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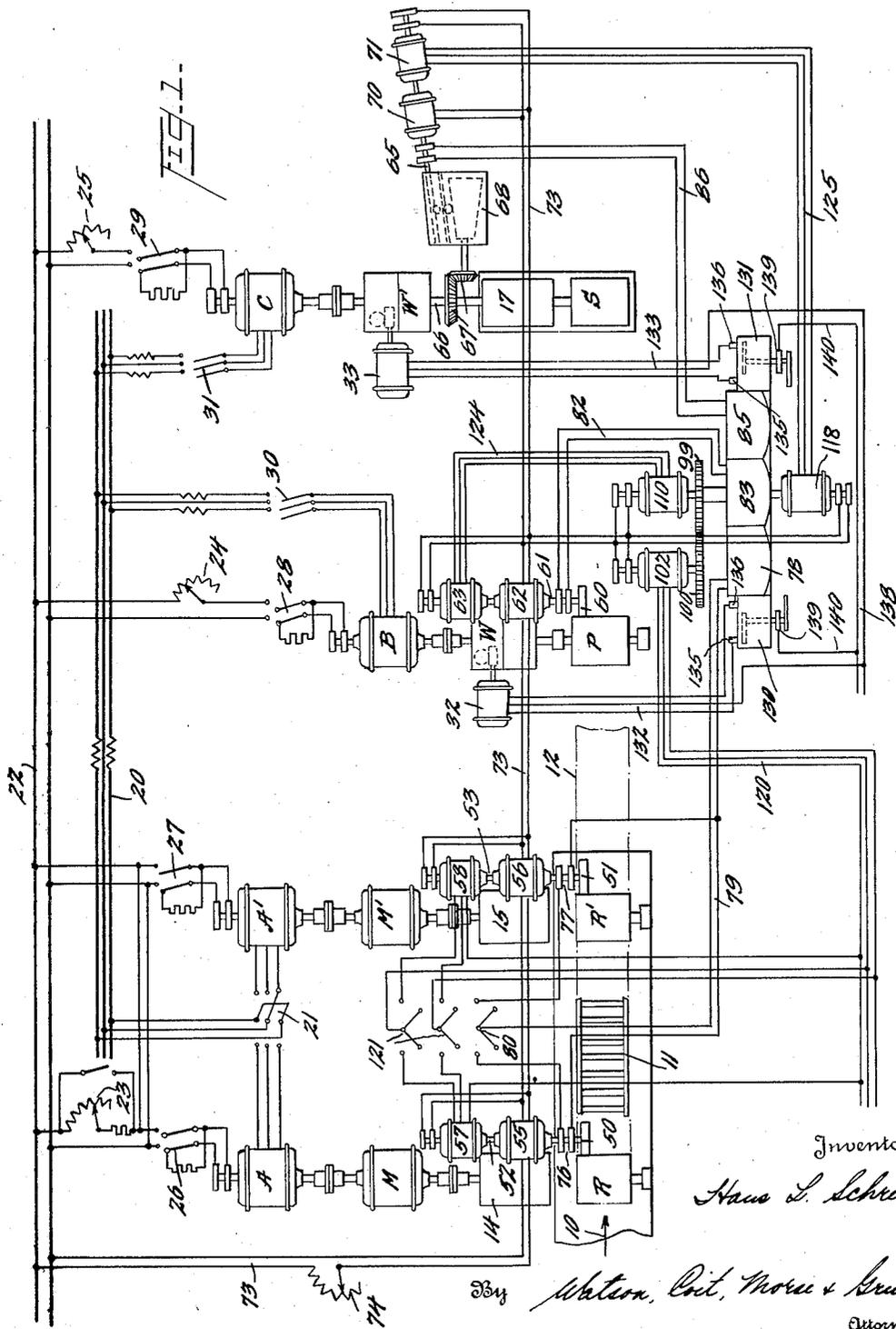
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2,022,574

CONTROLLING MEANS FOR FLYING SHEARS OR THE LIKE

Filed Feb. 25, 1932

4 Sheets-Sheet 1



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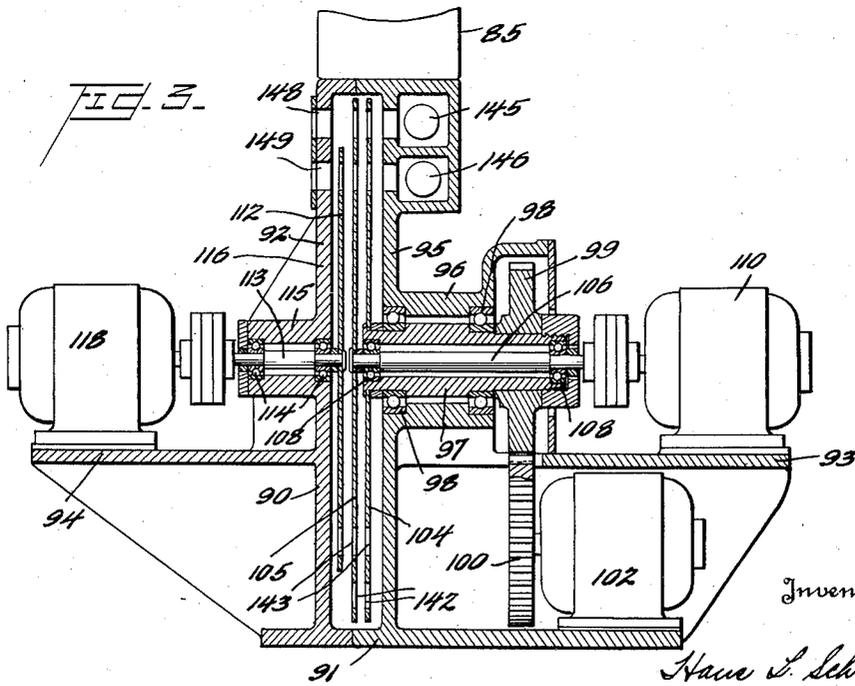
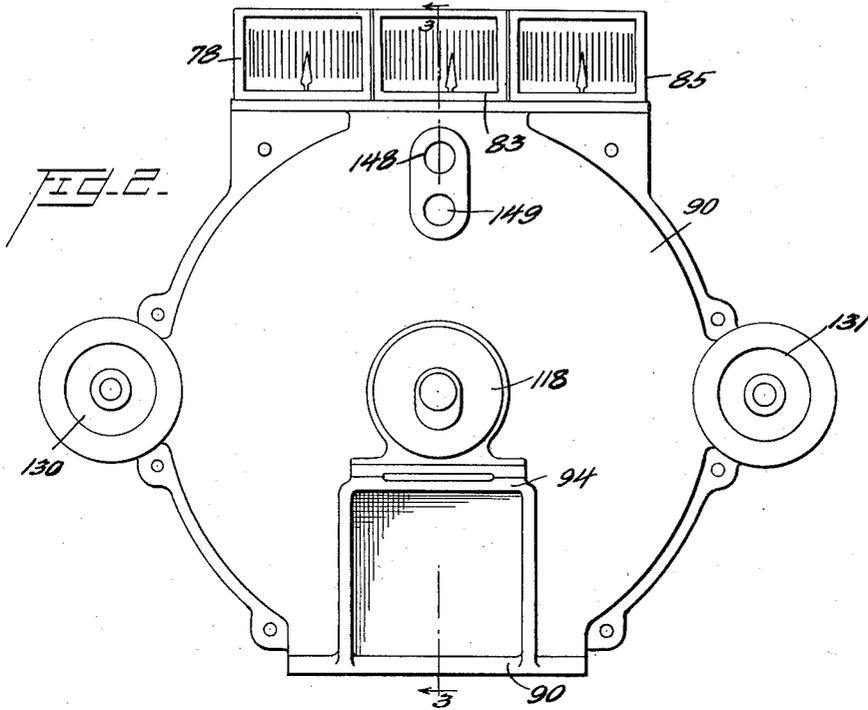
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CONTROLLING MEANS FOR FLYING SHEARS OR THE LIKE

