

Feb. 20, 1940.

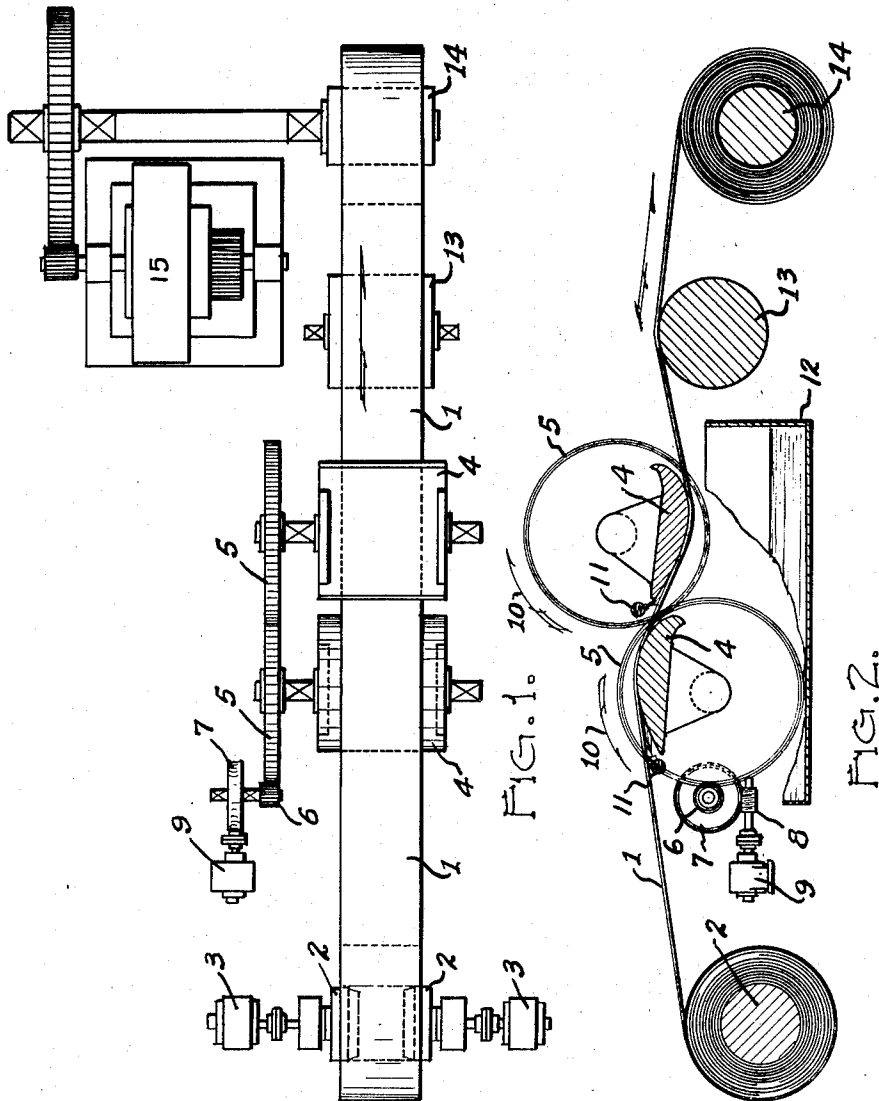
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2,190,986

