W. R. CLARK.

SYSTEM OF CONTROL FOR TANDEM ROLLING MILLS AND THE LIKE.

APPLICATION FILED AUG. 22, 1912.

1,267,184.

Patented May 21, 1918.

2 SHEETS—SHEET 1.

Fig. 1.

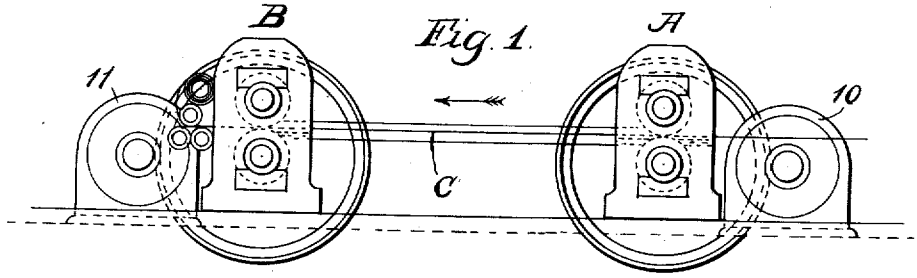


Fig. 2.

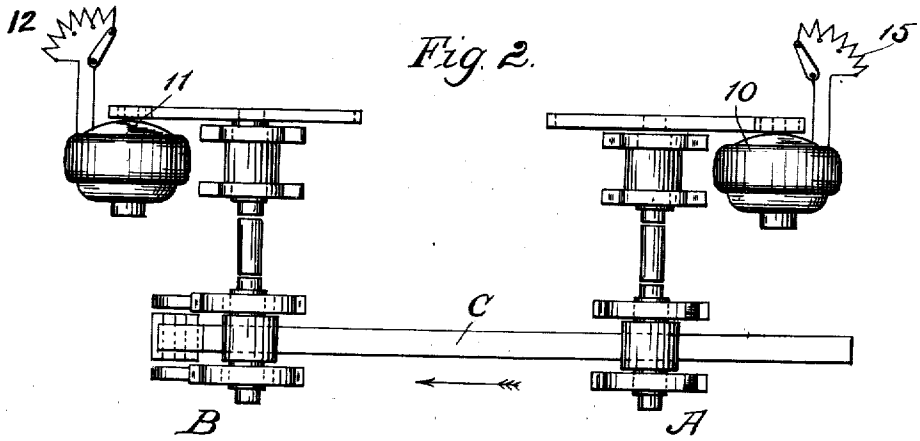
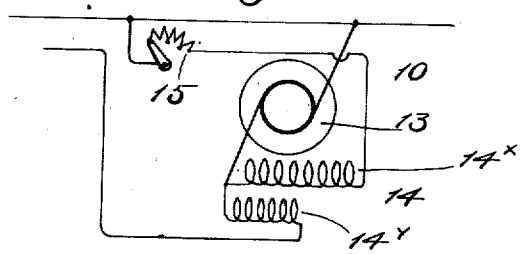


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

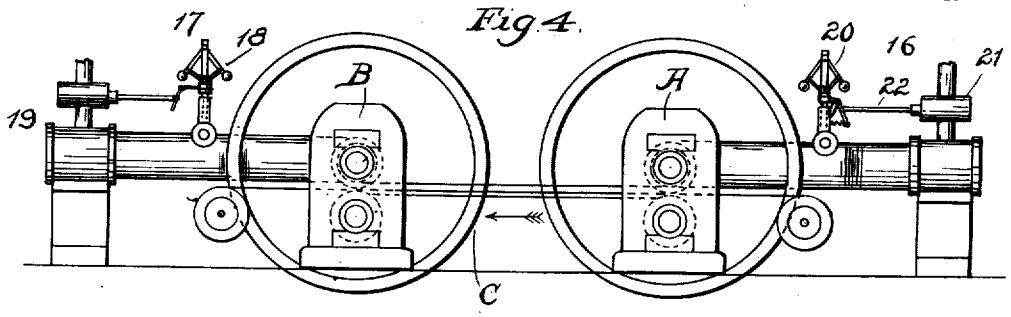


Fig. 5.

