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SPECIFIC ASPECTS IN POSITIONING OF THE RE-HEATING FURNACES AT A LAYOUT OF MANY DIFFERENT ROLLING MILS

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ABSTRACT
Some specific aspects in positioning of the re-heating furnaces at a layout of different rolling mills, for a period of about last hundred years in rolling mills practice are presented in this paper. Practical solutions in the above mentioned (a.m.) field are presented for the different rolling mills. Some of the a.m. aspects are explained, confirming that both, the type of a rolling mill and the economic aspect are dominant in planning and carrying out the construction of an optimal rolling mill layout, in regard to the position of the re-heating furnace and the other rolling mill facilities.

INTRODUCTION
In a layout of any (hot) rolling mill there is a necessity to position one or more re/heating furnaces, to be in an optimal position regarding to the other main and auxiliary rolling mill equipment. In this paper it is presented an overview of almost previous one and a half century of the a.m. positioning, with a view to the theoretical approach and with some explanations from a practice, related mostly to the IRON AND STEEL WORKS – ZENICA. Regarding the theoretical considerations of the a.m. positioning which are presented, as well as from the practical point of view, some explanations are given, regarding the development in that field, and some specific requirements in a practice, from both technological and economic aspects.

1. OLD DESIGN IN A POSITIONING OF THE RE-HEATING FURNACES
From the literature [1,2,3,4,5,6,7,8,9] recommendations it is clear that any (namely hot) rolling mill needs to have at least one reheating furnace (like many light/medium/heavy section and also the wire rod mills) - in that case these are the pusher type furnaces (very rarely with an addition of a tunnel type furnace for an additional heating), up to ten (like many blooming mills - in that case these are the soaking pit type furnaces). Respectively, in both theoretical and practical considerations in this paper, blooming mills are not any more taken into account.

General recommendation for the positioning of the re/heating furnace/s in rolling mills layout are:

- Proximity to the roll stand/s
- Under a crane
- In a compliance with the other auxiliary equipment
- Enough space for the concerned workers in handling of hot billets/blooms
- Enough space for the concerned workers in maintenance and repair works

1.1. Light section rolling mills case – 1

Following figure represents (Figure1.) a typical cases of the positioning of the re/heating furnace/s at a layout of the light section rolling mills about the beginning of 20th century.

