from the metal of the plate; they must be smoothed off by a pneumatic chisel otherwise blisters may form during further rolling at the sheet mill. The rolling of slabs with a plate of 1Kh18N9T steel is carried out with the plate at the bottom, and from OKh13 steel with the plate at the top. This is because at a rolling temperature of 1300-900°C, the plasticity of a layer of steel OKh13 is greater than the plasticity of the base layer, and the plasticity of 1Kh18N9T steel is less than that of the base layer and during rolling with the cladding layer on top, the sheet "binds" the top roll.

The heating is carried out as for St. 3 steel and the rolling as for 1Kh18N9T steel or also according to St. 3 steel. As a rule, the slab is rolled across its main axis. The reduction for the first longitudinal pass was equal to the thickness of the material poured to smooth out the side ridges, limiting the plate and the layer; the slab was then rotated through 90° in a horizontal plane and then rolled transversely.

In the rolling of steel with a cladding plate of 1Kh18N9T steel, the scale is removed by a hydraulic apparatus using rods; and in the case of OKh13 steel plate, on a grooved roll in the roughing stand without the addition of rods.

During cooling, the sheets buckle (up to 300 mm) thereby introducing difficulties into their transport and machining. To prevent this, a special bending machine must be installed in the line.

Sheets with a layer of 1Kh18N9T steel are heat treated at 900-920°C, which removes the work hardening obtained in the last passes in the stainless layer, and somewhat improves the structure of the base layer. Sheets with a cladding layer of OKh13 steel are subjected to high tempering. In those cases where the thickness of the sheets is greater than 28 mm, normalization with high tempering is employed.

After heat treatment, the sheets are dressed and cut to the required dimensions. Sheets with a cladding layer of 1Kh18N9T steel are also subjected to pickling. The difficulty of this process consists of the fact that to pickle the layer of 1Kh18N9T steel it is essential to have an aggressive medium which attacks the basic layer. A method has been developed at the Kuznets Steel Combine in which the stainless layer is covered with a special paste. After 12-48 hours soaking, the sheets are etched in the usual solution for stainless sheets for 10-15 min.

This method for producing double-layer steel has not yet found wide application. It can only partially satisfy the requirements of the chemical industry for this steel.

* * *

# ON AN EFFICIENT LAYOUT FOR BLOOMING MILLS


## L. V. Andreyuk

Calibrator of the Magnitogorsk Metallurgical Combine


Great work has been performed at the Magnitogorsk Metallurgical Combine to increase the productivity of two blooming mills. Only within the last five years the productivity by input of blooming mill No. 2 has been increased 20% and of blooming mill No. 3, by 42%. The most important factor in the increase of productivity during this period was the installation of two additional nonreversing stands at blooming mill No. 2 and a 1100 reversing stand at blooming mill No. 3. The present arrangement of blooming mill equipment is shown in Figs. 1 and 2. Another two additional stands which were part of the 630 continuous billet mill had been installed somewhat earlier at blooming mill No. 2.

Thus the number of rolling stands operating in a single flow with blooming mill No. 2 is 17. Blooming mill No. 3 was converted to a double blooming mill. The presence at one and the same plant of two blooming mills, whose power was increased by various methods, makes it possible to compare two ways of increasing the productivity of blooming mills.

Table 1 shows the approximate data on the expenditures for installation of additional stands at both blooming mills.

The productivity of blooming mill No. 2 by input in 1954 as compared with 1952 (the additional stands were installed in 1953) increased by 319,362 tons/year and the capital expenditures per ton of increase of the annual productivity resulting from the data in Table 1 were

$$\frac{3{,}777{,}700}{319{,}362} = 11.83 \text{ rubles}$$

The productivity of blooming mill No. 3 in 1956

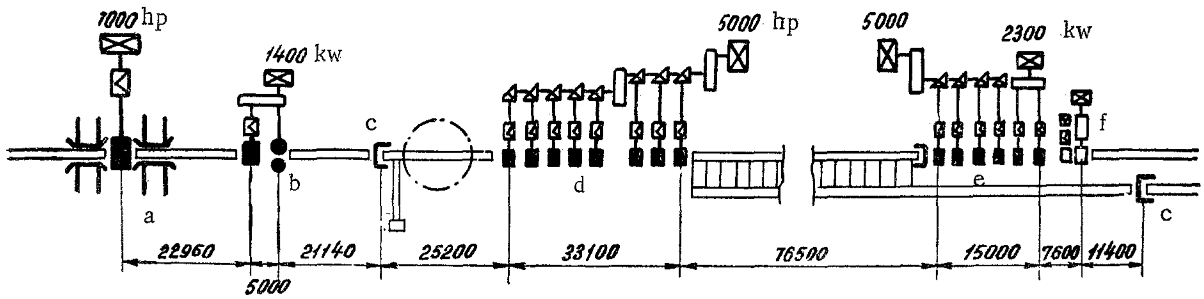


Fig. 1. Layout of the equipment at blooming mill No. 2: a) 1150 reversing stand; b) additional nonreversing stands; c) shears; d) 630 continuous billet mill; e) 450 continuous billet mill; f) electrical planetary flying shears.