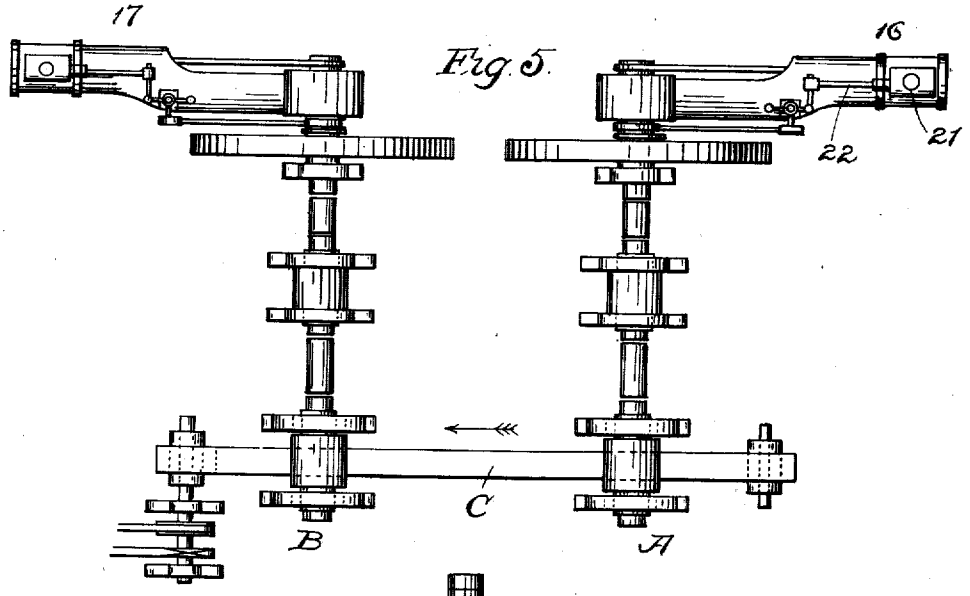
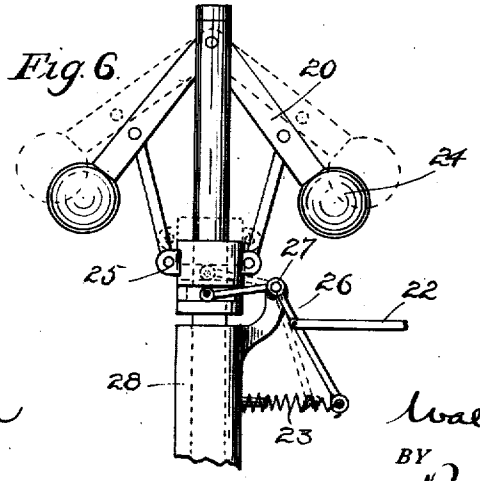


Fig. 6.



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UNITED STATES PATENT OFFICE.

WALTER R. CLARK, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO BRIDGEPORT BRASS COMPANY, OF BRIDGEPORT, CONNECTICUT, A CORPORATION OF CONNECTICUT.

SYSTEM OF CONTROL FOR TANDEM ROLLING-MILLS AND THE LIKE.

1,267,184. Specification of Letters Patent. Patented May 21, 1918.

Application filed August 22, 1912. Serial No. 716,435.

To all whom it may concern:

Be it known that I, WALTER R. CLARK, a citizen of the United States, residing in Bridgeport, county of Fairfield, and State of Connecticut, have invented certain new and useful Improvements in Systems of Control for Tandem Rolling-Mills and the like, of which the following is a full, clear, and exact description.

This invention relates to a system of controlling the relative speeds of rolling mills or similar metal working devices arranged in tandem, where the bar or sheet is acted on by the respective devices simultaneously. The improved system is especially applicable to tandem mills for rolling material of medium and heavy gage, so heavy in fact, that a considerable tension may be put upon the rolled bar, in addition to that exerted by a pair of rolls in rolling it, without straining it beyond its elastic limit.

