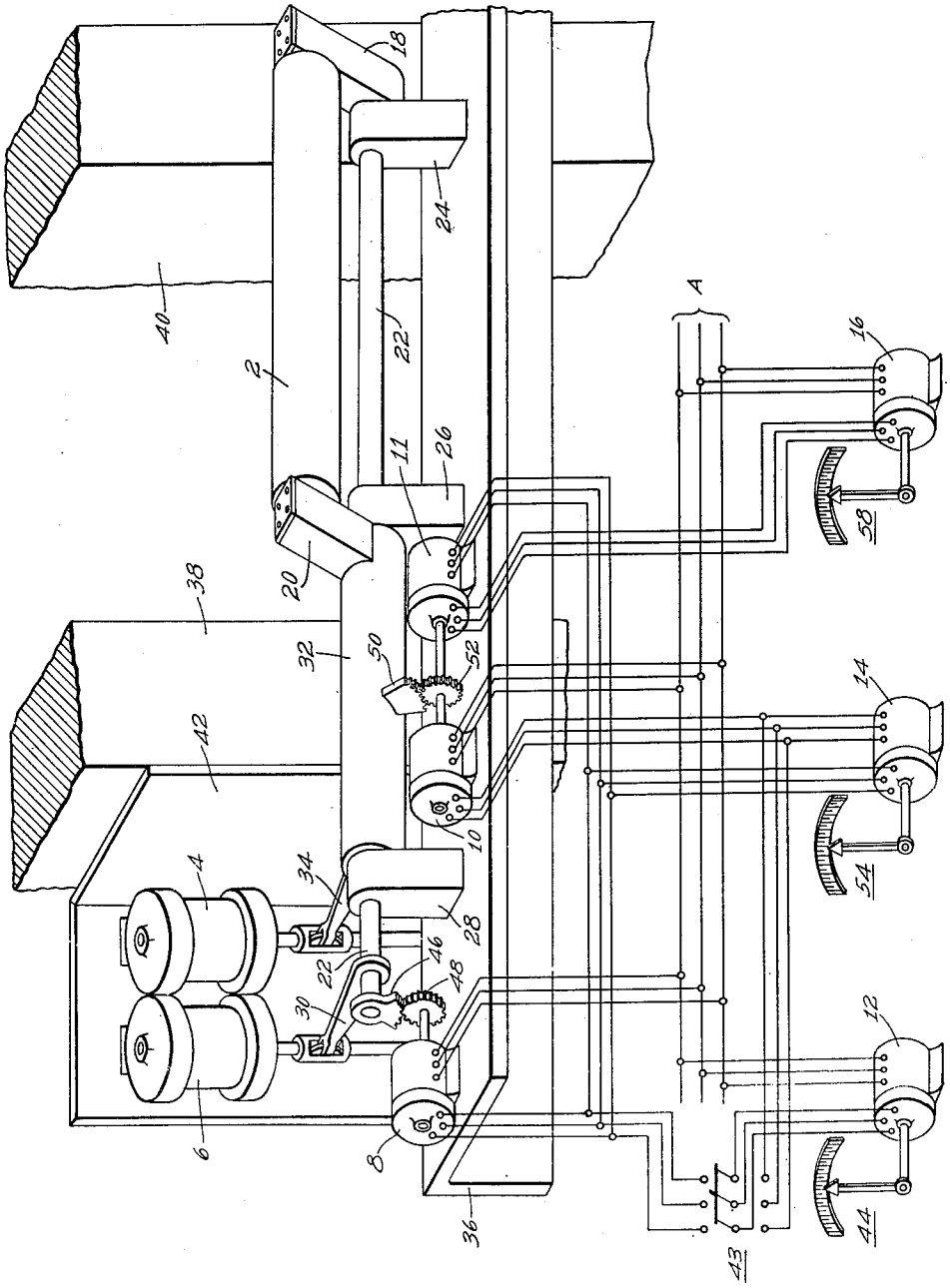
July 6, 1943. G. P. LESSMANN 2,323,818

TENSIOMETER

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TENSIOMETER

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My invention relates, generally, to tensiometers, and, more particularly, to tensioning devices and indicating means for subjecting a strip of material to tension and indicating the degree of strip tension as the strip passes between adjacent work devices.