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4 Sheets—Sheet 2



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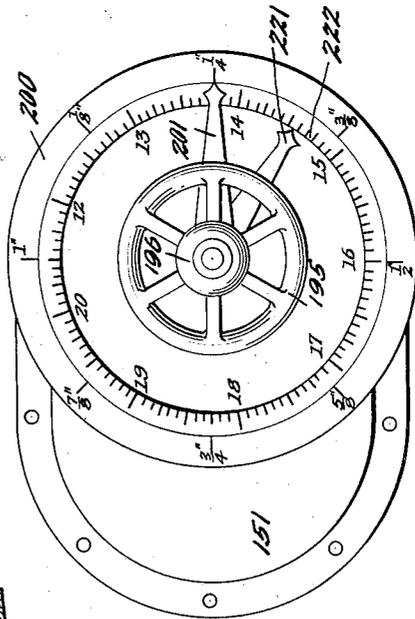
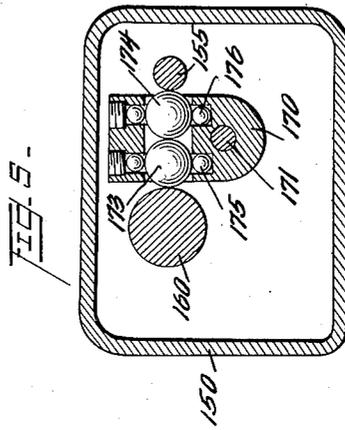
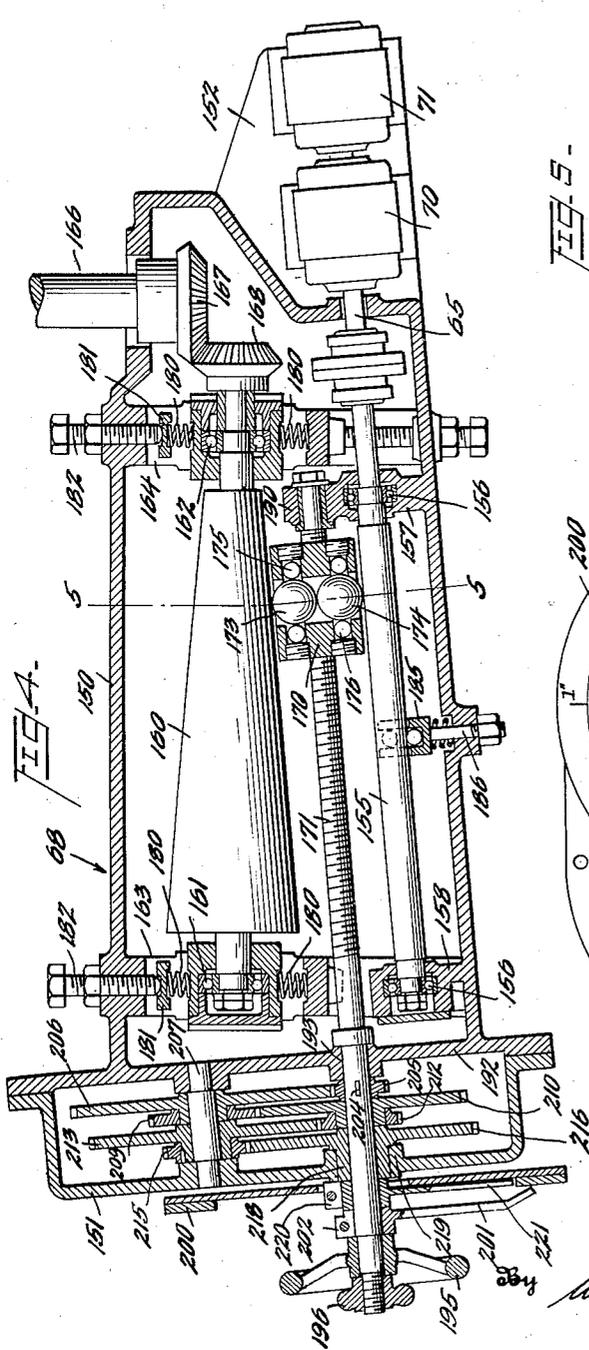
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CONTROLLING MEANS FOR FLYING SHEARS OR THE LIKE