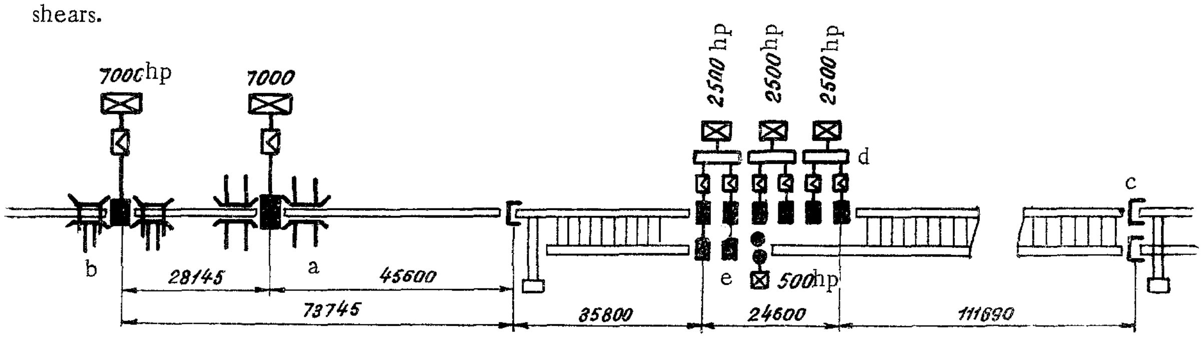


Fig. 2. Layout of equipment at blooming mill No. 3: a) 1150 reversing stand; b) additional 1100 reversing stand; c) shears; d) 720 continuous billet mill; e) group of slabbing stands..

as compared with 1954 (the 1100 stand was installed in 1955) increased and the capital expenditures per ton of annual productivity were 15.98 rubles.

For comparison it is possible to cite the capital expenditures per ton of annual productivity for the slabbing mill we recently put into operation; these were about 68 rubles. This magnitude for the redesigned blooming mill, according to the data of Giprostal', is 51.5 rubles.

It can be seen from the cited data that the increase in the productivity of the blooming mills by increasing the blooming facilities with a more complete utilization of the soaking pits, of the shears for hot cutting, of the storage areas, etc., is attained with considerably less specific expenditure than would be required for building a new blooming mill.

The initial capital expenditures per unit increase of productivity increased with the installation of the second reversing stand. However, preference should nevertheless be given to this variant in comparison with the installation of additional nonreversing stands. Its advantage lies in the fact that with the specific initial expenditures the blooming mills with two reversing stands can in the future continue, without additional expenditures, to increase the productivity by an increase in the heating facilities, by an increase in the output capacity of the rear section, etc. Such possibilities are very limited for a blooming mill with additional nonreversing stands.

It follows from Table 2 that the increase in the annual productivity of blooming mill No. 2 occurred parallel to the increase in the hourly productivity, which is determined mainly by the productivity of the rolling mills. Thus the potentials of the blooming facilities are utilized almost completely. Idle time due to the lack of heated metal were negligible.

Somewhat later, after the installation of the additional stands there was a reconstruction of the electrical

TABLE 1. Capital Expenditures for Installation of Additional Stands at the Blooming Mills of the Magnitogorsk Metallurgical Combine (in prices and norms quoted from July 1, 1950).

| Item of Expenditures | Total of expenditures | | | |
|---|---|---|---|---|
| | blooming mill No. 2 | | blooming mill No. 3 | |
| | Thousands of rubles | % | Thousands of rubles | % |
| Mechanical equipment (with installation) | 2649.9 | 70.1 | 4017.5 | 36.6 |
| Electrical equipment (with installation) | 483.1 | 12.8 | 3826.1 | 34.8 |
| Construction work and sanitary engineering | 260.1 | 6.9 | 2329.5 | 21.2 |
| Electric bridge crane (with installation) | — | — | 190.2 | 1.7 |
| Other expenditures | 384.6 | 10.2 | 620.9 | 5.7 |
| Total | 3777.7 | 100.0 | 10984.2 | 100.0 |

