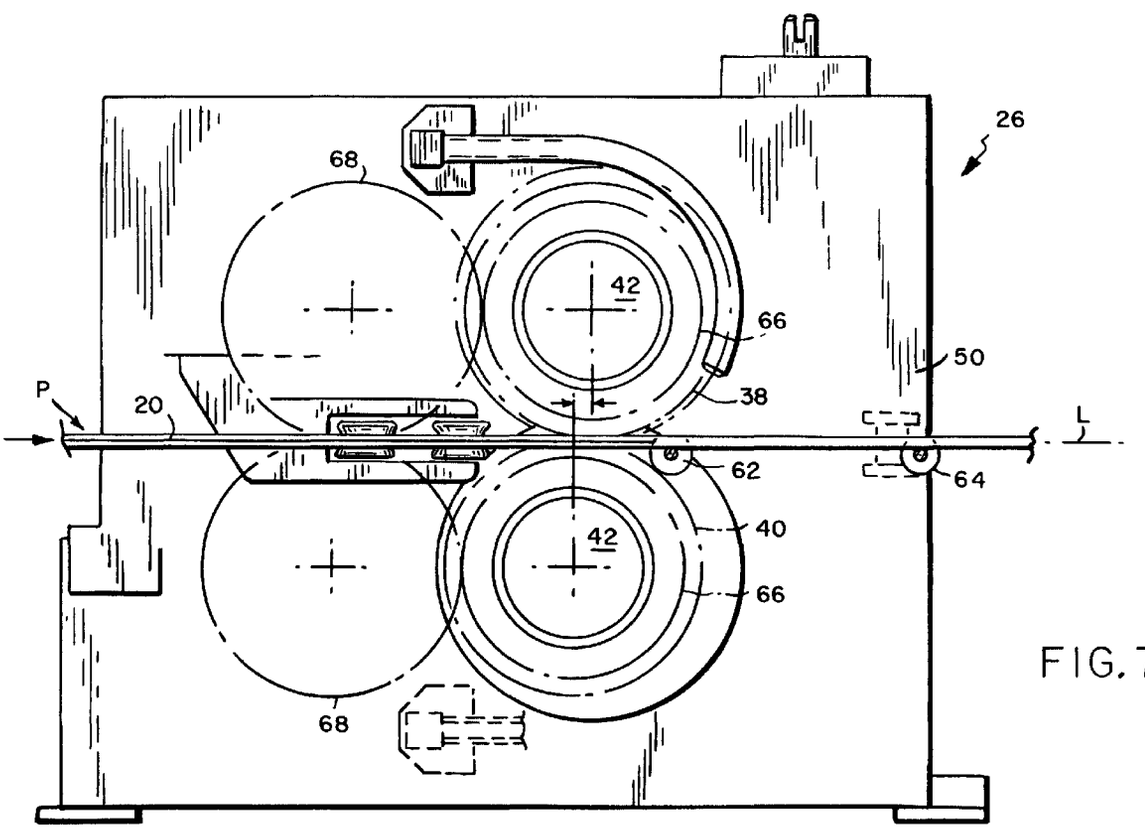


FIG. 7

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## Description

This invention relates generally to rolling mills producing elongated products such as bars, rods and the like, and is concerned in particular with an improved apparatus for longitudinally subdividing a relatively large intermediate, elongated product moving axially along a pass line into multiple smaller strands which are then directed to parallel continuing pass lines for further rolling into finished products.

In a typical conventional slitting operation, as depicted somewhat diagrammatically in Figures 1 to 5, a pair of rotatably driven slitting discs 10a, 10b are arranged on opposite sides of a pass line L. As shown in Figure 2, the periphery of each slitting disc is defined by angled shoulders 12 tapering to a sharpened edge 14. A product P is directed along the pass line between the slitting discs. Prior to its arrival at the slitting discs, and as shown in Figure 3, the product has a shaped cross section comprised of at least two segments 16, 18 joined one to the other by an intermediate web 20 of reduced thickness. Typically, when producing concrete reinforcing bars, the segments 16, 18 will have a somewhat oval cross-section with major and minor dimensions $D_1$, $D_2$ respectively.

Conventional thinking has heretofore dictated that the edges 14 of the slitting discs 16, 18 be spaced one from the other to provide a gap 22 (enlarged for ease of illustration in Figure 1), which prevents damaging contact of one disc with the other. Paradoxically, however, the gap 22 also prevents the discs from cutting cleanly through the web 20 joining the two product segments 16,18. Instead, the discs only partially penetrate the web 20. As depicted diagrammatically by the arrows in Figure 4, the angled shoulders 12 at the disc peripheries are designed to push the product segments apart, which in turn tears any unsevered portion of the connecting web. Thus, as shown in Figure 5, each separated strand 16', 18' exiting from between the slitting discs has a somewhat jagged surface imperfection 24. Such imperfections adversely affect the overall quality of the finished product.

Also, the need to laterally pull the segments apart limits the number of strands that can be created to not more than two during each slitting operation.