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4 Sheets-Sheet 3



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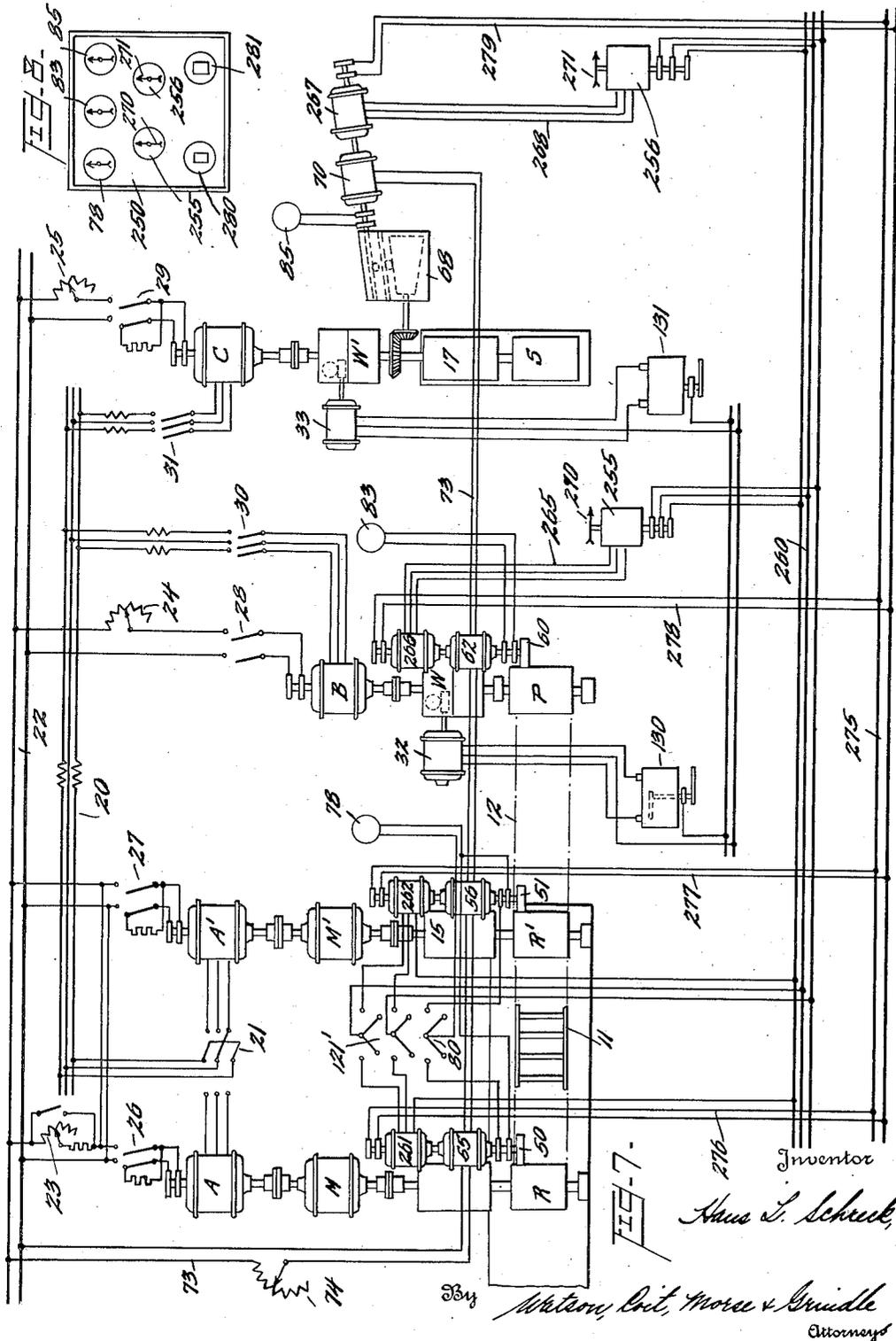
H. L. SCHRECK

2,022,574

CONTROLLING MEANS FOR FLYING SHEARS OR THE LIKE

Filed Feb. 25, 1932

4 Sheets-Sheet 4



# UNITED STATES PATENT OFFICE

2,022,574

## CONTROLLING MEANS FOR FLYING SHEARS OR THE LIKE

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Application February 25, 1932, Serial No. 595,199

15 Claims. (Cl. 80—3)

This invention relates to controlling means for flying shears or the like and has reference more particularly to mechanism for indicating and adjusting with a high degree of accuracy and refinement the relative speeds of such devices and other metal working instrumentalities with which they may be associated.

In its exemplary embodiment as set forth in the present specification, the invention contemplates the provision of an improved indicating and controlling means for bringing a flying shear and its associated feeding devices into proper synchronism with each other and with the final stands of a rolling mill from which the finished strip material is delivered to the shear to be cut into the desired lengths. However, the principles of the invention may be embodied in numerous other installations, both in the metal working and other industries, and are not to be construed as limited to any particular adaptation except by the scope of the subjoined claims.

Heretofore, in rolling mill establishments, much difficulty has been experienced in cutting material delivered from a rolling mill into desired lengths within the required tolerance, especially in the case of hot strip mills which are often run at very high speeds. Furthermore, a variation in the relative peripheral speeds of the rolls of the mill stands and of the pinch rolls which are generally employed to feed the material to the shear, will cause either buckling and bending of the stock or tensioning and slippage of the same between these two machines. These unsatisfactory conditions are apt to prevail even when the driving means of the pinch rolls and the shear are operatively connected to that of the rolling mill, and are, of course, aggravated whenever the rolls of the mill stands or of the pinch roll feeding device become worn and are turned down, or otherwise vary even in a slight degree from their original diameters upon the basis of which the attempted synchronization is generally made.

It is, therefore, an object of the present invention to provide, in an arrangement of this description, novel means for obtaining a rough synchronization of the sources of power of the various metal working and handling devices mentioned; means adapted to be associated directly with the mill rolls, and the pinch rolls, and with the flying shear for accurately indicating the relative linear speeds of these devices; means for controlling the driving mechanism of the pinch rolls and shear to bring them into synchronism with the rolling mill; and means for adjusting the driving mechanism of the flying shear to

secure the desired length of cut of the material within an exceedingly small tolerance.

This last mentioned feature involves novel mechanism adapted to be interposed between the flying shear and its associated speed indicating devices, adapted to permit a variation in the absolute speed of the shear in accordance with the length of the cut, while the shear speed indicator is registering an apparent exact synchronism with the rolling mill and the pinch rolls. By this means, the proper setting corresponding to the length of the cut may be made on the interposed mechanism and, when the operating machines are brought to an apparent synchronism, as shown by the indicating devices, the shear will accurately and automatically effect cuts at the prescribed intervals.

Other objects and features of novelty, including improvements in the mechanical, visual, and electrical devices included in the arrangements referred to will be apparent from the following specification when read in connection with the accompanying drawings in which certain embodiments of my invention are set forth by way of example.

In the drawings,

Figure 1 is a largely diagrammatic view of one embodiment of the invention, showing the last two stands of a rolling mill, a delivery table, a pinch roll stand, and a flying shear, together with their driving and controlling circuits;

Figure 2 is a front view of the shear control stand upon which are mounted the indicating devices and speed controls;

Figure 3 is a vertical cross sectional view taken on line 3—3 of Figure 2;

Figure 4 is a view substantially in longitudinal vertical cross section of the variable indicator control device for determining the length of the cut made by the shear;

Figure 5 is a transverse cross sectional view taken on line 5—5 of Figure 4;

Figure 6 is an end view of the device shown in section in Figure 4;

Figure 7 is a view similar to Figure 1 of another embodiment of the invention in which differential selsyn indicators are employed; and

Figure 8 is a front view of a suggested form of control panel for use in connection with this last mentioned modification.

Referring now more particularly to Figures 1 and 4 in which the driving mechanisms for the several metal working and handling devices are exactly the same, the last two finishing stands of a hot strip rolling mill are indicated at R and R'.

