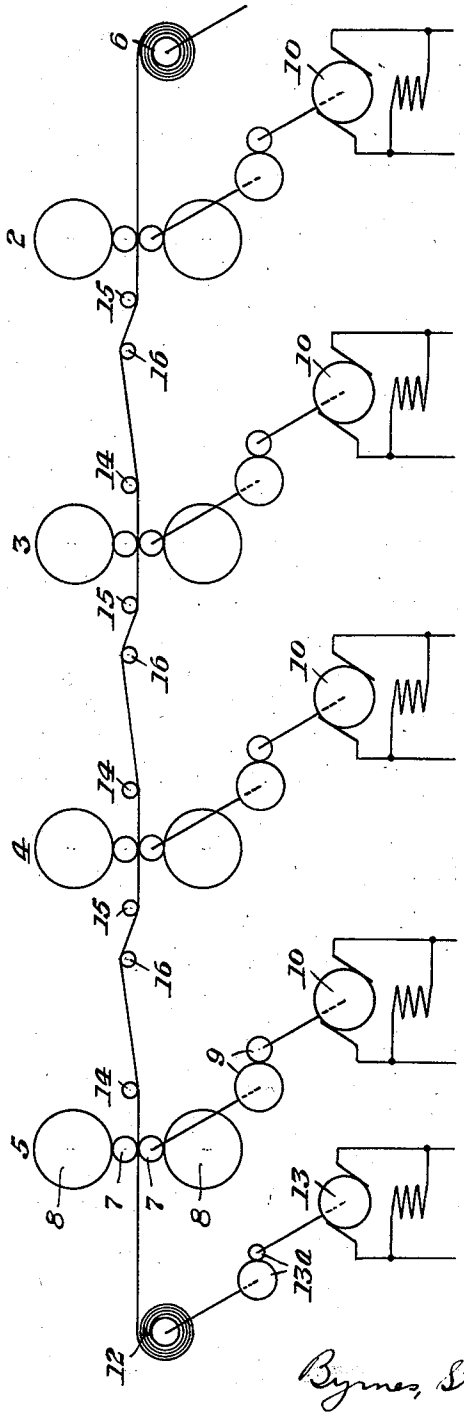
Nov. 21, 1939. L. IVERSEN 2,180,635

METHOD AND APPARATUS FOR COLD ROLLING STRIP METAL

Filed July 15, 1935 3 Sheets-Sheet 1

Fig. 1.



