

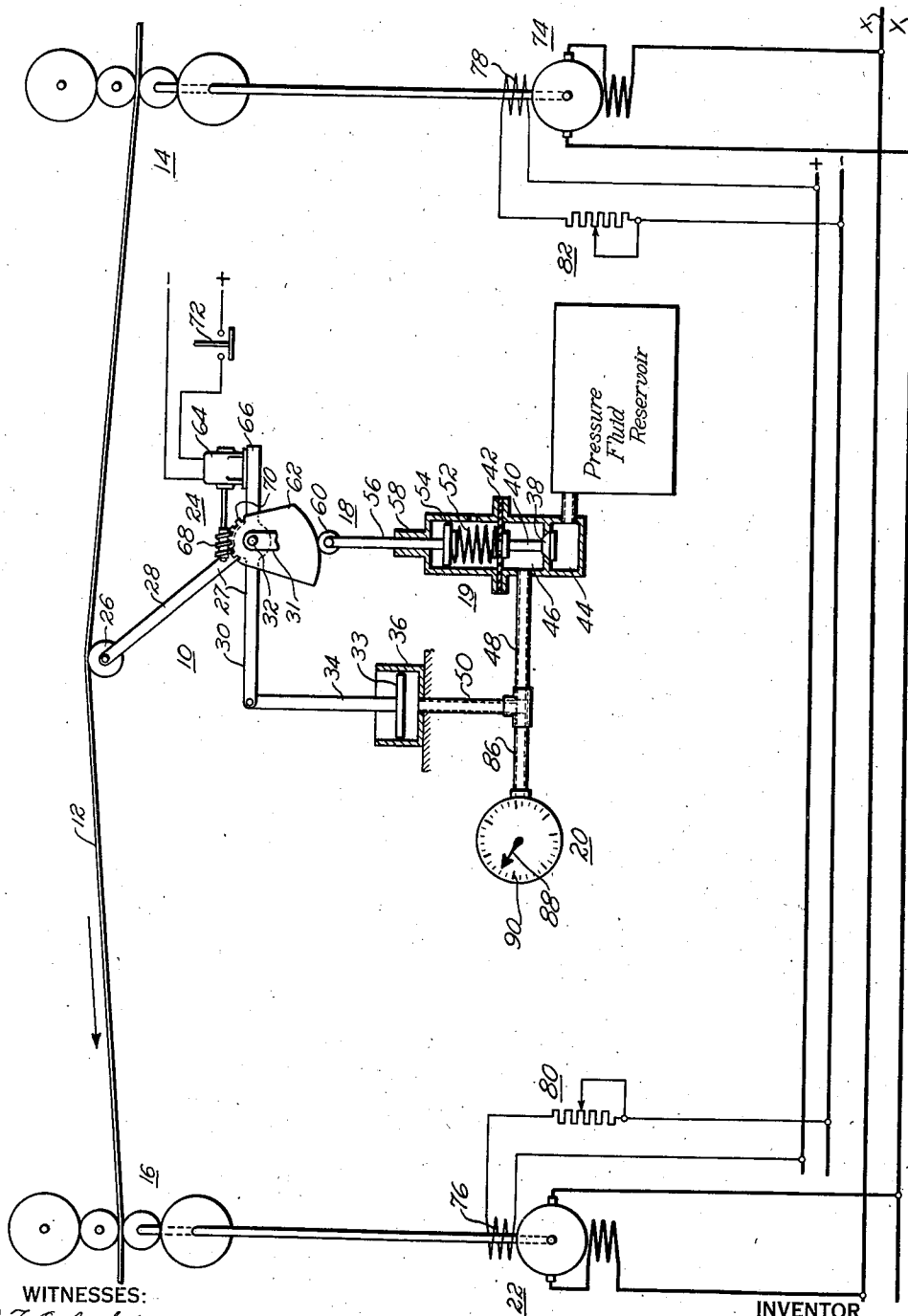
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TENSIOMETER

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WITNESSES:

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TENSIO METER

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11 Claims. (Cl. 80—35)

My invention relates, generally, to tensiometers, and more particularly to devices for producing tension on a strip of material as the material passes between adjacent work devices.

In the manufacture of sheet steel it is common practice to reduce the sheet to the desired thickness by passing the steel, in the form of a strip, through a series of reducing roll stands and to subject the strip to predetermined tensions by applying a transverse force to the strip through an idling roller which is forced against the strip between adjacent roll stands deflecting the strip from its normal pass line between the adjacent roll stands.