An objective of the present invention is to arrange the slitting discs so that they may effect a clean cut through the webs connecting product segments, thus eliminating the need to tear the webs apart. This in turn eliminates or at least significantly reduces any jagged surface imperfections on the separated strands.

A related objective of the present invention is to achieve the aforesaid optimized arrangement of the slitting discs without bringing the discs into damaging contact with each other.

A companion objective of the present invention is the provision of means for adjusting the relative positions of the slitting discs, thereby making it possible to compensate for disc wear without compromising product quality.

Another objective of the present invention is the provision of multiple pairs of slitting discs arranged to subdivided products into three or more strands.

The above objectives are achieved in accordance with the invention which in a broad aspect comprises apparatus for longitudinally sub-dividing an elongated product into two or more strands, the apparatus comprising at least two rotatable slitting discs arranged in substantially the same plane on opposite sides of a pass line, the rotational axes of the discs being offset one from the other in the direction of movement of the elongated product along the pass line.

In accordance with a preferred embodiment of the present invention, circular slitting discs are rotatably mounted in coplanar pairs on opposite sides of a pass line. A relatively large shaped intermediate product section is directed along the pass line. The intermediate product section has at least two segments joined by an intermediate web, and the peripheries of the slitting discs are arranged to penetrate that web from opposite sides of the pass line. The rotational axes of the slitting discs are offset one from the other in the direction of product movement along the pass line, thereby allowing for increased penetration of the disc peripheries into the product web, and without one disc periphery coming into damaging contact with the other disc periphery. The slitting discs are rotatably driven in opposite directions urging the product along the pass line while effecting a smooth cut of the connecting web as the product segments are separated into smaller strands.

Preferably, the slitting disc peripheries are tangent to a common line, and that common line is preferably the pass line along which the product is being directed.

Advantageously, multiple pairs of slitting discs are arranged to simultaneously subdivide a product into three or more strands.

The rotational axes of the slitting discs are preferably adjustable to accommodate disc wear without compromising the quality of the separated strands.

These and other objects, features and advantages of the present invention will be described in greater detail with reference to the accompanying drawings, wherein:

Figure 1 is a diagrammatic illustration of a typical prior art slitting apparatus;

Figures 2, 3, 4 and 5 are enlarged sectional views taken respectively along lines 2-2, 3-3, 4-4 and 5-5 of Figure 1;

Figure 6 is a top view, partially sectioned, of a slitting apparatus in accordance with the present invention;

Figure 7 is a sectional view taken along line 7-7 of Figure 6;

Figure 8 is an enlarged diagrammatic illustration depicting the offset relationship of the slitting discs;

Figure 9 is a sectional view taken along 9-9 of Fig-

ure 6;

Figure 10 is an end view looking from right to left in Figure 6;

Figure 11 is an enlarged sectional view taken along line 11-11 of Figure 6;

Figure 12 is an enlarged plan view of the cutting discs, with portions broken away to show the underlying separating discs; and

Figure 13 is an enlarged sectional view taken along line 13-13 of Figure 12.

With further reference to Figures 6-13, a slitting apparatus in accordance with the present invention is generally depicted at 26. The apparatus is designed to longitudinally subdivide an elongated product P moving axially along a pass line $L^2$.

As can be best seen in Figure 11, the product P has been configured by previous rolling operations (not shown) into a plurality of segments 28, 30, 32 and 34 joined one to the other by relatively thin intermediate webs 36.

A plurality of pairs of slitting discs 38,40 are carried on parallel support shafts 42 arranged on opposite sides of the pass line L. The support shafts are journalled by roller and thrust bearing assemblies 44, 46 for rotation in eccentric sleeves 48, the latter in turn being journalled for rotation in a suitable housing structure generally depicted at 50. As shown in Figure 8, the rotational axes A of the support shafts 42 are offset one from the other by a distance "X" measured in the direction of product movement along the pass line L. Typically new slitting discs 38 will have diameters ranging from about 150 to 200 mm, and the offset distance X will typically be in the range of about 10 to 30 mm. Preferably, the offset distance X will be less than about 5 % of the maximum diameter of the slitting discs.

The slitting discs 38, 40 of each pair are arranged in a coplanar relationship. The offset distance X enables the peripheries 38', 40' of the slitting discs to be brought closer together with respect to the webs 36 without one coming into damaging contact with the other. In the preferred embodiment herein illustrated, the peripheries 38', 40' are each tangent to but at different locations along a common line which advantageously is the pass line L.

By arranging the slitting discs in the above described offset relationship, each disc periphery 38', 40' can penetrate a web 36 to a greater extent, thereby achieving a clean cut without having to pull the interconnected segments apart in order to tear any unsevered web portions. More particularly, and as can best be seen in Figure 13, a web 36 will be partially cut as at 52 by the lower slitting disc periphery 40' at one location, and the remaining web will be cut as at 54 at a second location by the upper disc periphery 38'. This is advantageous from several respects. The resulting clean cut avoids or at least substantially minimizes any resulting jagged surface imperfections. Also, since the slitting operation of the present invention does not rely on lateral separation of the product segments, three or more segments can be simultaneously slit by multiple pairs of slitting discs during a single slitting operation. One cut will not interfere with the next adjacent cut because none of the cuts requires lateral segment separation.

