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SALZGITTER INDUSTRIEBAU GESELLSCHAFT MBH

SALZGITTER

H. Hemmer

Yugoslavia.
FINAL REPORT.

YUG -021- E (SIS)
Zenica Steel Plant.

002001

YUG - 021 - E (SIS)

FINAL REPORT

SALZGITTER INDUSTRIEBAU GMBH

SALZGITTER INDUSTRIEBAU GMBH
Salzgitter-Druette 1
Federal Republic of Germany

re: YUG - 021 - E (SIS)
Zenica Steel Plant

On November 24, 1969, a contract was concluded between the United Nations Industrial Development Organization of the one part and Salzgitter Industriebau GmbH of the other part according to which Dipl. -Ing. Heinrich Hemmer, a member of our company, was assigned, from December 5, 1969, to February 4, 1970, to the

forge of the Zenica Steel Plant

in order to

prepare an expert's opinion on the existing furnaces,

prepare proposals regarding possible improvements of the operation and maintenance of these furnaces, and

to train the counterpart personnel

as is described in detail in the contract of November 24, 1969, under 1.02.

Early in January 1970, the Technical Management of the Zenica Steel Plant asked our expert to extend the above-mentioned investigations to the

rolling mill furnaces of the Zenica Steel Plant

and to indicate the period by which his assignment to Zenica had to be extended for this purpose.

Since at that time he already knew the conditions and possibilities of Zenica, he considered an extension of his assignment by two weeks, i. e. till February 18, 1970,to be sufficient. On January 29, 1970, the UNDP

Resident Representative of Belgrade addressed to him the telegram WIEN - R/TLX 1069 16/15 28 1025 approving this extension. His assignment to Zenica thus lasted from monday, Dezember 8, 1969, in the evening to Tuesday, February 17, 1970, in the evening. For seven weeks, i. e. till January 23, 1970, he worked in the forge, for the remaining three weeks in the rolling mill. The briefing in Vienna took place on December 5, 1969, the debriefing on February 19, 1970.

On the occasion of the briefing he was ordered to send regularly interim reports to the UNIDO headquarters at Vienna through UNDP Belgrade. These reports dated December 15, 1969, January 8, 1970, and February 2, 1970 were attached to the draft final report which was sent to you in five copies on April 4, 1970.

We take the liberty to submit in the following, in accordance with para. 1. 06 (c) of the contract of November 24, 1969, a

F I N A L R E P O R T

regarding our expert's activity at Zenica.

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1.00 Activity in the forge of the Zenica Steel Plant

The forge of the Zenica Steel Plant consists of five shops. Three shops of about 150 x 25 m are used for hot forming, and the two other shops which have similar dimensions for finishing or wheel manufacture. The three shops for hot forming are provided almost exclusively with equipment which after the war had already been in use and then supplied to Yugoslavia, or which had been bought from other countries which had received them in a used state. In the main, the equipment consists of:

1 600 t press, hydraulic
1 1850 t press, with steam multiplier
1 5100 t press, hydraulic

1 900 kg steam-hammer
3 1650 kg steam-hammers

1 600 t arbor press, hydraulic
1 2000 t punching press, hydraulic
1 wheel tire rolling mill
1 wheel web rolling mill

The pertaining furnace installations consist of

7 car-hearth furnaces for heating and reheating, the car-hearths having a size of abt. 1.5 x 3 m to

2 car - hearth furnaces for heat treatment, one having a size of abt. 1.8 X 5 m, the other of 1.8 x 11 m

1 car-hearth furnace, new, of Gipromez Leningrade, for ingots of up to abt. 30 t

2 OFAG rotating hearth furnaces, the outer diameter being abt. 11 m, for a capacity of 8 t/h each

5 small improvised furnaces in the hammer mill

1 large (abt. 3 x 3 x 11 m) and

2 small (abt. 1.2 x 1.5 x 3 m) cooling pits which had also been constructed by means of used materials.

With the exception of the new furnace constructed by Gipromez which corresponds to the latest standard, these furnaces probably

1. were already partly worn at the moment of delivery, and
2. originally were partly used for other purposes, e.g. for shell manufacture, whereas in Zenica they are employed for heating and reheating ingots of up to abt. 30 t.

As regards these furnaces, the Management objects to the following characteristics:

a large need of repairs

an insufficient uniformity of the temperatures over the cross-section and length

a considerable formation of scale.