The direction of movement of the material through the mill from the earlier stands is indicated by the arrow 10 and a roll table along which the material passes from the stand R to the stand R' is indicated at 11, and a run-off or delivery table upon which the strips leave the mill is shown at 12. The finishing stands R and R' are preferably driven from the motors M and M' respectively through the pinions enclosed in the pinion housings 14 and 15. The driving motors M and M' are of a suitable type and size for operating the finishing stands of the rolling mill and are adapted to be supplied with current from a suitable source which is not shown in the drawings.

In order to cut the strips delivered from the mill into the desired lengths, there is provided a flying shear S of a type suitable for the purpose, and, since the shear S is adapted to be located at a distance from the last rolling mill stand R', there is provided a feeding device which is adapted to transfer the strip from the run-out table 12 to the shear and which, in the illustrated embodiment, comprises the pinch roll stand P. The pinch rolls are adapted to be driven by the synchronous motor B, and a similar synchronous motor C is provided for driving the flying shear S. The transmission of the driving force from the motor B to the pinch roll P is accomplished through the change speed gear W which may be of any suitable type, but comprises preferably a hydraulic transmission device of the type disclosed in the following patents: Williams 893,558, 925,143 and Janney 924,787. The driving connections between the motor C and the flying shear S comprise, in addition to the similar variable speed gear W', the pinions enclosed in the housing 17.

In order to provide a basic synchronism between the rotary speeds of the driving means for the shear, the pinch rolls, and the finishing stands of the rolling mill, the synchronous motors B and C are adapted to be driven from the synchronous generators or alternators A or A', which are in turn driven from the mill motors M and M' respectively. The motors B and C are connected selectively with the alternators A or A' by means of the circuit 20 in which is inserted the transfer switch 21. The fields of the alternators A and A' and of the synchronous motors B and C are adapted to be excited from the direct current lines 22, and the supply of such current is adapted to be controlled by means of the rheostats 23, 24 and 25 and the field contactors 26, 27, 28 and 29. Switches 30 and 31 are also provided in the electrical connections between the alternators and the synchronous motors. Alternators are provided in connection with each of the finishing stands R and R' since either stand R or stand R' may be used as the final finishing stand of the mill, and transfer switch 21 is employed to throw in the alternator corresponding to the mill stand which is being used as the last finishing stand in any particular instance. Incidentally, it is particularly desirable that the transfer switch 21 be associated for simultaneous actuation with the transfer switches which control the auxiliary indicating equipment to be later described.

The variable speed gears W and W' are actuated by means of the motors 32 and 33 which are adapted to be controlled from a remote point by devices which will be described subsequently in connection with the description of the indicating devices referred to.

It will be readily seen from the foregoing description and explanation, that the driving mo-

tors of the pinch rolls and the flying shear are always in synchronism with the motors M and M' which drive the final rolling mill stands, so that any variation in the rotational speed of the rolling mill will cause a simultaneous and corresponding variation in the rotational speed of the driving means for the pinch rolls and shear, whether this variation is intentional, such as for rolling material of different sections, or whether it is due to any fluctuation in the voltage supplied to the main driving motor. Furthermore, any desired changes in this timed relation between the pinch rolls and the rolling mill or between the flying shear and the rolling mill may be effected by means of the variable speed gears W and W' which are interposed between the pinch rolls and the flying shear and their respective driving motors. In this connection, it is to be mentioned that the variable speed gear W is primarily intended to be employed in synchronizing the peripheral or linear speeds of the finishing stand rolls of the mill and the pinch rolls due either to the initial employment of rolling mill rolls and pinch rolls of differing diameters or due to subsequent developing changes in the diameters of these rolls due to wear. Manipulation of the change speed gear W is accomplished in response to indications of such changes which are given by the indicating devices which will be described. The function of the variable speed gear W' which is adapted to control the flying shear S is, however, to adjust the rotation of the flying shear with respect to the linear speed of the delivered material so as to effect the desired length of cut. For example, a rolling mill of this type is adapted to deliver hot strip steel to the shear at the rate of from 800 to 2400 feet per minute and the shear which is used is adapted to cut this strip material into lengths of from 12 to 20 feet, these factors necessitating a variation in speed of the flying shear of from about 40 cuts up to 200 cuts per minute.

In accordance with the objects of the present invention, the control of the relative speeds of the pinch rolls, the flying shear and rolling mill stands is accomplished by manual operation of the remote controls of the change speed gears W and W', in response to indications of variations in the predetermined relative speeds of the pinch rolls and the shear and the mill caused either inadvertently by the changes in the operative equipment or due to intentional variations in the control equipment for the purpose of changing the length of the cut material. The indicating mechanism referred to, particularly the one illustrated in Figures 1, 2 and 3, will now be described.

Respectively associated with the finishing stands R and R' and mounted for frictional contact with one of the working rolls thereof, are the rollers 50 and 51 which are mounted upon the shafts 52 and 53 which also serve as the rotor shafts of the tachometer generators 55 and 56 and the synchronous generators 57 and 58. Similarly mounted for frictional contact with one of the rolls of the pinch roll stand P is the roller 60 upon the shaft 61 of which are mounted the rotors of the tachometer generator 62 and the synchronous generator 63. A somewhat similar installation is provided in connection with the flying shear, but in this case the shaft 65 is connected to the main drive shaft 66 of the flying shear by means of the bevel gears 67 and the change speed device 68. Upon the shaft 65 are mounted the rotors of the tachometer generator 70 and the synchronous generator 71. The ta-

chometer generators 55, 56, 62 and 70 are preferably small, separately excited D. C. generators and are adapted to develop a voltage directly proportional to their rotational speed. The fields of all these generators are connected in series with the source of direct current by means of the circuit 73 which is adapted to be controlled by the rheostat 74. Alternatively connected with the commutators 76 and 77 of the tachometer generators 55 and 56 associated with the mill stands is the tachometer 78. This connection is effected by means of the circuit 79 which is controlled by means of the transfer switch 80 which is arranged for simultaneous actuation with switch 21. Similarly, the circuit 82 connects the armature of the tachometer generator 62, associated with the pinch rolls P, with the tachometer 83 and the armature of the generator 70 is connected with the tachometer 85 by means of the circuit 86. Since, as previously stated, the tachometer generators develop a voltage directly proportional to their rotation speed, the tachometers 78, 83 and 85 may comprise voltmeters with their scales graduated either in revolutions per minute or linear feet per minute, and thus a rough indication of the absolute speeds of the mill, the pinch rolls, and the flying shear may be had.