As can best be seen in Figure 9, the eccentric sleeves 48 are preferably provided with toothed segments 56 which mesh with opposite hand pinion gears 58 carried on a common vertically disposed adjustment shaft 60. Rotation of shaft 60 will cause simultaneous rotation of the eccentric sleeves 48 in opposite directions, which in turn will adjust the positions of the support shafts 42 and their respective slitting discs 38 with respect to the pass line L. Such adjustments accommodate changes in the slitting disc diameters as they are periodically reground to compensate for wear.

As can be best seen by a combined reference to Figures 6, 7 and 12, the outboard pairs of slitting discs 38,40 are followed by separating discs 62 designed to deflect the severed outboard strands 28', 34' laterally outwardly to guide assemblies (not shown) which redirect the strands to parallel paths. The center pair of slitting discs 38,40 is likewise followed by a separating disc 64 which laterally spreads the two separated center strands 30', 32' for redirection along parallel paths.

The support shafts 42 carry gears 66 which are separate from each other, each gear 66 being in meshed relationship with a gear 68 on a gear shaft 70. The gear shafts 70 are parallel to the support shafts 42, and the gears 68 are intermeshed. One gear shaft 70 is driven by an external drive (not shown). This arrangement drives the support shafts 42 and the slitting discs 38, 40 carried thereon in opposite directions indicated schematically by the arrows in Figure 13, thus serving to pull the product P through the slitting apparatus.

In light of the foregoing, it will now be understood by those skilled in the art that various changes and modifications can be made to the embodiment herein disclosed without departing from the spirit and scope of the invention. For example, the number of pairs of slitting discs can be varied to accommodate a wide range of product configurations and resulting numbers of severed strands. The manner in which the parting between the support shafts is adjusted can be changed, for example by shifting only one shaft while allowing the other to remain stationary. In some cases, it may be advantageous to have the slitting disc peripheries overlap a common reference line.

## Claims

1. Apparatus for longitudinally subdividing an elongated product (P) moving axially along a pass line $L_2$, said product having at least two segments (28,30 etc.) laterally spaced one from the other and integrally joined by an intermediate web (36) of reduced

thickness, said apparatus comprising:

at least two slitting discs (38,40) rotatably mounted in a substantially coplanar relationship, the periphery (38',40') of said slitting discs being arranged to protrude between said segments and to penetrate said web from opposite sides of said pass line, the rotational axes of said slitting discs being offset one from the other in the direction of movement of said product along said pass line to provide a corresponding offset of the maximum penetration of the disc peripheries into said web; and
means for rotatably driving said slitting discs in opposite directions to urge said product along said pass line while effecting a subdivision thereof into smaller strands.

**2.** Apparatus as claimed in claim 1 wherein the peripheries (38',40') of said slitting discs are tangent to a common line.

**3.** Apparatus as claimed in claim 1 wherein the peripheries (38',40') of said slitting discs are tangent to said pass line.

**4.** Apparatus as claimed in any one of the preceding claims wherein a plurality of pairs of slitting discs (38,40) are arranged laterally of the pass line to effect multiple longitudinal subdivisions of said product.

**5.** Apparatus as claimed in any one of the preceding claims further comprising separating means (62,64) arranged along said pass line downstream of and in substantial alignment with said slitting discs for laterally separating said strands.

**6.** Apparatus as claimed in any one of the preceding claims further comprising means (48,60) for adjusting the distance between the rotational axes of the slitting discs.

**7.** Apparatus as claimed in claim 6 wherein said slitting discs are carried on support shafts (42) extending orthogonally with respect to said pass line, and wherein said means for rotatably driving said slitting discs comprises gears (66) on said support shafts in meshed relationship with intermeshed gears (68) carried on gear shafts (70) parallel to said support shafts.

**8.** Apparatus as claimed in claim 7 wherein said support shafts are journalled for rotation in eccentric sleeves (48) with means (60) for rotating said eccentric sleeves in order to adjust the spacing between said support shafts.

**9.** Apparatus as claimed in any one of the preceding claims wherein amount (X) of said offset is less than about 5% of the diameter of the slitting discs.

**10.** Apparatus as claimed in any one of the preceding claims wherein said slitting discs are arranged, ignoring said offset, essentially one above the other, and wherein the rotational axis of the upper disc (38) is arranged downstream from the rotational axis of the lower disc (40).

**11.** A method of sub-dividing an elongated, rolled product into two or more longitudinally sub-divided strands, said rolled product having at least two segments laterally spaced from one another and integrally joined by an intermediate web of reduced thickness, said method comprising feeding said rolled product axially along a pass line between substantially coplanar, rotatable slitting discs whose rotational axes are offset from one another in the direction of movement of the rolled product along the pass line, whereby the slitting discs together substantially penetrate said intermediate web without the peripheries of the discs contacting each other.

