United States Patent

[11] 3,596,487

[72] Inventor **Karl S. O. Forsberg**
Hogstengsgotau St., 77700 Swedjebacken, Morgardshammar, Sweden

[21] Appl. No. **790,295**
[22] Filed **Jan. 10, 1969**
[45] Patented **Aug. 3, 1971**
Continuation of application Ser. No. 381,625, July 10, 1964, now Patent No. 3,422,654.

[54] **ROLLING MILL**
2 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **72/228,** 72/230
[51] **Int. Cl.** **B21b41/04,** B21b 41/10
[50] **Field of Search** 72/228, 230, 232, 227

[56] **References Cited**
UNITED STATES PATENTS

148,811	3/1874	Comer	72/230
379,974	3/1888	Morgan	72/228
407,177	7/1889	Daniels	72/228
619,144	2/1899	Day	72/230
675,591	6/1901	Edwards	72/230
3,187,993	8/1965	Hein et al.	72/230
3,422,654	1/1969	Forsberg	72/228

Primary Examiner—Milton S. Mehr
Attorney—Pierce, Scheffler & Parker

ABSTRACT: A continuous rolling mill plant for rod steel and wire having several rolling mill units each consisting of a pair of stands disposed side-by-side with a first stand of each pair being aligned in the direction of rolling, which stands form a finishing train permitting continuous rolling. The second stands of each pair permit repeater rolling. A runout roller table may be arranged below the finishing train in order to discharge the roller material from any stand. Instead of a runout roller, table coiler means may be arranged along and adjacent to the finishing train.

