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P. BLAIN
METHOD OF ELECTRICALLY DRIVING BAND
ROLLING MILL REELS

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2 Sheets-Sheet 1

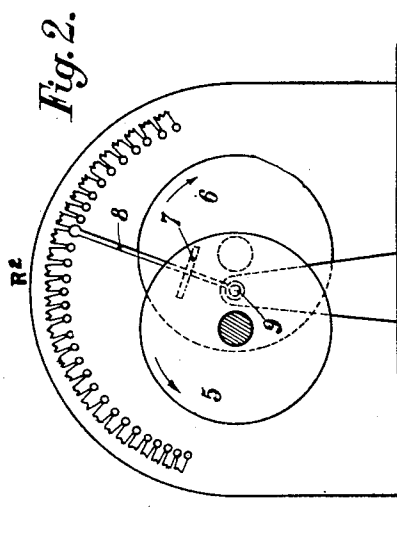
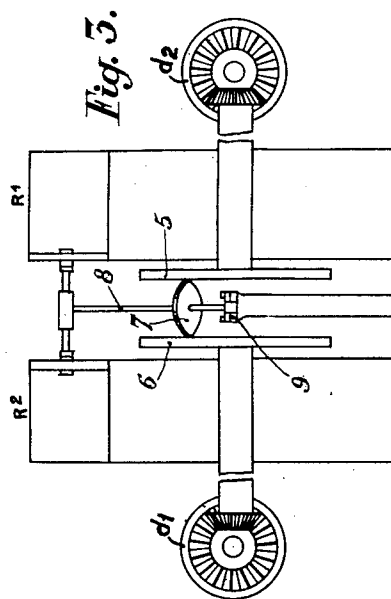
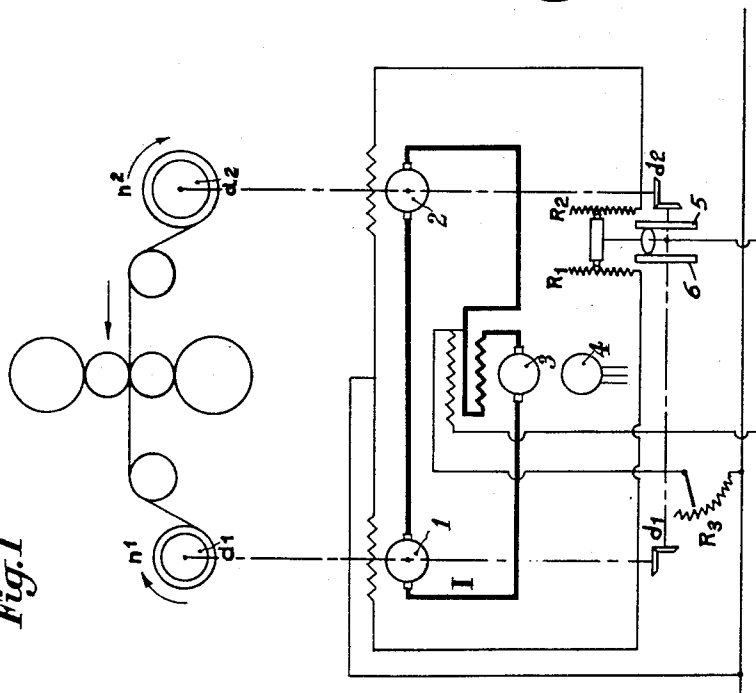


Fig. 1



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2 Sheets-Sheet 2

Fig. 4.

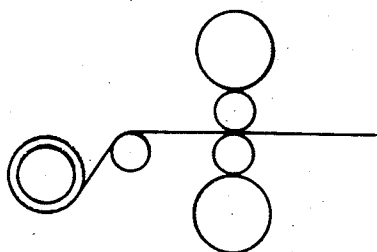
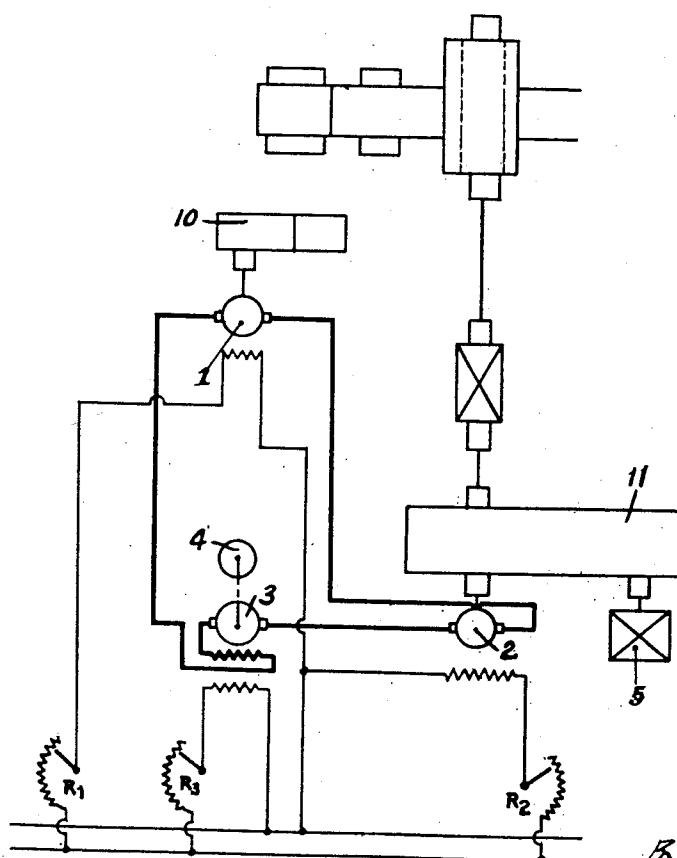


