Feb. 6, 1940. T. SENDZIMIR 2,189,329

TENSION ROLLING MEANS

Original Filed July 16, 1935 3 Sheets-Sheet 1

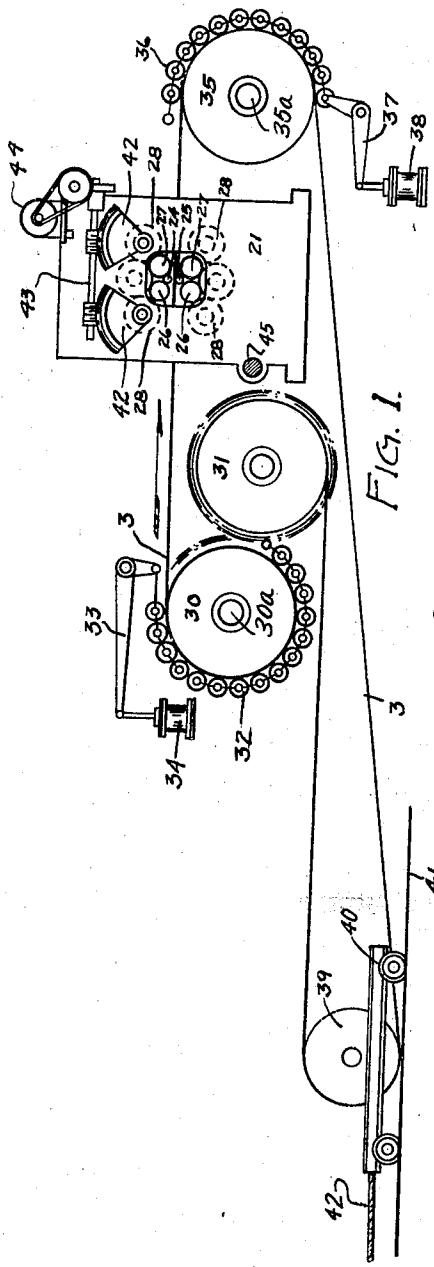


FIG. 1.

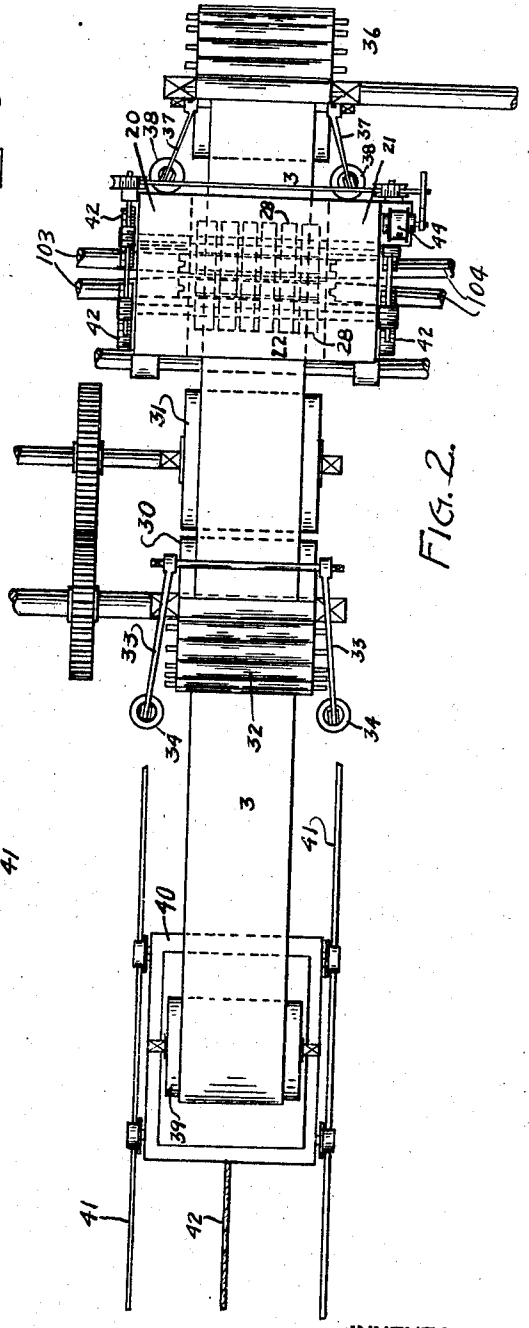


FIG. 2.