Our expert summarized his impressions, ideas, and proposals regarding possible improvements in an "Opinion Regarding the Furnaces of the Forging and Pressing shop of the Zenica Steel Plant" which he prepared at Zenica in the

German language from January 19 to 23, 1970, and which consists of 16 pages and four drawings.This opinion was approved of with satisfaction, translated promptly into the Serbo-croation language and reproduced.

Contrary to the hot forming shops, the finishing shops are equipped with new machines which were supplied almost exclusively from the Soviet Union and Poland. The plant comprises also new high-rated heat-treatment furnaces with a diameter of 1.2 to 1.5 m and a depth of 10 m for the tempering and hardening of main shafts for ships etc. This modern equipment of the finishing unit enables the Plant to have its production of railway wheels, parts for ship-building etc. in accordance with international standards, e.g. the British Lloyd's Registers Rules.

Owing to the lack of heavy cranes, it has hitherto not been possible to employ the 5100 t press appropriately. For this reason,

1 150 t forge crane and
1 60 t manipulator

were bought. For the treatment of ingots of up to 150 t, it will be necessary to construct appropriate furnaces. One of such furnaces has already been ordered.

In order to replace the outdated steam-hammers, a modern Austrian forging machine was bought which is now under erection. In this connection, the Management would very much appreciate it if the operators of this machine could be trained before the startup in a plant working already with such a machine. This point is dealed with in detail under 5.01.

In this zone, a modern rocker-bar heating furnace will be mounted. This project as well as the heavy ingot furnace project are commented upon in the opinion.

There is no doubt that the erection and startup of the already used and partly outdated presses, furnaces etc. at Zenica represent a remarkable achievement since it was necessary to train the operating team, to create tempering, material testing and other possibilities and to open up a market.

2.00 Activity in the rolling mills of the Zenica Steel Plant

As regards the rolling of rails, beams, and wire, the Zenica Steel Plant has an old tradition, since it was founded by the turn of the century. In 1912 production amounted to 35,000 t/a. In 1935, investments were made with a view to increasing the capacity to 100,000 t/a. The four stand three-high mill constructed at that time is today the chief support of the rail and beam production. After the war, a modern American cogging mill with a face diameter of 915 mm was mounted. The production amounts today to 800,000 t/a, the plant being rated for only 500,000 t/a. At that time, the equipment was completed by used trains and furnaces so that today wire, medium and light sections, hot-rolled strip etc. can be rolled in five mills of this type.

During his activity in the rolling mills, our expert was employed on the following furnaces:

11 "Salem" pit furnaces in the cogging mill 915 Ø

2 "Siemens" push-type furnaces in the medium-sized rolling mill 550 ϕ

1 "Siemens" push-type furnace in the wire mill

2 "Custodis" push-type furnaces in the small mill 320 ϕ

1 "Gipromez" push-type furnace in the rail and beam mill 800 ϕ

1 "Ofag" push-type furnace in the rail and beam mill 800 ϕ

1 "Custodis" push-type furnace in the small mill 320 ϕ

1 "Poeta" push-type furnace in the small mill 280 ϕ

For the rolling mills, too, the Management objects to the large need of repairs and to problems related to the formation of slag in the soaking hearths. With the exception of the "Siemens" furnace in the wire mill which recently was modified, also the heat consumption of all the furnaces our expert inspected seems to be too large.

Just as it has been the case for the forge, our expert compiled his impressions, ideas, and proposals regarding possible improvements in an "Opinion Regarding the Rolling Mill Furnaces of the Zenica Steel Plant" in the German language. This opinion was prepared during the last days of his stay in Zenica and was translated in the meantime, upon the suggestion of the Management, into the Serbocroatian language and reproduced. Contrary to the conditions prevailing in the forge, the rolling mill furnaces do not represent the bottleneck; at least this is not obvious and cannot be concluded from the given steel mill capacity. The trains are operated at high capacity, which underlines the impression that the Management has under control all the problems arising in the Steel Plant.

3.00 General remarks regarding the repair and maintenance of the furnaces of the Zenica Steel Plant

From the wearing conditions of the furnaces it can be concluded that the refractory materials available in Yugoslavia are in accordance with the European standard and are therefore, entirely adequate to the load. If the durability of the furnaces is neverhteless unsatisfactory, this fact is due to the organizational conditions described below. Only for several burner linings - e. g. at the pit furnaces -, it has been recommended to use imported materials for tests in order to be in a position to make comparisons.