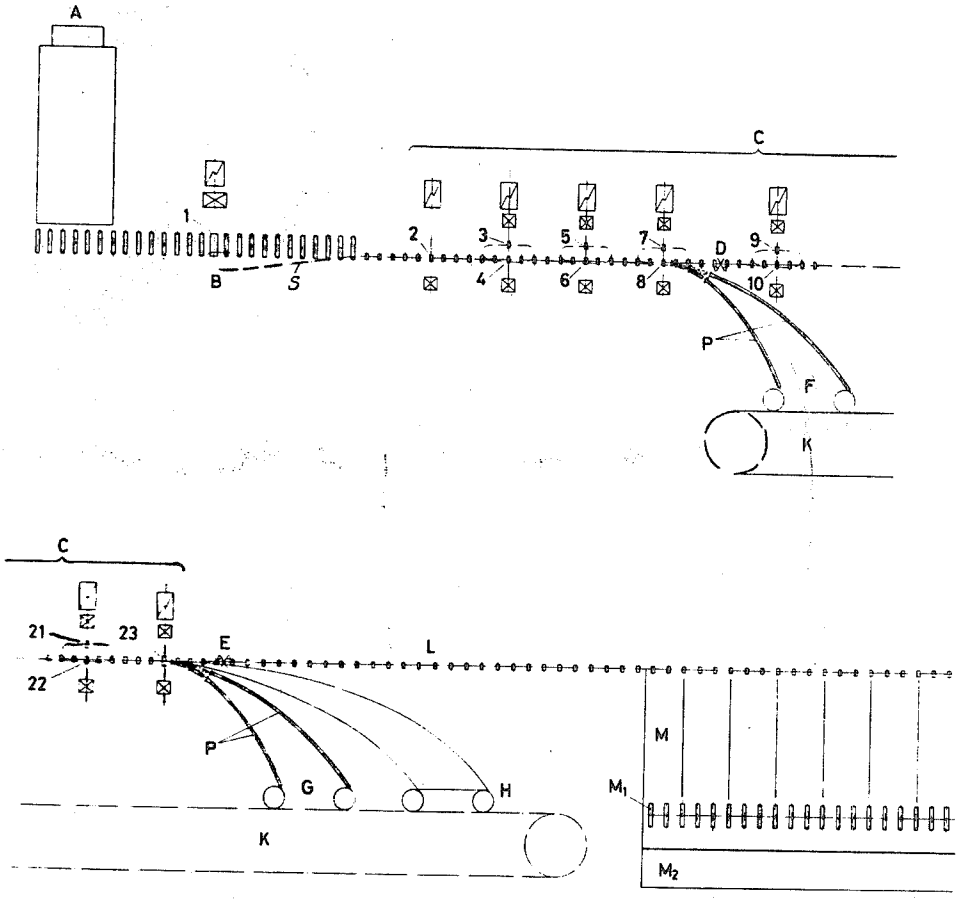


Fig. 1a

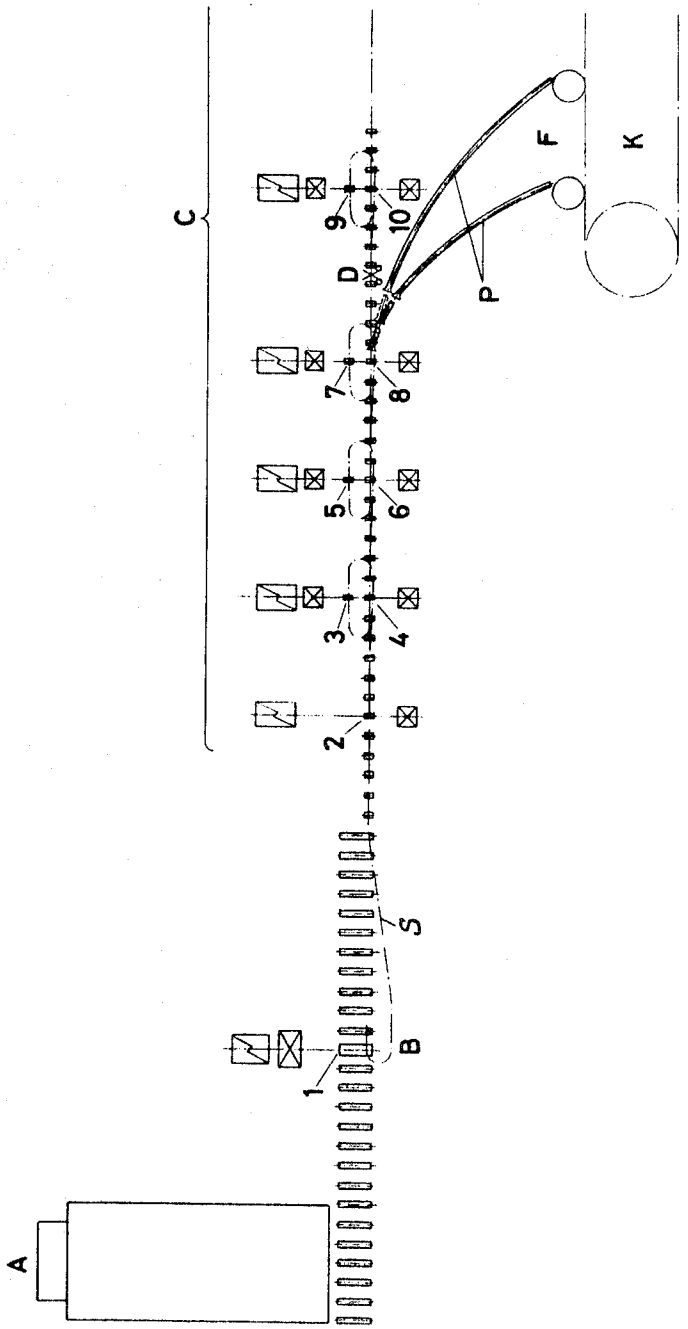
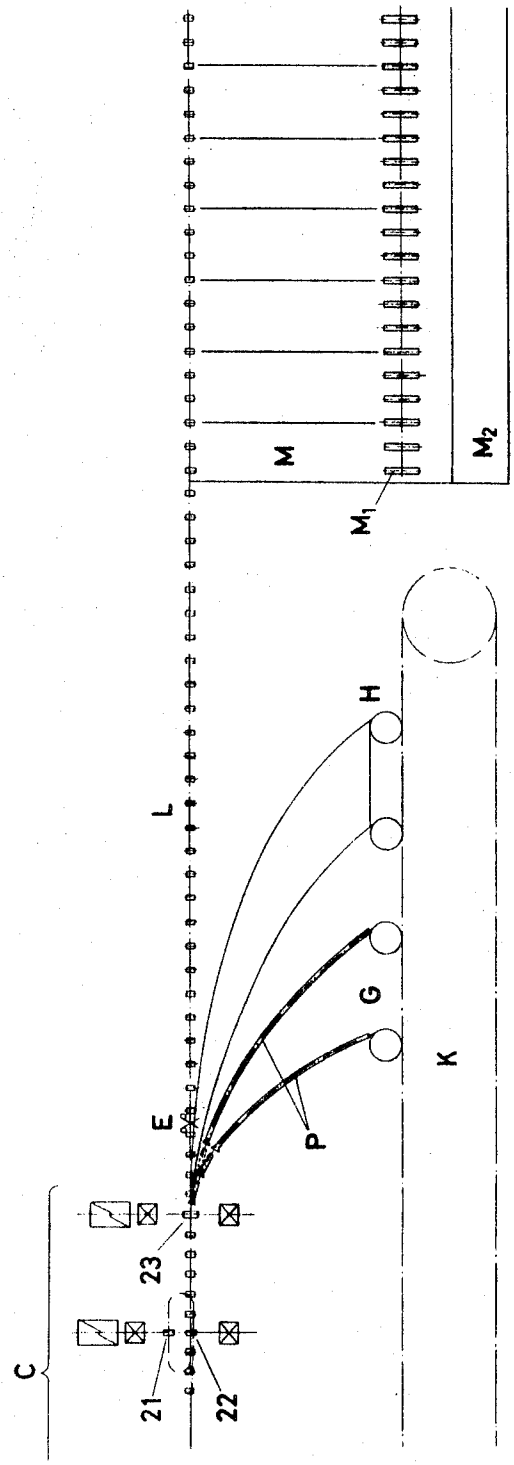


