

Jan. 9, 1934.

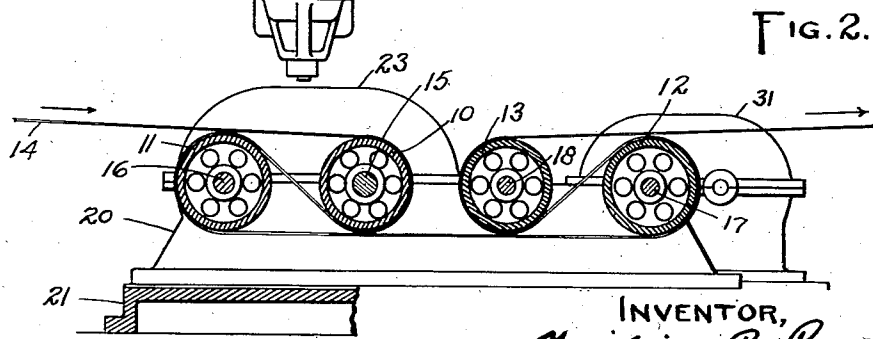
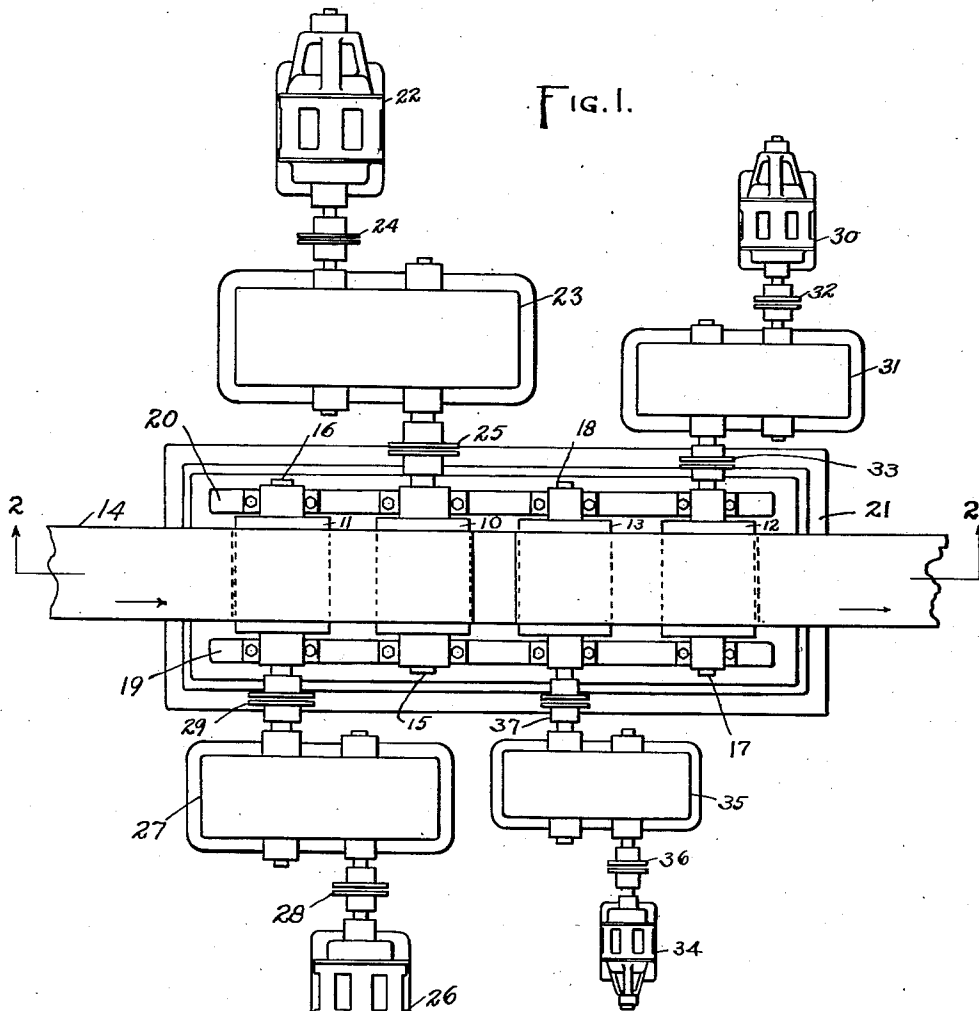
W. C. CORYELL

1,943,005

STRIP MILL

Filed May 26, 1928

3 Sheets-Sheet 1



INVENTOR,  
*William C. Coryell*  
& *Thomas H. Ferguson*  
ATT'Y.

Jan. 9, 1934.

W. C. CORYELL

1,943,005

STRIP MILL

Filed May 26, 1928

3 Sheets-Sheet 2

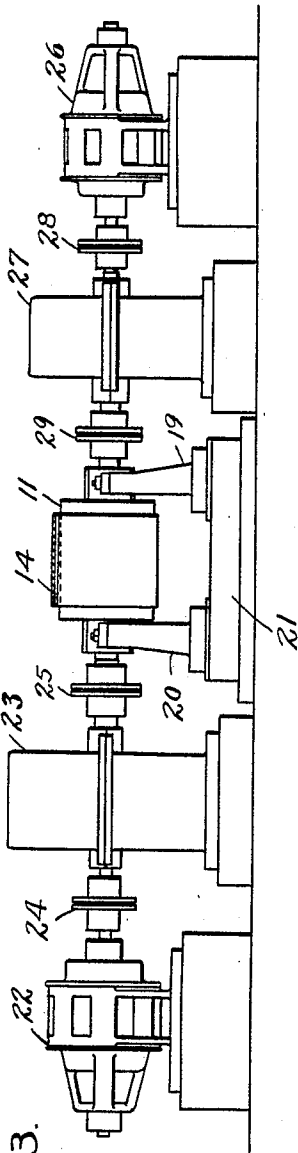


FIG. 3.