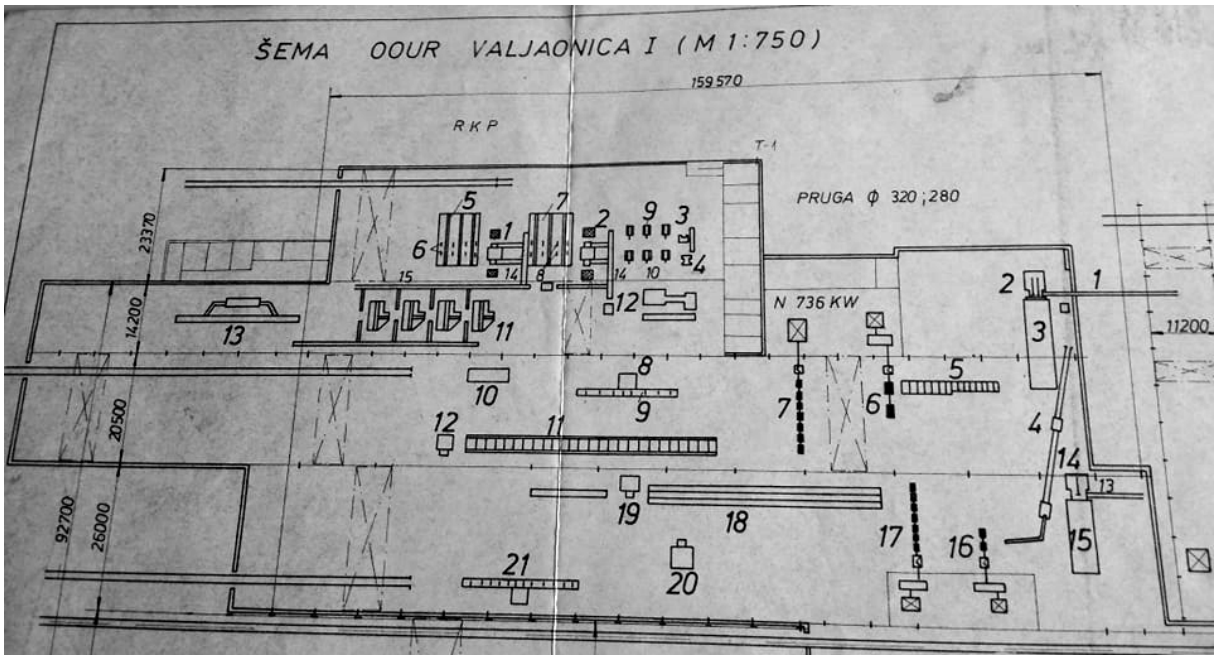

Figure 1. The layout of the oldest light section rolling mill in the IRON AND STEEL WORKS – ZENICA (built in 1893. [2])

The oldest light section rolling mill in the IRON AND STEEL WORKS – ZENICA, which was built in 1893. was consisted of two light section rolling mills, namely dia 320 mm and 280 mm. From the Figure 1. it is clear that both rolling mills, had its own pusher type re/heating furnace (for dia 320 mm, re/heating furnace is under symbol 3, and for dia 280 mm, re/heating furnace is under symbol 15), although it was possible that the furnace under symbol 3, could supply both rolling mills (two different pusher machines had pushed two separate rows of short billets, sq. 77mm – length 2m, for dia 320 mm rolling mill, and sq. 60 mm – length 1m, for dia 280 mm one), and the other one under symbol 15 was exclusively for dia 280 mm rolling mill (very short billets, sq. 60 mm, with the length of 1m).

That was quite typical case at that time, to cover both technological and economic aspects, especially having in mind that a lot of hard manual work was needed, to handle hot billets and deliver them to the roll stands area, as well as for maintenance and repair works on the furnaces.

1.2. Light section rolling mills - case 2

Following figure represents (Figure 2) a typical cases of a positioning of the re/heating furnace/s at a layout of the medium section rolling mills in the period between 1930-1950.

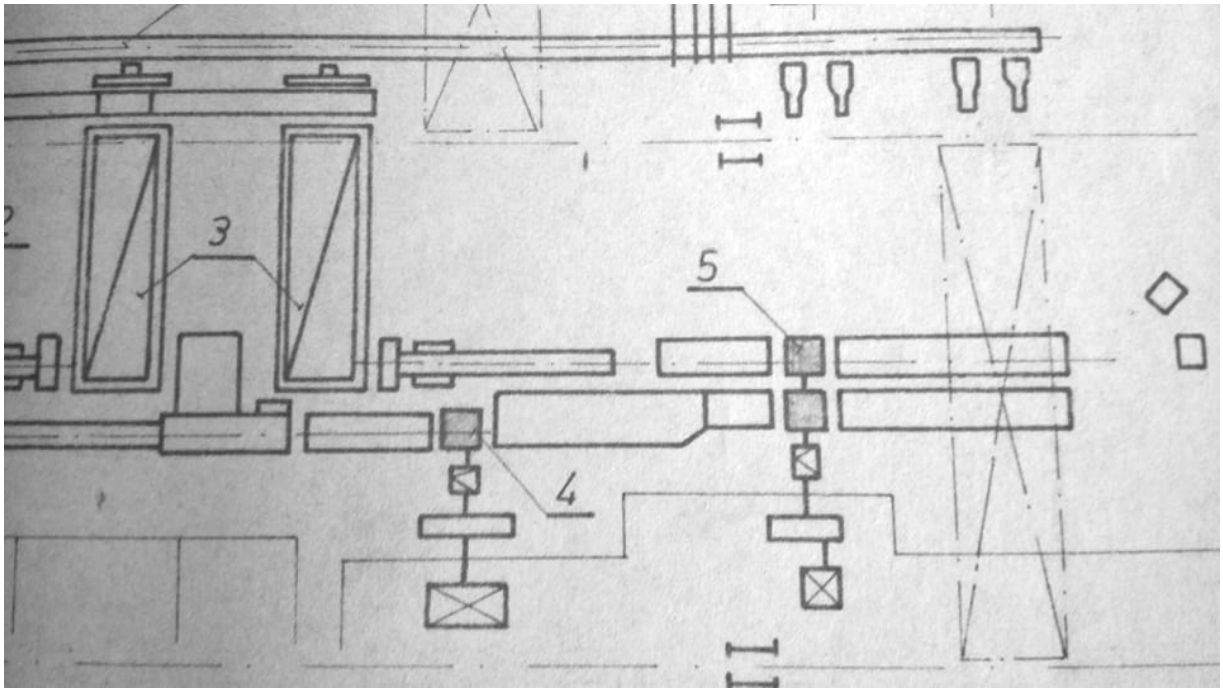

Figure 2. The layout of the 2nd generation light section rolling mill in the IRON AND STEEL WORKS – ZENICA (built in 1955. but technologically belonging to 1930-ies [2])

