The Blast Furnace and Steel Plant

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Inspection of Trumbull Steel Company Plant

Pittsburgh and Cleveland District Sections of the Association of Iron and Steel Electrical Engineers Visit Warren, Ohio, on an Inspection Trip of the Trumbull Steel Company's Plant.

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ABOUT 500 members of the Association of Iron and Steel Electrical Engineers and their steel plant friends left on a special train over the P. & L. E. railroad on the morning of June 26, 1920, for an inspection tour of the Trumbull Steel Company's plant at Warren, O.

The special train of seven coaches left Pittsburgh at 9 a. m. and arrived at Warren at 11:15 a. m. On reaching Warren, the train was moved over the Trumbull Steel Company's siding until the main office building was reached. After leaving the train all the visitors were assembled on the lawn directly in front of the office building and their picture was taken. Immediately following this, the visitors retired to the White warehouse, where luncheon was served. After lunch the guests were separated into units of about 10 persons. Each unit was furnished a guide and the inspection of the plant was started.

On leaving the warehouse the hospital and storeroom were first inspected. From there, the tin house and annealing building, the pickling building and the shear floor and hot mill building were visited in the order mentioned. In the hot mill building was found 34 mills, 13 of which were driven by a 2,000 hp 61 rpm Mesta engine, 13 by a 2,000 hp 61 rpm Tod engine, and four sheet and four jobbing mills driven by a 1,800 hp 200 rpm slip ring induction motor. Alongside of this building was a new filter house under construction, which is to furnish water for the water cooled standings, roll necks for the strip mills and boiler feed water. Following was a 1,200 ft. building for the new 14 inch continuous strip mill, which is under construction. This mill is to be driven by two 1,250 hp and four 800 hp dc motors. These motors will receive 500 volts from two 3,300 kw synchronous motor generator sets, each having a separate unit. The product of this mill is to be 30 foot bars of various weights. Parallel to the 14 inch mill is another new building under construction, which will house the 9 inch hot strip mill. This mill is also to be driven by three 1,200 hp motors with scherbious control. Then we proceeded to No. 1 substation. Here 22,000 volts are received, 3 phase 60 cycle coming through the second floor to nine 2,000 kva transformers connected delta-delta. Power is then delivered through another set of oil C/B to a main bus at 2,200 volts, then through a high capacity 15,000 volt full automatic oil C/B without low voltage trip to the sectionalized bus, then through disconnects to lead cables to different motor rooms through 4½ inch O. D. fiber conduit. The cable used is 7,000 volt 3 conductor varnished insulation 500,000 cm.

Next the cold strip mill was visited. Located here was a new dc power station with a present capacity of 3,500 kw dc and 5,000 kw will be added in the near future with a 1,200 kva synchronous condenser for power factor connection. The present dc load in this department averages 5,000 amperes and frequent 7,500 ampere peaks but with present increase will average 12,000 amperes with peaks of about 15,000 amperes. The generator bus consists of 12 pieces of ¼x5 inch copper and tapers off to six pieces for the lower end of the distributing switch panels. The cold strip mills present equipment consists of 8x10 inch, 12x16 inch and 16x20 inch tandem mills together with the necessary single mills, combination mills, slitters, shears, levels and oil machines. The capacity of this mill will shortly be doubled when a 20x24 inch tandem mill, a 16x20 inch tandem mill, an 8x10 inch tandem mill with two 8 inch combination mills, three 8 inch single mills, three 12 inch single mills and one 12x20 inch single mill with auxiliary apparatus will be installed. In connection with the cold strip mill is the annealing department where the steel is placed on bottoms covered, annealed and cooled in the presence of coke gas, for which a producer is used.