The maintenance of all the furnaces of the Zenica Steel Plant has been entrusted by contract to "Vatrostalna", a state-owned company having its seat at Zenica. This company developed from the building shop of the Zenica Steel Plant, but is entirely independent since 1960. Apart from abt. 30 engineers and designers, the company employs abt. 1000 masons and auxiliary workers who are assigned to abt. 30 project sites in Yugoslavia, but also to Kuwait, Egypt, Austria, Switzerland, and West Germany. The company has an affiliate at Gelsenkirchen in West Germany.

The "Vatrostalna" is a very efficient company. The whole know-how of the countries in which the company is working is available to it and handled with mastery. On the other hand, one cannot help having the impression that this large company does not or cannot expend enough time and care as are necessary for the solution of detail problems arising in connection with the operation and repair of industrial furnaces.

It is obvious that in the last analysis the interests of "Vatrostalana" of the one part and the Zenica Steel Part of the other are different. The relationship between supplier and customer must necessarily be strained, which in this case must affect the maintenance and durability of the industrial furnaces.

On the other hand, the trend to be observed in all industrial countries shows that large steel plants proceed more and more to not to perform repair work themselves and to entrust it to other companies. Experience has shown that in this way the plants can be maintained with less difficulties and without labour reserves being necessary for this purpose - the expenses incurred in this connection being held almost at the same level.

The Zenica procedure to entrust another company with the repair of the furnaces thus is absolutely modern and consequent. The only particularity is that "Vatrostalna" does not have competitors so that the Management of the Steel Plant does not have any possibility to make comparisons. On the other hand, the manifold interests and the good business situation of this large company have as a result that problems arising in connection with industrial furnaces necessarily cannot be solved. E.g. a member of "Vatrostalna" made excellent proposals which obviously were based on great knowledge and experience, but could hitherto not be realized since "Vatrostalna" and the Zenica Steel Plant did not have experts with whom to discuss these proposals. Furthermore, it is not warranted that in all cases the appropriate material of the appropriate shape is used at the right place.

Knowing these circumstances, the Management of the Steel Plant carried out a reorganization according to which a department - with its centre in the steel mill - will be established which will exclusively be responsible for the maintenance of all the furnaces of the Steel Plant, incl. the blast furnaces. This project has been approved of in both opinions which propose in addition to entrust this department with the storage or with the keeping of store files.

This department would consist of not more than 12 to 15 persons - one chief, another two engineers as well as assistant engineers and foremen. The establishment of such a department would pay quickly, and would less mean to control "Vatrostalna" than to utilize to a larger extent the remarkable capacity of that company within the scope of a partnership.

4.00 Special proposals regarding the improvement of the durability and controllability of the furnaces in the forge and rolling mills of the Zenica Steel Plant

In the "Opinion Regarding the Furnaces of the Forging and Pressing Shop of the Zenica Steel Plant" of January 22, 1970, and in the "Opinion Regarding the Rolling Mill Furnaces of the Zenica Steel Plant" of February 12, 1970, numerous detailed proposals supported by drawings have been made which relate partly to the improvement of the furnace durability, and partly to the improvement of the furnace controllability. A part of these proposals were realized immediately as e. g. the use of waste rolled sections as supporting blocks in the forging furnaces in order to

improve heat transfer and to reduce the formation of scale, or a more suitable lining of the covers at the pit furnaces in the rolling mill. Another part of these proposals will probably be realized in the course of time in this form or other. Other proposals as e. g. that to use the existing rotating hearth furnaces of the forge which are not run to full capacity for the supply of the new forging machine are to be considered to be suggestions for future planning.

5.00 Proposals regarding a further aid to the Zenica Steel Plant by UNIDO

5.01 Procurement of a fellowship with a view to training a team for the forging machine under erection

The Management has several times expressed the wish to have the future operation team of the forging machine under erection trained in a plant in which such a machine is already in operation. This applies to one engineer, one technician, and two foremen.

It is proposed that UNIDO finds out such a plant and makes possible the training of the said persons within the scope of a fellowship. Though this problem is not in connection with the job description, our expert considered it appropriate to mention this point in the report, since it is obviously a particularly urgent wish of the Management.

The machine has a weight of abt. 500 t and produces, in a three-shift operation, abt. 20,000 t/a forgings of high quality and true to gauge so that an expenditure ensuring a faultless startup of the machine would certainly pay. As the machine runs fully automatically, the training

should cover above all the methods of programme setting and the dressing of equipment.