Such a device for tensioning the strip as it passes between adjacent roll stands is described in detail in my copending application Serial No. 133,419, filed March 27, 1937, now Patent No. 2,189,609, issued February 6, 1940. The device of this prior application functions to maintain a substantially constant predetermined tension on the strip and comprises, generally, a bell crank on one arm of which is mounted a tensioning roller which is forced against the strip by a fluid pressure actuated piston. The pressure applied by the piston is maintained substantially constant by an adjustable pressure regulating valve. The length of the arms of the bell crank, the angular displacement of these arms with respect to each other and the normal position of the tensioning roller with respect to the pass line are all so arranged as to produce a substantially constant tension on the strip within a limited range of deflection of the strip. Regulating means are provided for so controlling the mill motor speed as to maintain the strip deflection within the predetermined range in which a substantially constant tension is maintained on the strip. The tension on the strip may be changed by manual adjustment of the pressure regulating valve, since the strip tension varies directly with the pressure applied to the actuating piston.

In some strip rolling mills it has been found desirable to regulate the speed of the mill motors by hand and to employ a tensioning device which will produce a strip tension which varies inversely with the amount of deflection of the strip from the normal pass line. In such a mill, the tension on the strip may be varied by varying the speed of one of the mill motors adjacent the tensioning device to change the amount of deflection of the strip. In such a system it is desirable that some means be provided for giving an indication of the strip tension as it is varied by changing the strip

deflection through adjustment of the speed of the mill motor adjacent the tensioning device.

An object of the invention, therefore, is to provide a strip tensioning system for a strip rolling mill which shall function to vary the tension on the strip in accordance with variations in the length of the strip between adjacent roll stands and which shall function to provide an indication of the tension on the strip.

Another object of the invention is to provide a strip tensioning system for a strip rolling mill which shall utilize a pressure fluid actuated tensioning device for producing tension on a strip of material as it passes between adjacent roll stands and which shall function to so control the fluid pressure acting on the tensioning device as to vary the tension on the strip in accordance with variations in the length of the strip between adjacent roll stands and which shall also function to give an indication of the tension on the strip as a function of the fluid pressure acting on the tensioning device.

A further object of the invention is to provide a tensioning system for a strip of material as it passes between adjacent sets of reducing rolls, which shall utilize a pressure fluid actuated tensioning device and which shall function to provide selectable ranges of tension within each of which ranges the tension on the strip shall vary in accordance with variations of the strip length between the adjacent sets of reducing rolls.

These and other objects and advantages of the invention will be apparent from the accompanying detailed description taken in connection with the accompanying drawing, the single figure of which is a diagrammatic representation of a portion of a tandem strip rolling mill embodying the principal features of my invention.

In practicing my invention, I provide a pressure fluid operated tensioning device which tensions a strip of material, such as steel, as it passes between adjacent reducing roll stands and in the direction shown by the arrow. The tensioning device applies a tension to the material in accordance with the fluid pressure acting on the tensioning device and a control device is provided for controlling the value of the fluid pressure applied to the tensioning device in accordance with the degree of deflection of the strip by the tensioning device. Thus, by changing the speed of the mill motor to decrease the deflection of the strip, the strip tension will be increased. A pressure responsive tension indicating device is provided having a dial calibrated in terms of strip tension so that the operator may

regulate the mill motor to produce whatever tension is desired as indicated by the indicator.

In order to provide different ranges of tension for a given range of deflection of the strip, an adjusting means 24 is provided for the control device 18 which varies the fluid pressure in accordance with the deflection of the strip.

Referring to the drawing for a more detailed description, the tensioning device 10 comprises an idler roller 26 mounted upon one arm 28 of a bell crank 27 which is provided with another arm 30. The bell crank is mounted for rotation on the support 31 by means of a shaft 32. The bell crank arm 30 is mechanically connected to a piston 33 through a piston rod 34, the piston 33 being actuated by fluid pressure in the cylinder 36.

The length of the arms 28 and 30 of the bell crank 27, the angular displacement of these arms with respect to each other, and the normal position of the tensioning roller 26 with respect to the normal pass line of the mill may be arranged, if it is so desired, so as to produce a substantially constant tension on the strip within a limited range of deflection of the strip, as mentioned hereinbefore and fully explained in my hereinbefore referred to copending application Serial No. 133,419.