In the operation of steel strip rolling mills, it is common practice to subject the strip to tension as it extends between adjacent roll stands, and/or between a roll stand and an adjacent reel, by causing a bearing member in the form of a tensioning roller to engage the strip and apply a transverse deflecting force thereto.

Such tensioning rollers are usually arranged to be actuated by a single operating device which rigidly connects the two end bearings of the tensioning roller and thereby imparts the same movement to both ends of the tensioning roller. Means are also commonly provided for causing the strip tension to vary inversely with the strip deflection so that the strip deflection is a measure of the strip tension. Such a tensioning device is shown and described in my copending application, Serial No. 252,934, filed January 26, 1939, now Patent No. 2,250,540 issued July 29, 1941.

Differences in the screw-down settings of the two ends of the reducing rolls result in a difference of strip reduction from one side of the strip to the other, and, even though the desired total tension may be applied to the strip, all or most of the tension may be applied to one side of the strip, and there may be such an unbalance of the strip tension as to tear the strip at the point where the greatest tension is applied.

The object of my invention, generally stated, is to provide a tensioning device for strip material which shall be of simple, rugged and efficient construction and which may be economically manufactured and installed.

A more specific object of my invention is to provide a strip tensioning device which shall function to indicate the total strip tension or deflection, the individual tensions or deflections on the two sides or edges of the strip, and the tension differential or deflection between the two sides or edges of the strip or any one or combination of these tensions or deflections.

A further object of my invention is to provide for independently mounting and actuating the opposite ends of the tensioning roller of a strip tensioning device.

Another object of my invention is to provide for independently actuating the opposite ends of the tensioning roller of a strip tensioning device by separate actuating means remotely disposed from the roller.

These and other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing, the single figure of which is a perspective view of a strip tensioning device embodying the principal features of the invention.

In practicing the invention a bearing member or tensioning roller **2** has its ends rotatably mounted on independent supporting arms which are separately actuable by power translating devices **4** and **6** to cause the tensioning roller to apply a transverse force to a strip of material to thus subject the strip to tension. The tensioning device may be so constructed as to vary the strip tension as a function of the strip deflection as described in my Patent No. 2,250,540. A synchro-tie or motion transmitting and receiving system comprising induction machines **8**, **10**, **11**, **12**, **14** and **16** is so connected and so controlled by the individual movements of the actuating means for the separate ends of the tensioning roller **2** as to provide an indication of the tension on the two edge portions of the strip, the total tension on the strip, and the difference between the tensions on the two edge portions of the strip.

Considering the invention more in detail, the tensioning roller **2** is rotatably mounted in suitable bearings on the supporting arms **18** and **20** and these bearings are in turn mounted on spherical bearings such as those described in the patent to A. G. F. Wallgren No. 2,219,669, issued October 29, 1940, to provide freedom of independent movement of the two ends of the tensioning roller **2**. The arm **18** is secured by any suitable means to a shaft **22** which is rotatably mounted on supporting members **24**, **26** and **28**. An operating arm **30** is secured by any suitable means to the shaft **22** and is acted upon to apply a torque to the shaft **22** by the power translating device **6**.

The supporting arm **20** is secured by any suitable means to a sleeve member **32** which is mounted for rotation on the shaft **22**. An operating arm **34** is secured by any suitable means to the sleeve **32** and is acted upon to apply a torque to the shaft **22** by the power translating device **4**.

The supporting members **24**, **26** and **28** are mounted on a beam member **36** which is secured by any suitable means to the mill housing members **38** and **40** of the strip rolling mill with which the tensioning device is associated.