The manufacturer of the machine, Messrs. GFM, Gesellschaft für Fertigungstechnik und Maschinenbau GmbH, Steyr, Ennserstraße 14, Austria, was contacted, and some telexes were exchanged with them in this matter. It was found that there are considerable obstacles to the project of training experts of Zenica elsewhere in the operation of this machine. By a direct contact between UNIDO and this company, however, these difficulties could be removed.

5.02 Training of the new repair and maintenance department by means of stays in foreign countries with a view to exchanges of experiences

In general it can be stated that a team of young engineers with an all-round education is available to the Zenica Steel Plant. Stays in foreign countries with a view to gaining experience would be very helpful for these engineers. This applies in particular to the members of the new repair and maintenance department who have no practical experience in this field. The numerous tricks by means of which the durability of industrial furnaces can be improved could be imparted to them in this way. Another solution consists in sending once again, for one or two months, an expert to Zenica as soon as this department is finally established and has gained first experiences. The task of this expert would be to select the refractory materials available in Yugoslavia in agreement with the members of this department, or to establish an appropriate stockholding with a view to reducing the stocks kept at present.

6.00 Summary

Our expert stayed for ten weeks at Zenica where he inspected the furnaces of the forge and of the rolling mills. He prepared two opinions including proposals supported by drawings for obtaining an improved durability and controllability of the furnaces. The statements of these opinions were discussed in detail with the members of the Management and the shops. A part of the proposals was realized immediately.

The discussions covered the possibilities of obtaining improvements by organizational measures. In future, a special department will be entrusted with the maintenance of the furnaces. It is proposed to give the members of this department the opportunity of studying the conditions prevailing in comparative steel plants in foreign countries. This training should cover the technical field as well as the procurement and storage of refractory materials.

The Management of the Zenica Steel Plant would very much appreciate it if the operators of a forging machine under erection would be trained in good time in another plant.

W. Hummer

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SALZGITTER INDUSTRIEBAU GESELLSCHAFT MBH

SALZGITTER

EXPERT'S OPINION
ROLLING MILL FURNACES

VUG -021- E (SIS)
Zenica Steel Plant

Salzgitter Industriebau
Gesellschaft m b H

EXPERTS' OPINION

regarding the

ROLLING MILL FURNACES

of the

ZENICA STEEL PLANT

SALZGITTER INDUSTRIEBAU GMBH

Salzgitter Industriebau
Gesellschaft m b H

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By request of the Tecnical Management of the Zenica Steel Plant, and on behalf of the United Nations Industrial Development Organization (Re. YUG-201-E (SIS)), from December 1969 through January 1970, the situation with the furnaces in the Forging and Pressing Shop of the Zenica Steel Plant has been studied. From January 25, 1970 I was working in the rolling mill in order to inspect here too the existing furnaces and projects. To this end, my stay, originally scheduled till February 2. 1970, has been extended for another two weeks till February 18, 1970.

In dressing this report, some repetitions with regard to the "Opinion regarding the Furnaces of the Forging and Pressing Shop" were inavoidable. On the other hand, the two reports, as far as for example the statements about the ramming masses are concerned, should be considered as being a unit.

As far as the investigation of the project for a reconstruction of the two Siemens furnaces in the intermediate train and for the installation of an oil firing in the Gipromez furnace is concerned, the available time proved to be too limited.

Contents

1.10 The 11 "Salem" pit type Furnaces in the Cogging Mill

These furnaces are of American make and correspond to a model which is hundredfold service-proved in the United States. They are of a very rugged construction and are, with regard to the investment cost referred to the performance, certainly more economical than comparable types, e.g. rectangular single way large-space furnaces.

In the United States, still today the opinion prevails that a heavy formation of scale cleans the ingot surfaces. The heavy formation of scale is, therefore, over there not taken as a disadvantage. Since, in furnaces of such a construction, the ingots get in touch with the not well burnt out flame, the completely other circumstances in Europe (elevated steel prices, prevailing of unkilled steels) cannot be accommodated with a decreased formation of scale.

In Zenica, slag must be removed from these furnaces every 4 to 5 weeks which, apart from an important expenditure for wages, decreases the capacity. Item 2,10 gives suggestions for solving this problem.

Already in the Forge has been noticed that the ramming mass used for lining the burner orifices does not handle the working conditions. This is rather even more valid for the pit type furnaces. It results not only in an insufficient guidance of the gas/ air mixture, but also the brickwork above the burners begins to sink down so that with the installation of that unsuitable ramming mass the whole refractory lining of the pit type furnaces will be impaired.

The vertical brickwork gets extremely loaded since all the ingots rest against the wall. In consideration of these circumstances can be said that the chamotte quality supplied by Arandjelovac is suitable. Here, too, proposals will be made below.