The control device 18 for varying the fluid pressure acting upon the piston 33 in cylinder 36 comprises a pressure regulating reduction valve 19 which is connected between the cylinder 36 and the pressure fluid reservoir shown to maintain predetermined pressures in the cylinder 36. The regulating valve 19 comprises a valve 38 connected by a stem 40 to a flexible diaphragm 42. The valve 38 controls the flow of pressure fluid between the chamber 44, which is connected by a suitable conduit to the pressure fluid reservoir, and the chamber 46, which is connected by suitable conduits 48 and 50 to the cylinder 36. The regulating valve 19 is described in detail in my above-referred to copending application, to which reference may be made for a more detailed description of its construction and operation. The valve 19 operates to maintain the pressure in the cylinder 36, which is dependent upon the pressure applied to the diaphragm 42 by spring 52 acting upon the diaphragm 42. One end of the spring 52 bears against a plate 54 which is movable to and from the diaphragm 42 to adjust the tension on the spring 52. Thus the pressure acting in the cylinder 36, and therefore, the tension on the strip 12 may be varied by moving the plate 54 to vary the tension on the spring 52.

The means for adjusting the tension on the spring 52 and, therefore, the tension on the strip 12 may comprise a stem 56 slidably mounted in the housing 58 of the regulating valve 19 and connected to actuate the plate 54. A roller 60 is mounted on the end of the stem 56 and is so disposed as to be moved by a cam member 62 which is mounted upon the shaft 32. The cam 62 is maintained in any desired adjustable relation with respect to the bell crank 27 by means of the cam adjusting device 24 mounted on the bell crank so that upon rotation of the bell crank 27, due to change in the deflection of the strip 12, the cam 62 will be rotated, thus varying the vertical displacement of the roller 60 and changing the adjustment of the fluid pressure regulating valve 19. The cam position adjusting device 24 may comprise a motor 64 mounted upon a bracket 66 which, in turn, is mounted on the bell crank 27, and a worm 68 driven by the motor 64 and co-operating with a worm gear 70 on the cam 62.

The motor 64 may be connected at will to any suitable source of energy by means of any suitable circuit control device 72. It will be seen that when the motor 64 is operated, the angular relation of the cam 62 with respect to the bell crank 27 will be changed, so that for a given deflection of the strip 12, any desired tension may be applied to the strip by suitably adjusting the relative positions of the cam 62 and the bell crank 27.

The motors 74 and 22, which drive the rolls of the roll stands 14 and 16, respectively, are connected to any suitable source of power indicated by the conductors X and Y. The field windings 76 and 78 of the motors 22 and 74 are connected to any suitable source of direct current indicated by the plus and minus signs, and the speeds of these motors may be varied by adjustment of the rheostats 80 and 82 connected in these field circuits in a well known manner.

The tension indicating device 20 may be any suitable fluid pressure responsive device connected by a suitable conduit 86 with the conduits 48 and 50 so that it will have the same fluid pressure applied to it as is applied to the piston 33 in the cylinder 36. The tension indicating device is provided with a pointer 88 which traverses a dial 90 graduated in terms of strip tension.

In the operation of the device, with a given displacement of the cam 62 with respect to the bell crank 27 and with the strip 12 deflected to a given position by the idling roller 26, a tension will be applied to the strip which is indicated by the tension indicator 20. If now it is desired to increase the tension upon the strip 12, the speed of the motor 22 may be increased by proper adjustment of its field excitation by means of the rheostat 80, thus taking up some of the slack in the strip extending between the roll stands 14 and 16 and decreasing the deflection of the strip 12 from the normal pass line between the two roll stands and lowering the idling roller 26.

The movement of the idling roller 26 to a lower position by speed adjustment of the motor 22 will cause the cam 62 to rotate in a counter-clockwise direction to increase the tension on the spring 52 through the vertical movement of the roller 60, stem 56 and plate 54. This increase in the tension on the spring 52 will cause the pressure regulating valve 19 to automatically increase the fluid pressure in the cylinder 36, thus increasing the force exerted by the piston 33 upon the bell crank 27 and, in turn, increasing the tension on the strip 12. This new tension will be indicated by the tension indicator 20 and the new tension may be adjusted to the desired amount by regulating the speed of motor 22 while observing the indication on the tension indicator 20 until the indicator 20 indicates the desired tension.