Fig. 1b



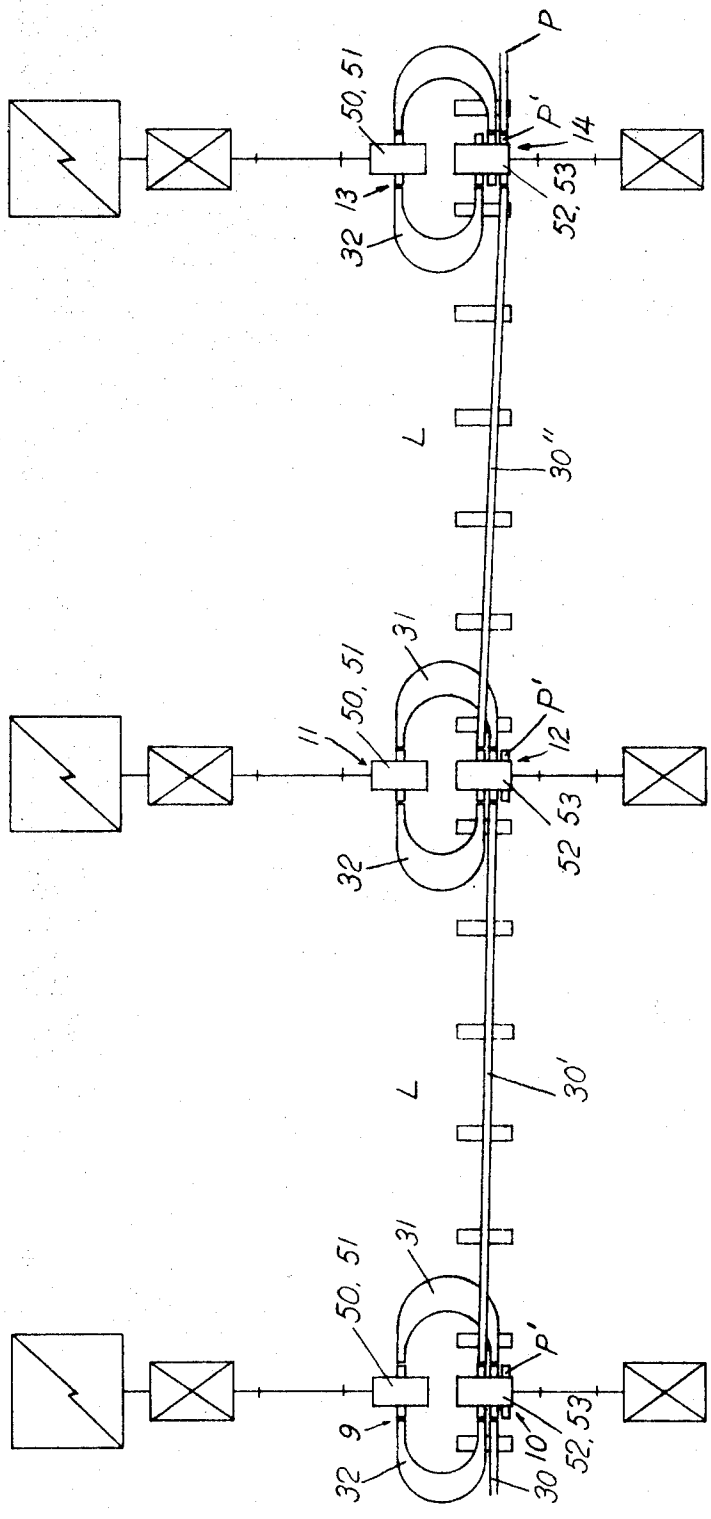

P
50, 51
P'
14
13
52, 53
32
L
30''
31
50, 51
11
P'
12
32
52 53
L
30'
31
50, 51
P'
9
10
32
30
52, 53

Fig. 2

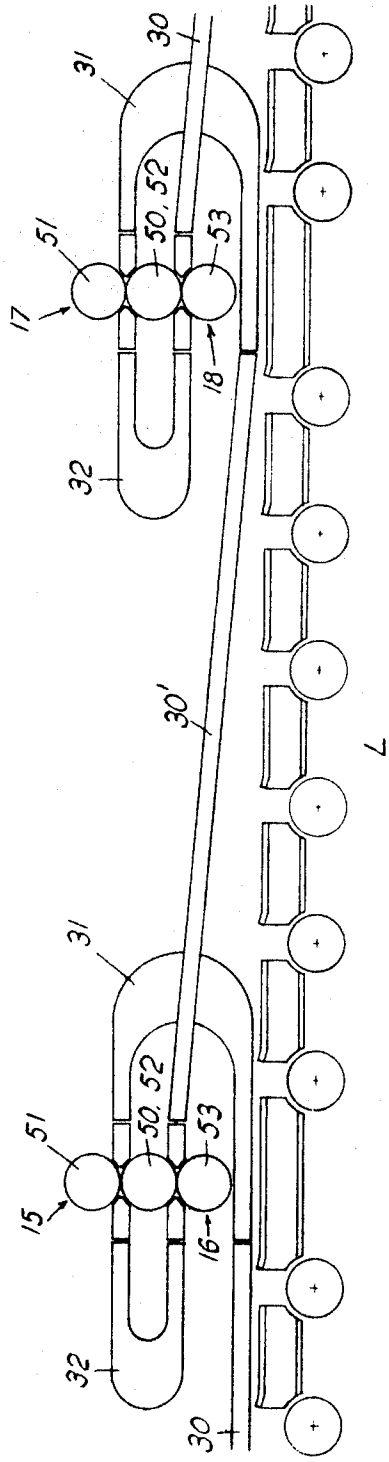


Fig. 3

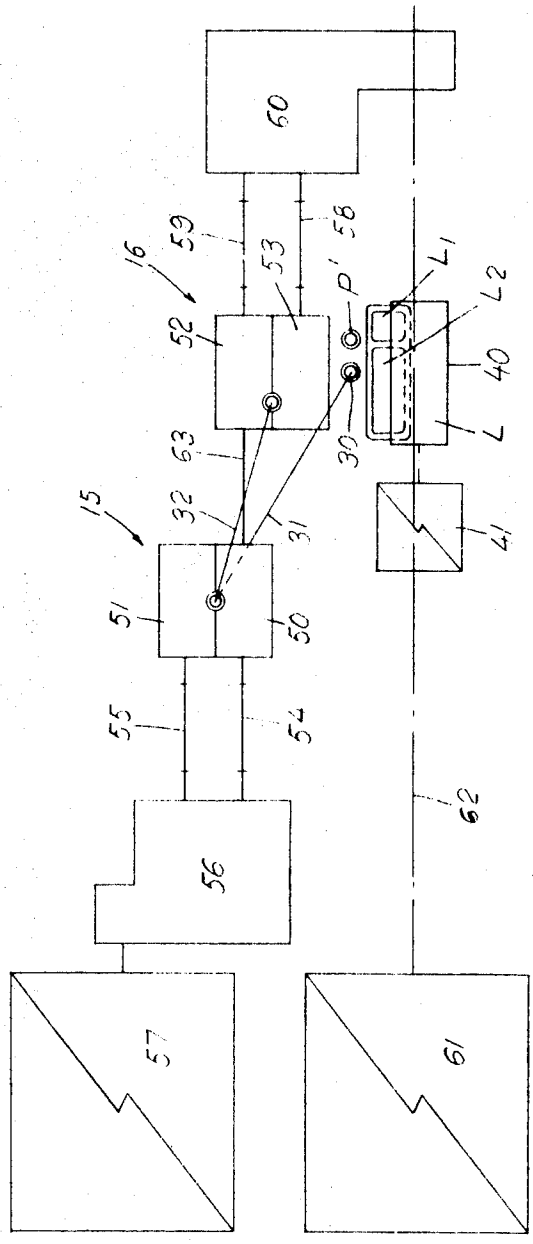


Fig 4

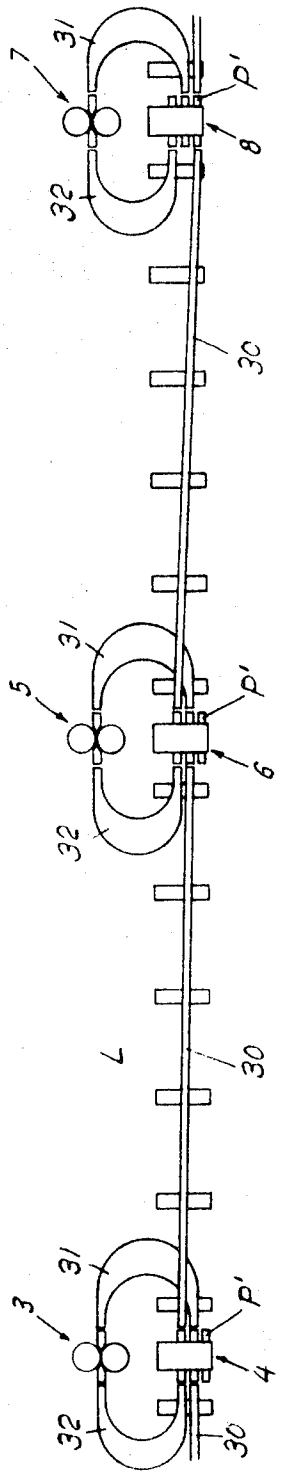


Fig. 5

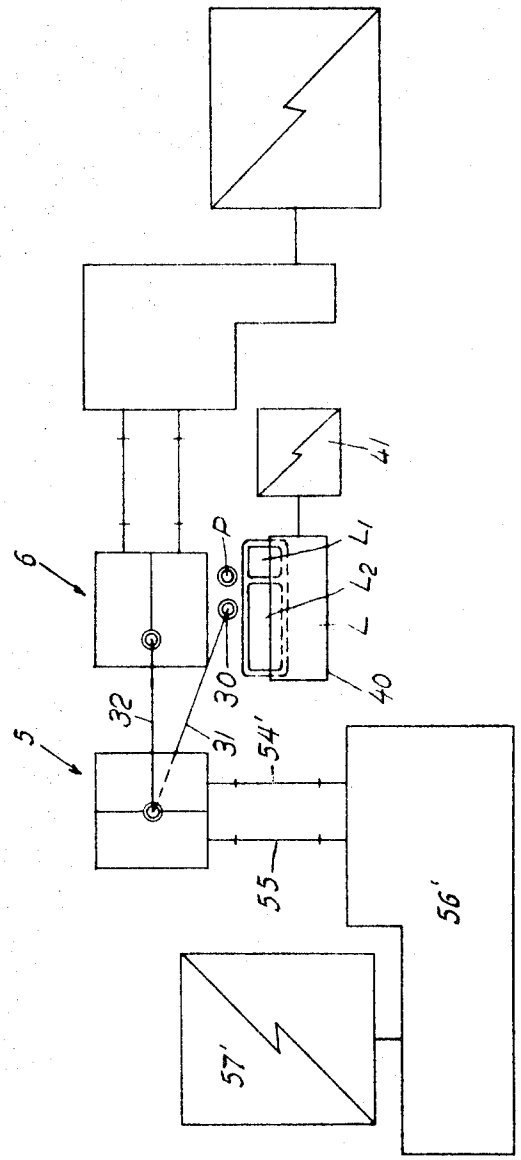


Fig. 6

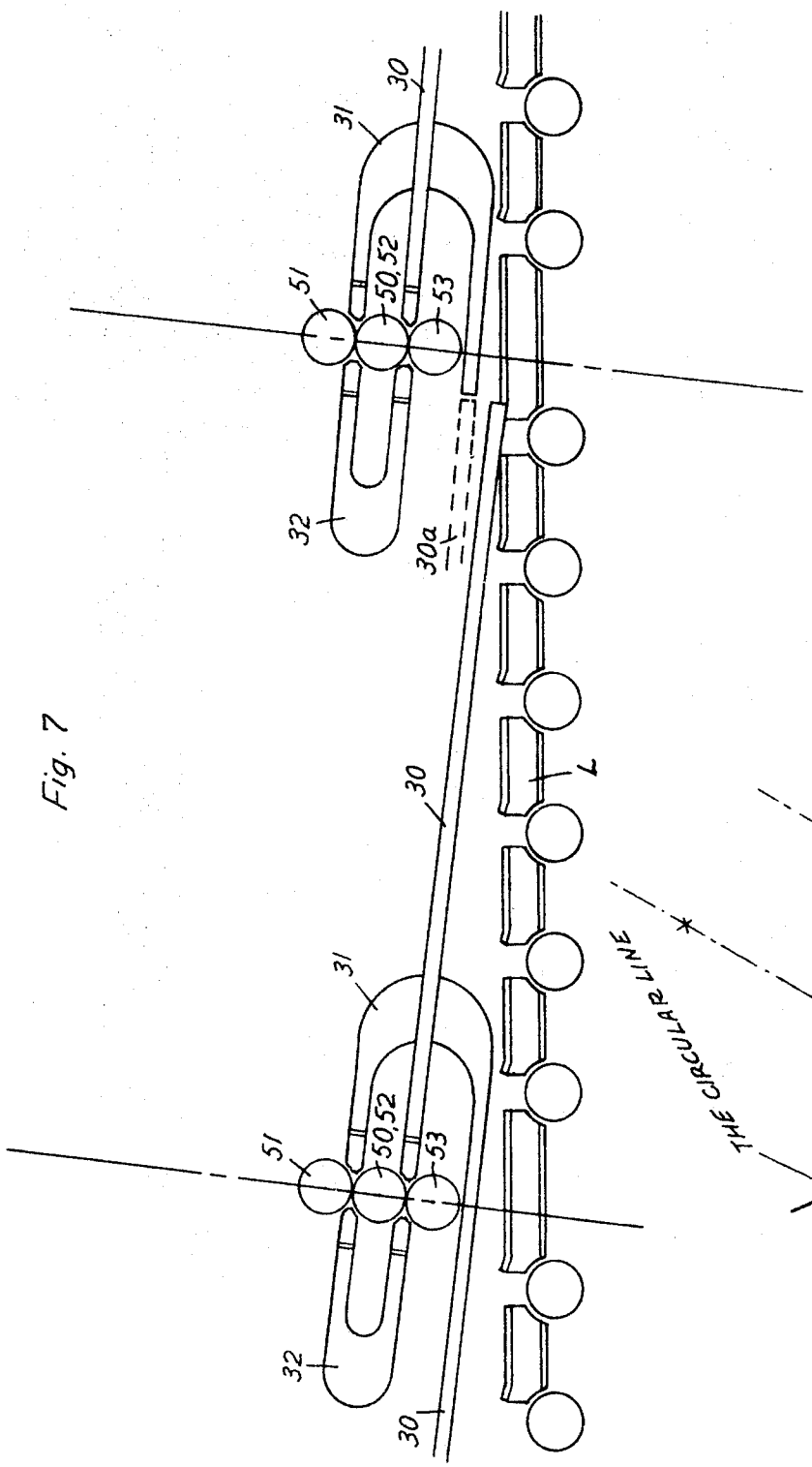

30
31
51
50,52
53
32
30a
L
30
31
51
50,52
53
32
30

Fig. 7

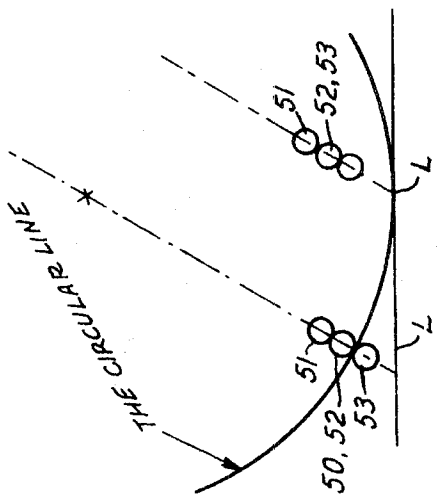

THE CIRCULAR LINE
51
52,53
L
51
53
50,52
L

Fig. 8

ROLLING MILL

This is a continuation application of my copending application, Ser. No. 381,625, filed July 10, 1964, now U.S. Pat. No. 3,422,654.

This invention relates to a rolling mill possibly comprising a roughing mill, cooling bed and/or coiler means with associated auxiliary means.

The rolling mill technique of today involves rolling material of special qualities with a high production at the same time as the orders are relatively small. Rolling mills with such a program heretofor had to roll in open looping mills which were of limited use when strips of small width or sections of smaller dimensions had to be rolled and when high production and high billet weights were required. The rolling mills for merchant iron had to roll substantially in continuous rolling mills which are characterized by high production but showing properties which are less good with respect to surface finish and narrow tolerances.