The chamotte granulation used for sealing the covers is more suitable than the granulated blast furnace slag used in the forge.

The covers are lined with other and heavier material as it is provided for in the "Salem" drawings. The supporting bricks are from chrome-magnesite ("Salem": chamotte) and the spherical parts from chamotte ("Salem": light chamotte). This results in an over-load of the lifting bogies but which caused no dammage up to now.

Under the given circumstances it is quite suitable to use chrome-magnesite for the supporting bricks. But it is a serious mistake and not workmanlike to wall up these bricks with a so-called "basic" alumina mortar. The inspection shows on each of the supported covers that this mortar runs out, and that each of the bricks rests independently in the steel frame. For the time being, the life of the covers is 18 month which is, under the given circumstances, insufficient.

At the time being, the furnaces undergo a general repair once a year. For the covers and for the body, a life of 3 years should be achievable.

The performance of the furnace, and likewise the formation of scale is directly influenced by the temperature of the blocks received. The transport cars should be insulated and equipped with a cover, for which the rolling mill department has already prepared proposals.

Performance and durability of the furnaces are handicaped by the fact that the steel plant does not remove the runners from the ingots. Since this causes directly additional cost in the rolling mill by increased forming of slag and obstructing the adjusting of the ingots, this should be remedied.

It cannot be supposed that a steel plant somewhere else in the world will send ingots with runners to the rolling mill.

It seems that the performance of the 11 pit type furnaces is sufficient for the cogging train, and that they are not the narrowest bottleneck for the blooming.

1.20 The 5 push type furnaces in the wire, medium sized and small rolling mill in Tetovo.

1.21 The reconstructed "Siemens" furnace in the wire mill.

The reconstruction has been apparently good for this furnace. The operators are speaking highly about it. The heat consumption remains certainly within the limits.

The watercooled pushing chute represents a source of heat loss. It would be possible to work without same. But since it has proved useful it should be retained.

1.22 The two "Siemens" push type furnaces in the medium sized rolling mill 550 dia. in Tetovo.

These furnaces meet positively modern standards. Notwithstanding, a reconstruction is imperative since the gas and air conduits are installed in a disadvantageous manner and difficult to survey, which complicates feed and adjustment of the burners.

The burner wall on the output side stands out against the steel construction, an impairment that can be eliminated in the reconstruction. It is likewise possible to replace the two rows of front burners by 1 row correspondingly larger ones as this has been provided for in the VASTROSTALNA project.

As opposed to the pit type furnaces in the blooming and to those in the forge, the burner linings of all the push type furnaces make a good impression, a fact that cannot be readily explained since it

has been pretended that the same type of ramming mass has been used everywhere. But for burners in rolling mill furnaces, chrome-magnesite ramming mass is nowhere used.

It is strange that the watercooled support and skid pipes are not insulated. With the Fuel and Power Department, and with Mr. Zaplatič exists unanimity that this results in excessive heat losses. If the furnaces are run in an enforced manner, the disadvantages become particularly important. The insulating problem could be solved, and this should be done occasionally of repairs.

For furnaces of such type a durability of one year is a rule.

1.23 The 2 "Custodis" push type furnaces in the small mill 320 dia.

It cannot be said that these furnaces meet the latest standard. Above all there is no contraction in the cover so that an infavourable pressure distribution in the furnace must be supposed to which the lateral burners can only partially counteract. The heat consumption of these furnaces must be high.

On the other hand the capacity of the two furnaces seems to be sufficient for feeding the production line.

1.31 The Gipromez furnace in the rail and beam mill 800 dia.

This furnace is doubtless a sturdy and modern unit. But arguments can also be made. The suspension of the skid pipes is such that not only an increased water circulation is required but the heat transfer by convection is likewise obstructed. The designers throughout the world have certainly different opinions with regard to the suitable execution of this pipelaying. But two pipes, one upon another, as they are being arranged in this furnace, are in any case disadvantageous.

The heat is dealt with very handsomely in this furnace. The watercooled sealing beam on the pusher end represents a large and cooled surface without insulation inside the furnace, and the lateral burners in the lower zone are working, strictly speaking, direct into the stack.

Side and flap valves in the waste gas flues are very heavy and can scarcely be moved by the servo motors.

As far as could be observed the MAGMALOX hearth which has been installed occasionally of the last repair, has proved to be positively economical.

There are no objections to modify this furnace to oil firing, especially if steam atomizing will be used.