Heretofore, in rolling sheets or bars of brass or other metal by means of individually driven tandem mills, it has been customary to rely solely on manual control of the speed of the individual mills. For example, if two individually driven stands of rolls are arranged in tandem fashion, to successively reduce the bar or sheet, it is usual merely to provide hand operated speed controlling devices whereby the operator may regulate individually the speed of the respective prime movers or motors driving the respective mills. Where this manual control is the only one provided, however, considerable difficulty is encountered in distributing properly the total work of reduction of the metal between the individual pairs of rolls. For instance, if one of the mills slows down from any external cause, or if it speeds up or slows down as a result of a change in the gage of the material being rolled due to the expansion of the rolls or hard spots in the metal, or other causes, it is a very difficult matter, in fact practically impossible, to control manually the speed of the other mill in consonance with the irregular speed variations of the first named mill. Hence it follows, that in such a system of control the distribution of work is very uneven, the tension of the material passing from one mill to the other fluctuates considerably, and is usually either too great or too small to produce a uniform and economical rolling of the metal, and the results of the operation as a whole are generally unsatisfactory.

The object of the present invention is to avoid the above defects and provide a system in which the relative speeds of the mills or other devices are controlled automatically. In other words, my improved system of speed control provides for an automatic adjustment of the speed of one mill as the speed of the other varies, so as to compensate entirely for the relative speed variations of the mills with reference to the distribution between the latter of the total work of reduction. Hence if the mills are adjusted so that each performs a certain proportion of the total work, the ratio of the output of the respective mills will be maintained automatically in spite of external influences and in spite of variations in the gage of the metal rolled.

To these and other ends the invention consists in the novel system of speed control to be hereinafter described and claimed.

In the accompanying drawings,

Figure 1 is a side elevation of a rolling mill installation embodying my invention, the respective stands of rolls being driven by electric motors,

Fig. 2 is a top plan view of Fig. 1,

Fig. 3 is a diagram of the motor of one of the stands,

Fig. 4 shows in elevation a tandem rolling mill installation in which the respective mills are operated by steam engines,

Fig. 5 is a top plan view of Fig. 4, and

Fig. 6 is a detail of the governor of one of the engines.

The improved system is applicable to rolling mills driven by electric motors, steam engines, internal combustion engines, and other motors or prime movers. The general principles are the same in each case, and I have only selected for illustration, embodiments in which electric motors and steam engines, respectively, are employed for driving the mills.

Referring to Figs. 1 to 3, showing the electric motor arrangement or embodiment, A and B indicate stands of rolls to act simultaneously on successive portions of a bar or sheet of metal C passing from the mill A to

the mill B, as indicated by the arrows. The mill A first acts on the bar or sheet and reduces it to a certain extent, and the reduced portion of the bar passes forwardly to be further reduced by the mill B which is arranged in advance of the mill A as regards the direction of feed. The mill or stand A is driven by means of an electric motor 10 geared to the rolls in any suitable manner and the mill B is similarly driven by means of an electric motor 11. The speed of the motor 10 is controlled manually by a controller or rheostat 15 and the motor 11 is similarly controlled by a rheostat 12.

In the embodiment illustrated, the motor 11 is intended to represent a shunt wound motor operating at a substantially constant speed under fluctuating loads. On the other hand, the motor 10 for driving the mill A is so wound, as distinguished from the shunt motor 11, as to decrease in speed and increase in torque in proportion to an increase in the load, and vice versa. In other words, the motor 11 for the mill B is practically a constant speed motor, while the motor 10 of the mill A varies in speed inversely in proportion to the load. In order to give the motor 10 the characteristics above noted, I use by preference a compound winding, as shown in Fig. 3, where the armature is indicated at 13 and the field at 14. The field 14 comprises a shunt winding 14^x and a series winding 14^y, the shunt winding 14^x being connected with the rheostat 15 by means of which the speed of the motor 10 may be varied by the operator. I prefer, in actual practice, to have the normal shunt winding 14^x constitute about 80 per cent. of the total field winding, in which case the series winding 14^y will only amount to about 20 per cent. By this arrangement the motor retains practically all of the shunt motor characteristics which adapt it particularly for driving a stand of rolls, and yet the series portion of the field is sufficient to cause enough speed variation in proportion to the load to effect the operation now to be described.