TEMPERING SHEET METAL

Filed Nov. 29, 1937

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

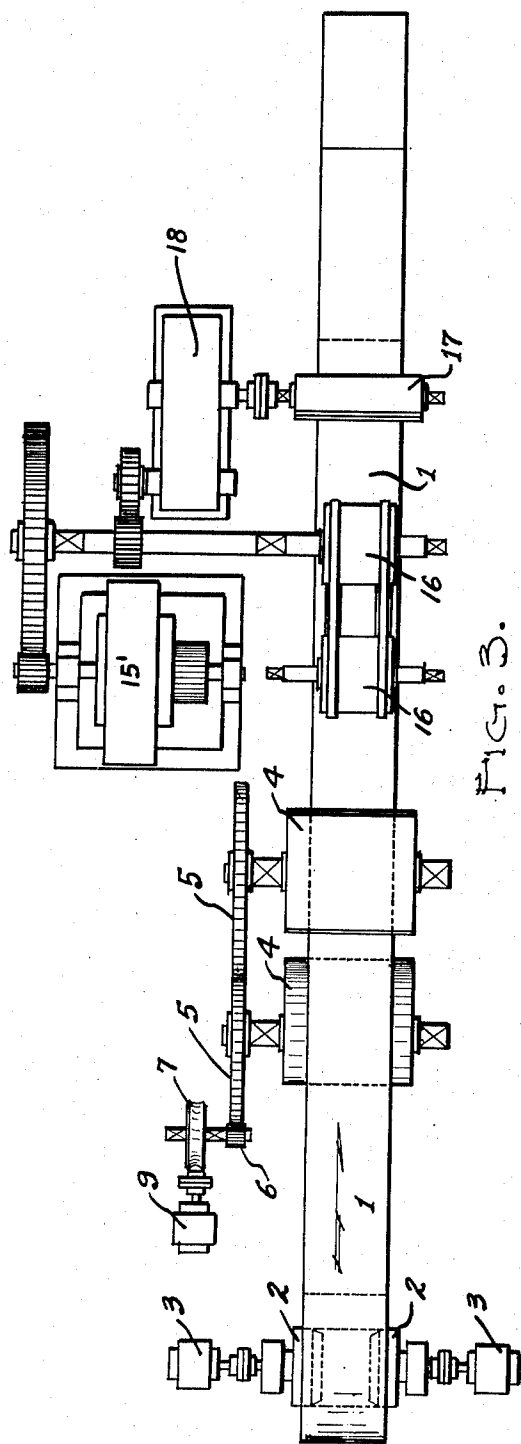


FIG. 3.

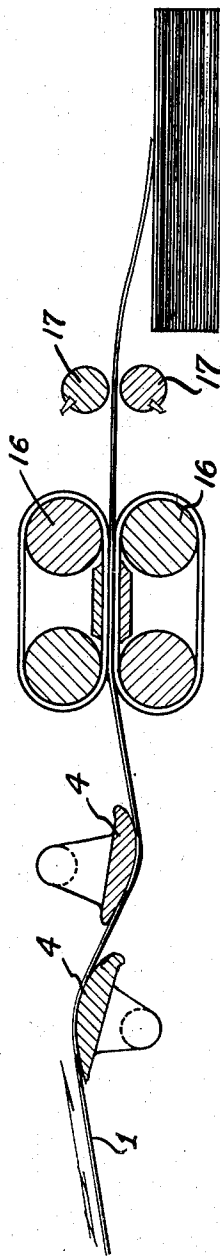


FIG. 4.