In the event that the dimensions of the bell crank 27 and the positioning of the tensioning roller 26 are such as to produce substantially constant strip tension when a constant force is applied to the bell crank, the strip tension will vary in direct proportion with the fluid pressure acting on the operating piston 33. Thus the tension will vary directly with the indication on the scale of the pressure responsive indicating device 20 and the indicating device may be calibrated with a uniform scale in terms of strip tension.

If, for any reason, it is desired that a different pressure be applied to the strip 12 at a given deflection of the strip and position of the idling roller 26 or that a different range of tensions be

applied to the strip for a given movement of the idler roller 26 by the change in speed of the motor 22, the relative position of the cam 62 with respect to the bell crank 27 may be changed by energizing the motor 64 to rotate the cam 62 with respect to the bell crank 27 through the action of the worm 68 and the cooperating worm gear 70.

The adjustment of the amount of strip between the roll stands 14 and 16 and, therefore, the deflection of the strip may be also made by a variation in the speed of the motor 74, or, if desired, adjustment of the speeds of motors 22 and 74 may be made simultaneously for this purpose.

It will be seen that I have provided a strip tensioning device which shall function to vary the tension on a strip of material as it passes between adjacent work devices in accordance with the variations in the amount of material extending between the work devices, which shall indicate the tension on the material and which shall be inexpensive to manufacture, install and maintain.

In compliance with the requirements of the patent statutes, I have shown and described herein the preferred embodiment of my invention. It is to be understood, however, that the invention is not limited to the precise construction shown and described, but is capable of modification by one skilled in the art, the embodiment herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a system for controlling the tension on a strip of material as it extends between adjacent work devices, a bearing member disposed to be forced against the strip to deflect the strip and thus tension the strip, a mechanism for causing the bearing member to subject the strip to substantially constant tension within a predetermined range of deflection of the strip when a constant force is applied to the mechanism, force exerting means for actuating said mechanism, means actuated in accordance with the deflection of the strip for varying the force exerted on said mechanism, and indicating means responsive to the force exerted by the force exerting means for indicating the tension on the strip.

2. In a system for controlling the tension on a strip of material as it passes between adjacent work devices one of which has an adjustable speed driving means, a bearing member disposed to be forced against the strip to deflect the strip and thus subject the strip to tension, a mechanism for causing the bearing member to subject the strip to substantially constant tension within a predetermined range of deflection of the strip when a constant force is applied to the mechanism, force exerting means for actuating said mechanism, means actuated in accordance with the deflection of the strip for varying the force exerted on said mechanism, indicating means responsive to the force exerted by said force exerting means for indicating the strip tension, and means for so selectively controlling the speed of the adjustable speed driving means as to provide the strip deflection which will result in the desired strip tension as indicated by said indicating means.

3. In a system for controlling the tension on a strip of material as it passes between adjacent work devices, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the work devices to thus tension the strip, a pressure fluid operated force exerting means for actuating said

tensioning means, means for automatically varying the fluid pressure acting on said pressure fluid operated force exerting means in accordance with the degree of deflection of the strip to thereby vary the force exerted by said force exerting means to thus vary the tension on the strip, and indicating means responsive to the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of said fluid pressure.

4. In a system for controlling the tension on a strip of material as it passes between adjacent pairs of reducing rolls, one of which pairs of rolls has an adjustable speed driving means, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the pairs of rolls to thus tension the strip, a pressure fluid operated force exerting means for actuating said tensioning means, means for automatically varying the fluid pressure acting on said pressure fluid operated force exerting means in accordance with the degree of deflection of the strip to thereby vary the force exerted by the force exerting means to thus vary the tension on the strip, indicating means responsive to the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of said fluid pressure, and means for so controlling the speed of the adjustable speed driving means for the one pair of rolls as to produce the desired tension on the strip as indicated by said indicating means.

5. In a system for controlling and indicating the tension on a strip of material as it passes between adjacent work devices, an idling roller, a pressure fluid operated force exerting means for causing said roller to bear against the strip to deflect the strip from its normal pass line and thus tension the strip as it passes between the adjacent work devices, an adjustable fluid pressure regulating valve for controlling the fluid pressure acting on said force exerting means, means responsive to the movement of said roller with respect to the normal pass line for adjusting the fluid pressure regulating valve to vary the fluid pressure acting on said force exerting means, and hence the tension on the strip, in accordance with the degree of deflection of the strip by the idling roller, and a fluid pressure responsive indicator connected to be actuated by the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of the fluid pressure acting to tension the strip.