Second generation of the light section rolling mill in the IRON AND STEEL WORKS – ZENICA was built in 1955, and they were technologically belonging to 1930-ies. Since it was the type of semi-mechanized light section rolling mill with one rougher, two intermediate roll stands, and the line train of stands as a finishing mill, with six double-two high stands, two (same) pusher type re/heating furnaces (each one of 20 t/h capacity) were needed-built, and they are under the symbol 3 at the a.m. Figure 2.

Typically for that time layout, some extra auxiliary equipment were needed around the furnace/s, and two furnaces were needed primarily because of a (relatively) high capacity of that semi-mechanized rolling mill and because of their mutual substitution in case of maintenance and repair works on the furnace/s.

The billets being heated/rolled were of sq. 77 mm, much longer (4 m) than in the case 1 and accordingly a capacity was higher.

That was quite comfortable with much better positioning than in the case 1, but that was also the next generation of the rolling mills, which was much more modern than the rolling mills presented in the a.m. case. Accordingly it was bigger cross-section of the billets, as well as their length.

1.3. Medium section rolling mills – case 3

Following figure (Figure 3) represents a typical case of a positioning of the re/heating furnace/s at a layout of the medium section rolling mills in the period between 1930-1950.

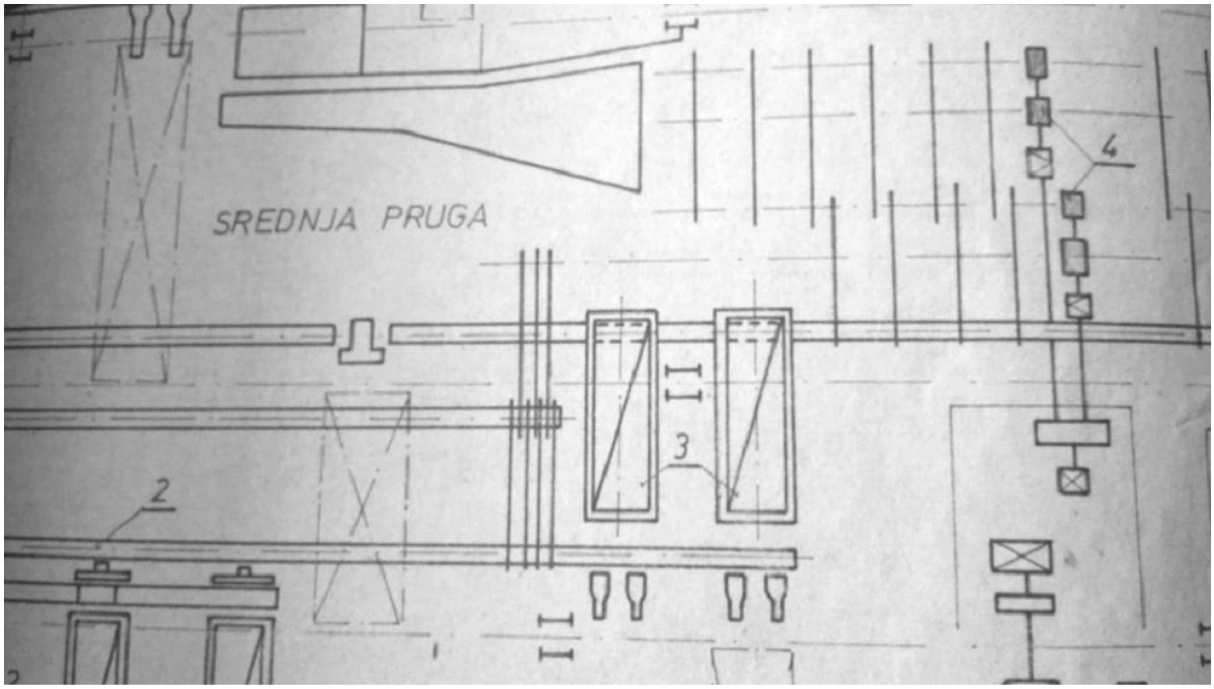

Figure 3. The layout of the medium section rolling mill in the IRON AND STEEL WORKS – ZENICA (built in 1955. but technologically belonging to 1930-ies [2])