**12.** A method as claimed in claim 11 wherein the slitting discs positioned on opposite sides of the pass line are driven in opposite directions so as to urge the rolled product along the pass line, while effecting sub-division of the product into said strands.

**13.** A method as claimed in claim 11 or 12 wherein the rolled product is separated into individual strands by separating means located downstream from said slitting discs and arranged to exert a separating force between said strands.

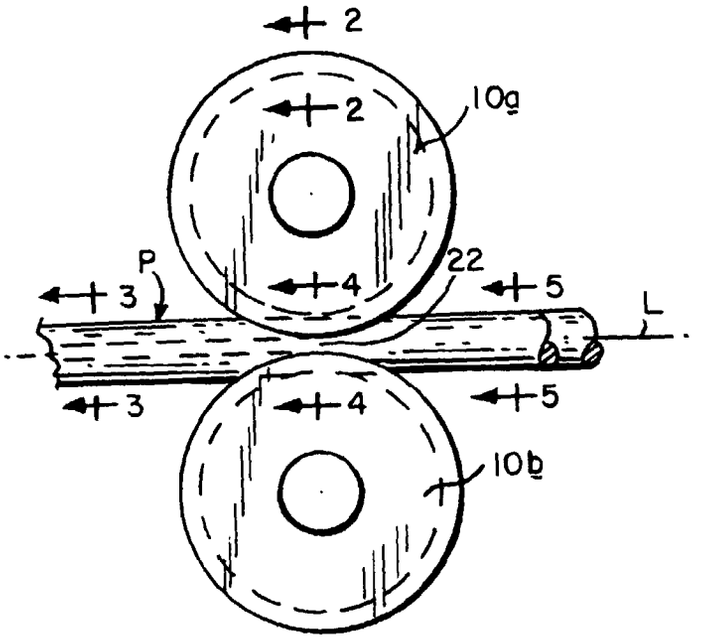


FIG. 1 PRIOR ART

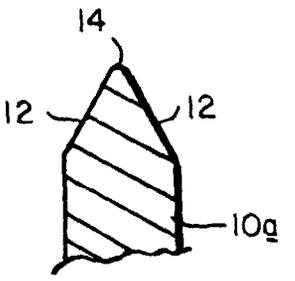


FIG. 2 PRIOR ART

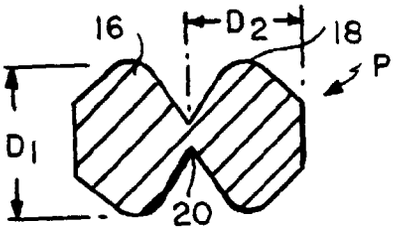


FIG. 3 PRIOR ART

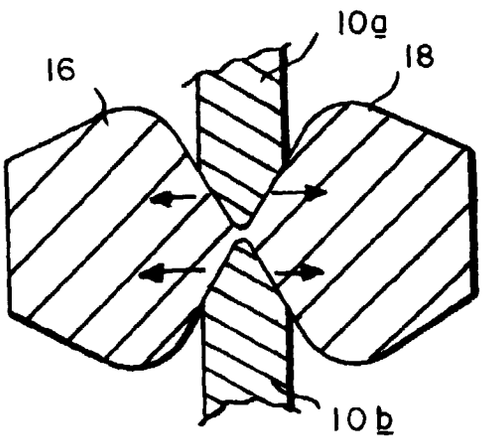


FIG. 4 PRIOR ART

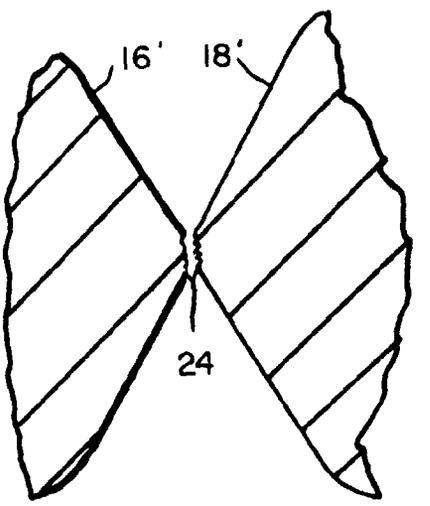


FIG. 5 PRIOR ART

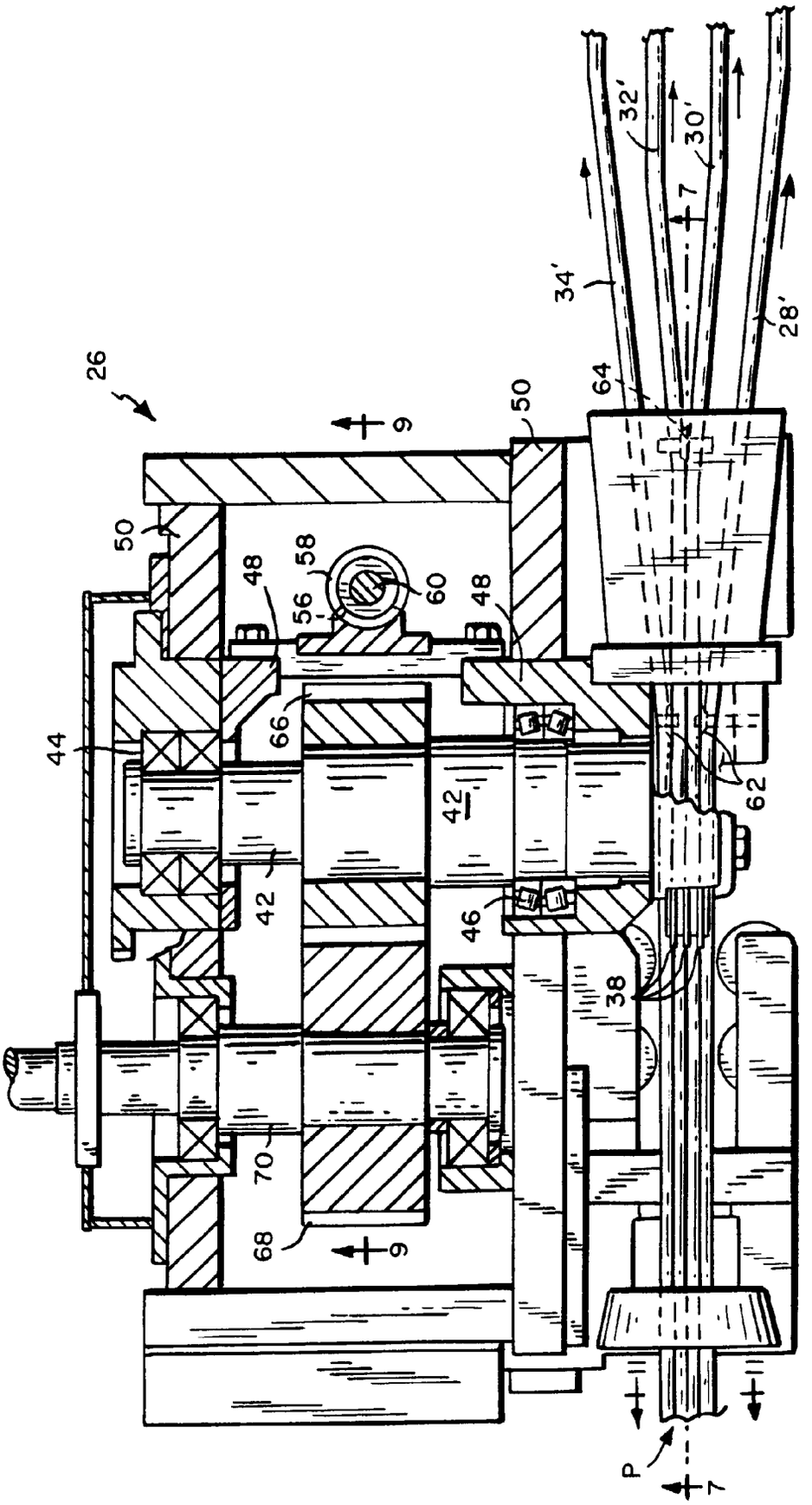


FIG.6

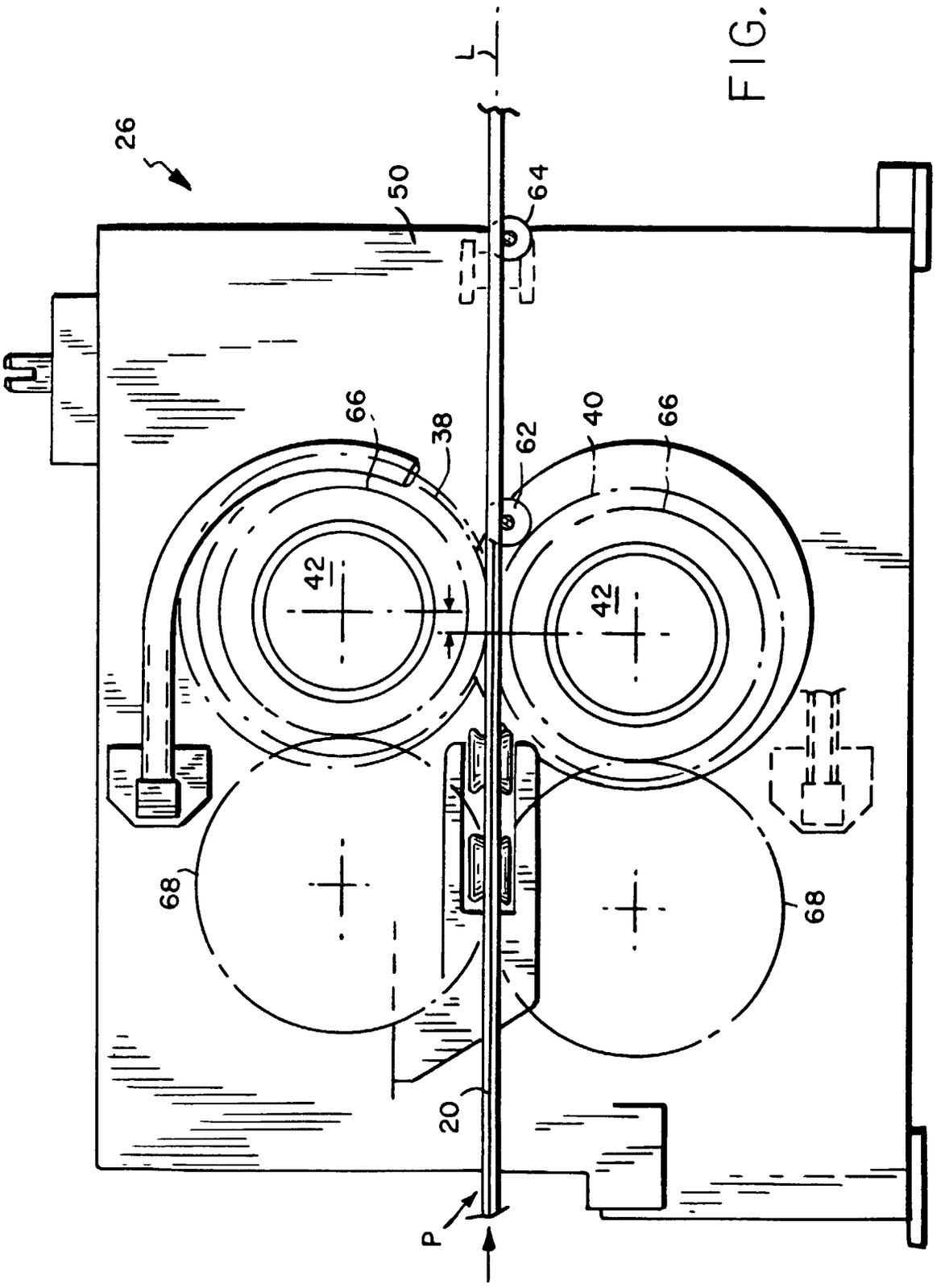