Next in order the steel works department was visited. An 18 inch Morgan mill driven by a 3,500 hp 93 rpm slip ring induction motor, and a 21 inch Morgan mill driven by a duplicate motor were passed by on the way to the blooming mills. Here a 5,000 hp reversing motor 0-40-120 rpm was driving a 36 inch reversing United Engineering Company's blooming mill. This mill rolls at the rate of 60 ingots per hour, 20 x 22 inch ingots weighing 6,700 pounds are broken down to 6¾x6¾ inch blooms. Twenty-four gas heated pits heat the ingots for this mill. All valves and covers on these pits are electrically operated.

The open hearths were then visited. Here were found seven 100-ton furnaces with all equipment such as valves, doors, draft fans, all electrically operated. Included in the equipment are ladle cranes with 175 main and 40-ton auxiliary hoists. All together there are 839 motors installed in the plant with a total of 36,043 hp. The power consumed in 1919 was 50,000,000 kwh.

Leaving the plant at 5 p. m., the visitors were then taken on a special train to Youngstown, O., where a banquet was served at the Ohio Hotel, covers being laid for 650 people. Following the banquet a technical session was held. A very interesting paper on "Electric Drives for Band Mills," was presented by A. W. Mohrman, electrical superintendent of the strip department of the Trumbull Steel Company. Mr. Mohrman during the course of his remarks said:

Here the writer will discuss the conditions as they appear on a special built, semi-continuous mill for rolling bands. The mill is arranged with 10 stands of rolls, which are driven by 3 variable speed slip ring induction motors, one 1,500 hp, and three 1,200 hp, each controlled by 650 kva Scherbius system, with speed regulation from 270 to 450 rpm, and synchronous speed being at 360 rpm.

The first 5 stands are driven by being connected by gears to a common shaft, which is gear connected to a 1,500 hp slip ring motor. This end of the mill is usually known as the roughing train, next in the finishing end, No. 6 is driven by a 1,200 hp motor, Nos. 7 and 8 are coupled together, and are driven by another 1,200 hp motor; No. 9 is so arranged that it may be either connected to No. 6 or No. 10. No. 10 being the finishing stand, is driven by a 1,200 hp motor, and is so connected that the top roll is run by friction, which gives the required finish so hard to obtain.

The writer can, from personal experience, with this type of mill state that it is very flexible, and is able to perform the proper functions for any size within the limits of the mill, for within a year the 52,458 net tons rolled consisted of 3,889 different sizes ranging from 10 to 90 per cent of the width of the roll and from .050 inches up to approximately .75 inches in thickness.

For jobbing facilities it cannot be beaten, for it often happens that orders come by wire as rush orders, which are often rolled, and in the shippers hands before the order has gone through the customers office routine, and the shipper must wire the customer for shipping instructions. The speed of the miss must be so arranged that the delivery speed of one mill is the entry speed of the next in order to prevent looping or pulling tight, either of which is objectionable. Where tho loops are greater than 12 to 20 inches there is a danger of the strip doubling up, and entering the next mill and stalling or breaking the rolls. When this happens a number of cobbles are caused, and a great amount of time is lost in rearranging the mill. If the steel pulls tight it ruins the product, often causing the piece to stick in the rolls.

It may appear that these points mentioned have nothing to do with the drive, yet indirectly they have, for an uneven temperature affects the elongation, and as a result the speed must be changed, for the harder the steel the more power it takes to roll. Therefore the characteristics of the drive must be such that sudden loads of from no load to 125 per cent full load will affect the speed but slightly. There must be incorporated with the control such devices that will enable the speed to be changed instantaneously regardless of the load.

Cold strip rolling is only further developing the steel by rolling cold, this is usually done on mills of slow speed, with four mills arranged in tandem. Here the speed need not be so closely regulated as in hot strip rolling, although the closer degree of stability, the better are rolling conditions as well as the product. In cold strip rolling the loop is objectionable, although it can be carried away manually, but when the metal drags on the floor it picks up foreign substances and carries it through the next roll, and often ruins the roll of product. When the steel pulls tight there is danger of it scoring the roll or breaking, when it breaks, it will only have to be re-entered and rolling continued.