Medium section rolling mill in the IRON AND STEEL WORKS – ZENICA was built in 1955., but technologically belonging to 1930-ies. Since it was the type of partly (not fully) mechanized medium section rolling mill, driven from both sides of the line train of four stands, having two first roll stands at lower rolling speed and last two roll stands at higher rolling speed. Two very same pusher type re/heating furnaces (each one of 25 t/h capacity) were needed-built, and they are under the symbol 3 at the a.m. Figure 3.

That layout is a sort of higher level than in the case 1.2. primarily because of higher weight of the billets/blooms (the billets sq. 77 mm, up to the blooms of sq. 180 mm and for both, the lengths from 3,5 – 4,5 m), than the billets (in the case - 2), what requires a higher level of the equipment reliability, since any sort of manual handling of hot blooms is inappropriate.

That was quite comfortable and slightly better positioning than in the case - 2. Accordingly it was bigger cross-section and weight of the entry material (billets were of the same cross-section, but the blooms were used of sq. 150-180 mm, as well as their lengths) and that was the main reason for the a.m. better positioning.

1.4. Heavy section rolling mills – case 4

Following figure (Figure 4) represents a semi-typical case of a positioning of the re/heating furnace/s at a layout of the heavy section rolling mills in the period between 1930-1950.

Heavy section rolling mill in the IRON AND STEEL WORKS – ZENICA was built in 1939 but technologically belonging to 1930-ies. Since it was the type of almost fully mechanized heavy section rolling mill of the line train of four stands, having two drive motors, by one from both sides, two similar pusher type re/heating furnaces (capacity of 60 and 45 t/h) were needed-built, and they are under the symbols 2 and 3 at the a.m. Figure 4.

That layout is at a similar technological level compared to the case – 3, with a main difference in higher weight of the blooms (sq. 180 mm up to rectangular cross-section 320x260 mm, and for both, the lengths from 3,5 – 4,5 m), than in that case, what requires another higher reliability level of the equipment, and according to that, an overhead control room was built, to ensure better and more precise visibility for proper handling-manipulation of the blooms being rolled.

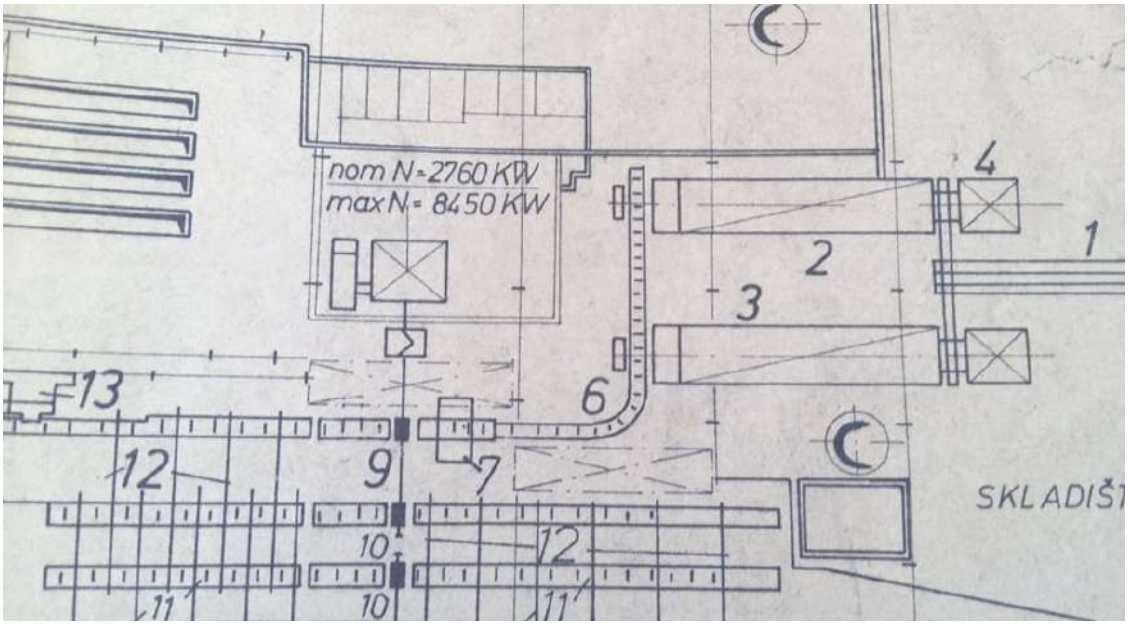

Figure 4. The layout of the heavy section rolling mill in the IRON AND STEEL WORKS – ZENICA (built in 1939. technologically belonging to 1930-ies [2])