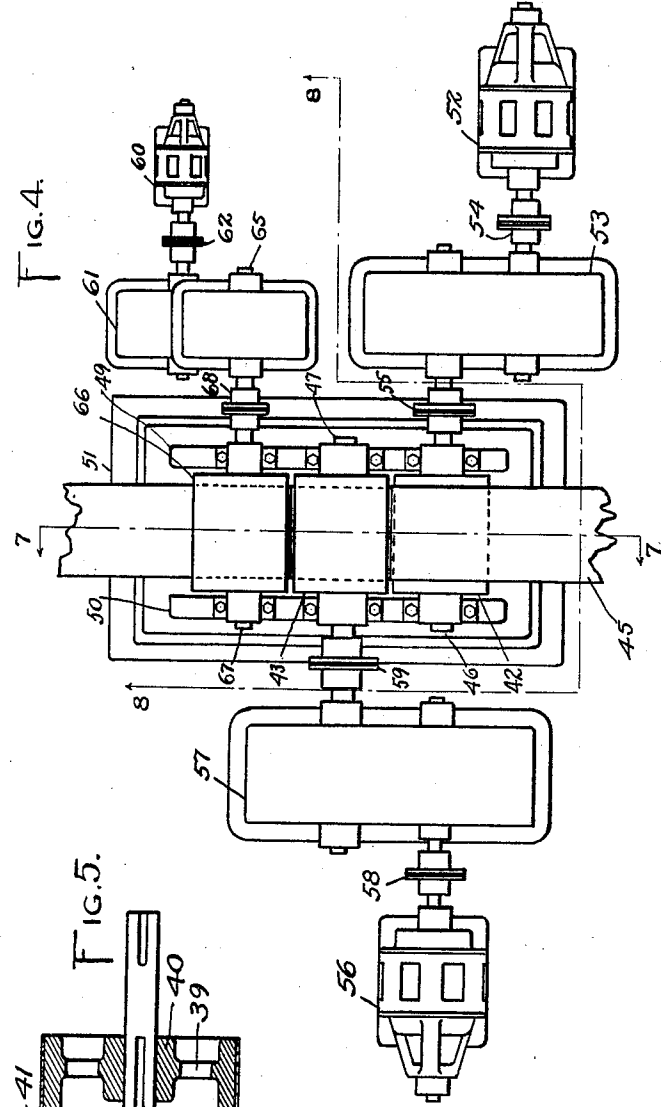


FIG. 4.

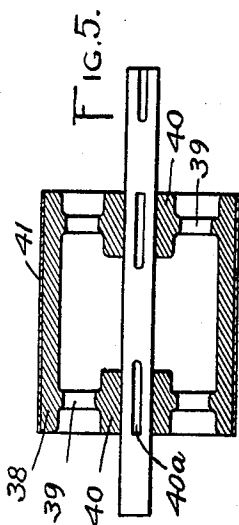


FIG. 5.

INVENTOR,  
William C. Coryell  
BY Thomas H. Ferguson  
ATTY.

Jan. 9, 1934.

W. C. CORYELL

1,943,005

STRIP MILL

Filed May 26, 1928

3 Sheets-Sheet 3

FIG. 6.

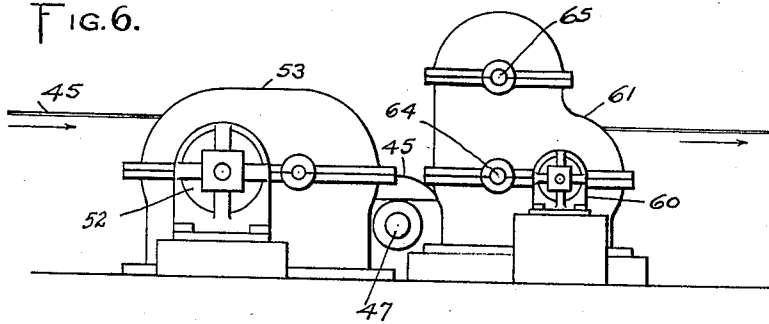


FIG. 7.