Supposing the bar or sheet of brass or other metal to be passing from the mill A to the mill B, so that it is successively reduced by the respective pairs of rolls, the mill B will be driven at a practically constant speed, which is preferably so adjusted with respect to the speed of the mill A, that the mill B pulls the sheet or bar through the rolls of the mill A to a slight extent, thereby assisting to a certain extent in the operation of the mill A and relieving the motor 10 of a corresponding amount of work. If now the mill B be slowed down, for example, by any external influence, or by a decrease in the thickness of the bar or sheet due to expansion of its rolls or hard spots in the metal, the pulling effect of the mill B on the bar or sheet passing between the rolls of the mill A will be correspondingly decreased. This will obviously put more work on the motor 10 of the stand A, and accordingly, the influence of the series winding 14^y of said motor will be immediately called into play, with the result that the speed of the motor 10 will decrease approximately in proportion to the increase of load produced by the decrease of speed of the mill B. Hence it will be understood that the decrease of speed of the mill B will be immediately followed by a substantially corresponding decrease of speed of the mill A, the latter adapting itself automatically to the speed decrease of the mill B in such a manner as to maintain the ratio of the reduction done by the two mills. Supposing that the speed of the mill B be increased for any cause, the pulling effect of this mill on the bar or sheet passing through the mill A will, of course, be correspondingly increased, thereby further relieving the motor 10, and as the load on the latter decreases the effect of the series winding 14^y is immediately to produce a corresponding increase of speed to compensate for the increase of speed of the mill B.

If at any time the mill A tends to roll the bar faster than the mill B can carry it, the former mill will tend to push the bar through the latter, thereby relieving the mill B of some of its work until the mill A has slowed down on an equilibrium point.

It is not necessary in all cases that the mill B be driven by an electric motor, as it might be driven by other means while still retaining the electric drive of the mill A. On the other hand, it is not always essential that the variable speed characteristics mentioned above in reference to the mill A be limited to said mill, as obviously an interchange of the driving motors 10 and 11 as between the mills A and B would be within the broad aspects of my invention. In other words, it might be practicable in some cases to have the mill A driven by a constant speed motor and to have the mill B driven by a variable speed motor.

In Figs. 4 to 6 inclusive, the relative arrangement of the mills A and B is substantially the same as that previously described, but the mill A is driven by a steam engine 16 and the mill B by a steam engine 17. The engine 17 is provided with a governor 18 connected with the throttle valve 19 (or otherwise arranged) so as to maintain a practically constant speed of the engine 17 and mill B under varying conditions of load. This means of speed control by means of a fly-ball governor is a very common one, and hence need not be described in detail. In order to provide for the variable speed characteristics of the engine 16 the action of the ball governor 20 thereof (con-

nected with the throttle valve 21 by means of the link 22) is opposed by a spring 23 which prevents the governor from operating the throttle valve sufficiently to compensate for variations of load, so that the speed of the engine 16 will decrease as the load increases, and vice versa. In the embodiment shown, the governor 20 comprises the usual centrifugally acting balls 24 acting on the usual sliding sleeve 25 to which is connected one end of a bell crank lever 26 pivoted to a fixed part 27 and suitably connected with the throttle controlling link or rod 22. As the balls are lowered by a decrease of speed (due to an increase of load) they tend to carry downward the collar 25 and to so actuate the valve rod 22 as to bring the speed again up to the normal, but this tendency of the fly-balls 24 is opposed by the spring 22, interposed between the standard 28 and the free extremity of the bell crank lever 26, so that the compensating effect of the governor is offset to a degree, with the result that changes of load will cause corresponding but inverse changes of speed.

As the speed characteristics of the engines 16 and 17 are substantially the same as those of the motors 10 and 11 heretofore described, it will be obvious that the operation of the installation now being described, will be substantially the same as that of the first installation. Moreover, it will be manifest that the invention can be carried out in substantially the same manner with gas engines or other prime movers having the characteristics above described. It is not necessary, in all cases, that the prime movers or motors of the respective mills or other metal working devices have different speed and torque characteristics, so long as at least one of the motors changes its speed automatically with a change of load.