As with any rolling mill furnace, here also a durability of one year must be achievable, and repairs should take only 3 - 4 days; so that bigger repairs would occur with three years intervals.

1.32 The "Ofag" furnace in the rail and beam rolling mill 800 dia.

This furnace presents no problems. Here also should be supposed that a MAGMALOX hearth would be economical. But a test with a combination of fusion casted rails "MECTOT" and chromite mass should previously be made. By no means should be done without the insulation of the skid rails and their beams.

1.40 The two push type furnaces in the small section rolling mill 280 and 320 dia.

Since these two trains will be shut down, these furnaces had not been inspected in detail. But the two hearths could likewise be provided with the combination of "MECTOT" rails/ramming mass.

2.00 Ideas and proposals for possible improvements.

2.10 The 11 "Salem" pit type furnaces in the cogging mill.

The performance of any pit type furnace plant is, additionally to the thermal efficiency of the furnaces, determined by 3 other factors:

slag removal,
durability of vessel and cover, and
temperature of the incoming ingots.

I am under the impression that in Zenica the conditions for a liquid slag discharge are favourable. Since this would be the most economical solution, tests should be made and not content oneself with a single experiment. The simplest way was to discharge the slag through the central gas outlet because of the high temperatures at that point. To this purpose, the furnace should be lined without the central chromite ring. Once a week this furnace should then be upheated without ingots for abt. 180°C so that the slag could discharge into the runner, which would take abt. 4 hours. Since the gate on the runner is permanently open, it could be removed from there during the operation. The space seems to be sufficient. A retainer could be placed into the horizontal part of the runner, perhaps according to fig. 1, in order to prevent a run off into the recuperator.

The vertical part of the runner could be cleaned with the tool shown in Fig. 2 by an ingot crane. These few minutes should be available.

This shorttime heating up of the furnace would be less harmful for the lining, the cover and the recuperator than monthly cooling in the actual mode of operation.

In the Salzgitter pit type furnace plant the attempt to convert to liquid slag removal failed due to the narrow space conditions. Here an excavator is used which has only to handle a super heavy duty compressed air hammer (crust crusher in the aluminium industry, make Boehler). In Zenica much space is available on the pit type furnace platform so that this possibility is not excluded so far.

It is difficult to understand that slag removal is only made with one compressed air hammer. A distributing head according to fig. 3 should be used. Since it is quite unlikely that 2 - 3 hammers will hammer synchronously the quantity of compressed air will be sufficient.

On proposal of the acting manager, dipl. ing. Nicolić, with Mr. Šehalič from VASTROSTALNA, a lining of the furnace bottom has been discussed, and a solution has been determined that enables to make a thinner brickwork in order to collect more slag between the furnace bottom and the interior edge of the burner. Using a fairly suitable insulating material there is no danger of damaging the T-beams in the substructure, though it is said that this happened in Jesenice.

Already in item 1.10 has been said that the ramming mass used for lining the burners does not stand through the stresses. Ramming the shaped parts for burners outside the furnace is quite modern, but the chance is lost to get a positively jointless monolithic burner opening.

In any industrial furnace, the burners are of the same importance as the carburetor for a motor car. Therefore, economies should not be made, and an experiment with DEWISIT would be advisable

in order to have a comparison. A good direction of the gas flow could positively result in decreased slag forming.

In Germany, the vertical brickwork for these furnaces would be lined with the semi-silica-bricks of Messrs. Peter Peters at Stolberg/Rhld. They are low-priced. In contrast to the normal lime bound silica bricks they have a content of abt. 3% alumina (Al_2O_3) which is pretended to be already included in the there existing quartzite.

Basically, silica material is very suitable for pit type furnaces above the slag zone since it has, in contrast to chamotte, no deformation range, but liquefies rather abruptly with temperatures above 1,600° C. In the range above 700° C it has an excellent resistance to sudden changes of temperature.

Clay-bound silica bricks resist also a cooling down for slag removal. When fitting, the important dilatation has to be considered by providing expansion joints.

In the Thyssen Group, pit type furnaces are frequently lined with silica bricks of normal coke oven quality. The silica bricks in store at Zenica have an open grain aspect. It is especially this open grain that could result in a sufficient resistance to sudden changes of temperature for being used in a pit type furnace. When occasion arises, an experiment should be made with this type of bricks.

Another experiment with burnt chromite bricks of Yugoslavic make would be recommendable. These experiments could be restricted to areas of abt. 1 m^2 above the slag zone.