This invention retains the good properties of the open looping mills at the same time as it renders possible continuous rolling of strips and sections with high billet weights. The invention is of high flexibility and allows high production as in continuous rolling mills where even high billet weights may be used.

The invention is characterized by one or a plurality of finishing rolling mills comprising a suitable number of rolling mill stands preferably separately electrically operated and mounted continuously, preferably in rolling mill trains of at least two rolling mill stands, adapted for repeater rolling or continuous rolling in at least one pass line or in combination of repeater rolling and continuous rolling. The invention further is characterized in that the material can be finishing rolled in the pair of rolling mill stands most suitable for the rolled dimension, in such a manner, that the material can be directed on a runout roller table located preferably below the rolling mill stand and extending, for example, to a cooling bed or coiler, and that the material can be directed to coilers in pipes preferably placed below the rolling mill stands.

The motors are preferably driven with direct current, preferably from separate rectifiers.

The invention will be described in the following, embodiments of the invention being shown on the accompanying drawings wherein:

FIG. 1*a* and FIG. 1*b*, taken together to constitute FIG. 1, show schematically the principal parts of one embodiment of a rolling mill plant according to the present invention, including in this view a roughing mill, a cooling bed and associated equipment;

FIG. 2 shows schematically a plan view of three rolling mill units and a runout roller table mounted according to the invention;

FIG. 3 shows schematically a side view of two rolling mill units and a runout roller table mounted according to the invention;

FIG. 4 shows schematically a transverse view of a rolling mill unit and a runout roller table mounted according to the invention;

FIG. 5 shows schematically a plan view of three rolling mill units mounted according to the invention;

FIG. 6 shows schematically a transverse view of a rolling mill unit mounted according to the invention;

FIG. 7 shows schematically a side view of two inclined rolling mill units according to the invention; and

FIG. 8 diagrammatically illustrates the circular line path taken by rolled material in the case of the assembly shown in FIG. 7, according to which the strand of material which has passed between rolls 52, 53 is translated in an arc which passes below the following stand.

Referring to the drawings, A designates a heating furnace, B is a roughing mill, C a finishing rolling mill, D a crop shear, E a dividing shear, F are coilers, preferably for material of smaller

diameter, G are rod coilers, H strip coilers, K is a hook conveyor, L a runout roller table, M a cooling bed and P are guide pipes for wire rod coilers.

The cooling bed M is provided with a cold shear roller table M_1 for transporting the material to a cold shear (not shown) or directly to a conventional discharging device (not shown).

The complete rolling mill plant usually will further include, in the finishing rolling mill section C and positioned in the interval between FIG. 1*a* and FIG. 1*b*, a greater number of rolling mill stands than are represented in FIGS. 1*a* and 1*b*, and likewise may include an additional crop shear similar to that represented at D. Thus stands 9, 10 shown in FIG. 1*a* may be and usually are followed by a series of similar stands 11, 12 and 13, 14 as shown in FIG. 2, and further by a series of similar stands 15, 16 and 17, 18 as shown in FIG. 3.

In FIG. 1*a* and 1*b*, the flow line of material being processed is indicated by a dot-dash line S.

According to FIGS. 1*a* and 1*b*, a billet heated in a furnace A is rolled in a roughing mill B to desired dimension. For continued rolling to smaller dimension the hot bar is transferred from the roughing mill B to a finishing rolling mill plant C with a first rolling mill stand 2 from which the hot material is transferred below stand 4 through guide pipe and repeater (not shown in FIGS. 1*a* or 1*b*) to stand 3 and thereafter to stand 4 by means of a repeater (not shown in FIGS. 1*a* or 1*b*), and so on until the desired dimension is obtained, whereafter the finished material is transferred to a runout roller table L for delivery to cooling bed M. The material difficult to be transferred by means of guide pipes and repeaters is rolled in the pass line 2-4-6 and so on in a continuous manner. Material to be coiled is led via guide pipes P to wire rod coilers F when the material is of coarser dimension, or in the case of material of smaller dimension to wire rod coilers G, and when the material is strips to strip coilers H. From the coilers F, G, H the material is discharged to a hook conveyor K. Material transferred to the runout roller table L is divided in the dividing shear E to cooling bed lengths. The material having cooling bed lengths are discharged in known manner to cooling bed M for cooling and thereafter transported on a cold shear roller table M_1 to a cold shear where the material is cut to desired length and discharged in a discharging device.

The dividing shear E may be fixed after the last rolling mill stand or displaceable to be placed in close contact with the finishing rolling stands. Hereby the dividing shear may also be utilized for cropping the first or last end of the material to be coiled.

FIG. 2 shows on a larger scale the stands 9—10 in FIG. 1*a* and the sequential stands 11, 12 and 13, 14.

The rolling mill units of the finishing rolling mill plant C may be designed as shown in FIG. 2. According to FIG. 2 the rolls of the stands in the one line are designated by 50 and 51 respectively and the rolls of the stands in the other line by 52 and 53 respectively.