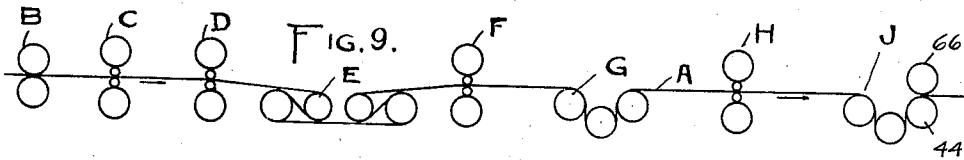
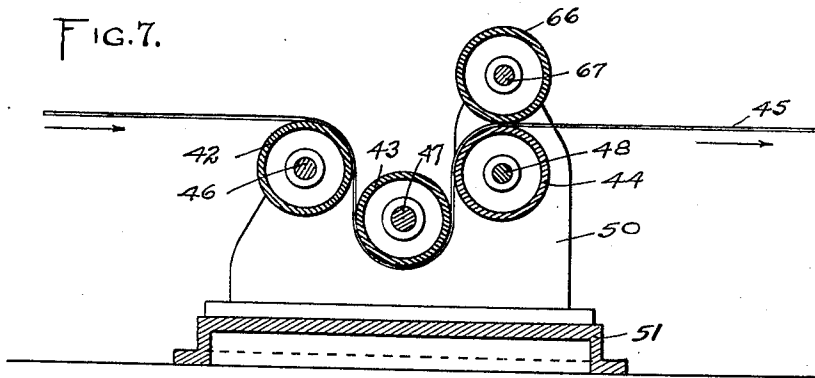
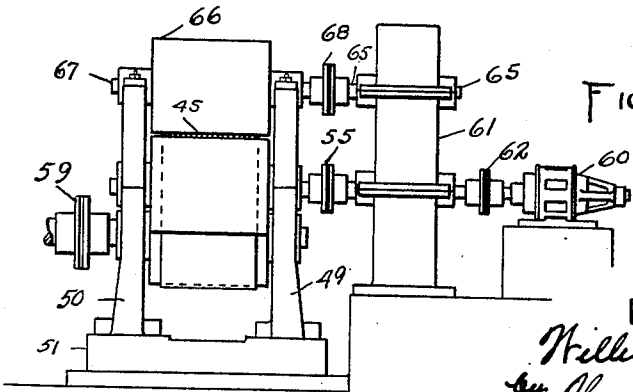


FIG. 8.



INVENTOR,  
*William C. Coryell*  
by *Thomas H. Ferguson*  
ATT'Y.

# UNITED STATES PATENT OFFICE

1,943,005

## STRIP MILL

William C. Coryell, Youngstown, Ohio, assignor,  
by mesne assignments, to United Engineering  
and Foundry Company, Pittsburgh, Pa., a cor-  
poration of Pennsylvania

Application May 26, 1928. Serial No. 280,681

18 Claims. (Cl. 80—4)

The present invention relates generally to strip mill plants and has to do more particularly with pulling the metal strip from the mill or mills of such a plant. An important feature of the invention is the employment of a power driven pulling drum which makes frictional contact with the strip and, acting by friction, draws the strip from the mill, frictional contact between the strip and the drums of the pulling machine being maintained by a slight pull upon that portion of the strip which has passed from the drum.

As developed in a machine, means are provided for giving the strip a good wrapping about, or contact engagement with, the pulling drum. Usually, other similar drums are provided in the machine for this purpose. These additional drums are also preferably power driven. Thus they not only guide the strip but they also apply further pull to the same. It, therefore, follows that the finished machine has at least two drums of which one, at least, is power driven. Obviously, more drums are employed where a greater pull is desired. In any given case, the number of power driven drums will be made to accord with the total pull required. In the present disclosure, four-drum and three-drum pulling machines are shown and described. These will illustrate the principles of the invention, and the requisite changes for more or fewer drums will be readily apparent to a designer skilled in this class of machinery.

The pulling machines herein disclosed are especially suited to continuous mill operation, and have particular value where the plant is operated with compressions and tensions such as contemplated by the method of my Patent No. 1,618,515, granted February 22, 1927.

Another feature of the invention resides in the arrangement of pulling machines and rolling mill stands wherein a reducing mill not only serves to reduce the strip passing through it but at the same time pulls upon that portion of the strip which is before the mill, that is on its feeding-in side, to maintain the strip taut enough for the proper operation of a frictional pulling machine through which the strip is passing on its way to the mill. This arrangement may be repeated several times in a continuous rolling mill plant, and thus, the strip maintained taut at all points as it travels through the mill. This arrangement fits in very nicely with the method of my Patent No. 1,618,515, before mentioned.

Having pointed out the general features and character of the invention, attention is now di-

rected to the following detailed description wherein the different features and aspects of the invention are presented. This description should be considered in connection with the accompanying drawings which illustrate the same. For a measure of the invention reference should be had to the appended claims.

Referring to said drawings, Fig. 1 is a plan view of a pulling machine constructed in accordance with the present invention and illustrating the embodiment employing four pulling drums; Fig. 2 is a sectional side elevation of the same, the plane of section being indicated by the line 2—2 of Fig. 1; Fig. 3 is a front elevation of the same; Fig. 4 is a plan view of a pulling machine constructed in accordance with the present invention employing three pulling drums; Fig. 5 is a longitudinal section through one of the pulling drums; Fig. 6 is a side elevation of the three-drum machine; Fig. 7 is a longitudinal section of the three-drum machine, the plane of section being indicated by the line 7—7 of Fig. 4; Fig. 8 is an elevation of the three-drum machine, parts being omitted as indicated by the line 8—3 of Fig. 4; and Fig. 9 is a diagram of a strip mill plant illustrating that feature of the invention wherein the mills cooperate with the pulling machines or the pulling machines cooperate with each other to prevent slackness in the strip while passing through the plant. Throughout these views, like characters refer to like parts.