Fig. 5.



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METHOD OF ELECTRICALLY DRIVING BAND
ROLLING MILL REELSPaul Blain, Paris, France, assignor to Societe
Anonyme des Acieries et Forges de Firminy,
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1 Claim. (Cl. 318—7)

1

The electric drive of band rolling mill reels should allow of securing the following operating conditions:

1. The pull on the band should be permanent. It may be less when the mill is at rest, but it should not sink to zero during stops without the interference of the operator.

2. In running time the pull exerted by the winch should retain a constant value in spite of the continuous variations of the wind-up diameter, and this, at all speeds and irrespective of the acceleration.

3. It should be possible to control the pull within comparatively wide limits depending on the rolling effect to be obtained.

4. The power consumed by the braking winch should be recovered as completely as possible.

The methods presently resorted to for the electric drive of band rolling mill winches consist in coupling the winch with a D. C. motor whose armature most frequently is fed with the voltage impressed upon the rolling mill main driving motor and whose separate excitation is controlled either by a current regulator or by a special exciter that performs the same function. In some instances it is attempted to secure uniformity in the pull exerted on the band as the same is wound up by means of a rheostat controlled by a lever rested on the winding up or winding out coil and by which the diameter of the latter is gauged. Most of these arrangements, in addition to being quite elaborate, will not allow of fulfilling the requirements set up. In most cases, owing to the delay that will occur in the building up of the excitation field in D. C. machines, the pull on the band undergoes quite considerable variations during those periods when the rolling speed is varied, notably at starting and stopping. In those arrangements where provision is made for the control of a regulating member by means of a lever rested on the winding in or winding out coil the operator is inconvenienced. Besides, such arrangements are liable to injury in the event of band fracture.

The method providing the subject-matter of my invention is free from all these inconveniences. The winch driving motors will undergo no abrupt or considerable variation in their excitation as the rolling speed varies, so that the delay in the building up of the excitation field cannot interfere with the uniformity in the pull exerted on the band. In addition, uniformity in the pull as the coiling diameter varies is secured without the necessity of resorting to any regulation controlled by a lever rested on the coil.

2

In the accompanying drawings, the Figure 1 is the profile of a reversing rolling mill and the wiring diagram of the electric control of the two rolling mill reels. The Figures 2 and 3 are the front and side views of the apparatus automatically adjusting the excitations of the electric machines driving the reels by connecting up a kinemometer on the two shafts. The Figure 4 is a side-face view of a rolling mill with non-reversing bands and the Figure 5 a plan view of said rolling mill and of the drive of its reel and shaft.

This method will first be described in its application to the drive of the winches in a reversing rolling mill. In the Figure 1, 1 and 2 are two electric machines, with opposed separate excitations, and in all other respects preferably identical by the windings and inductors as well as by the windings and armatures, so that for the equality of rotary speed and for the equality of inducing current the E. M. F.'s of said two machines shall be the same.

With a view to simplify the drawing the said machines are assumed to be coupled directly with the rolling mill winches, but they could as well drive the same through speed-reducing gears.

The armatures of the machines 1 and 2 are fed in series from a differential compound excitation generator 3 driven by a motor 4. The separate excitation windings of machines 1 and 2 are fed from the D. C. net and regulated with the aid of rheostats R_1 and R_2 respectively. The shunt winding of the generator 3 is regulated with the aid of a rheostat R_3 . The excitation windings of machines 1 and 2 are connected in the desired direction in order that a pull shall be exerted on the band by both of the winches controlled thereby. In these conditions, assuming that the rolling work proceeds e. g. in the direction indicated in Fig. 1, the machine 1 will operate as a motor and the machine 2 as a generator. The electromotive forces of these machines are thus opposed to each other in the circuit connecting the armatures of machines 1, 2 and 3, and provided the excitations in machines 1 and 2 are regulated at all times with the aid of rheostats R_1 and R_2 in such manner that with machines revolving respectively at speeds n_1 and n_2 their electromotive forces shall have equal absolute values, the intensity I of the current in the circuit through the armatures will remain constant irrespective of the rolling speed. Obviously, the obtainment of such balance between the electromotive forces requires that

$$n_1\phi_1 = n_2\phi_2$$

ϕ_1 and ϕ_2 being the induction fluxes in machines 1 and 2 that are supposed to have as above mentioned, the same inducing and armature windings.