The hot material from stand 8 (shown in FIG. 1*a* but not shown in FIG. 2) is transferred below stand 10 through guide pipe 30 and repeater 31 to stand 9 where it is rolled between the rolls 50, 51. The hot material is then led via repeater 32 to stand 10 in which it is rolled between the rolls 52, 53. When rolled in stand 10 it is led through the guide pipe 30 to next rolling mill unit including the stands 11 and 12, where the same rolling procedure is repeated. According to this example stand 12 is the finishing rolling mill stand for the desired dimension and since the material is to be coiled it is led through the guide pipe 30, below the stand 14 and further through the guide pipe P to the coiler (not shown in FIG. 2). The guide pipes P' are used when a stand is omitted in the rolling process. A runout roller table L is mounted below the stands.

FIG. 3 shows on an enlarged scale a sequence of finishing stands 15, 16 and 17, 18 following the stands shown in FIG. 2 and preceding the stands shown in FIG. 1*b*.

The rolling mill units of the finishing rolling mill plant C may be designed as shown in FIG. 3. According to FIG. 3 the

rolls of the stands in the one line are designated by **50** and **51** respectively and the rolls of the stands in the other line by **52** and **53** respectively. Both of the rolling mill units consist of staggered rolling mill stands with horizontal rolls.

The hot material from a previous stand (not shown in FIG. 3) is transferred below stand **16** through guide pipe **30** and repeater **31** to stand **15** where it is rolled between the rolls **50**, **51**. The hot material is then led via repeater **32** to stand **16** in which it is rolled between the rolls **52**, **53**. When rolled in stand **16** it is led through guide pipe **30'** to next rolling mill unit including the stands **17**, **18** where the same rolling procedure takes place. A runout roller table L is mounted below the stands.

FIG. **4** schematically shows a section through the stands **15** and **16** in FIG. **3**.

The rolls of stands **15** and **16** are designated by **50**, **51** and **52**, **53** respectively. The rolls **50** and **51** may be mounted in a conventional manner and driven by universal couplings **54** and **55** respectively and by a pinion stand **56** possibly combined with a reduction gear from a motor **57**. The rolls **52** and **53** are driven in like manner via universal couplings **58** and **59** respectively from a pinion stand **60** possibly combined with reduction gear from a motor **61** via a long shaft **62**. The motor **61** may, of course, be placed close to said pinion stand **60**, in which case the long shaft **62** is abandoned. The rolling mill unit shown consists of staggered rolling mill stands, e.g., the rolls of the one stand are mounted higher than the rolls of the other stand. In continuous rolling where the hot material passes only between the rolls **52** and **53** it may be necessary to use the powers of the two motors **57** and **61** because the procedure is rather power consuming. This is most suitably achieved by means of a slidable coupling **63**. In order to be able to utilize different roll diameters of rolls **52** and **53** when coupling **63** is in operational position the roll **52** can be driven separately via coupling **63**, roll **50**, coupling **54** and pinion stand **56** from the motor **57** if the coupling **59** is disconnected. In this case the roll **53** is driven via coupling **58** and pinion stand **60** from motor **61**.

The runout roller table L is mounted within and below the rolling mill plant C as shown in FIG. **4** and may be provided with one or a plurality of channel sections L_1, L_2. The rollers **40** may be cylindrical, conical, grooved or inclined, as deemed most suitable, and be operated by separate motors **41** or in another suitable way.

FIG. **5** shows on a larger scale the stands **3**—**8** in FIG. **1***a*.

The rolling mill units of the finishing rolling mill plant C or parts thereof may be designed as appears from FIG. **5**. The difference here is that the rolls of the one stand of each rolling mill unit are vertical. This design, however, does not include the possibility of coupling the motors of the two stands by simple means as shown in FIG. **4**. Below the rolling mill units the runout roller table L is arranged.

FIG. **6** schematically shows a section through the stands **5** and **6** in FIG. **5** and illustrates how the stand **5** is driven via couplings **54'**, **55'** and pinion stand **56'** from a motor **57'**.

FIG. **7** corresponds to FIG. **3** but the stands are inclined in relation to their vertical line so that a circular line touching the pass line between the rolls **52**, **53** even touches the point where the transfer of the rolled material passes below the following stand. In order to illustrate the transferring of material to runout roller table L the guide pipe **30** is directed to the runout roller table. When using the following rolling mill unit the guide pipe has the position as indicated by **30***a*.

FIG. **8** more clearly shows the aforesaid circular line.

All parts comprised in the mill may be of any suitable construction. The number of the units may, of course, vary, for example the number of roll pairs, coilers, cooling beds etc. The roughing mill in the embodiment shown comprises only one rolling mill stand **1**, but may, of course, comprise several stands arranged in a line or continuously. The roughing mill may at the same time be a finishing rolling mill for material of greater dimensions. The stands of the finishing rolling mill, designated by **2**—**23**, may be more or less in number. Prior to or within the finishing rolling mill one or several open trains for longer looping formation may be provided.