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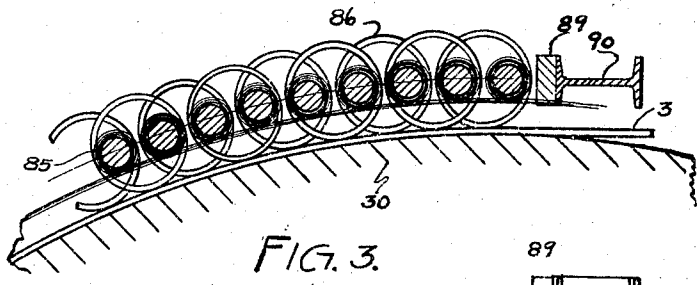


FIG. 3.

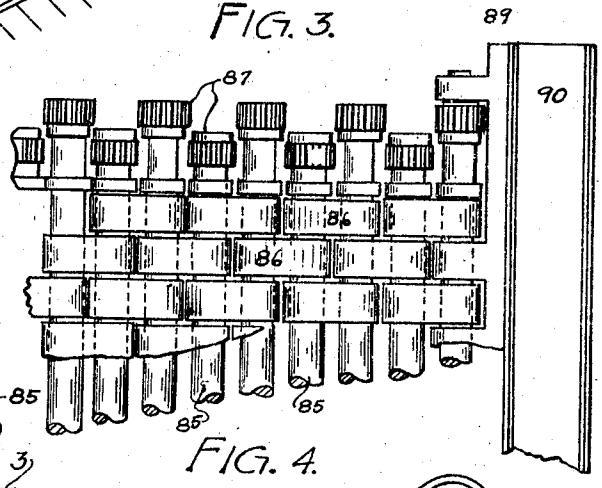


FIG. 4.

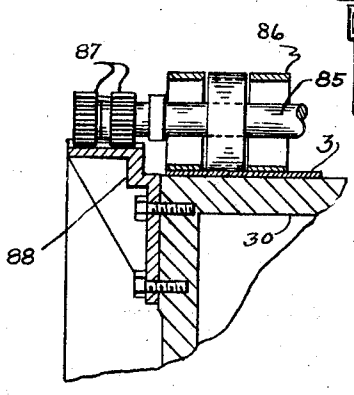


FIG. 5.

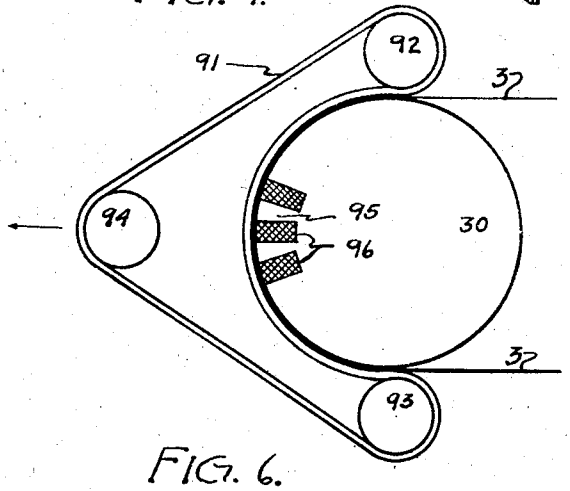


FIG. 6.