Referring to the drawings in detail and more particularly to the four drum machine, illustrated in Figs. 1, 2, 3, and 5, I have a plurality of pulling drums 10, 11, 12, and 13 over which the strip 14 passes as it travels through the machine in the direction indicated by the arrows. In this instance the drums just mentioned are provided with, and keyed to, shafts 15, 16, 17, and 18 respectively. These shafts are in turn journaled respectively in adjustable bearings mounted upon the upper portion of upright housings 19 and 20, the housings being mounted upon the bed-plate 21. In the present instance the axes of the drum shafts 15, 16, 17, and 18 lie in the same horizontal plane, and clearance between the strip 14 and the drums 11 and 12 is provided by positioning the pulling machine a little below the general level of the passes of the mill. This gives the strip a slight downward inclination as it approaches the drum 10 and a slight upward inclination as it leaves the drum 13. The clearance between the strip 14 and the pulling drums 10 and 13 is provided, by making the drums 10 and 13 of slightly less diameter than the drums

11 and 12. This arrangement of drums provides a large arc of contact between the strip 14 and each of the drums. It is this contact through an appreciable arc that makes it possible for the drum to exert a pull upon the strip. In the arrangement shown, practically a maximum contact arc is provided for each drum.

It is entirely operative and practical in this machine to locate the axes of the drums 10 and 13 in a horizontal plane slightly above the horizontal plane in which axes of the drums 11 and 12 are located. This arrangement gives in a very simple manner the desired clearance between the strip and each of the four drums without setting the pulling machine at the lower level.

In this embodiment drum 10 is driven, by means of shaft 15, from an electric motor 22 through the agency of a speed reducer 23 and the connecting flexible couplings 24 and 25. In like manner, drum 11 is driven by means of shaft 16, from an electric motor 26 through the agency of a speed reducer 27 and the connecting flexible couplings 28 and 29. Again, in like manner, drum 12 is driven by means of shaft 17, from an electric motor 30 through the agency of a speed reducer 31 and the connecting flexible couplings 32 and 33. And finally, in like manner, drum 13 is driven by means of shaft 18, from an electric motor 34 through the agency of a speed reducer 35 and the connecting flexible couplings 36 and 37. Obviously, belting and pulleys might be used instead of speed reducers, where belts are employed they are preferably endless steel belts of the kind described and illustrated in my prior Patents Nos. 1,309,244 and 1,309,245, dated July 8th, 1919.

The drums 10, 11, 12, and 13 may be constructed in various ways and of different kinds of material. In the present instance, they are composed of metal, and, as more particularly illustrated in Fig. 5, each drum comprises an outer cylindrical shell 38, provided with a plurality of transverse webs 39 which are thickened at their centers to provide hubs 40. The latter are bored out to fit the shaft upon which the particular drum is located. These drums are secured to their shafts by any suitable means such as keys fitted into suitable keyways 40<sup>a</sup>. Their surfaces may be variously finished. In some instances the surface may be produced by merely turning down the metal. In other instances by turning and polishing. In others the drum may be turned with a slight crown at the middle to act as a guide for the strip. Or again with a thin layer of sheet cork 41. In the latter case, the cork is secured to the surface of the drum by a preparation of shellac gum dissolved in alcohol, or secured by some other suitable adhesive. The cork surface when used with the metal strip 14, provides a stronger frictional pull because of the high coefficient of friction between the cork and the metal being pulled. The cork covering is ordinarily dispensed with where the tension and consequently the pressures are high, but the same can be used to good advantage with relatively low pressures. This will be understood more fully when the mill arrangement of Fig. 9 is explained hereinafter.

Referring to the three-drum machine, illustrated more particularly in Figs. 4 to 8 inclusive, I have as before a plurality of pulling drums 42, 43, and 44, over which the strip 45 passes as it travels through the machine in the direction indicated by the arrows. In this instance, the drums just mentioned are provided with and

keyed to shafts 46, 47, and 48 respectively. These shafts are in turn journaled respectively in adjustable bearings mounted upon upright housings 49 and 50, the housings being supported by the bed-plate 51. In this embodiment, drum 42 is driven by means of shaft 46, from an electric motor 52 through the agency of a speed reducer 53 and the connecting flexible couplings 54 and 55. In like manner, drum 43 is driven by means of shaft 47 from an electric motor 56 through the agency of a speed reducer 57 and the connecting flexible couplings 58 and 59. And finally, in like manner, drum 44 is driven by means of shaft 48 from an electric motor 60 through the agency of a speed reducer 61 and similar connecting flexible couplings, one of which, designated 62, is shown in the drawings. The second coupling of this pair lies directly beneath the coupling 68, as the parts appear in Fig. 4, and, of course, in line with the shaft 48. Obviously, other arrangements of driving means might be used instead of motors, speed reducers and flexible couplings.

The drums 43, 44, and 45 may be constructed in the manner as described for the drums of the four drum machine. Or, the drums for either machine may be built up of ply-wood, paper, fibre or other suitable materials common in the construction of power pulleys. The drums for either machine may be designed and built in devious ways by those who are skilled in the power transmission field, in accordance with the general principles in use in the design and building of power pulleys. Or, when very heavy tractive effort is required, as in the case of making a heavy reduction in one or more mills, the pull of the drums may be very greatly augmented by introducing electro-magnetic coils into the drums and in otherwise applying the art of those skilled in the design and building of magnetic drums for separators.