FIG. 7

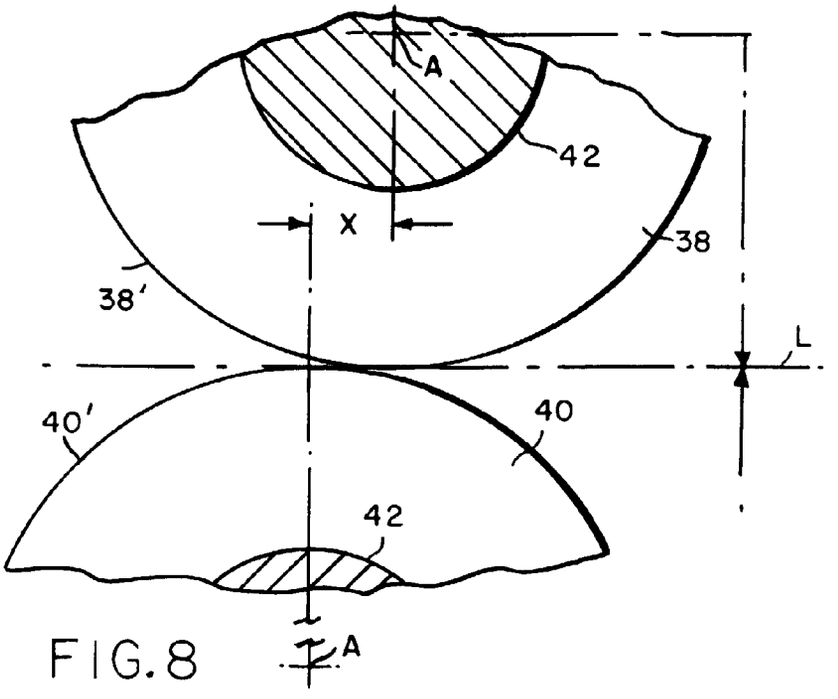


FIG. 8

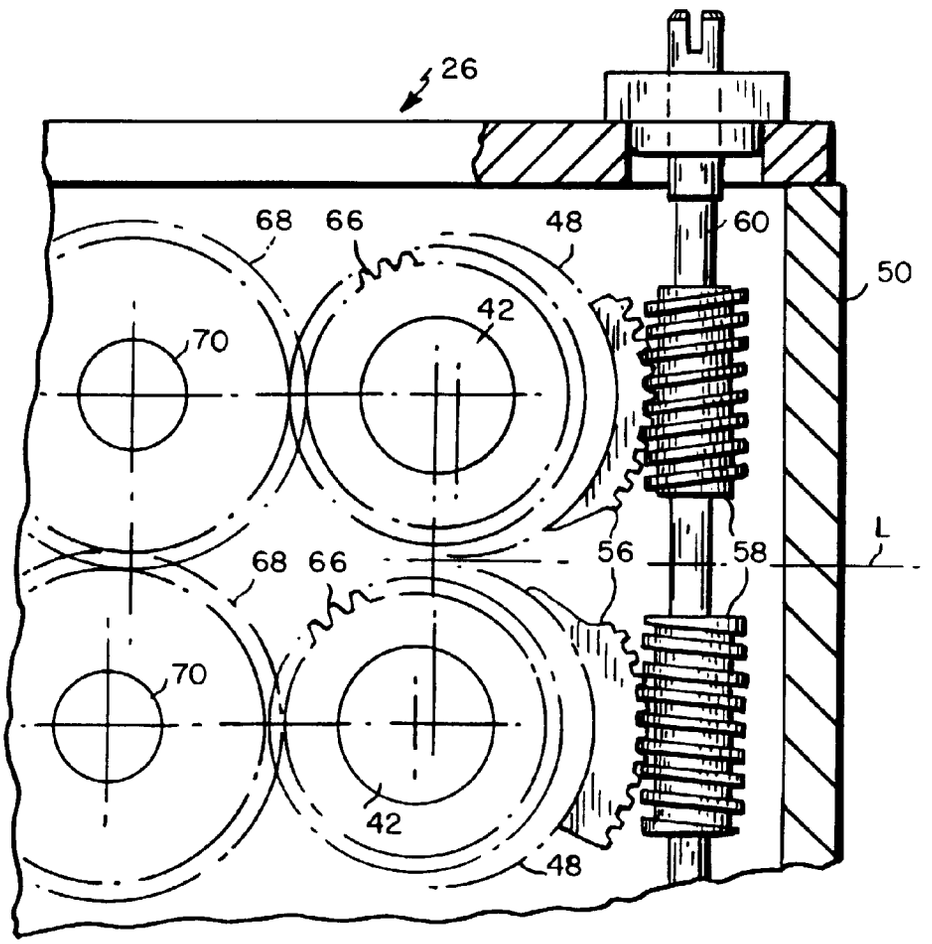


FIG. 9

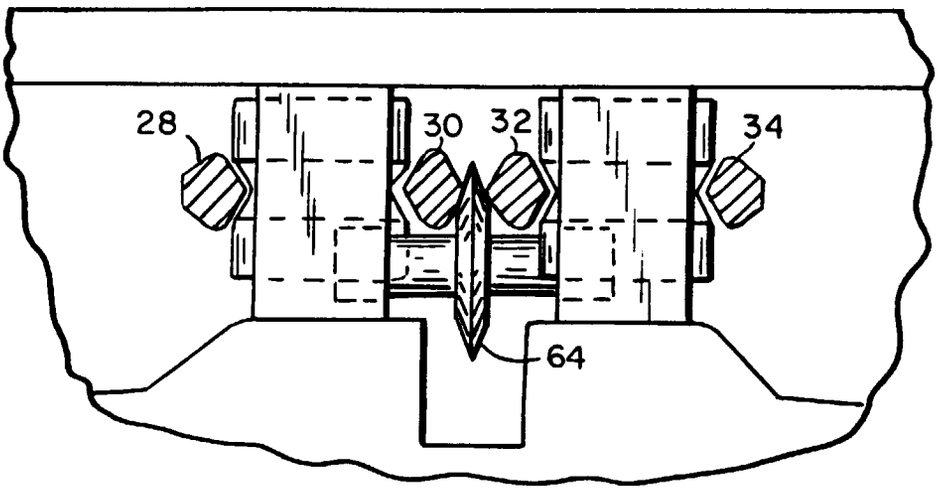


FIG. 10

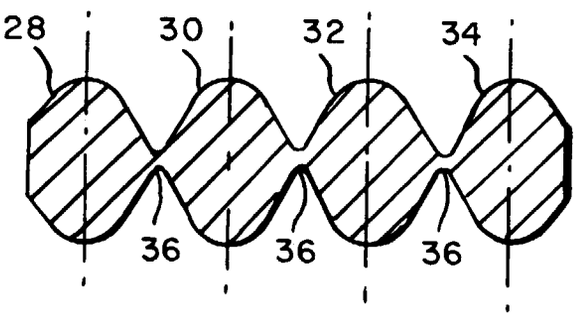


FIG. 11

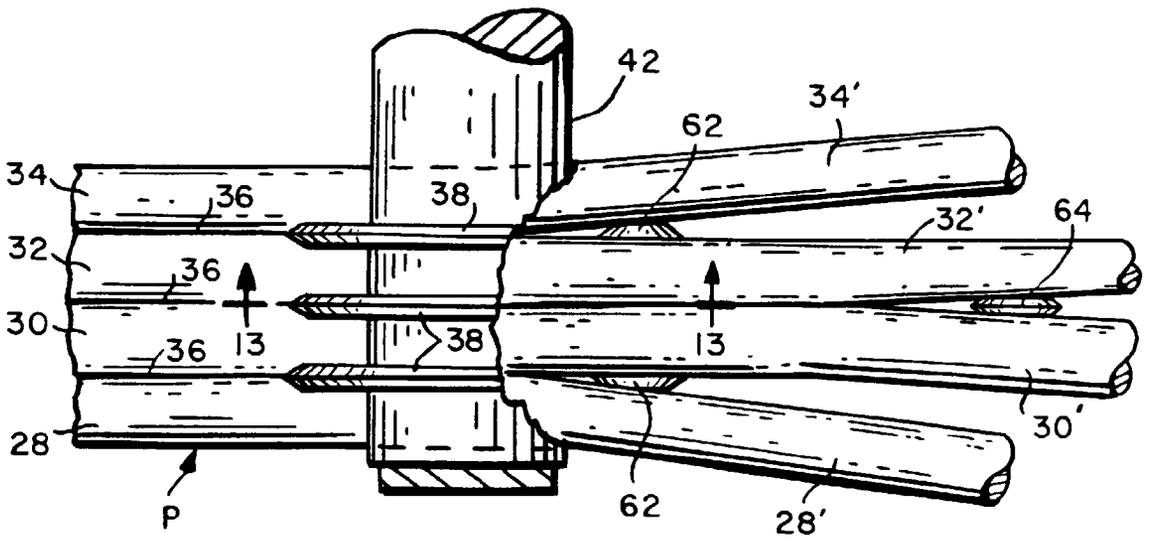
42
34'
62
34
36
38
32
32'
64
36
30
36
13
38
13
30'
28
P
62
28'

FIG. 12

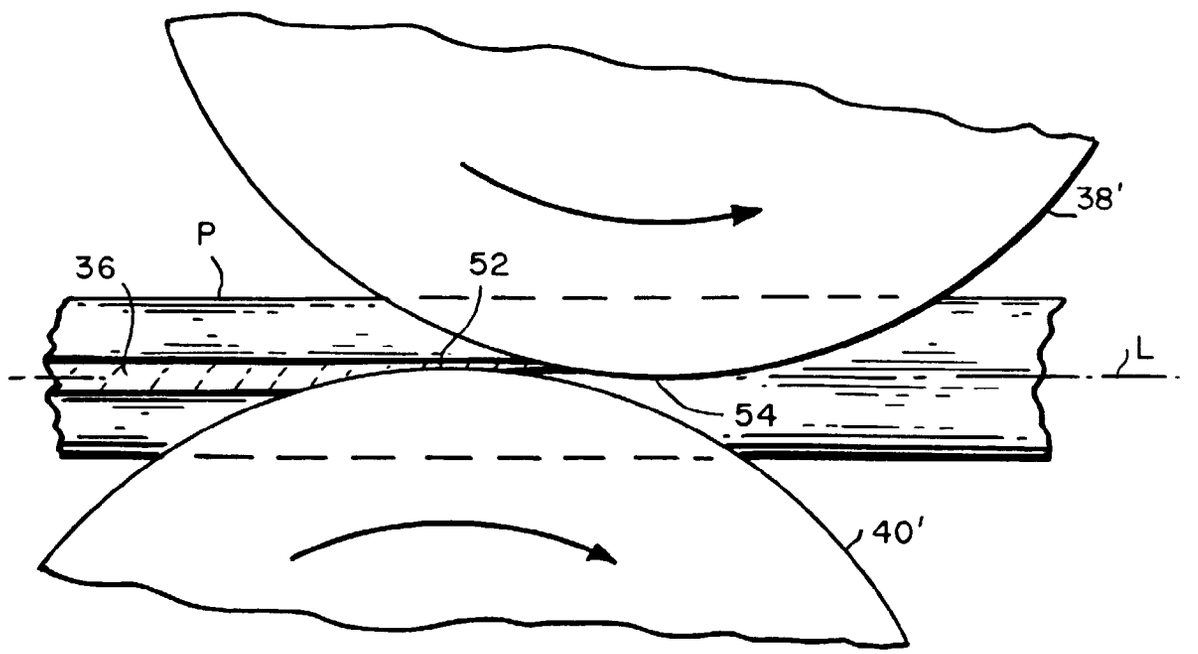
38'
P
36
52
L
54
40'

FIG. 13

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# EUROPEAN SEARCH REPORT

Application Number
EP 97 30 9677

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X<br>Y<br><br>A | GB 326 696 A (ROBINSON PHILIP)<br>* the whole document *<br>--- | 11,13<br>1-6,9,<br>10,12<br>7 | B21B1/08<br>B21B31/26 |
| Y<br><br>A | FR 1 531 186 A (GIPROSTAL)<br>* the whole document *<br>--- | 1-6,9,<br>10,12<br>7,8,11 | |
| A | EP 0 528 154 A (DANIELI OFF MECC)<br>* column 6 - column 7; figures 2A,4,6,9 *<br>--- | 1-7,9-13 | |
| A | US 3 982 455 A (BOWMAN RAYMOND EARL)<br>* the whole document *<br>--- | 1,4,5,<br>9-13 | |
| A | US 3 336 781 A (WILSON NORMAN A ET AL)<br>* column 7 - column 8; figures 9-11 *<br>----- | 6-8 | |

| TECHNICAL FIELDS SEARCHED (Int.Cl.6) |
|---|
| B21B |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 27 February 1998 | Rosenbaum, H |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)