The power translating devices **4** and **6** may be any suitable means for applying force to the oper-

ating arms 30 and 34 such as the pressure fluid operated pistons described in my Patent No. 2,250,540. The power translating devices 4 and 6 are supported on a bracket member 42 which in turn may be secured in any suitable manner to the mill housing 38 or the supporting beam 36.

The interconnected induction machines 8, 10, 11, 12, 14 and 16 may be three-phase wound rotor induction motors the primary or stator windings of the machines 8, 10, 12 and 16 being connected to a three-phase power bus A. The induction machines 8 and 10 are associated with the induction machine 12 by the selective connection of the rotor windings of the machines 8 and 10 with the rotor winding of the machine 12 by means of a double-throw switch 43. The connections between the rotor winding of the machine 12 and the rotor winding of the selected one of the machines 8 and 10 are such that, when the rotors of the connected machines are in corresponding positions the potentials induced in the respective rotor windings are equal and in opposite directions and, therefore, no current flows in the rotor circuits. When the rotor of the selected machine 8 or 10 is moved relative to its stator winding, there is no longer a balance of potentials in the rotor circuits and the resultant current flow causes a torque to be exerted by the rotor of the machine 12 which will move the rotor and actuate the indicator 44 until the potential balance is reestablished by the movement of the rotor of the machine 12 to the position corresponding to the position of the rotor of the machine 8.

The rotor of the induction machine 8 is connected to be moved in accordance with the movement of the shaft 22 by means of gear members 46 and 48 attached to the shaft 22 and the shaft of the machine 8, respectively. In a like manner the rotors of the machines 10 and 11 are actuated in accordance with the movement of the sleeve of the sleeve 32 by gear members 50 and 52 which are attached to the sleeve 32 and the common shaft of the machines 10 and 11 respectively.

The induction machine 14 has its rotor winding connected in circuit with the rotor winding of the machine 8 and its stator winding connected in circuit with the rotor winding of the machine 10. The reaction between the rotor and stator windings of the machine 14 are such as to cause the indicator 54 to assume a position in accordance with the difference between the movements or angular displacements of the shaft 22 and the sleeve 32.

The induction machine 11 has its stator winding connected in circuit with the rotor winding of the machine 8 and its rotor winding connected in circuit with the rotor winding of the machine 16. The reaction between the rotor and stator windings of the machine 16 are such as to cause the indicator 58 to assume a position in accordance with the sum of the movements or angular displacements of the shaft 22 and the sleeve 32.

In the operation of the device of the tensiometer will be disposed on the mill housings 38 and 40 is indicated between two adjacent strip rolling mills or between a strip rolling mill and an adjacent strip reel to bear upon the strip with a transverse force to thereby tension the strip by deflecting it from its normal pass line between these two adjacent work devices. The two ends of the tension roller 2, being actuated by separate power translating devices 4 and 6, may deflect the strip different amounts depending upon the relative thickness of the side portions of the strip adjacent the end portions of the tensioning roller 2. In the event that there is such a difference of deflection between the two sides of the strip, the indicator 54 will indicate this deflection differential. The indicator 44 will also indicate the individual deflections of the two ends of the tensioning roller 2 by selective operation of the double-throw switch 43. The indicator 58 will likewise indicate the sum of the deflections of the two sides of the strip.

In the event that the tensioning device is designed to have such a tension-deflection characteristic that the strip tension is a function of the strip deflection, as fully explained in my Patent No. 2,250,540, the indicators 44, 54 and 58 may be so calibrated as to indicate the tension on the strip. Thus the indicator 44 will indicate the tension applied to the side of the strip adjacent the end of the tension roller 2 which is actuated by the power translating device 6 through the operating arm 30, the shaft 22 and the supporting member 18 when the double-throw switch 43 is in the upper position. Likewise the indicator 44 will indicate the tension applied to the side of the strip engaged by the end of the tension roller 2 which is actuated by the power translating device 4 through the operating arm 34, the sleeve 32 and the supporting member 20 when the double-throw switch 43 is in the lower position. In like manner the indicating device may be calibrated to indicate either the sum of the tensions on the two sides of the strip or the difference between these tensions. Likewise the indicator 54 will indicate the differential between the tensions on the two side portions of the strip and the indicator 58 will indicate the sum of the tensions on the two side portions of the strip.