Of course, I do not wish to limit myself in all of the various aspects of my invention, to the application of the present system to the tandem rolling of sheets or bars. I have used the term "rolling mill" in a broad sense intending to cover such an equivalent device as a wire drawing block or other apparatus. It is, moreover, evident that the invention is not limited to the use of two metal working devices arranged in tandem, as a larger number may be grouped together in some cases. Various changes in these and other respects may be adopted within the scope of the appended claims.

What I claim is:

1. In a tandem rolling mill installation, the combination with the respective mills, of a separate prime mover for driving each of the same, and means controlled directly by variations of tension in the stock between the mills, independently of variations of length incident to such tension changes, for automatically varying the speed of the prime mover of one mill, to compensate for speed variations of the other mill, substantially as described.

2. The combination of metal working devices arranged in tandem for simultaneous operation on a length of stock fed by one of said devices to the other, separate prime movers for said devices, and means controlled by the direct action of the stock on one of said devices due to variations of tension in that portion of the stock between said devices, and independently of changes of length in such portion incident to such tension changes, for automatically and directly varying the speed of one of said devices to compensate for the speed changes of the other.

3. The combination with metal reduction devices arranged in tandem for simultaneous action on successive portions of a length of stock, of individual prime movers to drive the respective devices, one of said prime movers being adapted to so operate the corresponding metal reducing device that it will pull the stock through the other metal working device, and at least one of said prime movers being constructed to decrease in speed with an increase of load caused directly by a change of tension in that portion of the stock in the interval between said reduction devices, said prime mover being constructed to vary its speed independently of variations of length of that portion of the stock in the interval between said devices incident to the aforesaid tension changes.

4. The combination with metal reduction devices arranged in tandem for simultaneous action on successive portions of a length of stock fed from one of said devices to the other, of prime movers for driving the respective devices individually, one of said devices being so driven as to pull the stock through the other to a certain extent, whereby the tension in the material between the two devices acts to transfer work from one of the prime movers to that of the other device, the prime mover of such following device being constructed and arranged to decrease in speed with an increase of load independently of changes in the length of the stock incident to an increase of load, substantially as described.

5. The combination of rolling mills arranged in tandem, means to drive one of said mills at a substantially constant speed, and an electric motor for driving the other mill, having a compound winding, whereby said motor varies in speed with a variation of load to compensate for speed variations of the first mill; substantially as described.

6. The combination of rolling mills arranged in tandem, of means to drive one of said mills at a substantially constant speed, and an electric motor for driving the other mill, having a relatively large shunt field

winding, and a relatively small series field winding, whereby the speed of such last mentioned mill is automatically varied to compensate for speed changes of the first mill; substantially as described.

7. The combination of metal working devices arranged in tandem for simultaneous operation on a length of stock which passes from one of said devices to the other, means for driving the second device at practically a constant speed, and a motor for driving the first device which varies in speed with a variation of load and is directly controlled by the variable tension on the stock, independently of changes in the length of the stock incident to the tension changes; substantially as described.

8. The combination of metal working devices arranged in tandem for simultaneous operation on a length of stock fed from one of said devices to the other, means for driving the second device at a practically constant speed, and an electric motor for driving the first device, having a series field winding whereby it is adapted to decrease in speed with an increase of load; substantially as described.

9. Apparatus for operating on material of the kind described, comprising a plurality of elements having passes to simultaneously act on several different parts of the same piece of material, and means to feed the material through the passes, comprising an electric motor for each pass, at least one of said motors being so wound as to decrease in speed with an increase of load whereby the tension of the material being operated on directly and automatically controls the speed of the motors.

10. The combination of metal reducing devices arranged in tandem for simultaneous action on successive portions of a length of stock fed by one of said devices to the other, and separate prime movers for driving the respective devices independently, at least one of said prime movers constituted by an electric motor which is wound to vary its speed directly and automatically as a result of variations in the tension of the stock in the interval between said reducing devices, whereby said electric motor varies the speed of its reducing device to correspond with speed variations of the other reducing device; substantially as described.

11. The combination of metal working devices arranged in tandem for simultaneous operation on a length of stock fed by one of said devices to the other, a prime mover for driving one of said devices, an electric motor for driving the other device, and adjustable means for controlling the speed of said electric motor, said motor so wound as to decrease in speed with an increase of load on its reducing device without actuation of said speed controlling means, whereby the speeds of the reducing devices are directly and automatically controlled by variation of the tension of the stock; substantially as described.