INVENTOR

Lorenz Iversen

by his attorneys

Byrnes, Stebbins & Blenko

Nov. 21, 1939. L. IVERSEN 2,180,635

METHOD AND APPARATUS FOR COLD ROLLING STRIP METAL

Filed July 15, 1935 3 Sheets-Sheet 2

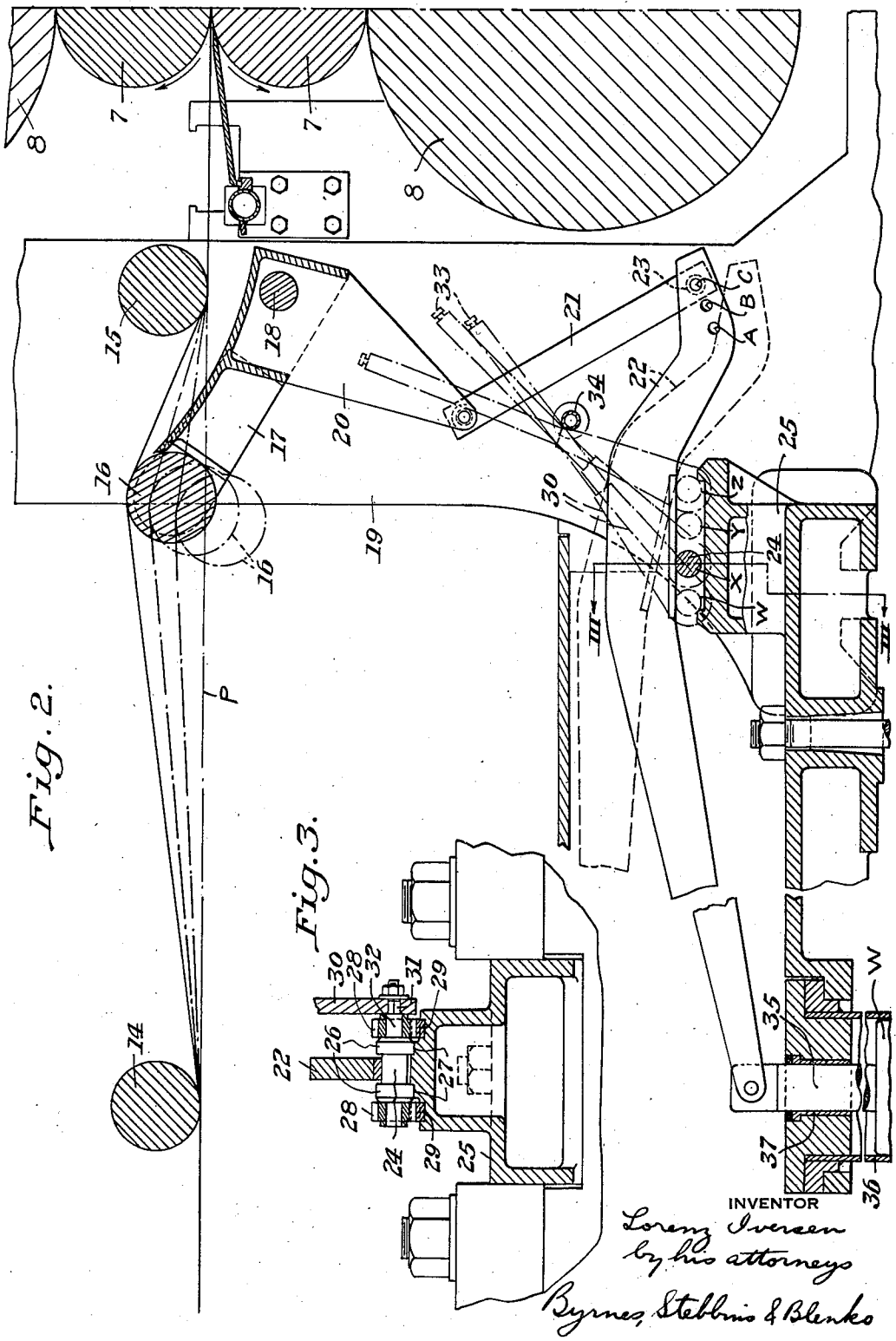


Fig. 2.

Fig. 3.

INVENTOR

Lorenz Iversen

by his attorneys

Byrnes, Stebbins & Blenko

Nov. 21, 1939. L. IVERSEN 2,180,635

METHOD AND APPARATUS FOR COLD ROLLING STRIP METAL

Filed July 15, 1935 3 Sheets-Sheet 3

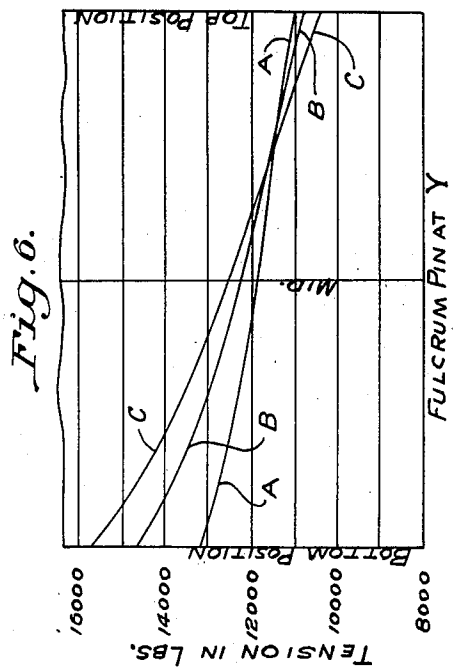


Fig. 6.