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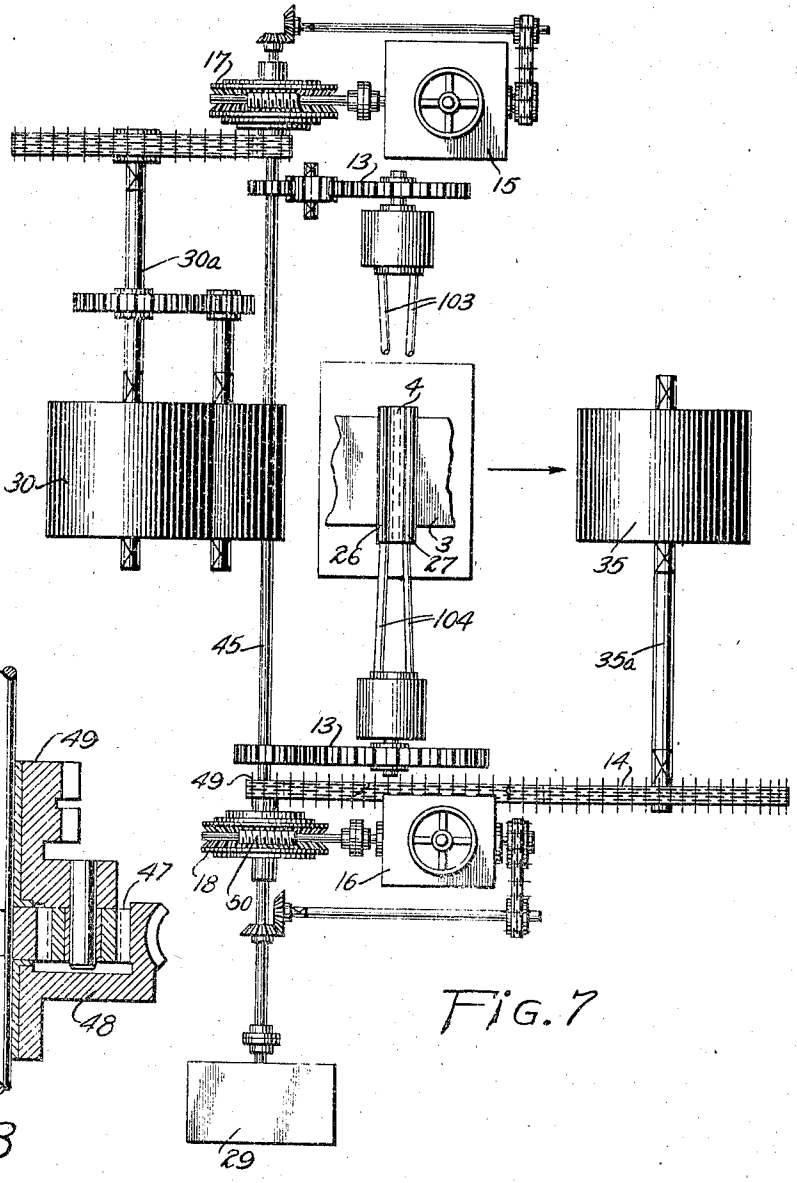


FIG. 7

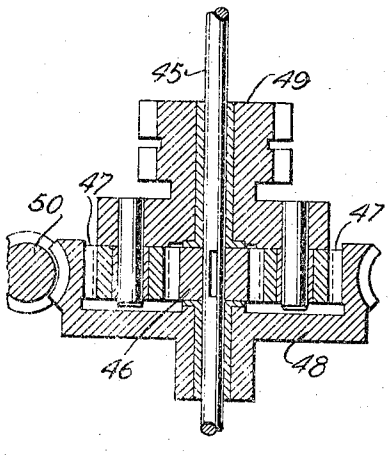


FIG. 8

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UNITED STATES PATENT OFFICE

2,189,329

TENSION ROLLING MEANS

Tadeusz Sendzimir, Katowice, Poland, assignor to The American Rolling Mill Company, Middletown, Ohio, a corporation of Ohio

Original application July 16, 1935, Serial No. 31,697. Divided and this application June 4, 1936, Serial No. 83,534

17 Claims. (Cl. 80—32)

My invention relates to the rolling of metal strips of a wide variation in widths and thickness, in which tension applied to the piece is either part or all of the working force applied thereto. This application is a division of my application Serial No. 31,697, filed July 16, 1935 which matured into Patent No. 2,169,711 on August 15, 1939, and my copending application Serial No. 31,698, filed of even date therewith, is also a division thereof.