In order that the said requirement shall be fulfilled at all times and automatically the rheostats for machines 1 and 2 are controlled by a device adapted to assign a quite definite value to the strength of the field currents for the machines considered at each particular value of the ratio between speeds n_1 and n_2 , said strengths being so chosen that $n_1\phi_1 = n_2\phi_2$. A possible embodiment of such an automatic control of the rheostats of machines 1 and 2 is illustrated for the purpose of exemplification and not of limitation in front and side elevational view respectively in Figs. 2 and 3. In these figures, 5 and 6 designate a pair of discs whose axes are parallel and which are respectively rotated in opposite directions as shown by the arrows at speeds bearing equal ratios with the speeds n_1 and n_2 of the rolling mill winches. 7 designates a small wheel to which the discs 5 and 6 frictionally impart a rotational motion about a rod 8 swingably mounted at 9. This mechanism, which is referred to in treatises of kinematics as a kinemometer, possesses the following property: the rod 8 will assume a well defined position at each particular value of the ratio between the rotational speeds of discs 5 and 6. Since the discs are driven at speeds proportional to those of the winches and consequently to those of the machines 1 and 2, the rod 8 will assume a well defined position at each particular value of the ratio between speeds n_1 and n_2 . In order that the relation $n_1\phi_1 = n_2\phi_2$ shall be satisfied at all times it is only necessary to provide the extension of rod 8 with a pair of brushes making contact with the studs of the rheostats R_1 and R_2 arranged opposite to each other as shown in Fig. 3, the values of the resistances connected between the studs being suitably chosen.

It can be shown easily that since the condition $n_1\phi_1 = n_2\phi_2$ is satisfied at all times thanks to such a device the pull exerted on the band by the winches 1 and 2 in Fig. 1 will remain uniform throughout the rolling of a coil as long as the current I in the circuit through the armatures of machines 1 and 2 remains constant. Moreover, the pulls in both directions are such that equal stresses will be set up in the length that enters the rolling mill and the one that comes out of it. Since the said pulls are only dependent on the ratio between speeds n_1 and n_2 they are independent of the rolling speed. Finally, the pulls can be varied easily by influencing the strength I of the current through the armatures with the aid of the rheostat R_3 which controls the exciting current for the differential compounded generator 3, the series winding of said generator exerting a regulating effect that will minimize such variations in the current I as might result, with a given setting of rheostat 3, from small differences between the theoretical and the actual values of the resistances in 1 and 2. Consequently, the conditions specified at the beginning of the present text are satisfied automatically: the pulls will remain constant throughout the rolling of a coil irrespective of the rolling speed and the ac-

celeration, and the said pulls will be maintained when the rolling mill is stopped.

The foregoing description concerns the application of the method to the drive of a reversing rolling mill. The same method can also be applied to the drive of the winch of a non-reversing rolling mill. In that case the wind-up winch is coupled through a reducing gear 10 with a D. C. separate excitation machine 1 as illustrated in elevational and plan views respectively in Figs. 4 and 5. A further D. C. separate excitation machine 2, advantageously of the same type as the machine 1, is coupled with the driving shaft of the rolling mill, 11 designating a speed-reducing gear. The machine 2 is driven either at the speed of the working roll or at higher speed, the only condition practically necessary being that in operation the machine 2 shall run at a speed of the same order as the speed which machine 1 will possess when the winch is filled to one half. The machines 1 and 2 will then be coupled electrically exactly according to the diagram in Fig. 1, the discs 5 and 6 of the device controlling the rheostats R_1 and R_2 being revolved respectively at the same speeds as machines 1 and 2 or at speeds bearing equal ratios to those of said machines.

The aggregate will then operate just as described in connection with a reversing rolling mill: the pull exerted by the winch on the band will remain constant until the operator modifies the strength of the current through the armatures by manipulating the excitation regulator R_3 for the generator 3.

In the preceding descriptions it has been assumed that the regulators R_1 and R_2 are connected directly in the excitation circuits for machines 1 and 2. The said regulators could as well be connected in the excitation circuits for the excitators of said machines, which may become necessary where high-power machines 1 and 2 are involved.

What I claim is:

A drive for the band rolling mill reels, comprising two D. C. electric machines with separate excitation coupled respectively to two reels, the armatures of said machines being connected in series with the armature of a feeding generator driven by a constant speed motor, the excitations of said two machines being adjusted automatically to a value so that their E. M. F.'s shall be equal and opposed at each instant, this result being obtained with the help of a rheostat with double field, whose cursor is controlled by the movable member of a kinemometer measuring the ratio of the speeds of the machines actuating the reels, the two discs of the kinemometer being joined mechanically to the two machines in question.

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