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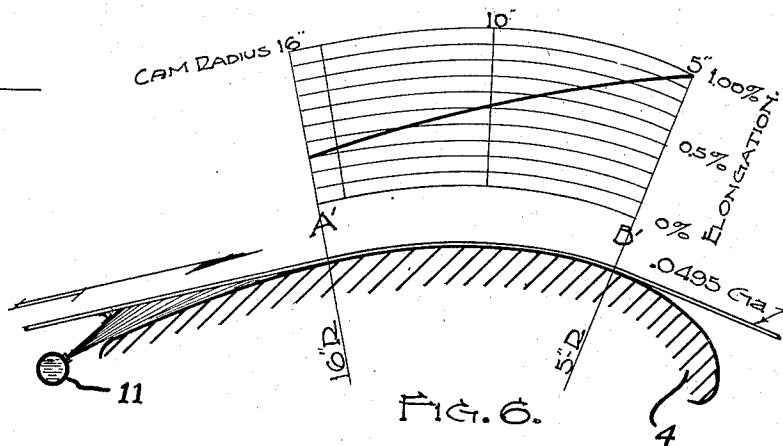
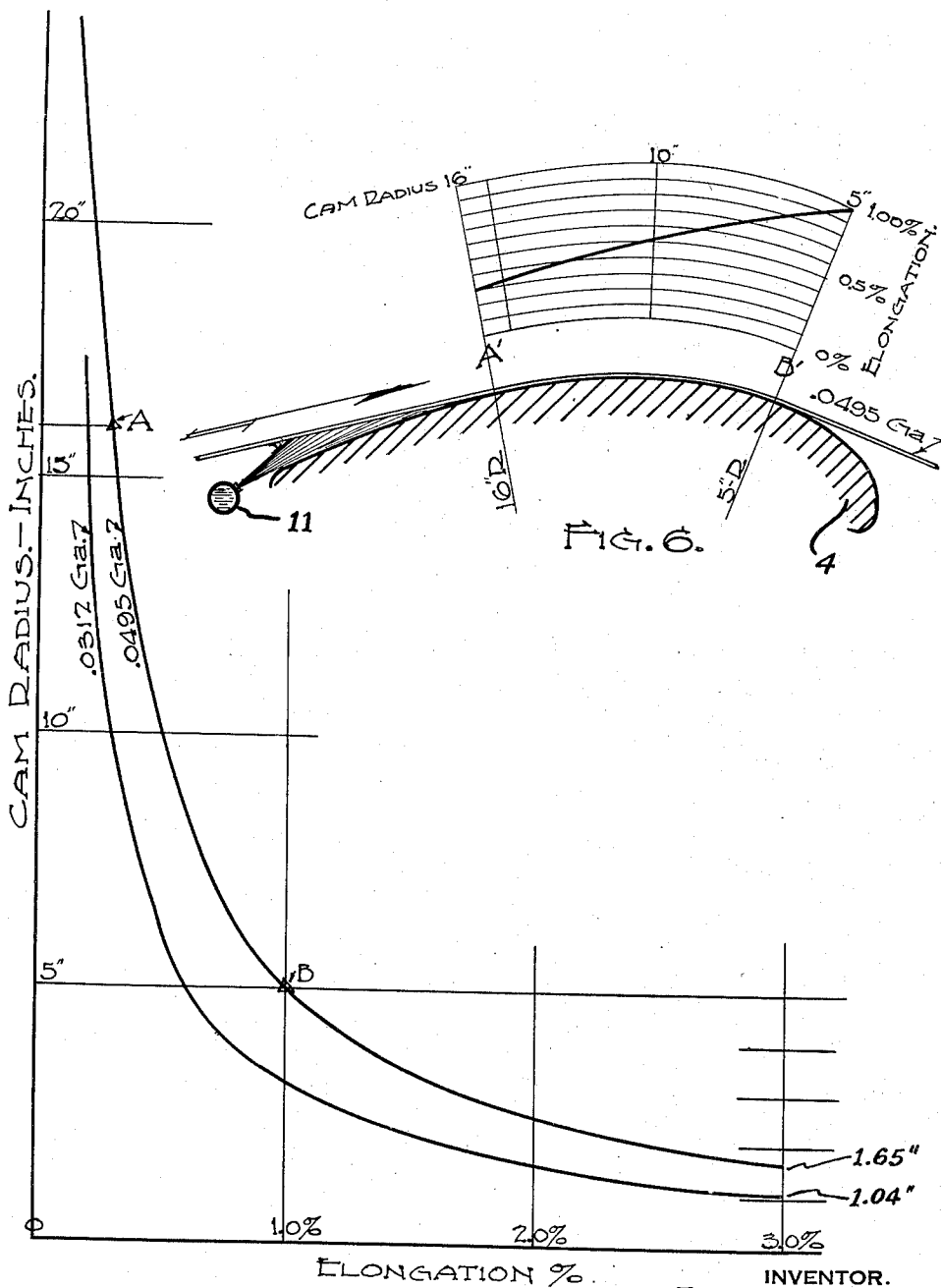
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UNITED STATES PATENT OFFICE

2,190,986

TEMPERING SHEET METAL

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Application November 29, 1937, Serial No. 177,024

12 Claims. (Cl. 29—33)

My invention relates to that class of operations in the production of metal strip which is known as temper rolling.