It is the object of my invention to provide a tension rolling practice in which the metal strip is extended during each pass by a definite amount in length, irrespective of the pulling force applied thereto. I am thus enabled safely and regularly to apply tensioning forces which could not be applied according to existing practice, and also I avoid defective operations incident to non-uniform material used as a starting material.

It is evident that if a metal strip is permitted to pass toward a pair of working rolls, either idle or driven at a definite speed per minute, and the piece is drawn out of the working rolls at a definite speed per minute, that the difference between the entering speed and the exit speed is an absolute measure of the elongation of the strip.

I will further describe the general aspects of my method by reference to diagrams, and will describe mechanisms suitable for carrying out my method, the inventive features of my invention being set forth in the appended claims.

In the drawings:

Figure 1 is an elevational view of an apparatus suitable for the practicing of my invention.

Figure 2 is a plan view thereof.

Figure 3 is a sectional view of an exemplary form of feeding device.

Figure 4 is a plan view thereof.

Figure 5 is a partial transverse section.

Figure 6 illustrates another type of pulling device in semi-diagrammatic elevation.

Figure 7 is a plan view more clearly showing the drives for the various mechanisms.

Figure 8 is a sectional view of a planetary arrangement which may be employed in connection with the drives.

In carrying out my invention I roll a metal strip in such a way that the elongation thereof remains constant. To this end, in the apparatus aspect of my invention, I provide a strip reducing and elongating device, such as a mill, and a positive feeding-in device therefor, as well as a positive feeding-out device, the two last mentioned devices being positively driven with a ratio of motion corresponding to a predetermined elongation. The combination of the two feeding devices, positively geared together, by way of example, and acting concurrently at different speeds on the same strip, the speeds increasing in the direction of movement of the strip, is a combination which will exert tension on the strip. Since pure stretching or elastic elongation is to be avoided as much as possible, the operation of the system depends upon the elongating device, namely, the mill, adapted to exert transverse pressure on the strip. Such a mill will have both a forward and a back tension exerted upon it through the action of the feeding-in and feeding-out devices. Since these devices operate in a predetermined ratio of motions, to give a desired elongation, the system is operative so long as the mill produces an elongation substantially equivalent to that predetermined.

It is well known that strip for cold rolling as commercially produced, is subject to sporadic variations both as to temper and gauge. In the manufacture of finished stock, particularly for automotive and like uses, it is imperative that gauge variations originally occurring in the starting pieces be not exaggerated in the finished product. An operative situation is attained if gauge variations in the finished piece, considering its thinness, are not substantially more than proportional to gauge variations in the starting piece, considering its thickness. An ideal situation would be approached more closely by the securing of a finished piece in which the gauge variations were less than the proportional relationship referred to.

My system is self-compensating as respects these factors. If the elongation produced by the mill tends to increase, as by the rolling of a spot of softer temper in the strip, the tension between the mill and the feeding-out device will decrease, thus tending to lessen the forces producing elongation. If the elongation produced by the mill tends to decrease, as when a thicker spot of the strip or a spot of harder temper reaches the mill, the tension will increase, thus tending to increase the elongation. The back tension tends to vary with the forward tension, as will be clear, to complete the compensation aforesaid. The relationships between tension, screw pressures in the mill and elongation, are known. Thus it will be obvious that with the variations in tension which occur as aforesaid, the compensatory effects take place in the mill. These compensatory effects counteract the normal tendencies for thinner or softer parts of the strip to be elongated more than in proportion to the general elongation, and

for harder or thicker parts of the strip to receive less than their proportional elongation.

Nevertheless, because the elongation is constant, as determined by the organization of apparatus to which I have referred, the tension variations which permit uniform elongation are controlled so that the danger of breaking the strip is avoided. It would not be possible by any other system of which I am aware, artificially to produce varying tensions in the strip without serious danger of breakage. In my system the specific elongation directly affects the tension, the general elongation remaining constant, so that I do not encounter the difficulties which arise when strip moving instrumentalities are attempted to be controlled as to speed in accordance with measurements of a variable condition. A primary one of such difficulties is to be found in the fact that the response of the controlled apparatus is delayed so that the controlling condition frequently has altered by the time the compensatory effect comes into play. In my system the active devices are so correlated that there is no intermediary agency between cause and effect in the controlling and controlled agencies.