Such magnetic drums are well known and need not be particularly described. Several companies are engaged in their manufacture. As illustrative, see, for example, Bulletin No. 14 of the C. G. Buchanan Co., Inc., 90 West Street, New York, New York, Bulletin No. 29 of Magnetic Manufacturing Co., Milwaukee, Wisconsin, and Bulletin No. 25-P of Dings Magnetic Separator Co., Milwaukee, Wisconsin, the latter being dated May, 1923.

The function of the speed reducer, in all cases, is to reduce the high rotative speed of the motors to the comparatively slow rotative speed of the drum. In so doing, the effort or pull of the motor is correspondingly increased at the drum. It is of course understood that the flexible couplings are securely keyed to the respective motor, speed reducer and drum shaft and that their function is to transmit the torque of the motor to the drum, even though the several shafts are not exactly in alignment.

In the case of the unit which includes the drum 44, the motor 60 and the speed reducer 61 for example, two slow shafts 64 and 65 are provided in the speed reducer 61, so that an upper drum 66 may be introduced in the pulling machine above the drum 44, and thus produce the relation of a pair of pinch rolls. Top pinch roll 66 is constructed of metal in accordance with the other drums heretofore referred to and is keyed to its shaft 67 in the same way that the lower drum 44 is keyed to its shaft 48. The flexible coupling 68 on the shaft 67 is similar in every respect to the flexible couplings shown.

These flexible couplings are well known and

need not be particularly described. For illustrations reference may be had to Catalogue No. 26 of Thomas Flexible Coupling Co. of Warren, Ohio, dated August 1925.

about 180 degrees arc of contact and by allowing the first and third drums to idle. The first and third drums would, therefore, in such case, not be connected to a driving means, and the second drum would exert all the pull.

It is the intention in the present case to make use of shunt wound motors with suitable speed controls. A type of control adapted for this class of work is one employing one main rheostat for simultaneously controlling all four motors and in addition an auxiliary rheostat in each of the lines to the three smaller motors, each auxiliary rheostat having a micrometer adjustment for small changes of speed. It is a characteristic of this installation when operated from the same source of power, or from regulated different sources of power, to exert a constant torque. The speeds of the three smaller motors will be precisely adjusted to the speed of the main motor by means of the above mentioned auxiliary rheostats.

It should be pointed out in this connection if a single motor should make an effort to run away with its drum the tractive resistance of the strip on the other drums automatically throws an added load on the run-away motor resulting in holding it back by the overload. Therefore, the tractive resistance of the strip operating in a predetermined amount on each drum constitutes an equalizing medium or a regulator for all the working motors.

In the diagram of Fig. 9, I have illustrated a strip mill plant wherein the four-drum and three-drum machines are employed. This diagram illustrates a continuous mill plant wherein the strip is fed and conveyed without interruption for long stretches of strip.

The strip, designated A, travels in the direction indicated by the arrows. It is fed between rolls B which may perform any desired function upon the strip as for example, flattening out the strip or pinching or frictionally gripping it to insure its being properly fed. In the latter case, the rolls B are positively driven and the strip is forced forward to the mill C. The latter is of the type which employs small reducing rolls backed by large backing up rolls. As the strip passes through the mill C it is reduced in thickness, and consequently elongated.

The strip then passes through mill D which also comprises small diameter compression rolls, and large diameter backing up rolls. Next to the mill D is a four-drum pulling machine E of the type illustrated in Fig. 1. This pulling machine applies a pull to the portion of the strip on the delivery side of the mill D.

After leaving the pulling machine E the strip passes through a mill F which is also composed of small diameter reducing rolls and large diameter backing up rolls. In passing through mill F the strip is further reduced in thickness, and consequently further elongated. After leaving mill F it passes through a three-drum pulling machine G which is like that illustrated in Fig. 4, except that the pinch roll 66, shafts 67 and 65, and coupling are all omitted.

The three-drum machine G does not exert the same degree of pull upon the strip as does the four-drum machine E. In other words, as the strip passes beyond the mill D, it is subjected to pulls which decrease in intensity. The speeds have been greatly increased however. Variations of speeds as between different pulling machines are cared for in the motor, the gearing or the diameters of the pulling drums. Naturally

5 In the case where the pulling drums and pinch roll requires excessive adjustment to accommodate varying strip thicknesses and to provide for excessive wear, the upright housings may be built along the lines of rolling mill housings and be provided with complete adjustable bearings, counter balances and screw downs as are well known in the rolling mill art, without departing from the field of this invention. Likewise, in the case of the adoption of the rolling mill type of design it may be advisable to have a wider range of adjustment than is provided by the usual flexible coupling 59 for example. In such a case the motor and speed reducer will be placed at a greater distance from the pulling machine, to provide for mill type of couplings and spindle, between the speed-reducer and the corresponding drum. These couplings and spindles are of many types ranging from the simple crab-coupling, to the patented universal couplings all of which are well known to men skilled in the rolling mill art.