A much more accurate indication of the synchronous operation of the devices described, however, is intended to be effected by the additional indicators which will now be described, and which are adapted to show, not absolute speeds of the three units mentioned, but their relative speeds. By these means, most of the error in making comparative readings from the three tachometers will be eliminated as will also be the necessity for making calculations based on absolute speeds of the flying shear and rolling mill in order to determine the setting of the variable speed control of the shear required for a given length of cut. These differential or relative indications are effected by means of a series of rotating perforated discs which may conveniently be installed in a housing or framework such as is illustrated in Figures 2 and 3 of the drawings and may be designated as the shear control stand and indicated in the drawings by the numeral 90. The shear control stand 90 is provided with a base 91, a substantially cylindrical housing 92 and brackets or shelves 93 and 94. Upon the rear wall 95 of the cylindrical portion 92 is formed a cylindrical hollow projection 96 within which a sleeve 97 is mounted for rotation upon the bearings 98. Splined upon the rear end of the sleeve 97 is the gear 99 which is adapted to mesh with the gear 100 of the same diameter. The gear 100 is supported upon and driven by the shaft of the synchronous motor 102. Upon the forward end of the tubular sleeve 97 is secured the circular disc 104.

A similar disc 105 is also mounted for rotation within the housing 92 and is secured to the axial shaft 106 which is disposed within the sleeve 97 and is mounted for rotation relative thereto within the bearings 108. The shaft 106 is adapted to be driven by the synchronous motor 110. A smaller disc 112 is also mounted within the housing 92 concentrically with the discs 104 and 105 but is of a slightly smaller diameter than these last mentioned discs. The disc 112 is secured for rotation with the shaft 113 which is mounted in the bearings 114 carried by the cylindrical forward projection 115 of the front wall 116 of the housing 92. This shaft is adapted to be driven by the synchronous motor 118.

The synchronous motor 102 is adapted to be connected by means of the circuit 120, which includes the switch 121 which forms a part of the combined transfer switch 21, 80, 121 alternatively with the synchronous generators 57 and 58 associated with the mill stands R and R'. The synchronous motor 110 is connected with the pinch roll synchronous generator 63 by means of the circuit 124 and the synchronous motor 118 is similarly connected by means of the circuit 125 with the synchronous generator 71 associated with the flying shear S. The field windings of all of these synchronous motors and generators are adapted to be connected for excitation with the direct current circuit 73 as clearly shown in the drawings.

Preferably upon the top of the shear control stand 90 are disposed the three tachometers 78, 83 and 85 which have already been described. Upon either side of the stand 90 are located the pinch roll and shear controlling switches 130 and 131 respectively. These switches 130 and 131 are connected with the motors 32 and 33 which control the variable speed gears W and W' by means of the three wire lines 132 and 133. Two of the wires of the circuit 132 are connected to alternatively used poles 135 and 136 respectively and the third one is connected to one side of the supply line 138, while another pole 139 of the switch 130 is connected to the other side of the line 138 by means of the connection 140. By a suitable and well known connection between the line 132 and the windings of the motor 32 actuation of the motor in either direction may be obtained by throwing the switch 130 and connecting either the pole 135 or 136 with the pole 139. The switch 131 controlling the motor 33 which actuates the variable speed gear W' of the flying shear is constructed and actuated in exactly the same way as switch 130, and the various associated elements have been given corresponding numerals.

Returning now to the differential speed indicating devices comprising the discs 104, 105 and 112, it will be seen that the discs 104 and 105 are provided with two concentric series of apertures 142 and 143. Disc 112 is provided with a single series of apertures which are adapted to register with the series of apertures 143 in the other two discs. Behind these discs are disposed the sources of light 145 and 146 before which the apertures of the concentric series 142 and 143 are adapted to be successively brought during rotation of said discs. Sight openings 148 and 149 are provided in a front wall 116 of the housing 92, and are disposed in line with the respective sources of light 145 and 146.

Disc 105, being connected, as previously described, with the synchronous motor 110 which is driven from the pinch rolls, and disc 104 being driven by the synchronous motor 102 associated with the rolling mill, it will be readily seen that when these two discs are rotating at exactly the same speed the working rolls of the mill and the rolls of the pinch roll stand are also operating at the same peripheral or linear speed. It will be readily understood how the synchronism of the rotation of the discs 104 and 105 may be ascertained by observation through the opening 148. If the illumination from the source 145 is steady (or, in case of non-register of the openings in discs 104 and 105, there is no light visible) the discs are rotating in absolute synchronism. If, however, the light issuing from the opening 148 is seen to flicker or vary in intensity, the

discs and consequently the mill and pinch rolls are out of synchronism, and they must be brought back into proper timed relation by manipulation of the switch 130 which controls the variable speed gear W. Whether or not the variable speed gear W is to be advanced or retarded may be readily determined by an inspection of the rough indication afforded by the tachometers 70 and 83. Upon effecting a return to synchronism of the mill and pinch rolls, and consequently the discs 104 and 105, the apparent synchronism of the flying shear S with the now synchronized mill and pinch roll stand is determined by an inspection of the sight opening 149. If a variation in the intensity of the light issuing from this opening is observed, then the control switch 131 is turned to advance or retard the variable speed gear W', in accordance with the rough indication gained from the tachometer 85, until the disc 112 is synchronized with discs 104 and 105.

Thus, it will be seen that the manual control of the pinch rolls may be readily effected in response to indications from the mechanism just described and this adjustment, being based upon the linear speed of the rolling mill and the pinch rolls, is independent of the variations in diameter of these rolls due to wear or other alterations.

As indicated in previous descriptions, the synchronism between the disc 112 associated with the flying shear and the discs which are connected with the pinch roll and rolling mill stand, indicates only an apparent synchronism of the flying shear and the other units, the actual timed relation between the rotation of the shear and the speed of operation of the mill being variable in accordance with the length of cut that it is desired, to effect upon the material. In order to have the flying shear rotate at the proper speed to effect a given length of cut and yet to record or register upon the indicating device just described an apparent synchronism, the speed changing device 68 is interposed between the shaft of the indicating generators 70 and 71 associated with the shear, and the main drive shaft 66 of the shear.