The general features of my invention are described and claimed in my copending applications aforementioned, and the purpose of the present application is to describe and claim certain particular features thereof.

I have illustrated as an embodiment of a device suitable for my practice, a mill having as its housing a single casting forming vertical columns **20**, **21**, and cross members **22**. The working rolls **24**, **25**, are to be driven, and the thrust upon them is transmitted by a pair of idler rolls **26** and **27**, two for each working roll, to backing up devices in the form of a series of shafts with rollers upon them, generally indicated at **28**. As described in my application Serial No. 31,698, the shafts may be supported on a series of journal members whose outer peripheries are curved eccentrically to the journals and seated in similarly curved channels in the frame cross members. By adjustably rocking these journal members the mill is adjusted as to its pass.

As an entrance feeding device, I have illustrated in Fig. 1 and Fig. 2, two drums **30** and **31** close together mounted respectively on shafts **30***a* and **31***a*; the drum **30** being driven and the strip **3** passed three-quarters around each of them. The drums may be faced with friction material, and geared together if desired. The function of the drum **31** in the particular embodiment shown is that of causing the material to wrap about the surface of the drum **30**, and to change its direction for the purpose of the arrangement shown in Fig. 1. In order to increase the frictional engagement of the strip **3** with the drum **30**, I provide a sheath **32**, fixed at one end to a suitable immovable support, and having means at the other end to draw it tightly about the surface of the cylinder **30**. Exemplary means are indicated more or less diagrammatically in Fig. 1, as a bell crank **33**, and a fluid pressure cylinder **34** for operating it. As an exit feeder I have illustrated a mechanism, the essential detail of which is a driven drum **35**, mounted on a shaft **35***a* with a sheath or chain of rollers **36** about its periphery, which chain can be tightened around the drum by the power mechanism **37**, **38** and the rollers of which are driven by being geared to the drum.

The strip **3** passes from the feeding-in device, through the mill and through the feeding-out device. If the strip is an endless strip, there may be provided a take-up means consisting of a drum **39** mounted on a carriage **40**, operating on tracks **41**. The strip **3** passes around this drum, and the carriage has applied to it a tensional force through a cable **42**, by some suitable means not shown. Since the tensioning of the strip as it is being actively worked in the mill is accomplished by the feeding-in and feeding-out devices, it is not necessary to exert any tension on the strip at either end of the mill beyond these devices, excepting such tension as may be required to take up the strip, or to help to hold it against the frictional driving means of the feeding-in and feeding-out devices.

In Figs. 3 to 6, inclusive, I have illustrated certain forms of pulling devices. Referring to Figs. 3, 4, and 5, the numeral **30** illustrates a feeding drum. The strip is again illustrated at **3**. The sheath or device for holding the strip tightly against the drum **30** comprises a series of shafts **85**. These shafts are formed into a chain-like structure by being interlinked at intervals throughout their length by means of ring members **86**. These ring members alternately couple adjacent shafts. Preferably these shafts bear gear members **87** at their ends, which mesh with a gear member **88**, bolted or otherwise fastened to the drum **30**. Thus these shafts tend to rotate as the drum **30** rotates, and through their rotation to impart movement to the rings **86**. This sheath arrangement is supported at one end in journaling means **89** for the last shaft, which journaling means are attached to a fixed support **90**. The other end is similarly provided with journaling means attached to the power tensioning arrangement indicated at **33** and **34**, or **37** and **38** in Fig. 1. As the sheath is tensioned in this way, the ring members **86** tend to become elongated. Great pressure may thus be exerted in holding strip **3** against the drum **30**, without at the same time building up frictional resistance to the movement of the strip **3** with the drum **30**.

I have shown in Fig. 6 another type of feeding device, in which the drum **30**, around which the strip **3** passes, is provided with a flexible external sheath **91**, which is endless, and which passes over pulleys **92** and **93** adjacent the drum **30**, and a pulley **94** interspaced therefrom, which pulley is mounted both for rotation and for sliding movement. The sheath member **91** may be tensioned against the drum **30** by pulling outwardly upon the pulley **94** in the direction of the arrow. While great pressure may be exerted upon a drum in this way, the sheath **91** is adapted to move with the drum so as not to retard the movement of the strip **3**.