TABLE 2. The Increase in the Productivity of the Blooming Mills of the Magnitogorsk Metallurgical Combine after Installation of Additional Stands.

| Blooming mill | Indices | Year prior to reconstruction | Years after reconstruction (without consideration of the year when reconstruction was being done) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| № 2 | Annual productivity by input, % | 100.0 | 113.6 | 124.5 | 125.3 | 125.5 | 126.8 |
| | Productivity at the busy hour, % | 100.0 | 115.0 | 123.8 | 126.8 | 127.1 | 127.5 |
| | Idle times due to lack of hot metal, % | 2.8 | 4.0 | 2.3 | 2.4 | 4.5 | 2.7 |
| № 3 | Annual productivity by input, % | 111.9 | 141.5 | 144.1 | 151.2 | 156.3* | — |
| | Productivity at the busy hour, % | 111.2 | 160.1 | 164.1 | 167.2 | 170.9* | — |
| | Idle times due to lack of hot metal, % | 2.5 | 11.2 | 11.8 | 8.1 | 5.5* | — |

* For the first quarter of 1959.

equipment of the 1150 reversing stand, which assured an additional certain increase in the productivity; after this, during the last three years, the productivity of blooming mill No. 2 has increased negligibly.

On blooming mill No. 3 the rapid increase in the productivity still has not kept up with the increase in the hourly productivity (Table 2). This means that the potentials of the reversing blooming stands are still not totally utilized. Idle time due to the lack of heated metal after installation of the second reversing stand increased more than four times. By putting into operation additional heating facilities this idle time was reduced, and the annual productivity increased without any additional expenditures for the group of blooming stands. *

However, the reversing stands in the composition of the blooming mills have great shortcomings.

Thus on the 1100-1150 blooming mills with a standard drive of 7000 hp the working torques are within 180-200 meter-tons. With an acceleration of the motor of 40-45 revolutions per minute per second, and with the magnitude of the flywheel moment of the motor with the mill about 510 meter $^2$ tons, the dynamic moment of the acceleration is about 30% of the torque being developed by the motor. Consequently, 100 kw of the power of the reversing motor are equivalent to 70 kw of the power of the nonreversing motor. If we take into consideration the necessity of supplying the reversing motor from the transformer unit which approximately triples the power of the electrical machines of the main drive, then the power of the drive of the reversing mill should be greater than the power of the ac motor of the nonreversing mill by $\frac{100 \times 3}{70}$=4.3 times.

The heavy and high-speed auxiliary equipment is also driven from the dc variable motors. The drive power of the auxiliary equipment of the reversing stands is close or even exceeds the power of the main-drive motors.

*It is expedient to make an estimate of the variants of reconstructing blooming mills starting from the specific expenditures per ton of increase of the planned output and not from the productivity actually attained. Editor.

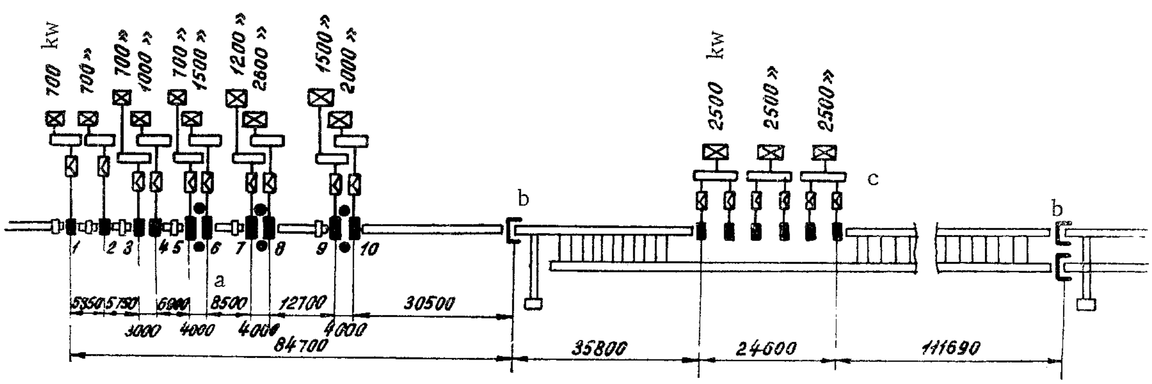


Fig. 3. Diagram of the arrangement of the equipment of a continuous-type blooming mill: a) 1100 continuous blooming mill; b) shears; c) continuous billet mill; 1-10) numbers of stands.