6. In a system for indicating and controlling the tension on a strip of material as it passes between a pair of work devices, one of which has a variable speed driving means, an idling roller, a pressure fluid operated force exerting means for causing said roller to bear against the strip to deflect the strip from its normal pass line and thus tension the strip as it passes between the adjacent work devices, an adjustable fluid pressure regulating valve for controlling the fluid pressure acting on said force exerting means, means responsive to the movement of said roller with respect to the normal pass line for adjusting the fluid pressure regulating valve to vary the fluid pressure acting on said force exerting means, and hence the tension on the strip, in accordance with the degree of deflection of the strip by the idling roller, a fluid pressure responsive indicator connected to be actuated by the fluid pressure acting on said force exerting means and cal-

ibrated in terms of the strip tension as a function of the fluid pressure acting to tension the strip, and means for so controlling the speed of the adjustable speed driving means for the one work device as to produce the desired tension on the strip, as indicated by said indicating means, through the control of the degree of deflection of the strip.

7. In a system for controlling the tension on a strip of material as it passes between adjacent work devices, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the work devices to thus tension the strip, force exerting means for actuating said tensioning means for varying the force exerted on said tensioning device by said force exerting means in accordance with the degree of deflection of the strip by said tensioning means, adjustable means for varying the range of the variation of the force exerted on said tensioning device for a given range of deflection of the strip, and indicating means responsive to the force exerted by said force exerting means calibrated to indicate the tension on the strip.

8. In a system for controlling the tension on a strip of material as it passes between adjacent pairs of reducing rolls, one of which pairs of rolls has an adjustable speed driving means, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the pairs of rolls to thus tension the strip, force exerting means for actuating said tensioning means, means for varying the force exerted on said tensioning device by said force exerting means in accordance with the degree of deflection of the strip by said tensioning means, adjustable means for varying the range of variation of the force exerted on said tensioning device for a given range of deflection of the strip, indicating means responsive to the force exerted by said force exerting means calibrated to indicate the tension on the strip, and means for so controlling the speed of the adjustable speed driving means for the one pair of rolls as to produce the desired tension on the strip as indicated by said indicating means.

9. In a system for controlling the tension on a strip of material as it passes between adjacent work devices, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the work devices to thus tension the strip, a pressure fluid operated force exerting means for actuating said tensioning means, means for varying the fluid pressure acting on said pressure fluid operated force exerting means in accordance with the degree of deflection of the strip to thereby vary the force exerted by said force exerting means to thus vary the tension on the strip, adjustable means for varying the range of variation of the fluid pressure acting on said pressure fluid operated

force exerting means for a given range of deflection of the strip, and indicating means responsive to the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of the said fluid pressure.

10. In a system for controlling the tension on a strip of material as it passes between adjacent pairs of reducing rolls, one of which pairs of rolls has an adjustable speed driving means, tensioning means for exerting a transverse force against the strip to deflect the strip from its normal pass line between the pairs of rolls to thus tension the strip, a pressure fluid operated force exerting means for actuating said tensioning means, means for varying the fluid pressure acting on said pressure fluid operated force exerting means in accordance with the degree of deflection of the strip to thereby vary the force exerted by the force exerting means to thus vary the tension on the strip, adjustable means for varying the range of variation of the fluid pressure for a given range of deflection of the strip, indicating means responsive to the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of said fluid pressure, and means for so controlling the speed of the adjustable speed driving means for the one pair of rolls as to produce the desired tension on the strip as indicated by said indicating means.

11. In a system for indicating and controlling the tension on a strip of material as it passes between a pair of work devices, one of which has a variable speed driving means, an idling roller, a pressure fluid operated force exerting means for causing said roller to bear against the strip to deflect the strip from its normal pass line and thus tension the strip as it passes between the adjacent work devices, an adjustable fluid pressure regulating valve for controlling the fluid pressure acting on said force exerting means, means responsive to the movement of said roller with respect to the normal pass line for adjusting the fluid pressure regulating valve to vary the fluid pressure acting on said force exerting means and hence the tension on the strip in accordance with the degree of deflection of the strip by the idling roller, adjustable means for varying the range of variation of the fluid pressure by said regulating valve for a given range of strip deflection, a fluid pressure responsive indicator connected to be actuated by the fluid pressure acting on said force exerting means and calibrated in terms of the strip tension as a function of the fluid pressure acting to tension the strip, and means for so controlling the speed of the adjustable speed driving means for the one work device as to produce the desired tension on the strip, as indicated by said indicating means, through the control of the degree of deflection of the strip.

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