With the use of suitable material for the vertical brickwork above the burners a durability of 3 years must be achievable with a positive degree of certainty. The magnesite brickwork in the slag zone is to be executed thus way that once a year half a brick can be set before.

Experiments with imported ramming masses seem to be too expensive.

The chamotte grade used for sealing the covers proves to be quite suitable. Usually, indeed, is a quartz grain size of 5 - 6 mm dia.

In item 1.10 has already been said that under the given circumstances it is quite correct to use chrome-magnesite bricks as supporting bricks for the covers. As per information of VATROSTALNA they cost NDin 5,000 per ton. It is rather obscure why, with this price, the dimensions of the bricks are so inaccurate that they must be trimmed on 3 points. It should be determined a more suitable format as soon as possible.

The groove (groove and tongue) is, as per my opinion, not necessary in this case. It complicates considerably the manufacture of the brick. If it would be eliminated, the brick should be cheaper. If it had smooth surfaces, instead of mortar of some type a 3 mm sheet could be introduced which would make the support considerably stabler.

Since with a cover diameter of 5 m the support has a length of abt. 17 m, following to each 10th brick an expansion joint is to be installed which corresponds to a dilatation of 1%. A wood pulp board is more suitable as an insert into the expansion joint.

and cheaper, as the asbestos board used. The fact that could be got by with much less expansion joints results only from the running out chamotte mortar, which becomes evident on any of the supported covers.

For lining the spherical part, at the time being only two dimensions are in use. Here much trimming work is necessary. Here, even excellent workmanship is done. But it should be taken into account that the trimming operation bears a silicosis risk and that it is ultimately absurd to trim by hand bricks that had been given a format in the factory. If would be operated with concentric rings, as provided for in the "Salem" drawings, 4 formats would be sufficient provided that would be decided to execute the centre in a diameter of abt. 600 mm in high-quality ramming mass. But a high-quality good binding chamotte mortar is to be used for lining.

As had been suggested by Mr. Šehalič from VATROSTALNA, on cover 2 the chamotte bricks had been somewhat raised (fig. 5) in order to get a better distribution of forces in the support. Combined with the use of a basic mortar this will certainly result in a prolongation of the durability of the cover up to 2 years.

The "Salem" drawings indicate insulating material as material for the spherical part. It would be recommendable to make an experiment with the Porit-S quality from Arandelovac in order to relieve the lifting bogies. But in this case, the pores of these bricks must be closed by a coat on the fire side, at least by two coats of water glass.

The covers should be durably numbered and a record is to be kept with the lay times of each cover, so that the efficiency of the different measures can be studied.

With a corresponding selection of the brick material, the mortar etc., a life of three years must be achievable without making expensive changes, as suspended arches etc. In this case had to be suspected that the steel outside ring or the seal would become to be the weakest link. This could certainly be remedied by a water cooling. This would bring advantages for the sand groove and the superior part of the furnace as a total. Taking into account that this water cooling can be riskless shut down during the process, the problem of cooling the outside ring is solvable.

2.21 The reconstructed "Siemens" furnace on the wire mill

Since in this furnace the reconstruction has been quite successful, it does not present problems. The same is valid analogously for the other push type furnaces likewise.

It would be possible to execute the sealing beam as a water-cooled type according to fig. 7. Just on the input side a water-cooling cannot prejudice the heat balance of the furnace provided that care is taken that no cooled surface would face the fire without being insulated.

For the hearth, a combination of skid rails of "Mectot A" from SIC-Edison, Milano, and chrome mass according to fig. 8 would prove useful. The Mectot bricks are extremely accurate in the dimensions and so far superior to Magmalox or to Korvisit. In Salzgitter it proved to be useful to protect the fusion cast bricks by steel rails on both sides; a fact that worked out especially during the heating up period and that has no influence on the formation of slag.

Should this combination not stand the test, this is due to the ramming mass. This must in no case contain water glass, but must be bound with clay or with bentonite. The grain size of the chromite should be coarse, 1 - 3 mm. The big brick manufacturers have the tendency to use the fine portion which remains surplus in the manufacture of chrome-magnesite bricks, for the masses, wherefore the ramming masses frequently do not give satisfaction. Salzgitter purchases the chromite mass from Messrs. Weerpas & Lingen in Kettwig/Ruhr.

In Germany it is common to ram also the relieving arches and columns in corundum mass, since the erosion of the walls uses to start from these points. Additionally a considerable number of brick sizes will be saved up.