Other types of feeding devices may likewise be employed. By way of example, the drum **30**, as indicated at **95**, may be shaped to provide core sections, with windings **96** positioned therein so as strongly to magnetize the surface of the drum. This alone has been found sufficient to hold the strip **3** strongly thereto, where the strip **3** is fairly thick. Where the strip **3**, however, is relatively thin, there may not be a sufficient mass of the metal in the strip to be held to the magnetized drum with sufficient strength for my purpose. Where a magnetized feeding device is to be used with thin strip therefore, I prefer to make the sheath member **91** of magnetizable metal, having a relatively heavy mass. This can be accomplished by using for the sheath member **91**, iron or steel link chain of the type used in chain link drives.

I preferably employ a single power source for both pullers and for driving the rolls. This is indicated as a motor 29 in Fig. 7, which is geared to the rolls as at 13 to drive them in opposite directions. This motor is also directly coupled to the exit pulling device as at 14; and the exit pulling device is thus coupled to the entrance pulling device. In the coupling of the feeding in and feeding out devices, I employ adjustable change gear mechanisms 17 and 18, preferably in the form of a differential gear, the planetary elements of which are controlled by oil-operated motor-generator devices, 15 and 16 respectively. These matters are more fully discussed in my said Patent No. 2,169,711.

The drum 30 is driven through a shaft 30*a*, and the drum 35 is driven through a shaft 35*a*. The pairs of rolls 26 and 27 are driven respectively by the pairs of shafts 103 and 104.

The differential gearing device is shown in my application, Serial No. 742,075 filed August 30, 1934. I have indicated the gearing in general for driving the exit puller as 16, and the gearing for driving the entrance puller as 15. I have shown also in connection with each set of gearing an oil pump and oil motor device for controlling the differential element. I will now briefly describe these parts.

Each differential includes a pinion 46 fixed on the drive shaft, driving a series of planetary pinions 47, which in turn mesh with an internal gear 48, which is loose on the shaft 45, the external teeth of which form part of the drive. The planetary pinions are mounted on the web of a sprocket 49, idle on the shaft of the pinion 46. The gear 48 is held fast or driven by a worm 50, which is, in turn, driven by the oil motor generator transmission.

The oil device includes two similar elements, one pumping oil and the other driven by the oil pumped. The pump element is driven from some element of the drive which is convenient. A good form of device is one in which a series of pistons are driven around in a frame having cylinders for the pistons. Whether the pistons move in and out depends on the position of an eccentric ring that can be brought into contact with the piston rods. Devices of this character are known in the art.

The worm 50 either holds the gear member stationary, or drives it in one direction or the other. This controls the speed of motion transmission between the drive shaft 45 and the gear 49. The shaft 45, as shown in Fig. 7, is the drive shaft from the motor 29, and in the respective planetary gear arrangements the gear 49 is the gear which is coupled, as by a chain drive, to the feeding-in or feeding-out devices.

In the specific embodiments of my invention which I have herein described, I have illustrated the rolling of an endless band of metal. It will be understood that my invention is not restricted thereto. It will be understood that my arrangement is equally as well adapted for the rolling of continuous supplies of metal which are not endless, in the sense that opposite ends are joined together. Thus in feeding my mill, separate strips or sheets may be welded together before the material is fed to the mill, and finished pieces may be cut off after the material has passed through the mill. The forward and reverse rolling may, of course, be practiced upon any length of material in the mill, and the mill may then be set up and operated for the rolling of discontinuous lengths of metal. However, it will be understood that in the rolling of discontinuous lengths, there is bound to be some end wastage, for which reason I prefer to roll a continuous supply, at least so far as the mill and feeding devices are concerned. Different types of pulling devices may be employed, and with different types of pulling devices the exertion of such tension on the strip ahead of the feeding-in device and beyond the feeding-out device, as may be necessary for the operation of the pulling devices, will be within the skill of the worker in the art to provide.

