This invention relates to an improved indicator for visually conveying the spacing of the work rolls of a metal rolling mill during adjustments of such spacing and for indicating the deviations made in screwdown adjustment at either end of one of the work rolls during a finite period or term of operation of the mill. In the rolling of steel, particularly strip, there are two general conditions which must be followed very closely in the normal operation of the mill in addition to precise control of the speed of operation of the mill. These conditions are, first, that rapid adjustments must be made in the separation of the work rolls in changing from one product gauge to another and, secondly, that an operative levelness must be maintained between the work rolls under all conditions of service to arrive at a product which is of uniform thickness throughout its width and to avoid misguiding of the strip in its passage through the mill and thereby avoid tearing of the side edges of the strip by contact with the mill housings, etc.

The above requirements are particularly difficult to maintain in the case of multiple stand mills wherein a hot strip installation, for example, some six finishing stands may be installed in tandem intermediate the roughing mill stands and the final coiler. While some attempts have been made to fully automate the operation of single and multiple stand strip rolling mills, including control of roll spacing and leveling by means of simultaneous or independent automatic of the two screwdowns on each stand the ultimate responsibility for control and/or monitoring rests with a thoroughly experienced human operator, and it is the principal object of this invention to rearrange the screwdown indicator or indicators for the mill stand or stands whereby the rather difficult task of such ultimate control and/or monitoring is greatly facilitated.

In rolling mills operating at high productive speeds, as is now common practice, it is exceedingly difficult for an operator to keep in mind the operating idiosyncrasy of a roll stand for different gauges in speeds, and the problem is vastly compounded in the case of multiple stand mills. These variants may result from irregular wear of the work rolls, variable spring of the mill housings, inconsistencies in the performance of the clutch or clutches used to tie the front and back screwdowns together, and from various other causes. Also, it is difficult, particularly in a multistand mill, to keep in mind the initial or base-point deviation or spread of the front and back screwdown settings when making corrections or changes in gauge, changes in speed, and changes in bar or slab and finishing temperatures.

In furtherance of the above generally stated objects and for the further purpose of reducing the mental confusion unavoidably present in the human control and/or monitoring of the work roll spacing and leveling in a strip mill, the invention provides means whereby immediate prior to the making of any such adjustments in any of the roll stands of the mill the two screwdown indicating hands for each of such stands may be simply and rapidly brought together temporarily so that during the actual making of the adjustments the two hands of each stand will move as a unit without disturbing the relative rotational settings of the screwdowns while being instantaneously available for independent movement commensurate with the independent movement of the front and back screwdowns during the terminal stage of the adjusting movement.

For a better understanding of the structure and functioning of the present invention reference should now be had to the drawings wherein:

FIGURE 1 is a schematic side elevation of a strip rolling mill showing the screwdown indicator commonly used therewith; and

FIGURE 2 is a fragmentary sectional view of the screwdown indicator as used in FIGURE 1, this indicator being modified from the conventional to carry out the principles of the present invention.

Reference numeral 10 designates the front (or near side) housing of a conventional rolling mill having top and bottom work rolls 11 and 12, respectively, and top and bottom backup rolls 13 and 14, respectively. The housing 10 has bearing chocks to journal the near or front ends of the various rolls, and it will be understood that the top chocks are held in a downwardly adjusted position by a screwdown 15. Of course, a rear (far side) similar housing, chocks and screwdown are provided to journal and adjust the other ends of the rolls. Each of these screwdowns may be driven by a worm 16 through a worm wheel 17, and it will be obvious to those familiar with the art that it is common practice to provide a separate driving motor for each of the worms whereby the upper work roll 11 may be tilted with respect to the lower work roll. Also, in accordance with usual practice, a clutch, not shown herein, is provided to couple the two worms together whereby the spacing between the work rolls may be rapidly adjusted without losing the general or preset parallelism between these rolls.