The pinch roll 66 cooperates with the pulling roll 44 at the outgoing end of the pulling machine. It is not necessary to employ this pinch roll 66 in all instances. As before pointed out it is necessary in the non-magnetic drums to maintain a pull on that portion of the strip which has passed the pulling drums in order that the friction drums will perform their function of augmenting the pull, as we shall see more fully when we consider the mill plant arrangement of Fig. 9. The pinch roll structure of the three-drum machine, that is, rolls or drums 66 and 44, may be used in some instances for the purpose of furnishing this initial slight pull upon the distant end of the strip.

In the three-drum machine the drum shafts 42 and 44 are located some distance above the bed-plate 51 while the central drum shaft 47 is located at a lower level. By this arrangement the shafts and their drums occupy what may be called a staggered relation to the general direction of travel of the strip 45. Such an arrangement insures an increased amount of wrap around the three drums, there being in the design shown about 180 degrees wrap about the central drum 43 and about 90 degrees wrap about each of the other drums 42 and 44.

In the four-drum machine the drums 10, 11, 12, and 13 have their shafts positioned in practically the same horizontal plane but the way in which the strip 14 is threaded over, under and around the drums gives large arcs of contact between the strip and the drums. This threading of the strip gives the desired frictional contact areas between the drum surfaces and the strip. The arrangement here gives greater contact areas than the arrangement of the three-drum machine. In both machines the advantage is obtained by giving the strip decidedly diverting turns from its general direction of travel. Functionally considered, the drums of both machines are staggered with reference to each other. It should be observed that all drums of a single machine have substantially the same surface speed with a very slight slowing up occurring due to the decreasing stress in the strip.

Should a condition arise where it is necessary to have only a slight pull on the strip, the same can be obtained from a three-drum machine by positively driving the second drum which has

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

the thinner strip after several rollings admits of using smaller diameter drums in the second pulling machine than were used in the first pulling machine.

5 After passing pulling machine G, the strip passes through the mill H which is also of the four high variety, and may be the same in construction as mill D. Following the mill H, the strip again passes through a three-drum pulling machine J of the construction illustrated in Fig. 4. This time the pinch roll 66 with its cooperating parts are employed in conjunction with the adjacent drum 44. By the use of the roll 66 and drum 44 which in reality constitute pinch rolls, 10 the strip is given its final advance. Beyond the pulling machine J the strip may be cut off, coiled, or otherwise disposed of as desired. 15

The pinch roll action of roll 66 and drum 12 applies an initial pull to the strip A. As we move along the strip toward its feeding-in end, we find that this initial pull is added to by the pull exerted by the pulling machine J. Then the strip, after passing through mill H is again acted upon by pulling machine G to exert a pull on the portion of a strip leaving the mill F. Between 25 the mills F and D the four-drum pulling machine E exerts a pull upon the portion of the strip leaving the mill D. The initial pull exerted by the roll 66, and drum 44 is sufficient to maintain at all times good contact between the strip and the pulling drums of the machine J. 30

This pull on the strip is never reduced to the point where there is not good frictional engagement between the strip and the drums of each of the pulling machines. Thus, the portion of 35 the strip on the feeding-in side of the pinch roll 66 and drum 44 is taut enough to enable machine J to pull on the portion of the strip leaving mill H; again, the portion of the strip on the feeding-in side of mill H is taut enough to enable machine G to pull on the portion of the strip leaving mill F; again, the portion of the strip on the feeding-in side of mill F is taut enough to enable machine E to pull on the portion of the strip leaving mill D; 40 and finally the portion of the strip between mills C and D and the portion between mill C and rolls B are held under tension. Thus at no point is there any slack allowed in the strip. 45

Preventing slack insures proper frictional pulling contact between the pulling machine drums and the strip. If slack were permitted to a point 50 where the drums were not engaged then, of course, there would be no pull upon the strip by those particular drums. But from what has been said it will be seen that but a slight pull by roll 55 66 and drum 44 will suffice to keep all machines operating as contemplated. It will also be clear that the several drums of the pulling machines act cumulatively upon the strip to bring about its advance. 60

Instead of the motor control heretofore mentioned, it will of course be understood that other electric control systems may be employed. There are many such now in use in various industries, 65 notable examples being found amongst spinning mills, rolling mills and the like.

From the diagram, it will be seen that the pulling machine E in conjunction with the mill D provides for reduction and elongation of the strip in accordance with the method set forth in my Patent No. 1,618,515 previously referred to. Similarly, pulling machine G may cooperate with mill F to bring about reductions and elongations according to the same method. The same is true of 70 75

the set formed by the mill H and the pulling machine J.