The tension differential between the two sides of the strip may be due to a thickness differential between the two sides of the strip caused by unequal screw-down settings of the reducing rolls of the mill. In this event the indicators 44, 54 and 58 will indicate the tension on the strip and the tension differential between the two sides of the strip and the screw-down motors of the mill may be manipulated to correct any gauge differential that may be discovered to thereby maintain a uniform tension on the strip and produce a strip of uniform gauge throughout its width.

It is to be particularly noted that by disposing the operating devices for the two sides of the tensioning roller 2 beyond the mill housing, a minimum of space between the mill housings is occupied by the tensioning device and a maximum of space for operations in the area traversed by the strip is provided.

It will be seen that I have provided a strip tensioning device and strip tension indicating means which shall function to indicate the total strip tension, the individual tensions on the two sides of the strip, and the tension differential between the two sides of the strip which shall occupy a minimum of space in the rolling area, which shall be simple and inexpensive to manufacture, and which shall be efficient and inexpensive to install, operate and maintain.

In compliance with the requirements of the Patent Statutes, I have shown 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 herein, but is capable of modification by one skilled in the art, the embodiment shown

herein being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip and thus subject it to tension by deflecting it from the line between the work devices, a supporting arm adjacent each end of said tensioning roller, means rotatably mounting each end of the tensioning roller on its adjacent supporting arm, a sleeve member, means rotatably mounting said sleeve member in a position displaced from and substantially parallel with said roller, a shaft member substantially concentric with and extending through and beyond said sleeve member, one of said supporting arms being secured for rotation with said sleeve and the other supporting arm being secured for rotation with said shaft, and separate means for actuating said shaft and said sleeve to thereby cause said tensioning roller to apply a transverse deflecting force to the strip.

2. In a device for tensioning a strip of material as it extends between adjacent work devices, a sleeve member, a shaft member extending through and beyond said sleeve member, means mounting said sleeve member and said shaft member for rotation and with their axes substantially parallel to the plane of the strip, separate actuating means for imparting rotational movement to said shaft and said sleeve, two supporting arms spaced axially from and to one side of said actuating means, one of said supporting arms being mounted to be driven by and extending substantially radially from said sleeve, the other of said supporting arms being mounted to be driven by and extending radially from said shaft, a tensioning roller, means rotatably mounting said tensioning roller on and between said supporting arms, said roller being so disposed with respect to the strip as to bear against said strip and thus subject it to tension by deflecting it from the line between the work devices.

3. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip and thus subject the strip to tension by deflecting it from the line between the work devices, separate means for actuating the two ends of the tensioning roller to cause the tensioning roller to apply a transverse deflecting force to the strip, a plurality of polyphase wound rotor induction motors, means connecting the rotor of a first one of said motors to be actuated in accordance with the deflection of one edge of the strip by its associated roller actuating means, means connecting the rotor of another one of said motors to be actuated in accordance with the deflection of the other edge of the strip by its associated roller actuating means, means continuously energizing the stator windings of said first and said other motor, means electrically connecting one winding of a third one of the motors in circuit with the rotor winding of said first motor, means electrically connecting the other winding of said third motor in circuit with the rotor winding of the said other one of said motors, and indicating means actuated by said third motor.

4. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip and thus subject the strip to tension by deflecting it from the line between the work devices, separate means for actuating the two ends of the tensioning roller to cause the tensioning roller to apply a transverse deflecting force to the strip, said actuating means comprising means for causing the strip tension to vary as a function of the degree of strip deflection, a plurality of polyphase wound rotor induction motors, means ocnnecting the rotor of a first one of said motors to be actuated in accordance with the deflection of one edge of the strip by its associated roller actuating means, means connecting the rotor or another one of said motors to be actuated in accordance with the deflection of the other edge of the strip by its associated roller actuating means, means continuously energizing the stator windings of said first and said other motor, means electrically connecting one winding of a third one of the motors in circuit with the rotor winding of said first motor, means electrically connecting the other winding of said third motor in circuit with the rotor winding of the said other one of said motors, and indicating means actuated by said third motor.

5. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip and thus subject the strip to tension by deflecting it from the line between the work devices, separate means for actuating the two ends of the tensioning roller to cause the tensioning roller to apply a transverse deflecting force to the strip, said actuating means comprising means for causing the strip tension to vary as a function of the degree of strip deflection, a plurality of polyphase wound rotor induction motors, means connecting the rotor of a first one of said motors to be actuated in accordance with the deflection of one edge of the strip by its associated roller actuating means, means connecting the rotor of another one of said motors to be actuated in accordance with the deflection of the other edge of the strip by its associated roller actuating means, means continuously energizing the stator windings of said first and said other motor, means electrically connecting one winding of a third one of the motors in circuit with the rotor winding of said first motor, means electrically connecting the other winding of said third motor in circuit with the rotor winding of the said other one of said motors, indicating means actuated by said third motor, means connecting the rotor of a fourth motor to be actuated in accordance with the deflection of said other edge of the strip, means connecting the stator of said fourth motor with the rotor of said first motor, means connecting the rotor of said fourth motor with the rotor of a fifth motor, means continuously energizing the stator of said fifth motor, and indicating means actuated by said fifth motor for indicating the sum of the tensions on the to edges of the strip.

6. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip and thus subject the strip to tension by deflecting it from the line between the work devices, separate means for actuating the two ends of the tensioning roller to cause the tensioning roller to apply a transverse deflecting force to the strip, said actuating means comprising means for causing the strip tension to vary as a function of the degree of strip deflection, a plurality of polyphase wound rotor induction motors, means connecting the rotor of a first

one of said motors to be actuated in accordance with the deflection of one edge of the strip by ist associated roller actuating means, means connecting the rotor of a second one and a third one of said motors to be actuated in accordance with the deflection of the other edge of the strip by its associated roller actuating means, means selectively electrically connecting one winding of a fourth one of the motors in circuit with the rotor winding of said first or second motor, means electrically connecting the rotor of said first motor with the rotor of a fifth motor and the rotor of said second motor with the stator of said fifth motor, means electrically connecting the rotor of said first motor with the stator of said third motor, means electrically connecting the rotor of said third motor with the rotor of a sixth motor, means continuously energizing the stator windings of said first, second, fourth and sixth motors, means actuated by said fourth motor for indicating the separate tensions on the two edge portions of the strip, means actuated by said fifth motor for indicating the difference between the tensions on the two edge portions of the strip, and means actuated by said sixth motor for indicating the sum of the tensions on the edge portions of the strip.

7. In a device for tensioning a strip of material as it extends between adjacent work devices, a tensioning roller disposed to bear against the strip to deflect it from the line between the work devices, a supporting arm adjacent each end of the tensioning roller, means rotatably mounting each end of the tensioning roller on its adjacent supporting arm, a sleeve member secured to for rotation with one of said supporting arms and rotatably mounted in a position displaced from and substantially parallel with said roller, a shaft member secured to for rotation with the other of said supporting arms and substantially concentric with and extending through and beyond said sleeve member, separate means for actuating said shaft and said sleeve to thereby cause the tensioning roller to tension the strip by applying a transverse deflecting force thereto, and means responsive to the movements of said sleeve member and said shaft for indicating the individual displacements of the shaft and the sleeve, the sum of the displacements of the shaft and the sleeve, and the difference between the displacements of the shaft and the sleeve.

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