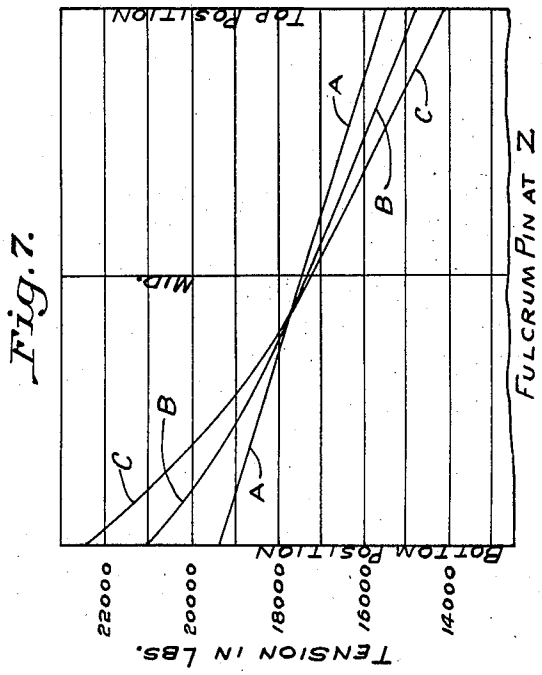


Fig. 7.

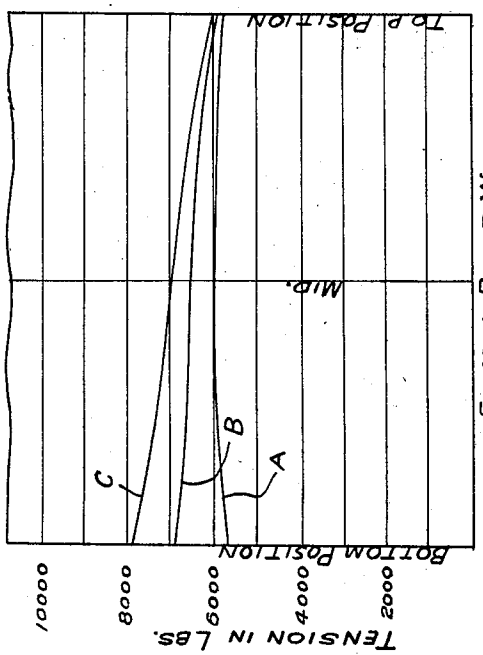


Fig. 4.

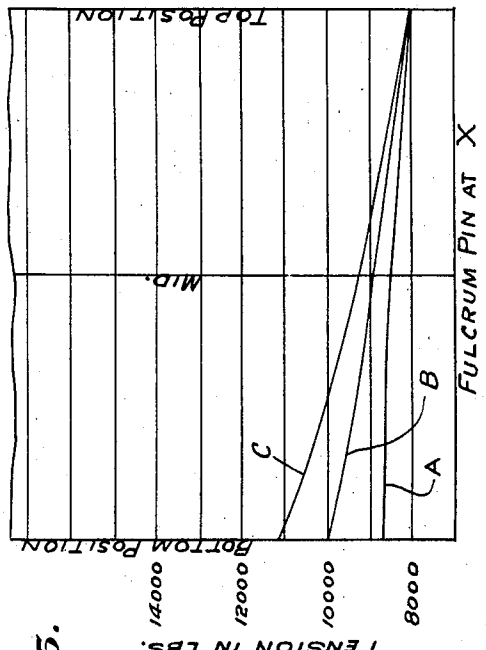


Fig. 5.