Now that we have an insight of the rolling conditions, the writer will attempt to apply the drive. In the single speed drives there is little for the drive to do except to keep moving, for the elongation is compensated for by the draft setting and the speed advancement obtained by different gear proportions although in some cases, the mills are provided with special looping devices.

In the singe speed mills which may be driven by either dc shunt, compound or induction motors, as a matter of fact when the hp required is low the dc motor seems to fill the requirements, but when the hp needed is over 1,000 hp, alternating current is used in the majority of cases, thus the induction motor is the universal motor. The cost of installation goes up with the hp on dc machines, due to the large motor generator equipment required, the ac motor has usually been given the preference. When the mills are all connected to a common shaft, the speed regulation is eliminated; if the drive slows down, the whole mill slows down in unison, therefore, reliability, simplicity, and the productive ability are the only requirements considered.

The variable speed mill seems to be the mill of greatest interest today, owing to its jobbing characteristics, and rush delivery of product.

On this type of mill something more valuable than single speed motors are required, for if the entire mill would have to be changed each time the order is changed, it would be slow work, for it is nothing to change an order from 7 to 15 times in a single turn of 12 hours. Therefore, by having a variable speed drive, as is often the case, all changes take place on the last two stands. So closely are speed regulation, flexibility and simplicity related that if one were left out, the entire installation would be a failure. Shunt or compound motors are often used to drive these mills with great success, nevertheless, the speed-torque of the induction motor has been greatly considered for variable speed mills, even in the continuous type where each mill is provided with individual drive. In some types of variable speed mills the two speed slip ring motor has been used, rheostatic control on induction motors has been considered, but rejected due to its series.

In a majority of cases, variable speed motors, with special designed control equipment have been installed. Inasmuch as the shunt motor can be built with speed regulation that is within 1/20 of 1 per cent by involving some secondary equipment, within its control, so it is possible to install within the secondary of an ordinary slip ring motor, such equipment that will give practically constant speed adjustment. All of the secondary energy is not dissipated in heat, a portion is returned for useful work; this is generally accomplished by two systems, namely, the Scherbius and the Rotary converter. Both closely meet the requirement of the variable speed mills, and both have been in operation for several years. In the Scherbius system a polyphases commutating motor shunt field excitation, commonly known as the regulating motor, is connected across the slip rings of the induction motor to be controlled, and is direct connected by shaft to an induction generator, which acts as a squirrel cage motor in starting. In the regulating set the counter emf of the regulating motor opposes the voltage across the slip rings, and by varying the excitation of the regulating motor the slip ring voltage opposite its counter emf must increase or decrease, and in bringing this about the main mill motor must either rise or fall in speed, because of the shunt excitation of the regulating motor and its cemf. The speed of the main mill motor remains practically constant throughout the entire range of load, for any speed setting of the control, and as before stated the slip energy is returned to the line, less the loss in motor generation.

The Scherbius system is built in two forms, the single and double range. Of these the latter is better adapted for band mill use. The double range is better and more efficient, for the reason that if for some reason, the control is down for repairs, the main mill motor can be run at synchronous speed, and this speed compensated for by the other drives.

The Rotary converter system while similar to the Scherbius system in principal, has many detrimental features, as very little is to be gained in the first cost, and on account of the speed being only on one side of synchronism. When the question arises as to which is best, the answer is either depending on the special requirements of the mill.

The Scherbius system, because of its many advantages over any other is generally used; briefly, they are: High efficiency, lower first cost except in special cases, overland capacity at any speed setting, synchronous speed being between maximum and minimum speed, and power factor correction without added complication.

Therefore, it must be concluded that the drive that fills the requirements of the mill in question is the drive required, and when all points are summed up the result will be an electric drive.

Following the technical session the visitors returned to their special train for Pittsburgh and arrived at the P. & L. E. depot at 11:30 p. m., after having completed the most successful trip ever undertaken by the Association of Iron and Steel Electrical Engineers.