TABLE 3. Regimes of Rolling on a Continuous Blooming Mill

| Blooms from ingots with dimendions $\frac{690\times620}{750\times680}$ mm and a weight of 7.0 tons. | | | | | Slabs from ingots with dimensions $\frac{1060\times550}{1100\times590}$ mm and a weight of 8.6 tons. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stand | $h$, mm | $b$, mm | $\Delta h$ mm | n RPM | Stand | $h$, mm | $b$, mm | $\Delta h$ mm | n RPM |
| 1к* | 610 | 630/690 | 80/140 | 3.00 | 1к | 1000 | 560/600 | 60/100 | 3.00 |
| 2к | 550 | 625 | 80/140 | 3.00 | 2 | 520 | 1005 | 40/80 | 3.00 |
| 3 | 545 | 565 | 80 | 2.95 | 3 | 470 | 1015 | 50 | 3.16 |
| 4к | 405 | 590 | 140 | 3.80 | 4 | 385 | 1030 | 85 | 3.80 |
| 5 | 515 | 420 | 75 | 3.00 | 5 | 345 | 1040 | 40 | 2.87 |
| 6к | 375 | 445 | 140 | 3.80 | 6 | 265 | 1025 | 80 | 3.80 |
| 7 | 370 | 390 | 75 | 4.47 | 7 | 225 | 1035 | 40 | 4.58 |
| 8к | 225 | 415 | 145 | 6.75 | 8 | 155 | 1020 | 70 | 6.75 |
| 9 | 340 | 235 | 75 | 7.87 | 9 | 130 | 1030 | 25 | 7.42 |
| 10 | 250 | 250 | 90 | 9.85 | 10 | 100 | 1010 | 30 | 9.85 |

*K=turning

The total power of the electrical machines of the reversing stand exceeds the power of the rolling mill motor by 3.6-4.9 times. If here we consider only a 70% use of the rolling mill motor then on the reversing stand the power of the electrical machines is more than 5.1-7.0 times that which would be required on a nonreversing rolling mill (it is possible to disregard the power of the slow-speed screw-down devices and the short invariable tables on the nonreversing stand). This means that the power of the electrical equipment of one reversing stand would be sufficient for 5-7 nonreversing stands operating with the same reductions and speeds (although such high speeds on a nonreversing stand are not necessary).

The mechanical equipment of the reversing stand is also heavy, cumbersome and expensive. The great length of the roll bodies increases the dimensions of the stand in width. The powerful and high-speed screw-down mechanism with the large balancing device increases the dimensions of the stand in height, and with it the height of the building. The wide tables should be calculated for the shocks and falling of ingots and,operate under heavy, high-speed conditions. The manipulators should be strong, massive, and high-speed.

If we take into consideration all the shortcomings of the reversing stands and that the needed productivity of certain of our blooming mills is already 3.5-4 million tons per year and more, then the idea proposed by Prof. A. A. Aleksandrov of developing designs for a continuous blooming mill is expedient.

We developed a variant of a group of 10 nonreversing blooming mill stands instead of two reversing stands applicable to the conditions of blooming mill No. 3 (Fig. 3). According to this variant it is possible to roll, on one set of rolls,blooms with a cross section of 250 x 150 and 290 x 290 mm, and also slabs with a maximum width of 1000 mm and a minimum thickness of 100 mm (the entire assortment of blooming mill No. 3 is thus rolled).

All the stands of this blooming mill except for the first and second are arranged in pairs. Each pair of stands operates as a continuous group. When selecting the reduction on the first stand of each pair, starting from the certain, natural bite,there is the possibility of considerably increasing the reduction on the second stands by realizing a forced undertaking of the strip by means of the first stand. The regimes for reducing the blooms and slabs are given in Table 3.

Edge reduction of the slabs is usually accomplished on the first stand and if the ingot is too wide then on the first and second stands. Between the last three pairs of stands there are undriven vertical rolls serving only for the removal of the width and for forming the side edges.

In front of each pair of stands and in front of the first and second stands manipulators are installed.

The diameter of the rolls in each stand is 1100 mm, the length of their bodies in the first four stands is 1400 mm and 2300 mm in the rest. Along the edges of the roll bodies of each stand, starting with the fifth, there are two passes.

The distance between the stands in which turning is done was selected from the condition of the arrangement of the longest flat with the necessary reserve. The over-all length of the blooming mill building remained almost the same. The working stands can be equipped with slow-speed screw-down devices with a magnitude of lift of the upper roll of 450-500 mm for the first and second stands and 250-300 mm for the remaining stands. Lifting of the upper roll is required only before starting to roll the next ingot. Manipulators and heavy tables are not necessary.