Conventional practice in temper rolling of metal involves passing the strip between mill rolls, thereby reducing the gauge, whereby in turn the strip is elongated. An objection to this method is that it does not produce a uniform temper throughout the surface of the strip, since commercial strip is not uniform in gauge. It, therefore, happens that localized points of thicker gauge will receive a greater reduction by rolling than other areas having a thinner gauge.

It may also happen that local areas of the strip may have a gauge which is thinner than that which the mill rolls are set to produce, and in such cases no cold working at all occurs in these areas.

From the above considerations it follows that cold tempering of the strip by reduction in gauge in order to produce a desired elongation does not produce as satisfactory results as could possibly be had if the elongation were produced by a more direct method.

Cold working for tempering purposes has also been accomplished by stretching, as for example, on a stretcher level machine. This method, however, is objectionable because it is too slow for sheets and impracticable for strip metal in coils which may be as long as 2000 to 5000 feet.

A conventional rolling mill such as may be used for tempering rolling of wide strip such as strip having a width of 60 inches or more, is usually a four-high mill on account of the fact that very high rolling pressures are encountered in reduction of gauge in order to extend the original length of the strip. Such mills are very heavy and are expensive to build and operate.

Cold working of metal may also be produced by flexing or bending the strip; but as far as I am aware, no satisfactory method has heretofore been devised to control the flexing or bending to produce the desired degree of elongation.

It is therefore an object of my invention to provide a method of tempering metal sheets or strip by flexing the strip in a controlled manner. It is another object of my invention to provide an apparatus which will cause the strip to be flexed controllably. Other objects of my invention include the provision of an apparatus which is of relatively low cost and has a higher rate of output than the conventional apparatus now used for this purpose, and the provision of an apparatus which is relatively light, weighing only a small

fraction as much as the conventional four-high mill.

Reference is now made to the drawings forming a part of this application, and in which:

Figure 1 is a plan view of a machine for tempering metal strip, in which the strip is rewound into coil form after the tempering operation.

Fig. 2 is a longitudinal cross sectional view of Fig. 1.

Fig. 3 is a view similar to Fig. 1 of a machine for tempering strip material in which the strip is sheared to sheet length.

Fig. 4 is a central longitudinal cross sectional view of Fig. 3.

Fig. 5 is a chart showing the relation of elongation to radius of flexing.

Fig. 6 is a diagram showing the progressive elongation of a strip as it passes over a flexing means.

In the practice of my invention I am not concerned with the reduction of gauge but only with the elongation of the strip. My invention is based upon the fact that when a strip of metal of a given gauge is flexed around a cylinder of a given diameter, the outer surface of the strip will be extended a certain amount. For example, if a strip having a thickness of 0.1 inch is wrapped around a cylinder 10 inches in diameter, the inside surface in contact with the cylinder will have a length of 31.416 inches (full 360°), and the outer surface will have a length of 32.044 inches. Thus the outer surface will be 0.628 inch or 2% longer than the inside surface.

Since the elongation has exceeded .0012%, the extreme fiber stress is beyond the elastic limit or above 35,000 pounds per square inch. Under these conditions the outside extreme fiber will be extended and the inside fiber will be shortened.

If now a unit stress of, for example 20,000 pounds per square inch, be added to the stresses set up by bending, then the outside fiber tension will be increased by 20,000 pounds per square inch, and will be 55,000 pounds per square inch. On the other hand, the net inside fiber stress will be equal to the difference (35,000 pounds per square inch compression, and 20,000 pounds per square inch tension), or 15,000 pounds per square inch compression. Under these conditions, a unit stress of 15,000 pounds per square inch is well within the working stress and there will be practically no shortening of the inside surface.