Reference numeral 18 designates the fixed dial or face of a conventional screwdown indicator or "clock," and this is commonly faced forward the front side of the mill so as to be readily viewable by the controller or monitor from his pulpit or enclosure. This indicator has a first hand 19 mounted on a projecting shaft 20 connected to the front screwdown of the mill through suitable gearing, not shown, to indicate the rotational position of the front screwdown. Commonly, also, there is provided a second indicating hand 21 which is mounted on a sleeve 22 connected through suitable gearing, also not shown herein, to the screwdown in the rear or far mill housing to indicate the rotational position of the screwdown in said rear or far housing. Thus, the controller or monitor can observe at a glance the settings of the two screwdowns of the mill stand and also the deviation of such settings which is indicative of the levelness or parallelism between the two work rolls of the stand.

For purposes to be hereinafter explained, one of the hands of the indicator—for example, hand 21 herein—is not fixed on its supporting shaft or sleeve, but is se freely revolvable thereon. Thus, in FIGURE 2, the hand 21 is rigidly secured to a flanged ferrule 23 freely revolvable on a bushing 24 which in turn is slipped onto the sleeve 22. However, means are provided herein to normally clamp the ferrule 23 to the sleeve 22 so that these parts may normally revolve in unison. Any suitable means may be provided to effect this controllable clamping, but for illustration purposes I have shown a generally annular electromagnet 25 which is keyed onto the sleeve 22 and which is arranged to be energized by brushes 26 bearing on slip rings 27. A suitable source of energizing current may be supplied to the brushes 26 by a battery 28 under command of a control switch 29 which may be either automatically or manually actuated depending on the general control circuitry provided for the mill. It should be understood, however, that when the magnet 25 is energized the ferrule 23 will be magnetically clamped thereto and the hand 21 will move with the sleeve 22. When the mag-
net is de-energized, the hand 21 is free to revolve independently of the sleeve 22, and for a purpose to be herein after described I provide the outer free end of the hand 21 with a weight 30 which pulls this hand to a straight down or 6 o'clock position when the magnet 25 is de-energized and the hand 21 is in any upper position except a precise straight-up or 12 o'clock position.

In the use of the above apparatus, when it is anticipated that some screwdown adjustments at the mill stand or stands will be required as, for example, the arrival of new rolling specifications or gauge for the next succeeding bar or slab, the control 29 is first actuated to de-energize the magnet or magnets 25 thereby allowing the hand or hands 21 to fall to a 6 o'clock position. At the start of adjusting movements and immediately upon the hand 19 of any stand reaching the 6 o'clock position the magnet 25 of this stand is energized by the control 29, and thereafter the two hands of this stand will revolve around the dial 18 in unison, making it easy for the operator or the monitor to count the revolutions. Of course, this presupposes the intercoupling of the two worms 16 of the stand whereby the spacing of the two work rolls 11 and 12 is varied without change in parallelism or levelness. However, it should be noted that while the front and back hands of the indicator are thus brought together there is absolutely no change whatever in the level of the work rolls from their fine adjustment reached during the rolling of the previous slab or bar.

Ordinarily, for new screwdown adjustments to arrive at a new finished gauge or a new finishing temperature or in compensation of speed changes in rolling the next succeeding slab or bar, no further differential adjustments as between the front and back screwdowns on the mill stand or stands will be required since generally the above referred to individual characteristics or idiosyncrasies of the stand or stands will have already been compensated for in the previous rolling. However, in some instances the new rolling schedule will develop a requirement for readjustment of the leveling settings of the front and back screwdowns of one or more of the stands, and the same will be accomplished by declutching the front and back worms of the stand or stands being relined, and, of course, the resultant new deviation or deviations will appear at once in the spread between the two indicator hands of the stand or stands being relined since at this time both hands of each hand are clamped to their respective drive shafts or sleeves. This newly indicated deviation or deviations is of considerable importance to the human opera-