In this case the aspect of proximity is well fulfilled, providing a sort of space reduction at the layout.

At the other hand, banded roller conveyer transporting hot blooms to the rougher, had caused sometimes short delay in smooth transportation of hot blooms to the Heavy section rolling mill in the IRON AND STEEL WORKS - ZENICA, and better solution would be a straight forward transportation system, which would require more space at a layout. Such a solution for the heavy section rolling mills of that generation is presented at Figure 5. [5], although there is only one re/heating furnace, but having sufficient capacity and reliability.

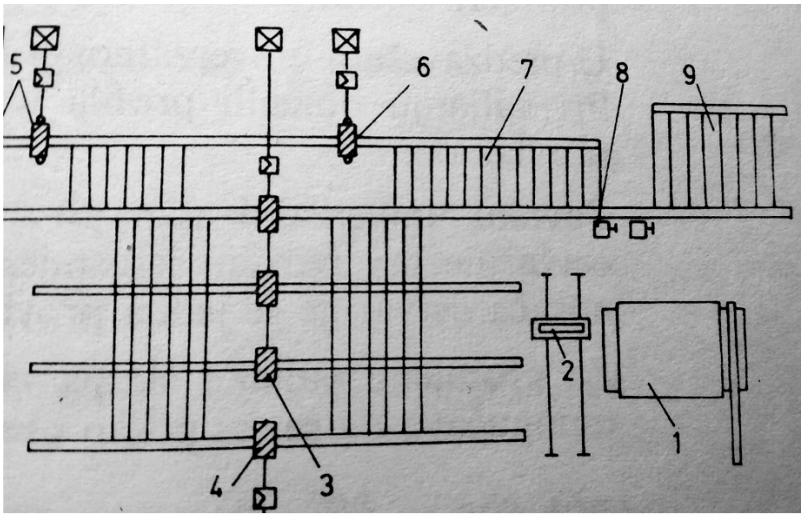

Figure 5. The layout of a heavy section rolling mill technologically belonging to 1930-ies [5])

Heavy section rolling mill [5], technologically belonging to 1930-ies, was a type of almost fully mechanized heavy section rolling mill of the line train of four stands, having two drive motors, by one from both sides, one intermediate roll stand individually driven and two individually driven roll stands in continuous finishing group. That rolling mill had one pusher type re/heating furnace under the symbol 1 at the a.m. Figure 5.

Such a solution for the heavy section rolling mills of that generation although having only one re/heating furnace, but having sufficient capacity and reliability, is better than in the case – 4, because of the possibility to provide a smooth supply of hot blooms to the rougher, without any delay, but with a transverse transportation carriage, which enables to get the a.m. blooms straight in the line of rolling.

2. MODERN DESIGN IN A POSITIONING OF THE RE-HEATING FURNACES

Modern design in a positioning of the re/heating furnace/s in a layout of the different rolling mills is under the same recommendations like in heading 1. but generally speaking the rougher is closer to the exit of hot billets-blooms from the furnace. Main positive difference is in biting the billets-blooms even a few meters after getting out from the furnace. Thus, the first part of the billet-bloom is already in rolling process, until the remaining part is still in the furnace.

Such an example is presented regarding Wire rod (two strands) continuous rolling mill and Light section-bar mill (two strands) continuous rolling mill, both in the IRON AND STEEL WORKS – ZENICA. Both rolling mills were turn-key built about 1976/7 in the digitalized era and technologically modern era, comprising continuous type of the rolling mills.

2.1. Modern light section rolling mills case - 5

The example of that Light section-bar (two strands) continuous rolling mill layout is presented at the Figure 6.