In the companion applications I have claimed the process aspects of rolling, as respects the matter of keeping the elongation constant, as well as certain broad apparatus aspects having to do with this particular feature. In this application I intend to cover certain of the mechanical elements and combinations. Inasmuch as modifications may be made in my invention without departing from the spirit thereof, it will be understood that the appended claims are not limited otherwise than by their express terms.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a tension rolling mill having means for taking up the elongation of the strip, feeding means having substantially no reducing function and located between the bite of the reducing rolls and the take up means, said feeding means comprising a rotating drum, power means to drive said drum, anti-friction means for holding a strip of metal in frictional contact with said drum to impart a predetermined linear velocity to the strip, said means comprising a flexible sheath having a fixed support at one end, and a movable support at the other end, and power means for actuating said movable support, said sheath comprising a plurality of rolls disposed in parallelism with the axis of said drum, and flexible means interconnecting said rolls.

2. In a tension rolling mill, feeding means having substantially no reducing function, said feeding means comprising a rotating drum, power means to drive said drum, and anti-friction means for holding a strip of metal in frictional contact with said drum, said means comprising a flexible sheath having a fixed support at one end, and a movable support at the other end, and power means for actuating said movable support, said sheath comprising a plurality of rolls disposed in parallelism with the axis of said drum, flexible means interconnecting said rolls, and means for rotating said rolls at peripheral speeds bearing a fixed relationship with the peripheral speed of said drum.

3. In a tension rolling mill, feeding means having substantially no reducing function, said feeding means comprising a rotating drum, power means to drive said drum, and anti-friction means for holding a strip of metal in frictional contact with said drum, said means comprising a flexible sheath having a fixed support at one end, and a movable support at the other end, and power means for actuating said movable support, said sheath comprising a plurality of rolls disposed in parallelism with the axis of said drum, flexible means interconnecting said rolls, and means for rotating said rolls at peripheral speeds bearing a fixed relationship with the peripheral speed of said drum, said last mentioned means comprising gears on said rolls and a gear on said drum meshing therewith.

4. A flexible sheath for holding sheet metal

in frictional engagement with a feeding drum, comprising a plurality of rolls adapted to be disposed in parallelism with the axis of said drum, relatively flexible metal rings encircling adjacent pairs of said rolls, fixed supporting means for one end of said sheath, and movable means for the other end of said sheath.

5. A feeding device for tension rolling mills, said feeding device comprising a drum, power means for rotating said drum, a flexible sheath surrounding a portion of the arc of, said drum and adapted to press a strip of metal against said drum throughout said portion of said arc, means for pressing said sheath against said drum and means for providing movement of said sheath with said drum, there being less than a single convolution of said strip in contact with said drum.

6. A feeding device for tension rolling mills, said feeding device comprising a drum, power means for rotating said drum, a flexible sheath surrounding a portion of the arc of said drum and adapted to press a strip of metal against said drum throughout said portion of said arc, means for pressing said sheath against said drum and means for providing movement of said sheath with said drum, said means comprising auxiliary drums, said sheath passing around said auxiliary drums, two of said auxiliary drums being disposed on opposite sides of said drum and thus holding said sheath against said drum, another of said auxiliary drums being movable toward and away from said drum to vary the tension on said sheath, there being less than a single convolution of said strip in contact with said drum at all times.

7. A feeding device having substantially no reducing function and intended for use in tension rolling, said feeding device comprising a drum, a magnetizable sheath traveling with said drum and outside a strip of metal to be fed thereby for holding said strip against said drum power means for rotating said drum, and means for magnetizing the surface of said drum to hold said strip of metal and said sheath thereagainst.

8. A feeding device having substantially no reducing function and intended for use in tension rolling, said feeding device comprising a drum, power means for rotating said drum, means for magnetizing the surface of said drum to hold a strip of metal thereagainst, means providing a relatively large magnetizable mass for increasing the effective force of magnetism on said strip, and means for providing movement of said last mentioned means with said drum and with said strip.