INVENTOR

Lorenz Iversen

by his attorneys

Byrnes, Stebbins & Blenko

Patented Nov. 21, 1939

2,180,635

UNITED STATES PATENT OFFICE

2,180,635

METHOD AND APPARATUS FOR COLD ROLLING STRIP METAL

Lorenz Iversen, Pittsburgh, Pa., assignor to Mesta Machine Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application July 15, 1935, Serial No. 31,432

13 Claims. (Cl. 80—35)

This invention relates to the cold rolling of strip metal in a continuous mill; that is to say, in a mill consisting of a series of stands adapted to work successively on the metal, different portions of the strip being acted upon by two or more stands of the mill at the same time. It is now well recognized that in cold rolling the compressive force of the rolls and tension on the strip are both important factors affecting the reduction. With increasingly close gauge tolerances it becomes necessary to effect a close control of these factors. It has heretofore been proposed (Bedell Patent 1,964,241, dated June 26, 1934), to deflect the strip from a straight-line path as it travels between successive stands of a tandem mill so as to maintain a substantially constant tension on the strip. It has also been proposed to maintain a substantially unvarying tension by using electric driving motors for the mill stands, which motors have suitable characteristics, as, for example, a drooping power curve. The difficulty with these prior systems has been that they presuppose a uniform and unvarying quality of strip. As a matter of fact, however, the hot rolled strip which is used as a starting material in a cold rolling operation may for a variety of reasons be non-uniform. For example, it may have hard spots which offer undue resistance to reduction, and unless special treatment is accorded to these hard spots there will inevitably be variations more or less serious in the gauge of the strip. The systems heretofore employed have not been adequate to meet situations such as that just described, and a further difficulty attendant upon electric motor control or regulation is that the inertia of the moving parts is such as to destroy any possibility of instantaneous response to a changed condition. In consequence systems of that sort have not only failed to overcome the difficulties but have induced additional gauge variations by reason of the hunting which occurs.

I have found that superior results may be obtained by deflecting the strip out of a straight-line path between stands and subjecting it to a varying tension, the amount of tension being automatically adjusted in accordance with the characteristics of successive portions of the strip as it travels through the mill. Preferably the degree of pressure variation is lessened in the later stages of reduction. At this time the differences in hardness between successive portions of strip will have been lessened in some degree by reason of the effect of cold work.

I so arrange the mill and its associated parts that a relatively short length of strip is subjected to deflection at any time. This not only makes for accuracy of tension effect but, what is more important, limits the effect of the varied tension to that portion of the strip which, because of its special characteristics, requires an adjustment of the reducing forces. Suppose that there be a hard spot in a strip, the hard portion having a length, say, of five feet. It is necessary to increase the tensile force which is applied to the strip in order to reduce this hard spot in the same amount as the adjacent portions of the strip. Obviously the increased tension should be applied for only a relatively limited period of time as otherwise its effect will be applied to the portions of the strip adjacent the hard spot and will reduce them unduly. I therefore place the roll stands relatively close together—not more than twelve work roll diameters apart—and preferably limit the span over which the advancing strip is deflected to not more than six work roll diameters.

In the accompanying drawings illustrating a present preferred embodiment of the invention,

Figure 1 is a diagrammatic view of a continuous mill employing the invention;

Figure 2 is a longitudinal section to enlarged scale of a portion of one of the mill stands, and the associated tensioning mechanism;

Figure 3 is a section on the line III—III of Figure 2; and

Figures 4 to 7 inclusive are diagrammatic views showing the various tension effects which may be secured by suitable adjustment of the tension device.

The mill shown in Figure 1 comprises a series of stands 2, 3, 4 and 5 adapted to successively engage and cold roll steel strip fed from a coil holder 6. Each of the stands is shown as being of the well-known 4-high type having working rolls 7 and backing rolls 8 of larger diameter. The working rolls are driven through gear reductions 9 by motors 10 of the constant speed type. After the strip passes out of the last stand, it is coiled on a reel 12 driven by a motor 13 through gearing 13a.

In the mill shown the working rolls are 18 inches in diameter and the stands are spaced 13 feet apart. This "close coupling" of the stands is important not only from the standpoint of space saving, but also, as above explained, from the standpoint of operation. Idle rolls 14 and 15 are placed between the stands and the strip may be deflected upwardly between them by a tensioning roller 16. In the mill shown the idle rolls are 10 inches in diameter and are spaced approximately 88 inches apart.

The tensioning rollers 16 are actuated and controlled by mechanism illustrated in detail in Figures 2 and 3. The same structure is employed between each two successive mill stands and a description of one will suffice for all. However, as hereinafter explained, different adjustments are employed in different cases.