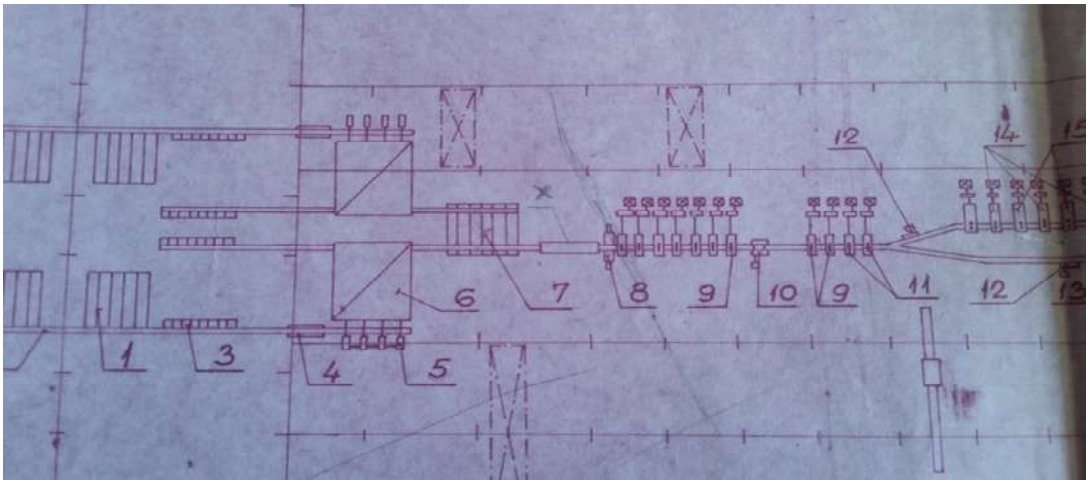

Figure 6. The layout of the third generation light section rolling mills in the IRON AND STEEL WORKS – ZENICA (built in 1977. technologically belonging to 1970-ies [2])

Third generation light section rolling mills in the IRON AND STEEL WORKS – ZENICA was built in 1977. technologically belonging to 1970-ies. Since it is the type of fully mechanized, digitalized and automated light section continuous rolling mill with one rougher and one intermediate group of roll stands, with two finishing mills, each one consisted of six two high stands, with alternatively horizontal-vertical position of the rolls. Such a modern, high capacity rolling mill had two (same) walking beam type re/heating furnaces, each one of 80 t/h capacity (for the billets sq. 80 mm, and the length of 12 m), and they are under the symbol 6 at the a.m. Figure 6.

It is important to notice that the exit of the billets from one of the furnaces was not in the line of rolling, and that is why one additional drag-over was installed there. Accordingly that was a sort of small technical inconvenience, without serious disturbance, although it is a sort of modern light section rolling mill design.

The layout presented at Figure 6. was later changed, due to some larger conception consideration, concerned with production process at continuous casting (CC) unit, which was later unified for the billets production of sq. 120 mm (instead of sq. 80mm, which was earlier rolled at Continuous billet mill, from CC blooms 320x280 mm), which was used, when that rolling mill was built and commissioned, but that is not considered in this paper.

2.2. Modern wire rod rolling mills case - 6

The example of that Wire rod (two strands) continuous rolling mill layout is presented at the Figure 7.