A billet heated in the furnace A is rolled in the roughing mill B to desired dimension and possibly directed via the runout roller table L to the cooling bed M or to a cooling bed of greater dimensions provided with cutting means (not shown) preferably placed between the roughing mill B and the finishing rolling mill C. For continued rolling to smaller dimension the hot bar is transferred from the roughing mill B to the finishing rolling mill C preferably provided with rolling mill stands **2** from which the hot bar is directed preferably below stand **4** through a guide pipe (not shown in FIG. **1***a*) and transferred to stand **3** by means of a repeater. In stand **3** the running material is rolled and then transferred to stand **4** for further rolling. Thereafter, the material is directed below stand **6**, transferred by repeater to stand **5** where it is rolled, and so on. Thus, the sequence of rolling is **2**, **3**, **4**, **5**, **6**, **7**, **8**, but before rolling in a stand with an odd number x the material is led below a stand with an even number $x+1$ but without rolling in that stand ($x+1$). Accordingly, material to be rolled is directed to stand **3** thence through guide pipes **30** (FIGS. **2**—**6**), and, optionally, repeaters **31**, FIGS. **2**—**6**, to stands **3** and **4** respectively, and so on, until the desired dimension is obtained, whereafter the finished material is directed to the runout roller table L for delivery to the cooling bed N. The material difficult to be repeated in guide pipes or repeaters, is preferably rolled in the pass line **2-4-6** (FIG. **1***a*) or **2-3-5** (FIG. **2**), and so on, in a continuous manner. The cropped end is preferably directed into a section L_1, FIGS. **4** and **6**, whereafter it is transported to a suitable point along the runout roller table L. The runout roller table L between the roughing mill B and the finishing rolling mill C may be of the usual open type. The runout roller table L after the finishing rolling mill C must be constructed according to established principles for braking and delivery of the material to the cooling bed M.

The guide means immediately nearby the rolls may be of conventional construction, as well as the other guiding devices and repeaters. The repeaters **31** and **32**, FIGS. **2**—**6** may be of simpler construction and comprise in their most simple design a pipe bent to an angle of substantially 180° and widened in the loop control part in the direction of the loop. When transferring the hot bar into such a repeater, the first end follows the outer edge of the pipe and enters the entry guide of the following stand. The speed of said stand must be somewhat higher than that of the hot material, so that the biting of the hot material by the rolls results in a reduction of the loop. For maintaining the loop position constant, the motors of the roll pairs must be affected by loop control regulating means, for example loop control photoelectric cells of known design. The hot material, thus, must lie entirely free of the repeater walls. When the last end of the hot material leaves the preceding stand it is drawn in against the inner wall of the repeater when the speed is low. When the speed is high, the loop or its last end is pressed out by centrifugal force against the outer wall of the repeater. Due to this fact, that at high speed also the last end is pressed against the outer wall of the repeater, pitching is prevented which causes twice folded or flattened last ends which may get caught in the entry guides.

The repeater described may, of course, be constructed with or without cover or, in that portion of the plant where the speed is high, without inner wall.

In continuous rolling, the hot material is transferred between the stands preferably in a conventional manner in channels possibly provided with loop lifters and with means for sensing the loop position.

When the hot material according to the invention leaves the stands at a height adjusted according to the construction to the runout roller table L, it is suitable to construct the stands inclined in relation to their vertical line in order to prevent repeated bending of the hot material, in such a manner, that a circle line drawn through the pass line of a stand in the roll opening touches the runout roller table immediately above the roller top of the runout roller table L.

In order to prevent stretching of the material by continuous rolling, it may be suitable to arrange one or several stands inclined as described above, but to design the following rolling mill train inclined to the preceding train. The rolled hot material thereby follows the curved line during transfer. When the subsequent stand bites the hot material, the material will be stretched, which can be prevented by controlling the motors of the stands within the chord height of the means for sensing the loop position.

When it is desired to maintain a fixed pass line, it is suitable to construct the stands **2—23** in the finishing rolling mill C for easy groove change laterally or vertically displaceable, the guide means being fixed. It is simplest, however, to construct the entry guides with the transfer means displaceable, which displacement may occur manually or be mechanized.

For rolling thin strips it is desirable to construct the stands in the finishing pass line of the finishing rolling mill C as a four-high mill. This is easily achieved by changing the entire roll mounting. In cases of wider strips which cannot be turned for edging in subsequent stands or be repeated, it may be suitable to place vertical edging stands between the rolling mill trains.

I claim:

1. A continuous rolling mill plant for rod, wire and strip, comprising several rolling mill units each consisting of two rolling mill stands one of which is suitable for finishing rolling, said finishing stands forming at least two aligned, trains, characterized by the following combination of features, viz:

a. that all of the rolling mill stands are arranged in sequence for the passage of the material subjected to roll
b. that the individual rolling mill stands are driven separately by motors connected to said stands by means of couplings;
c. that the finishing stands forming an aligned train consist of stands with horizontal rolls;
d. that a repeater transfers the material between the rolling mill stands of the same rolling mill unit; and
e. that repeaters transfer material from the aligned train to another train below the rolling mill stands of the aligned train without crossing any couplings.

2. A continuous rolling mill plant for rod, wire and strip, comprising several rolling mill units each consisting of two rolling mill stands, one of which is suitable for finishing rolling, said finishing stands forming at least one aligned train, characterized by the following combination of features, viz,:

a. that all of the rolling mill stands are arranged in sequence for the passage of material subjected to rolling;
b. that the finishing stands forming an aligned train consist of stands with horizontal rolls;
c. that a repeater transfers the material between the rolling mill stands of the same rolling mill unit;
d. that repeaters transfer material from the aligned train to another train below the rolling mill stands of the aligned train; and
e. that the rolling mill units comprise staggered rolling mill stands separately driven from both ends and that coupling devices connect the two staggered rolling mill stands in such a way that in straight continuous rolling the entire driving power can be transferred to the working rolling mill stands.