The tension roller 16 is mounted in a lever 17 pivoted on a cross shaft 18 mounted in the housing 19 of the mill stand. The lever 17 has an arm 20 which is connected by a link 21 to a lever 22. The lever 22 is provided with three holes A, B and C arranged to accommodate a pin 23 which makes the pivotal connection between the link 21 and the lever 22. By placing the pin in different holes different effective lever links can be obtained. The lever 22 rocks on a fulcrum pin 24 mounted on a base 25. The fulcrum pin is movable to any one of a variety of positions, four of which are indicated at W, X, Y and Z. The mounting of the fulcrum pin is best shown in Figure 3. It is formed with roller portions 26 running on tracks 27 formed on the base 25 and carries pinions 28 meshing with racks 29 fixed in the base. Rotation of the fulcrum pin causes it to move along the tracks 27, the rack and pinion construction insuring positiveness of movement. Rotation of the fulcrum pin is effected by an adjusting lever 30 having a latch connection 31 with an extension 32 of the fulcrum pin. A thumb button 33 permits of engaging or disengaging the latch connection, as desired, so that the operating lever 30 can be conveniently used. Operation of the main lever 22 does not exert any force tending to displace the fulcrum pin 24 from any adjusted position, and any inconsequential forces which may tend to move it are effectually resisted by the mere weight of the operating lever 30 which, when the fulcrum pin has been moved to the desired adjusted position, is allowed to rest against a cross bar 34.

The tensioning roller 16 is urged upwardly through the mechanism just described by means of a weight W attached to a plunger 35 and operating in a cylinder 36 connected to the base 25. The plunger 35 is carried in a bearing sleeve 37 in the cylinder head.

The weight W exerts a constant downward force but the amount of tension thereby exerted on the strip depends upon—

(a) The position of the fulcrum pin 24.

(b) The location of the pin 23, and

(c) The amount of deflection of the strip between the rollers 14 and 15.

I have indicated by a line P the path which the strip would take if it traveled in a straight line between successive stands, and have also indicated more or less arbitrarily top, bottom and middle positions which the roller 16 may take.

Figures 4 to 6 inclusive show the tension exerted on the strip for different settings of the several elements above enumerated. Figure 4, for example, shows the amount of tension in different positions of the roller 16 with the fulcrum pin located at W. There are three curves in this figure lettered A, B and C corresponding to positioning of the pin 23 in each of the holes A, B and C.

In the earlier stages of reduction the apparatus will be so adjusted as to exert considerable force, lesser forces being employed as the reduction proceeds. The total magnitude of the force, as well as the amount of variation therein for any given movement of the roller 16 may be readily fixed by the adjustments heretofore described.

In operation, if, say, the stand 2 fails to reduce a given portion of the strip in the same amount as adjacent portions, as, for example, if a hard spot is encountered, there is a corresponding decrease in elongation and as the hard spot travels over the span between the stand in which it was just rolled and the succeeding stand, the roller 16 will be deflected downwardly, thus increasing the tension on the strip and correspondingly increasing the amount of reduction effected on the hard spot in the succeeding stand because of the increased back tension which is applied. Similarly, if an undue reduction is effected in a stand there is a corresponding increase in elongation with consequent decrease in the tension.

The apparatus functions promptly whenever a condition such as this is encountered, and its effect is substantially limited to that portion of the strip which requires correction. Even though the effect be reflected in some small measure on portions of the strip at either side of the hard or soft spot, nevertheless the desired gauge is more closely approximated throughout the strip, and as successive stands and successive tension devices operate on the strip all irregularities are minimized or eliminated. This is especially so if the tension variations are reduced as the strip progresses through the mill.

An important feature of my invention is that the control is effected independently of the drive. The stands are driven, each at constant speed, and the necessity for complex electrical controls supposedly functioning to correct variations in the strip may be dispensed with.

I have illustrated and described a present preferred embodiment of the invention, but it will be understood that the same is not limited thereto but may be otherwise embodied or practiced within the scope of the following claims.