This speed changing device is illustrated in detail in Figures 4, 5 and 6 of the drawings, and is seen to comprise essentially a main housing 150, an associated gear box 151 and a bracket 152. Upon this bracket 152 are mounted the tachometer generator 70 and the synchronous generator 71 which, as stated before, have the common driving shaft 65. This shaft 65 is coupled to the cylindrical roller 155 which is adapted to rotate in the bearings 156 carried by the brackets 157 and 158. A conical roller 160 is rotatably mounted in the anti-friction bearings 161 and 162 which are resiliently supported in the brackets 163 and 164, and is adapted to be driven from the main driving shaft 66 of the flying shear S through the shaft 166, bevel gears 167 and 168. The driving ratio between the flying shear shaft and the indicating generators 70 and 71 is varied by means of adjustment of the carriage 170 along the threaded shaft 171. Balls 173 and 174 are mounted for free rotation in the anti-friction bearings 175 and 176 within the carriage 170 and are adapted to contact with each other and also with the driving cone 169 and the driven cylindrical roller 155. In order to regulate the contact pressure between these elements the bearings 161 and 162 within which the conical roller 160 is mounted, are supported by means of the springs

180 against which the spring followers 181 are urged by means of the adjustable bolts 182. These adjustable resilient mountings are disposed at spaced intervals around the brackets 163 and 164. In order to provide a resilient support centrally of the roller 155, the arcuate anti-friction bearing 185 is mounted upon the adjustable bolt 186 and is resiliently urged into contact with the roller 155 by means of the spring 187.

The threaded shaft 171 upon which the ball carriage 170 is mounted and by which it is adjusted longitudinally of the rollers 155 and 160 is rotatably mounted at one end in the bearing 190 formed in the bracket 157, and the other end is adapted to pass through the front wall 192 of the main housing 150 at 193. The shaft extends further through the front wall of the gear housing 151 and is provided near its outer end with the hand wheel 195 which may be rigidly secured to the shaft as by means of the nut 196.

The mechanism for indicating the adjustment of the ratio of this change speed device will now be described. Provision is made for a coarse adjustment in which a dial is graduated at small intervals, each of which represents one foot in length of the material being cut. By suitable gearing, these intervals are magnified upon another dial so that the entire circumference of this second dial represents one inch and is divided into finer graduations representing as small intervals as  $\frac{1}{8}$  or  $\frac{1}{4}$  of an inch. These dials are represented at 200 in Figures 4 and 6, and one of them has associated with it the pointer 201 which is rigidly secured as at 202 to the shaft 171. Keyed to the shaft 171 as at 204 is the small gear 205 which is adapted to mesh with the larger gear 206 rotatably mounted upon the auxiliary shaft 207 mounted in the gear box 151. Rigidly connected to the gear 206 is the smaller gear 209 which meshes with the larger gear 210 which is freely rotatable upon the shaft 171, and rigidly associated with the gear 212, which in turn meshes with gear 213 rotatably carried by the shaft 207. A small gear 215 is carried by the gear 213 and meshes with the gear 216 which is likewise rotatably mounted upon the shaft 171. This last named gear 216 is provided with an elongated hub 218 which is adapted to extend through the front wall of the gear box 151 and to rotate in the bearing 219. This extended hub or sleeve 218 also provides an outer bearing for the shaft 171. Rigidly secured to the outer end of the sleeve 218 as by means of the clamp 220 is the pointer 221 which is associated with the inner graduated portion 222 of the dial 200.

It will be seen that these inner graduations provide an adjustment of the length of the material cut ranging in the present example from 11 feet 6 inches to 20 feet 6 inches, at 1 inch intervals. The entire circumference of the outer dial represents 1 inch and is graduated at intervals of  $\frac{1}{8}$  inch. Thus, it will be seen that in this example the gearing in the housing 151 provides a ratio between the indicating pointer 201 mounted on the shaft 171 and the pointer 221 of 108 to 1, but it will be understood that the various parts of the speed changing gear and the indicating mechanism associated therewith may be proportioned differently for different purposes.

The function and operation of this gear changing device 68 will be apparent. For example, if it is desired to cut the strip material passing from the mill into lengths of 14 feet  $6\frac{1}{4}$  inches, the operator will simply turn the hand wheel 195 until the pointer 221 reaches the 14 feet 6 inch gradua-

tion on the inner dial and then further until the pointer 201 of the fine adjustment indicates  $\frac{1}{4}$  of an inch. This particular setting is shown upon the dials in Figure 6. The rotation of the screw shaft 171 in making this setting will, of course, bring the ball carriage 170 to the proper position along the cone 160 to secure the desired ratio between the shear drive shaft 66 and the indicating generators 70 and 71.

A change in the setting of this speed changing device will of course throw the disc 112 out of synchronism with the discs 104 and 105 associated with the pinch rolls and rolling mill stand. Upon detecting this change of synchronism through the sight opening 169 as previously described, the operator will advance or retard the control means of the variable speed gear W' to speed up or retard the flying shear S in order to bring the disc 112 again into synchronism with the other discs. When the discs are again synchronized the flying shear will be operating at the proper speed to cut the material into the lengths indicated upon the dial of the indicator change speed device 68. By this indicating and controlling means, the length of cut of the material may be adjusted and effected within a very small tolerance. Of course, so far as the broader aspects of the invention are concerned, any change speed gear arrangement can be employed in this connection, such as a series of stepped gears with an adjustable idler adapted to be selectively engaged with them. But the apparatus just described is preferred, since it is more convenient to adjust and more accurate results may be obtained by its use.

It will be realized from the preceding descriptions that at no point during the operation of the shear is it necessary for the operator to be concerned with absolute speeds of the mechanisms under his control. For example, it is not necessary for the operator to know that the mill is running at actually 2396.4 linear feet per minute, nor is it necessary for him to know that at this mill speed the shear must rotate at 177.5 revolutions per minute in order to cut the strip into lengths of 13 feet 6 inches. All that he is required to do is to make the desired setting on the dials of the indicator speed changing mechanism 68 and bring the flying shear into apparent synchronism by synchronizing the discs in the shear control stand.

An alternative arrangement of the indicating devices is illustrated in Figures 7 and 8 of the drawings and will now be described. The driving mechanism for the mill rolls, the pinch rolls and the flying shear and also the controlling means for the variable speed gears W and W' are exactly the same as in the example previously described, and this description will not be repeated here. Furthermore, the tachometer generators 55, 56, 62 and 70 are the same as in the previous example except that the tachometers 78, 83 and 85 are preferably mounted upon an indicating and control panel such as shown at 253. However, instead of the rotating disc indicating device employed in the first embodiment, there are here used the differential selsyn motors 255 and 256. These motors are of a well-known type of self-synchronous motor used extensively in indicating and controlling devices of various kinds, such for example, as described in the patent to E. M. Hewlett et al. 1,628,463 and E. J. Murphy 1,814,842. Both of the differential selsyns 255 and 256 have their three phase rotors

alternatively connected by means of the circuit 260 to the selsyn generators 261 and 262 which are associated with the friction rolls 50 and 51 respectively which bear against the mill rolls in the stands R and R'. This connection is made by means of the contacts 121' of the combined transfer switch, which is in all respects similar to the transfer switch 21, 30, 121 already described. The selsyn generators 261 and 262 are small alternating current machines with three phase stators and are adapted to replace the synchronous generators 57 and 58 of the other embodiment.