9. A feeding device having substantially no reducing function and intended for use in tension rolling, said feeding device comprising a drum, power means for rotating said drum, means for magnetizing the surface of said drum to hold a strip of metal thereagainst, means providing a relatively large magnetizable mass for increasing the effective force of magnetism on said strip, and means for providing movement of said last mentioned means with said drum and with said strip, said means comprising auxiliary drums, a band of magnetizable material passing around said auxiliary drums, two of said auxiliary drums being disposed on opposite sides of said drum and thus holding said band against said drum.

10. In a tension rolling mill, means for simultaneously propelling and tensioning that portion of the strip which lies between the bite of the reducing rolls and said means, said means comprising a rotating drum, common power means for imparting a rotating motion to the rolls at a certain speed and for simultaneously imparting a rotating motion to said drum at a speed bearing a definite relation to the speed of said rolls, and means for holding a single strip of metal in frictional contact with less than 360 degrees of arc of said drum.

11. In a tension rolling mill, means for tensioning the strip by imparting to it a motion at a speed correlated to the peripheral speed of the reducing rolls, said tensioning means comprising a rotating drum, common power means for imparting a rotating motion to the rolls at a certain speed and for simultaneously imparting a rotating motion to said drum at a speed bearing a definite relation to the speed of said rolls and means for holding a single strip of metal in frictional contact with less than 360 degrees of arc of said drum.

12. In a tension rolling mill having means for taking up the elongation of the strip, feeding means having substantially no reducing function and located between the bite of the reducing rolls and the take up means, said feeding means comprising a rotating drum, power means to drive said drum and anti-friction means for pressing the strip against said drum in a plurality of places along its surface of contact therewith, to increase the friction between the strip and the drum to impart a predetermined linear velocity to the strip, said means comprising a flexible sheath having a fixed support at one end and a movable support at the other end, and means for actuating said movable support.

13. In a tension rolling mill, having means for taking up the elongation of the strip, feeding means having substantially no reducing function and located between the bite of the reducing rolls and the take up means, said feeding means comprising a rotating drum, power means to drive said drum, and a sheath for pressing a strip of metal tightly against the surface of said drum to impart a predetermined linear velocity to the strip, said sheath consisting of a plurality of rolls and means for pressing each of said rolls against the surface while maintaining their position in parallelism with the axis of said drum.

14. In a tension rolling mill, feeding means having substantially no reducing function, said feeding means comprising a rotating drum, power means to drive said drum, and a sheath for pressing a strip of metal tightly against the surface of said drum, said sheath consisting of a plurality of rolls, and common means for simultaneously pressing all of said rolls against the surface of said drum, so that each roll is pressed with a force equal to that of the other rolls, irrespective of the absolute value of said force, and so as to preserve the position of the rolls in parallelism with the axis of said drum.

15. In a tension rolling mill having means for taking up the elongation of the strip, feeding means having substantially no reducing function and situated between the bite of the reducing rolls and said take up means, said feeding means comprising a drum, common power means for imparting a rotating motion to the rolls at a certain speed and for simultaneously imparting a rotating motion to said drum at a speed bearing a definite relation to the speed of said rolls, said drum being contacted by a single layer of the strip over less than 360 degrees of arc of said drum, and means for increasing the pressure of said strip upon said drum surface.

16. In a tension rolling mill, feeding means having substantially no reducing function, said

feeding means comprising a rotating drum, power means to drive said drum, and anti-faction means for holding a strip of metal in frictional contact with said drum, said means comprising a plurality of rolls disposed in parallelism about the periphery of said drum, and a series of staggered flexible means, certain of said series interconnecting certain of said rolls and others of said series interconnecting others of said rolls.

17. In a tension rolling mill, feeding means having substantially no reducing function, said feeding means comprising a rotating drum, power means to drive said drum, and anti-friction means for holding a strip of metal in frictional contact with said drum, said means comprising a plurality of rolls disposed in parallelism about the periphery of said drum, and a series of staggered flexible means, certain of said series interconnecting certain of said rolls and others of said series interconnecting others of said rolls, and means for rotating said rolls at peripheral speeds bearing a fixed relationship with the peripheral speed of said drum.

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