I claim:

1. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the stands each at constant speed, subjecting the strip to successive cold reductions in the several stands, maintaining the strip under tension between two successive stands, and varying the tension between such stands independently of the driving of the stands.

2. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the several stands each at constant speed, subjecting the strip to successive cold reductions in the stands, maintaining the strip under tension between stands, and varying such tension.

3. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the stands each at constant speed, subjecting the strip to successive cold reductions in the several stands, maintaining the strip under a varying tension between successive stands, to compensate for irregularities in the strip, the amount of variation being less between later stands of the mill than between preceding stands.

4. Apparatus for the cold rolling of metal strip comprising spaced substantially constant speed roll stands adapted for the continuous rolling of the strip, means between the stands for deflecting the strip from a straight-line path, and means biasing the deflecting means and effective for imposing a varying tension on the strip.

5. Apparatus for the cold rolling of metal strip

comprising spaced substantially constant speed roll stands adapted for the continuous rolling of the strip, means between the stands for deflecting the strip from a straight-line path, and means biasing the deflecting means and effective for imposing a tension on the strip which decreases with increasing departure of the strip from a straight-line path between stands.

6. Apparatus for the cold rolling of metal strip comprising a pair of mills adapted for the continuous rolling of the strip, means for driving the mills each at constant speed, and means arranged to engage the strip between two such mills and subject it to a varying tension.

7. Apparatus for the cold rolling of metal strip comprising a pair of mills adapted for the continuous rolling of the strip, means for driving the mills each at constant speed, and means adapted to engage the strip between the mills and deflect it from a straight-line path, said means being effective for imposing a tension on the strip which decreases with increasing departure of the strip from the straight-line path.

8. Apparatus for the cold rolling of metal strip comprising a plurality of mills adapted for the continuous rolling of the strip, tensioning means arranged between two successive stands adapted to engage the strip and deflect it from a straight-line path between the stands and impose a varying tension thereon, and a second tensioning means arranged between stands at a point closer to the delivery end of the mill than the first-mentioned tensioning device, the second tensioning device being also adapted to impose a varying tension on the strip but less in amount than the first-mentioned tensioning device.

9. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the several stands each at constant speed, subjecting the strip to successive cold reductions in the stands, maintaining the strip under tension between stands, deflecting the strip from a straight line path in its passage between stands by the application of a deflecting force, and varying such tension by varying the deflecting force.

10. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the several stands each at constant speed, subjecting the strip to successive cold reductions in the stands, maintaining the strip under tension between stands, deflecting the strip from a straight line path in its passage between stands by the application of a deflecting force, and varying such tension by varying the deflecting force, the tension being increased when a relatively hard portion of the strip travels between such stands.

11. In the method of cold rolling strip metal in a tandem mill having a plurality of driven stands, the steps consisting in driving the several stands, feeding a strip therethrough and subjecting the strip to successive cold reductions in the several stands, maintaining the strip under tension between stands, and compensating for local irregularities in the strip by varying the amount of tension between two successive stands as the portion in question is being reduced in such stands while maintaining the speed of such stands substantially constant.

12. Apparatus for the cold rolling of metal strip comprising spaced roll stands adapted for the continuous rolling of the strip, means between the stands for deflecting the strip from a straight-line path, means for urging the deflecting means in a manner to induce the strip to depart from a straight-line path between the stands, connections between the two last-mentioned means, including a lever arm, a fulcrum for said arm, and a support for said fulcrum, said fulcrum being manually movable along said support.

13. Apparatus for the cold rolling of metal strip comprising spaced roll stands adapted for the continuous rolling of the strip, means between the stands for deflecting the strip from a straight line path, said means being movable toward or from operative position, means for urging the deflecting means toward operative position, and connections between said means including a lever having one arm operatively connected to the deflecting means and the other arm operatively connected to the urging means, a fulcrum upon which the lever is rockably mounted, a fixed support, the fulcrum being movable thereon, and means for adjusting the position of the fulcrum on the support.

LORENZ IVERSEN.