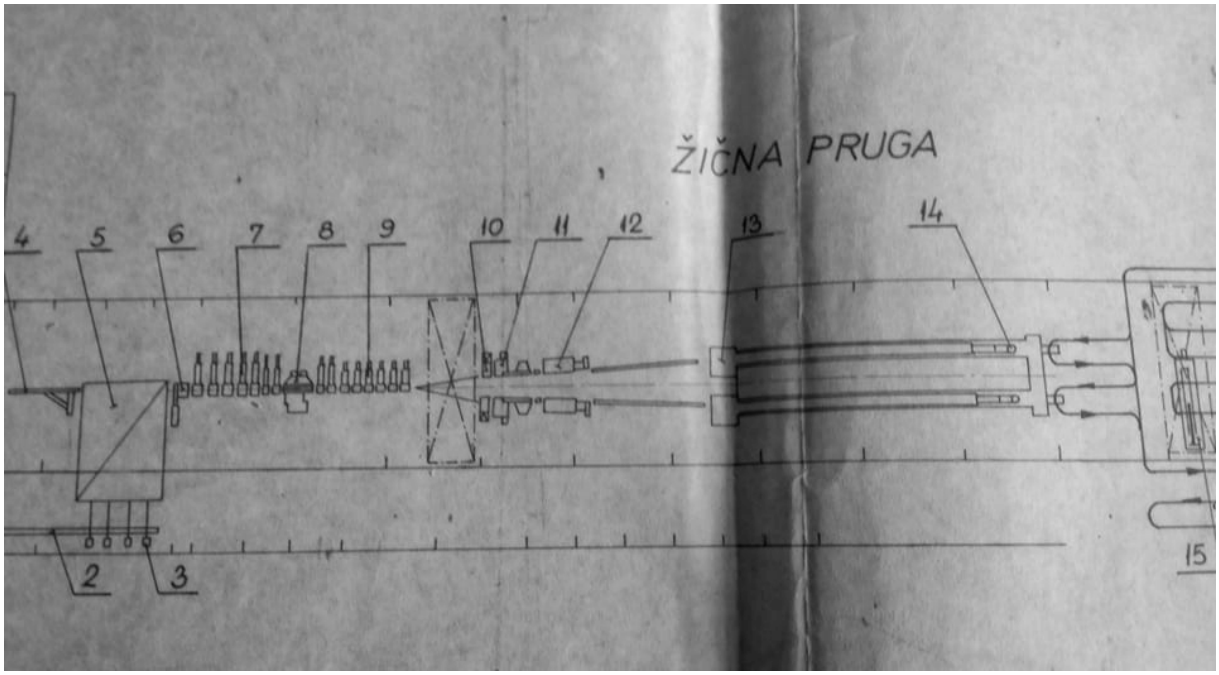

Figure 7. The layout of the third generation wire rod rolling mills in the IRON AND STEEL WORKS – ZENICA (built in 1977. technologically belonging to 1970-ies [2])

Third generation wire rod rolling mills in the IRON AND STEEL WORKS – ZENICA was built in 1977. technologically belonging to 1970-ies. Since it is the type of fully mechanized, digitalized and automated wire rod continuous rolling mill with one rougher and one intermediate group of roll stands, with two finishing mills, each one consisted of MORGAN type mono-bloc, having ten two high stands, with alternatively horizontal-wise position of 45 and 135 degrees of W-carbide rolls-roll/rings. Such a modern, high capacity rolling mill has the only one walking beam type re/heating furnace of 100 t/h capacity (for the billets sq. 115 mm, and the length of 12 m), and that is under the symbol 5 at the a.m. Figure 7.

It is important to notice that the exit of the billets from this furnace is in the line of rolling, but on top of it, it gives supreme opportunity that the first part of the billet is already in rolling process (even rolled), until the remaining part is still in the furnace. Accordingly that is a big technical advantage, classifying that wire rod rolling mill as a sort of modern wire rod rolling mill design.

The layout presented at Figure 7. even was not changed later, due to some larger conception consideration concerned with production process at continuous casting (CC) unit, which was later unified for the billets production of sq. 120 mm (instead of sq. 115mm, which was earlier rolled at Continuous billet mill, from CC blooms 320x280 mm), which was used, when that rolling mill was built and commissioned, but that is not considered in this paper.
That sort of the layout can be considered as the supreme one and technologically is not changed till nowadays. Only computer control systems on the re-heating furnace have been improved as well as (slightly) rolling speed.

3. CONCLUSIONS

- There are six presented cases on seven figures comprising seven different rolling mills and their layouts, concerned with a positioning of the re/heating furnace/s.

- These seven different rolling mills represent also an overview of historical development (for almost 150 years) in positioning of the re/heating furnace/s at a layout of these rolling mills.
- The most important concerned characteristic is a proximity of hot billet/bloom exit and a first rougher roll stand.
- The best solution is the opportunity (prevailing nowadays) that the first part of hot billet-bloom is already in rolling process (even already rolled), until the remaining part is still in the furnace.

General recommendations for the positioning of the re/heating furnace/s in rolling mills layout presented in theoretical part are the following.

- Proximity to the roll stand/s
- Under a crane
- In a compliance with the other auxiliary equipment
- Enough space for the concerned workers in handling of hot billets/blooms
- Enough space for the concerned workers in maintenance and repair works

All of these recommendations have been improved in a last 150 years, especially the first one, giving the opportunity nowadays that the first part of hot billet-bloom is already in rolling process (even already rolled, what is the most easy at the wire rod continuous rolling mills), until the remaining part is still in the furnace.

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