The three phase stator winding of the differential selsyn 255 is connected by means of the circuit 265 with the selsyn generator 266 which is adapted to be substituted for the synchronous generator 63 in association with the friction roller 60 bearing against the pinch roll of the pinch roll stand P. Likewise, the stator of the differential selsyn 256 is connected to the selsyn generator 267 by means of the circuit 268. It will now be readily seen that in a well-known manner, the indicating pointers 270 and 271 of the differential selsyns will remain stationary when the selsyn generators 266 and 267 are in synchronism with the rolling mill selsyn generator 261 or 262 which is being used, and that they will indicate a departure from synchronism by a movement in either direction. The direction of movement of these pointers will also indicate to the operator whether or not he is to advance or retard the variable speed gear control of the pinch rolls or the flying shear. All of the selsyn generators 261, 262, 266 and 267 are excited by means of alternating current obtained from the lines 275 to the connecting circuits 276, 277, 278 and 279. The controlling switches for the variable speed gears W and W' are indicated at 280 and 281 respectively upon the control panel 250.

The method of operation of this metal working installation will be apparent. The rolling mill is first put into operation and the combined lever transfer switch is closed in the proper manner to select the alternator which is associated with the stand used as the final finishing stand of the mill. Preferably, the pinch roll and the flying shear will be started simultaneously by throwing a master switch controlling both of these devices. The shear operator will then set the change speed device 68 to the proper length of cut desired. Once this setting is made, subsequent control of the shear is effected from either the shear control stand 90 or the shear control panel 250, depending upon which installation is employed. Then the control switch governing the operation of the variable speed gear W is actuated in order to bring the pinch roll speed into synchronism with the rolling mill speed in accordance with the rough indications given by the tachometers 78 and 83, and then more exactly by the indication afforded by the rotating discs or the differential selsyns. The same synchronizing operations are then made with respect to the flying shear control and the entire mechanism is in condition for effecting very accurately the desired shearing of the strip material.

Any suitable means for cropping the front end of the strip delivered from the mill may be employed in connection with this installation, but preferably one should be used which will operate with a shear control device of the present type while keeping the shear running continuously.

There has thus been provided alternative means for indicating the synchronism between the mill stands, the flying shear and the pinch rolls, one of which is purely electrical and the other a combined electrical and optical arrangement making use of the principles of the stroboscope.

Various changes and modifications may be made in the embodiments illustrated and described herein without departing from the scope of the invention as defined in the following claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a controlling device of the class described, a rolling mill, a flying shear adapted to cut material delivered from said mill into desired lengths, a pinch roll stand for feeding material to said flying shear, a rotary element adapted to frictionally engage one of the rolls of said mill, another rotary element adapted to frictionally engage one of the rolls of said pinch roll stand, rotary means driven by said shear, an electrical generator adapted to be driven by each of said rotary elements, and differential mechanisms adapted to be actuated by current received from said generators for directly indicating variations in the relative speeds of said mill and said shear, and of said mill and said pinch rolls.

2. In a device of the class described, a rolling mill, a flying shear adapted to cut material delivered from said mill into desired lengths, driving means for said mill, driving means for said shear, means for effecting substantial synchronism of the rotary speeds of said driving means, means for indicating directly for a given length of cut of the material the properly timed operation of said shear with respect to the peripheral or linear delivery speed of said mill, control means for varying the speed of the shear to attain and maintain such indicated timed relation, and means adjustable in accordance with the desired length of cut adapted to affect said indicating means so as to require an alteration in said control means for proper operation of the device to attain said length of cut and to resume said indicated or apparently synchronous operation.

3. In a device of the class described, a rolling mill, a flying shear adapted to cut material delivered from said mill into desired lengths, a feeding device for said flying shear, driving means for said mill, driving means for said shear, driving means for said feeding device, means for effecting substantial synchronism of the rotary speeds of said driving means, means associated with said mill and said shear for indicating any departure from the proper relation of the operation of said shear to the peripheral or linear delivery speed of the rolls of said mill for a given length of cut of material, and means associated with said mill and said feeding device for indicating any departure from actual synchronism of the linear or peripheral speeds of said mill and said feeding device.

4. In a device of the class described, a rolling mill, a flying shear adapted to cut material delivered from said mill into desired lengths, a feeding device for said flying shear, driving means for said mill, driving means for said shear, driving means for said feeding device, means for effecting substantial synchronism of the rotary speeds of said driving means, means associated with said mill and said shear for in-

dicating any departure from the proper relation of the operation of said shear to the peripheral or linear delivery speed of the rolls of said mill for a given length of cut of material, and means associated with said mill and said feeding device for indicating any departure from actual synchronism of the linear or peripheral speeds of said mill and said feeding device, control means for varying the speed of the shear to attain and maintain such indicated timed relation, and means for affecting the driving means of said feeding device to restore said linear synchronism.

5. In a device of the class described, a rolling mill, a flying shear adapted to cut material delivered from said mill into desired lengths, a feeding device for said flying shear, driving means for said mill, driving means for said shear, driving means for said feeding device, means for effecting substantial synchronism of the rotary speeds of said driving means, means associated with said mill and said shear for indicating any departure from the proper relation of the operation of said shear to the peripheral or linear delivery speed of the rolls of said mill for a given length of cut of material, and means associated with said mill and said feeding device for indicating any departure from actual synchronism of the linear or peripheral speeds of said mill and said feeding device, control means for varying the speed of the shear to attain and maintain such indicated timed relation, means for affecting the driving means of said feeding device to restore said linear synchronism, and means adjustable in accordance with the desired length of cut adapted to affect said shear indicating means so as to require an alteration in said shear control means for proper operation to obtain said desired length of cut and to resume said indicated or apparent synchronism.

6. In a device of the class described, in combination, a rolling mill, a flying shear for cutting material delivered from said rolling mill into predetermined lengths, driving mechanisms for said mill and said shear, means for indicating the operation of said flying shear in certain timed relation with said rolling mill, said means including a selsyn generator adapted to be driven by said rolling mill, another selsyn generator associated with said flying shear, and a differential selsyn motor connected in phase with said selsyn generators, and a visual indicator driven by said differential selsyn motor, a change speed device interposed between said shear and its associated selsyn generator and adjustable in accordance with the length of cut desired, and means associated with the shear driving means for varying said timed relation to secure the desired length of cut, whereby any variation in the change speed device tends to alter the position of said indicator until restored by the adjustment of said shear speed varying means.