In accordance with my invention I propose to bend the strip in one direction to extend one surface and then to reverse the process and extend the other surface in the same manner. In order

to cover the wide range of gauges for the various amounts of elongation desired, a large number of pairs of rolls of different diameters will be required and this of course will not be practical. In order to overcome this difficulty I utilize a pair of cams having curved surfaces which vary in curvature from one end of the cam to the other, to cover the range of gauges and elongations required. For example, to cover gauges from .031 inch to .0495 inch the radii required will vary between 1.04 inches and 29.75 inches (for elongations ranging from .002% to 3.00%) and all these curvatures can be developed in one cam surface.

In carrying out the invention I arrange the cams so that their position may be varied, so that in the production of a given elongation in a strip of a given gauge the strip will make contact with the cams, and at a point which is of a larger radius than is necessary to produce the desired elongation but which will begin to produce some elongation. As the strip moves over the cam and gradually contacts areas having shorter radii the degree of elongation will increase as the strip advances. I then arrange the strip so that it will leave the cam at that point which has the radius necessary to produce the desired elongation. In other words, the strip in leaving the cam will be tangent to the cam at the point at which the radius is such as will give the required elongation. The strip then passes over the second cam where the same cycle is repeated on the reverse side of the strip. I preferably arrange the coilers to pull on the strip at approximately 20,000 pounds unit stress.

Referring now to the drawings, the strip is indicated at 1, and is uncoiled from the spools 2 in a decoiling machine of conventional type, which may be connected to motor generators 3. These motor generators are arranged in conventional manner to drive the spools 2 during the threading operation but act as electrical generators when the strip is being unwound from the decoller, thereby producing the desired back tension. I have not described the decoller in any more detail since it forms no part of my invention.

The strip then passes over the cam members 4 as may best be seen in Fig. 2. The cam members are mounted in any desired way in connection with gears 5 which mesh together and one of which meshes with the pinion 6. A motor 9 drives the pinion 6 through the worm 8 and worm gear 7, which is mounted on the same shaft as the pinion 6. It will thus be seen that the position of the cams may be varied by means of the motor 9. It is to be understood that other means for adjusting the cam members 4 may be used and that I have only described a means which will be operative.

In order to lubricate the cam members for the passage of the strip, I provide nozzles 11 which provide sprays of a suitable lubricant from a tank 12, which may also act as a catch basin. A suitable pump and filter (not shown) may be used in connection with this lubrication. After leaving the second cam 4, the strip passes over the roll 13 to the coiler 14 which is driven by a motor 15, as shown.

In Figs. 3 and 4, I have shown a modification in which the strip, after passing from the cam members 4 is sheared to sheet length instead of being coiled by another coiler. In this embodiment I provide caterpillar elements indicated generally at 16 to exert the tension on the strip which in the embodiment of Figs. 1 and 2 is

exerted by the coiler. I also provide the conventional flying shear 17, driven through a suitable gear reducer 18 by the motor 18', which also drives the caterpillar element 16. This arrangement is desirable because the operation of the flying shears is based on the surface speed of the strip and therefore the same motor drives the caterpillar device and the shear.

In Fig. 5 I have shown a chart in which per cent elongation is plotted against cam radius in inches. From this chart it will be seen that a strip having a gauge of .0312 inch at an elongation of .2% will require a radius of 15.62 inches, while for an elongation of 3% it would require a radius of 1.04 inches. Similarly a strip having a gauge of .0495 inch for an elongation of .2% would require a radius of 24.75 inches while at 3% elongation it would require a radius of 1.65 inches. Intermediate elongations would, of course, be attained by causing the strip to leave the cam at the proper intermediate points.

In Fig. 6 I have shown a diagram of an enlarged cam surface 4 and have indicated thereon the locus of a 16 inch radius and of a 5 inch radius, and I have extended above the cam surface a chart showing the increase in per cent elongation as the strip passes over the cam surface. The strip has a gauge of .0495 inch, and it will be seen that if the strip leaves the cam surface 4 at the point B' it will acquire an elongation of 1 per cent. This may be checked by means of the graph of Fig. 5 where the condition obtaining in Fig. 6 is indicated at B.