It will be understood that the pull of any of these pulling machines may be varied by regulating the torque of the motors which drive the drums in the case of the three-drum machine. The pull may be varied also by positively driving one or more of the drums. Furthermore, a certain regulation may be obtained by varying the pull exerted by the pinch roll 66 and drum 44. A further regulation may be obtained by applying cooperating torque to the rolling mills themselves. 80 85

The arrangement of Fig. 9 is merely illustrative, and it is obvious that many other arrangements may be used and still the present invention employed. It should also be noted that the mills may be driven independently of the strip or not, as desired. Whether the mill, such as mill H of Fig. 9 exerts a pull on the strip by reason of a torque applied to its roll necks or merely allows tension to pass through from its pulling machine, as machine J, is immaterial so far as the effect of the resulting tension on the previous pulling machine, as machine G, is concerned. The degree of pull on the pulling machine is of no importance, provided only that it is sufficient to provide the necessary frictional engagement between strip and drum. 90 95 100

From what has been said, it will be seen that I have produced a novel strip mill plant arrangement as well as a novel pulling machine capable of embodiment in different forms and with different numbers of pulling drums. It will also be understood that although I have described the material worked upon as "strip", yet the same might be any relatively wide flat material which is sufficiently thin and of sufficient length to pass over the pulling drums in the manner pointed out herein. Such flat elongated material might differ in transverse section from the rectangular transverse section illustrated. It is, of course, necessary that the material be thin enough to bend around the drums when threaded through the mill stands and the operating machines. As the material to be worked upon increases in thickness the diameters of the drums must also be increased. Preferably the drum is somewhat wider than the strip, and, as before stated, is preferably crowned very slightly in the center. 105 110 115 120 125

Although the material out of which the parts of the pulling machines are composed is preferably metal throughout, yet in certain instances it may be desirable to employ drums of wood built up after the manner of wooden pulleys. In other instances the wood drums have their peripheries covered with leather, as pointed out relative to cork earlier in this disclosure. The cork covering upon the metal drums is desirable where the pressures are relatively low, and the uncovered metal or wood surfaces are preferable where the pressures are high. Thus, in the arrangement of Fig. 9 the drums of pulling machine E might have uncovered, smooth or polished magnetic or non-magnetic surfaces, whereas the drums of pulling machines G and J might be covered with leather or cork in the manner illustrated in Fig. 5. It may be mentioned here that the cork serves to protect the strip against scratches where it becomes more highly finished in the later passes. 130 135 140 145

It may be convenient in some cases to drive the several drums of my pulling machine with shafting and gearing using equalizing gearing for 150

equalizing the possible slight variations in speed as between the different drums, and thus make use of but a single motor.

drums, pinch roll means for exerting a pull on the strip on the delivery side of said drums and delivering the strip in elongated condition, and independently controlled driving means for severally driving said drums.

It will be obvious in carrying out my invention that many other alterations and modifications might be made in the particular disclosure presented without departing from the spirit and scope of my invention. I, therefore, do not wish to be limited to the exact details of the present disclosure, but aim to cover all such alterations and modifications by the terms of the appended claims.

6. In a plant of the class described, a mill for rolling metal strip, at least three positively driven drums for frictionally engaging the strip at different points in its travel to cumulatively pull on the strip to advance the same, the drums being positioned to divert the strip from its general direction of travel to increase the areas of contact between the strip and the drums, pinch roll means for exerting a pull on the strip on the delivery side of said drums and delivering the strip in elongated condition, and independently controlled driving means for severally driving said drums.

What I claim as new and desire to secure by a patent of the United States is:

7. In a plant of the class described, a mill for rolling metal strip, pinch roll means on the delivery side of said mill for exerting a pull on the strip passing from said mill and delivering the same in elongated condition, and means intermediate of said mill and said first mentioned means to add to the pull exerted by said first mentioned means, said intermediate means having a series of drums positioned to divert the strip from its general direction of travel, and means for positively rotating one of said drums to advance the strip.

1. A machine for pulling metal strip from a rolling mill comprising at least three positively driven drums for frictionally engaging the strip at different points in its travel and cumulatively acting to pull the strip from the mill, said drums having parallel axes and being positioned so as to wrap the strip over a portion of the periphery of each of said drums, and independently controlled driving means for severally driving said drums.

8. In a plant of the class described, a mill for rolling metal strip, pinch roll means on the delivery side of said mill for exerting a pull on the strip passing from said mill, means intermediate of said mill and said first mentioned means to add to the pull exerted by said first mentioned means, said intermediate means having a series of drums positioned to divert the strip from its general direction of travel, and means for positively and independently rotating a plurality of said drums to advance the strip.

2. In a plant of the class described, a mill for rolling metal strip, a positively driven drum on the delivery side of said mill for frictionally engaging and pulling the strip from the mill, means for engaging the strip on its way from said mill to said drum to divert the same from a direct path to thereby increase its contact area with the periphery of said drum, and pinch roll means for exerting a pull upon the strip on the delivery side of said drum and delivering the strip in elongated condition.

9. In a plant of the class described, a mill for rolling metal strip, a pulling drum on the delivery side of said mill for exerting a pull on the strip passing from said mill, said pulling drum being dependent for its operation upon frictional contact between said strip and drum, means for leading the strip to said drum and diverting it as it passes therefrom to provide a substantial frictional contact area between said drum and strip, and means for engaging the strip by rolling contact after it leaves said pulling drum, said engaging means being positioned to pull the metal strip and operating to maintain sufficient tension on the strip to enable said drum to pull the same and to deliver said strip in elongated condition.

3. In a plant of the class described, a mill for rolling metal strip, a positively driven drum on the delivery side of said mill for frictionally engaging and pulling the strip from the mill, a second drum having its axis parallel to that of said positively driven drum for engaging the strip on its way from the mill to said positively driven drum, said drums engaging the strip at points in its travel spaced apart and being positioned to provide diverting turns in the strip to thereby increase the contact areas of the strip with said drums respectively, and pinch roll means for exerting a pull upon the strip on the delivery side of said drums and delivering the strip in elongated condition.