7. In a metal working apparatus of the class described, a rolling mill stand, a rotary flying shear adapted to cut material delivered from said mill into predetermined lengths, a pinch roll stand disposed between said mill stand and said shear and adapted to positively feed said material to said shear, connected electrically operated means for driving said mill stand, said pinch rolls, and said rotary shear at basic angular velocity ratios, means associated with said mill stand and with said pinch rolls for directly indicating any departure from actual synchronism of the linear or peripheral speeds of said mill rolls and said pinch rolls, and means independent of the elec-

frically operated basic synchronism device for varying the angular velocity ratio between said mill stand and said pinch rolls to restore said actual synchronism, means associated with said mill stand and with said rotary shear for directly indicating any departure from the proper relation of the operation of said shear to the peripheral or linear delivery speed of the rolls of said mill for a given length of cut of material, and means also independent of the electrically operated basic synchronism device for varying the angular velocity ratio between said mill and said shear to effect the proper length of cut of said material.

8. In a metal working apparatus of the class described, a rolling mill stand, a rotary flying shear adapted to cut material delivered from said mill into predetermined lengths, a pinch roll stand disposed between said mill stand and said shear and adapted to positively feed said material to said shear, connected electrically operated means for driving said mill stand, said pinch rolls, and said rotary shear at basic angular velocity ratios, means associated with said mill stand and with said pinch rolls for directly indicating any departure from actual synchronism of the linear or peripheral speeds of said mill rolls and said pinch rolls, said indicating means comprising a pair of rotatable discs, a synchronous generator driven by said mill, another synchronous generator driven by said pinch rolls, synchronous motors actuated respectively by said generators and adapted to rotate said discs, optical means associated with said discs for detecting said variation in synchronism, and means independent of the electrically operated basic synchronism device for varying the angular velocity ratio between said mill stand and said pinch rolls to restore said actual synchronism, means associated with said mill stand and with said rotary shear for directly indicating any departure from the proper relation of the operation of said shear to the peripheral or linear delivery speed of the rolls of said mill for a given length of cut of material, said last named indicating means comprising a rotatable disc associated with the disc driven from said mill, a synchronous generator driven by said rotary shear, a synchronous motor actuated by said generator and adapted to rotate said disc, and optical means associated with these mill and shear discs for detecting said variations in operation, and means also independent of the electrically operated basic synchronism device for varying the angular velocity ratio between said mill and said shear to effect the proper length of cut of said material.

9. In a metal working apparatus of the class described, in combination, a rolling mill stand and a flying shear for continuously cutting strip material delivered from said mill into desired lengths, driving means for said mill stand, driving means for said shear, electrical means for synchronizing the operation of said driving means, change speed gearing interposed between the shear and its driving means, means for adjusting said change speed gearing to regulate the length of cut of said material, means associated with said mill and said shear for indicating certain relations between the speeds of these two instrumentalities, and means for altering said indicating means to a degree proportional to the change in length of material desired, said alteration corresponding in extent but opposite in effect to the adjustment of the change speed gearing required to attain such a length of cut.

10. In a metal working apparatus of the class described, in combination, a rolling mill stand and a flying shear for continuously cutting strip material delivered from said mill into desired lengths, means for indicating basic apparent synchronization of operation of said shear and mill for a given length of cut, means for altering the relation of said indicating means with one of the metal working instrumentalities named to a degree corresponding with the variation in length of cut desired, and means for changing the speed of one of said instrumentalities to an extent which will restore said indicating means to register said apparent synchronization, whereby the desired length of cut will be attained.

11. In a metal working apparatus of the class described, a flying shear adapted to cut material delivered thereto into predetermined lengths, means from which material is delivered to said shear, connected electrically operated means for driving said first named means and said rotary shear at basic speed ratios, means associated with said first named means and with said rotary shear for directly indicating any departure from the proper relation of the operation of said shear to the linear delivery speed of said first named means for a given length of cut of material, said indicating means comprising a pair of rotatable discs, a synchronous generator driven by said first named means, another synchronous generator driven by said shear, synchronous motors actuated respectively by said generators and adapted to rotate said discs, optical means associated with said discs for detecting variations in operation, and means independent of the electrically operated basic synchronism device for varying the speed ratio between said first named means and said shear to affect a proper length of cut of said material.

12. In a metal working apparatus of the class described, a rolling mill stand, a flying shear adapted to cut material delivered from said mill into predetermined lengths, a pinch roll stand disposed between said mill stand and said shear and adapted to positively feed said material to said shear, connected electrically operated means for driving said mill stand and said pinch rolls at basic speed ratios, means associated with said mill stand and with said pinch rolls for directly indicating any departure from actual synchronism of the linear or peripheral speeds of said mill rolls and said pinch rolls, said indicating means comprising a pair of rotatable discs, a synchronous generator driven by said mill, another synchronous generator driven by said pinch rolls, synchronous motors actuated respectively by said generators and adapted to rotate said discs, optical means associated with said discs for detecting said variation in synchronism, and means independent of the electrically operated basic synchronism device for varying the speed ratio between said mill stand and said pinch rolls to restore said actual synchronism.

13. In a metal working installation of the class described, an arrangement for synchronizing the operation of a flying shear with respect to that of either of two motor driven rolling mill stands comprising, in combination, a synchronous driving motor for said shear, a synchronous alternator operatively connected to each of the mill driving motors, a transfer switch for alternatively connecting said alternators to said synchronous shear driving motor according to which stand is being used as the final finishing stand of the mill, speed indicating devices associated

with said mill stands and with said flying shear, and a transfer switch for operatively connecting said mill stands alternatively with said speed indicating devices, both of said transfer switches adapted for simultaneous actuation.

- 5 14. In a metal working installation of the class described, which includes a flying shear, a plurality of rolling mill stands, and driving means for said shear and each of said stands; an arrangement for regulating the operations of the flying shear with respect to that of any one of said mill stands in order to cut the rolled strip material into desired lengths comprising, in combination, electrical means for synchronizing the operation of said driving means, change speed gearing interposed between the shear and its driving means, means for adjusting said change speed gearing to regulate the length of cut of said material, means associated with said mill and said shear for indicating certain relations between the speeds of these two instrumentalities, and means for altering said indicating means to a degree proportional to the change in length of material desired, said alteration corresponding in extent but opposite in effect to the adjustment
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of the change speed gearing required to attain such a length of cut, and a switching device for operatively connecting said electrical synchronizing means and said indicating means with any one of said rolling mill stands to be controlled thereby.

15. In combination with a metal working installation including a rolling mill, having a plurality of roll stands, and a flying shear for continually cutting strip material delivered from said mill into desired lengths; means for indicating basic apparent synchronization of operation of said shear and mill for a given length of cut, means for altering the relation of said indicating means with one of the metal working instrumentalities named to a degree corresponding with the variation in length of cut desired, and means for changing the speed of one of said instrumentalities to an extent which will restore said indicating means to register said apparent synchronization, whereby the desired length of cut will be attained, and means whereby all of said means may be placed in operative connection with any one of said mill stands.
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HANS L. SCHRECK. 25