12. The combination of metal reducing devices arranged in tandem for simultaneous action on successive portions of a length of stock fed by one of such devices to the other, and electric motors for driving the respective devices individually, so wound as to maintain automatically a predetermined speed ratio between said devices by the tension in the stock; substantially as described.

13. The combination of metal reducing devices arranged in tandem for simultaneous action on a length of stock, electric motors for driving the respective devices individually, so wound as to maintain automatically a predetermined speed ratio between said devices, and manually adjustable resistance means for controlling the speed of said motors; substantially as described.

14. The combination of metal reducing devices arranged in tandem for simultaneous action on a length of stock, prime movers for the respective devices, one of said prime movers being adapted to drive its reducing device at such speed as to pull the stock through the other device and thereby tension the stock to a certain extent, the prime mover of such other device being constituted by an electric motor having a compound winding whereby it is adapted to decrease its speed automatically with an increase of load due to a decrease of such tension of the stock, and variable resistance means for varying the speed of said compound wound motor; substantially as described.

15. The combination of metal reducing devices arranged in tandem for simultaneous action on successive portions of a length of stock, said devices having rotary parts adapted to feed the metal forward during the reduction thereof, separate prime movers for driving said rotary parts of the respective devices, and means for operatively connecting each prime mover with its reducing device, at least one of said prime movers being geared directly to its reducing device and said prime mover being so constructed and arranged as to vary the speed of said reducing device automatially by alteration of tension in the stock transmitted directly to said prime mover through such geared connection, whereby the speed of one of said devices is automatically changed to compensate for speed changes of the other.

16. The combination of metal reducing devices arranged in tandem for simultaneous operation on a length of stock fed by one of said devices to the other, a prime mover for driving one of said devices, a prime mover for driving the other device, gearing

connecting one of the devices with its prime mover so that the former is positively driven, said prime mover being constructed and arranged to vary its speed directly and automatically by a variation in load transmitted by said gearing to said prime mover when the stock undergoes a change of tension, independently of a change of length in the length of the stock incident to such tension change, and separate manually operable means for directly controlling the speed of such prime movers independently of the tension in the stock.

17. The combination of metal reducing devices arranged in tandem for simultaneous operation on a length of stock fed by one of said devices to the other, a prime mover for driving one of said devices, a prime mover for driving the other device, gearing connecting one of the devices with its prime mover so that the former is positively driven, said prime mover being constructed and arranged to vary its speed directly and automatically by a variation in load transmitted by said gearing to said prime mover when the stock undergoes a change of tension, independently of a change of length in the length of stock incident to such tension change, and separate manually operable means for directly controlling the speed of such prime movers independently of the tension in the stock while the automatic controlling means is in operation.

18. The combination of metal working devices arranged in tandem for the simultaneous operation on a length of stock, a prime mover for driving one of said devices, a prime mover for the other device, transmission mechanism for positively driving said other device from its prime mover, and manually operable means for directly controlling the speed of said prime movers, said last-named prime mover being constructed and arranged to vary its speed directly and automatically by variations of tension in the stock transmitted to it through said transmission mechanism, and independently of said manually operable speed controlling means and of changes in length of the stock incident to tension changes.

19. The combination of metal reducing devices arranged in tandem for simultaneous action on a length of stock, a prime mover for driving one of said devices, a prime mover for the other device consisting of an electric motor, gearing for positively driving such other device from said electric motor, and adjustable means for directly controlling the speed of said prime movers, said electric motor being constructed and arranged to decrease its speed with an increase of load imposed thereon through said gearing by variation of tension in the stock independently of said adjustable speed controlling means and of variations of lengths incident to tension changes, whereby the speed of one of said devices is automatically changed to compensate for speed changes of the other, said adjustable controlling means and said automatic control being adapted for simultaneous operation.

In witness whereof, I have hereunto set my hand on the 20th day of August, 1912.

WALTER R. CLARK.

Witnesses:

HENRY E. ROCKWELL,
M. OLIVE WILLIAMS.