4. In a plant of the class described, a mill for rolling metal strip, a positively driven drum on the delivery side of said mill for frictionally engaging and pulling the strip from the mill, and other drums having their axes parallel to that of said positively driven drum, one of said other drums engaging the strip on its way from said mill to said positively driven drum and a second of said other drums engaging the strip after it leaves said positively driven drum, said drums being positioned with reference to the general direction of travel of the strip to increase the contact areas of the strip with said drums, pinch roll means for exerting a pull upon the strip at the delivery side of said drums and delivering the strip in elongated condition, and independently controlled driving means for severally driving said drums.

10. In a plant of the class described, a first mill for rolling metal strip, a first pulling machine on the delivery side of said first mill for exerting a pull on the strip passing from said first mill, a second mill for rolling the strip after it leaves said first pulling machine, a second pulling machine on the delivery side of said second mill for exerting a pull on the strip passing from said second mill, said pulling machines having drums for engaging the strip and being dependent for their operation upon frictional contact with the strip, means associated with each of said pulling machines for diverting the strip as it engages said drums to provide an arcuate contact area in each instance between the drum and the strip to enable said operating frictional contact to be made, means positioned on the delivery side of said second pulling machine operative to pull the

5. In a plant of the class described, a mill for rolling metal strip, a plurality of positively driven drums for frictionally engaging the strip at different points in its travel from the mill and cumulatively acting on the strip to advance the same, said drums being positioned with reference to the general direction of travel of the strip to increase the contact areas of the strip with said

80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150

metal strip to exert and maintain a tension on the strip, said maintained tension enabling both pulling machines to exert a pull on the strip, and independently controlled driving means for severally driving said pulling machines.

11. A machine for pulling metal strip from a rolling mill comprising a plurality of drums positioned to engage the strip at different points in its travel, means for causing the strip to wrap itself about said drums in its travel through the machine, said drums depending upon the friction between them and the strip to pull the strip coming from the mill, means for tensioning the strip at a point beyond said drums from the mill to produce the requisite operating friction for said drums, and independently controlled driving means for severally driving said drums.

12. A machine for pulling metal strip from a rolling mill comprising a plurality of drums for frictionally engaging the strip at different points in its travel and cumulatively acting to pull the strip coming from the mill, said drums having parallel axes and being positioned so as to wrap the strip over a portion of each of said drums, means for tensioning the strip at a point beyond said drums from the mill, and independently controlled driving means for severally driving said drums.

13. In a machine for pulling metal strip from a mill, means for exerting a pull on the strip on the delivery side of the mill, two drums between said mill and means, said drums having pulling contact with the strip, said drums having parallel axes and being positioned so as to wrap the strip over a portion of each of said drums, and means for continuously applying a pulling torque to said drums independently one of the other to compensate for elongations of the strip in passing from one drum to the other.

14. In a plant of the class described, a series of mills and pulling machines in tandem through which strip is adapted to pass in one direction, each said pulling machine pulling the strip from one of the mills; each pulling machine including a plurality of drums for frictionally engaging the strip at different points in its travel and acting cumulatively to pull the strip from the associated mill, the drums of each pulling machine having parallel axes and being positioned so as to wrap the strip over a portion of each of said drums; means for tensioning the strip near its delivery end; electric motors for severally driving said pulling machine drums; and independent control means for controlling the speed of each of said electric motors.

15. In a plant of the class described, a mill for rolling metal strip, means on the delivery side of said mill for exerting a direct pull on the strip and delivering the strip in elongated condition therebeyond, a pulling machine intermediate of said mill and means, said pulling machine serving to add to the pull on the strip exerted by said means, said pulling machine having a plurality of drums frictionally engaging the strip at tandem points and cumulatively exerting a pull thereon, said drums having parallel axes and being positioned so as to wrap the strip over a portion of each of said drums, electric motors for severally driving said drums, and independently controlled means for controlling the speed of each of said electric motors.

16. The method of pulling upon metal strip passing through a plurality of mill stands as in a continuous mill plant, which method consists in pulling upon the strip at points alternating with the mill stands, there being at least one pull per stand and that pull being on the delivery side of the stand, and the pulls being independently controlled to take up stretch in the strip by a maintained tension at all points from the first mill stand to the last pull point, said tension varying from a minimum at the last pull point to a maximum at the first mill stand.

17. The method of pulling upon metal strip passing through a plurality of mill stands as in a continuous mill plant, which method consists in pulling upon the strip at a plurality of points on the delivery side of each mill stand and varying the pulls at said points independently of each other to compensate for elongations of the strip between the mill and the first pull point, between the first pull point and the second pull point, and so on through the last pull point, thus maintaining a pull on the strip at all points from the first stand to the last pull point.

18. The method of pulling upon metal strip being reduced by a rolling mill, which method consists in pulling upon the strip on the delivery side of the mill at a plurality of points and varying the pulls at said points independently of each other to compensate for elongations of the strip between the mill and the nearest pull point, between that pull point and the next, and so on throughout all the pull points, to thereby insure a continuous pull at all times throughout the length of the strip in its passage through the mill.

WILLIAM C. CORYELL.

5

10

15

20

25

30

35

40

45

50

55

60

65

70

75

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150