Rotation of the rolls from the motors is transmitted through a two-step reducer with cylindrical spiral gears (4,6,7,8,9, and 10th stands) and three-step reducers (remaining stands).

A calculation was not made for the capital expenditures for installation of such a stand. We consider that the increase in the weight of the mechanical equipment should,to a considerable degree, be compensated for by its simplicity, by the considerable reduction in the power for the electrical equipment for driving the stands and auxiliaries, by the reduction in the height of the building, by the elimination of the need for two additional stands with horizontal rolls and driven vertical rolls for rolling slabs, by the possibility of complete automation of the rolling process, etc.

The annual output of such a blooming mill with rolling 50% blooms with a cross section of 250 x 250 mm and 50% slabs with a cross section of 100-750 mm, if one takes the duration of the intervals between ingots as 15 sec, with 7200 working hours per year and the utilization factor of the stand as 0.9, is 3.8 million tons per year even with calculation for rolls of minimum diameter.

Taking into consideration the presence in the assortment of large blooms and slabs and the possibility of reducing the interval between ingots, the productivity of the blooming mill can be raised if necessary to 4.5-5 million tons per year and more.

Thus with capital expenditures approximately equal to the expenditures for installing a two-stand reversing blooming mill, the continuous blooming mill will have unlimited reserves of productivity.

In our opinion the installation of continuous blooming mills is already economically advantageous, starting with an output of 3-3.5 million tons per year. This figure can be determined more exactly after a careful study of the problem by the planning organizations.

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# EXPERIENCE ON THE OPERATION AND MODERNIZATION OF THREE-ZONE CONTINUOUS FURNACES

V. N. Medvedev, N. I. Butenko, and V. P. Murovtsev

Alchevsk Metallurgical Works

Three-zone bottom-fired continuous furnaces intended for heating slabs of maximum size 150 x 800 x 2000 mm have been built for the 2250 mill according to the design by "Giprostal' ". A mixture of coke-oven and blast-furnace gas of 2000 kcal heating value at a pressure of 220 mm water is used as fuel.

Air to the furnace is supplied by two fans of 25,000 $m^3$/hr capacity at a pressure of 360 mm of water. The air is heated up in metallic extended-surface recuperators.

A distinguishing feature of these furnaces is the positioning of the burners in the upper heating zone where they face the burners of the soaking zone (i.e., in the direction of the metal movement).

Square drilling bars are used as bottom beams. The longitudinal beams are set on edge and in the heating zone they are mounted on the supporting double beams of the same cross section with their ends built into the brickwork of the side walls. The transverse supporting beams in the continuous zone are also resting with their middle part on a longitudinal wall.

The furnaces are equipped with instruments for temperature measurement and automatic control.

In the course of the operation of the furnaces some short-comings were noted which resulted in a high specific fuel consumption (up to 190 kg/t low efficiency and poor heating of the metal. The main cause of the short-comings is defects in the design of the funace.

In recent years, the personnel of the Works have modified and improved some parts of the furnaces. In the heating zone additional Π-shaped beams have been installed and this has improved the rigidity of the supports and prevented the tubes from bending even if the cooling water supply is interrupted for a short time. The design of the water-cooled supporting beam at the discharge end has been modified because the welded supporting beam used to get fouled rapidly in its lower parts and burned through in 2.5-3 months. The present beam, made of rectangular tubes (drilling bars) has been in operation for over three years. The beam supporting the roof knuckle has been modified in a similar manner.

The rectangular hearth girders of Kh8S steel have been replaced by heavier T-girders made of Kh25H2 cast steel and, as a result, their service life has increased from three to eight months. Even now, however, the replacement of the girders causes additional shutdowns of the furnaces during which time a partial repair to the brickwork, hearth beams, etc., is carried out. In the period between the repairs, the hearth girders are sections, are supported individually with the use of kaolin bricks of a simple shape (Fig. 1). As a result of this the service life of the roof has increased and the amount of work which has to be carried out on the roof during the replacement of the hearth girders has been reduced.

The design of the small shaped joists of the roof knuckle has also been modified with the object of preventing the bricks from falling through the slots made in the lower flange of the joist for convenient anchoring of the bricks. As a result of bricks falling out, the joists burned through and therefore the furnace had to be shut down two or three times a year for the replacement of the brickwork of the roof knuckle. Now the lower flange of the beam is made without slots and the bricks do not fall out.

The covers of the discharge end were suspended on a No. 36 H-beam which warped at high temperature and became useless; its service life has been increased by