It is to be understood that modifications may be made in my invention without departing from the spirit thereof, and that I do not intend to limit myself otherwise than as pointed out in the claims which follow.

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

1. A process of treating a strip of metal, which includes the steps of progressively flexing said strip transversely of its length in one direction in an increasing degree, and then progressively flexing said strip transversely of its length in the opposite direction in an increasing degree, and pulling on said strip beyond the point at which said flexing operations are carried out.

2. A process of treating a strip of metal, which includes the steps of progressively flexing said strip transversely of its length in one direction in an increasing degree, then progressively flexing said strip transversely of its length in the opposite direction in an increasing degree, and coiling said strip under tension beyond the point at which said flexing operations are carried out.

3. A process of treating a strip of metal, which includes the steps of progressively flexing said strip transversely of its length in one direction in an increasing degree, then progressively flexing said strip transversely of its length in the opposite direction in an increasing degree, pulling on said strip beyond the point at which said flexing operations are carried out, and shearing said strip into sheets.

4. A process of treating a strip of metal, which includes the steps of flexing said strip in one direction transversely of its length in an arc of progressively decreasing radius of curvature, and then flexing said strip in the opposite direction transversely of its length in an arc of progressively decreasing radius of curvature, and pulling on said strip beyond the point at which said flexing operations are carried out.

5. A process of treating a strip of metal, which includes the steps of flexing said strip in one direction transversely of its length about an arcuate member having a progressively decreasing radius of curvature, and then flexing said strip in the opposite direction about an arcuate member having a progressively decreasing radius of curvature, pulling on said strip beyond said arcuate members, and causing the strip to leave said arcuate members at points at which the radius of curvature is such as will produce the required elongation for the particular gauge being treated.

6. A process of treating a strip of metal, which includes the steps of flexing said strip in one direction transversely of its length about an arcuate member having a progressively decreasing radius of curvature, and then flexing said strip in the opposite direction about an arcuate member having a progressively decreasing radius of curvature, pulling on said strip beyond said arcuate members, and causing said strip to make contact with said members at points at which the radius of curvature is insufficient to produce the elongation sought, and to maintain contact with said arcuate members to a point at which the radius of curvature is such as will produce the elongation sought, having in view the particular gauge being treated.

7. An apparatus for treating a strip of metal, comprising a pair of members having arcuate surfaces of progressively decreasing radii of curvature in the direction of passage of the strip, said members being disposed so that their curvature are reverse with respect to each other to cause said strip to be flexed first in one direction and then in the other.

8. An apparatus for treating a strip of metal,

comprising a pair of members having arcuate surfaces of progressively decreasing radii of curvature in the direction of passage of the strip, said members being disposed so that their curvatures are reverse with respect to each other to cause said strip to be flexed first in one direction and then in the other, and means for adjusting the angular relation of said members with respect to each other. 5

9. In combination, in the order named, a decoiler, an arcuate member of progressively decreasing radius of curvature, a second arcuate member of progressively decreasing radius of curvature, said second arcuate member being disposed so that its curvature is reverse with respect to the curvature of said first mentioned arcuate member, and a coiling device. 10

10. In combination, in the order named, a decoiler, an arcuate member of progressively decreasing radius of curvature, a second arcuate member of progressively decreasing radius of curvature, said second arcuate member being disposed so that its curvature is reverse with respect to the curvature of said first mentioned arcuate member, a pulling device, and a flying shear. 20

11. In combination, in the order named, a decoiler, an arcuate member of progressively decreasing radius of curvature, a second arcuate member of progressively decreasing radius of curvature, said second arcuate member being disposed so that its curvature is reverse with respect to the curvature of said first mentioned arcuate member, and a pulling device. 25

12. An apparatus according to the combination of claim 11, in which means are provided for adjusting the angular relation of the arcuate members with respect to each other. 30

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