2.22 The 2 "Siemens" furnaces in the medium sized mill 550 dia.

With regard to the sealing beam on the pusher end the same is valid as explained in item 2.2.

It is quite unusual to have the billets slid directly on the skid pipes. It would be recommendable to weld on e.g. 30 x 30 mm square irons.

In any plant the insulation of the skid pipes and of the sockets presents problems. But in no case should be done without this insulation since the otherwise caused heat losses become unproportionless high and handicap an enforced operation. If the tapers do not prove useful, this is caused by the ramming mass which must be of high quality and chemically binding. The insulation shall not be thicker than 25 mm, since this would otherwise

provoke an undesired shadow effect. The care spent during the repair period for insulating the tubes pays itself during the operation.

It is important to fix the tubes firmly in the foundation of the pushing device since this tends to push the tubes into the furnace thus causing the tubes to become distorted.

Where the billets come in contact with the tubes there will form coal spots which should disappear in the holding chamber. As far as could be observed, this works inobjectionably in Zenica.

In this furnace, with heavy charge, a hearth lining with the combined Mectot ramming mass would give especially satisfactory results.

2.23 The 2 "Custodis" furnaces in the small mill 320 dia.

Here, the sealing beam on the pusher end could likewise be provided with a water cooling installation.

The chrome steel rails could, in the high temperature area, be replaced by the Mectot construction.

2.31 The "Gipromez" furnace in the rail and beam mill 800 dia.

The sealing beam on the pusher end offers to the fire a big and cooled surface. An insulation according to fig. 9 could be installed.

The "System Derling" suspended arch has doubtless been developed for SM-furnaces in which the sheet and wire inserts cause a sealing. When used in rolling mill furnaces it results to be disadvantageous that the bricks have smooth surfaces on all sides, so that the sealing is made only by the effect of the mortar.

The spherical shaped spot on the reduced area of the suspended arch should be somewhat thicker than the other suspended arch, say for 100 mm. Furthermore a chamotte quality with a high alumina content should be used, e.g. KORUNIT 60 from Arandelovac. Also the suspension irons in this area must be of heat resistant steel, since here readily temperatures up to 500° C can arise, with which carbon steel looses its strength.

There are complaints that in the pushing process sometimes 2 blooms are going simultaneously over the chute. It has been noticed that the surfaces of same are little square edged which should be amended occasionally to the next repair. It should be investigated whether or not a welding of the blooms or a too elevated temperature in the furnace may be the cause for this.

At Salzgitter in such type furnaces the installation of television cameras, the displays of which are mounted in the control station of the pushing device have proved to be of value, especially with regard of a protection of the furnace during the pushing operation, when a not uniform advance occurs. The cost for an installation of such cameras (Siemens) is to be estimated to be abt. DM 50.000, and it should be investigated whether under the conditions of Zenica such a measure would be worthwhile.

It seems to be a disadvantage that the measurement of the gas and air quantities does not indicate its distribution to the upper and lower burners in the zone II. In my opinion it would be sufficient to measure the gas quantity only in the branch down, since from that difference also the upstreaming gas quantity can be seen. The air quantity can be determined according to the flame pattern and by occasional Orsat measurements. The fact

that the standard measuring length (before 10d, afterwards 5d) will not be given, should not annoy since an error would not make the result of the measuring invaluable, and the installation of a measuring orifice on a suitable point will, in any case, give a criterion.

If the furnace will be converted to oil firing, this problem will not be of further interest.

2.32 The "Ofag" furnace in the rail and beam mill 800 dia.

Also in this furnace, the sealing beam on the pusher end could be equipped with a water cooling device.

The skid rails should, at any circumstances, be insulated, since otherwise the heat losses will become prohibitive, especially in enforced operation.

In this furnace an attempt of lining the hearth with the combined "Mectot" rail chromite ramming mass should be especially worthwhile, unless the installation of a Magmalox hearth would be decided.

This furnace is equipped with a KARENA type suspended arch which has relatively large bricks. There is the opinion that the large bricks have a tendency to cracking. With the use of large bricks, the number of joints as such will reduce, but the forming of cracks will be attributed to the fact that the quality of the bricks does not correspond to the format. A dry pressed chamotte quality should be used, where the porosity can reach up to 23 - 25%. The Arandelovac quality Superior 50 could be used, for hazardous points also Korunit 50 or 60.

2.41 and 2.42 The "Custodis" and the "Poeta" furnaces in the small section rolling mill 280 and 320 dia.

These two furnaces have not been examined in detail. I feel that they are under very enforced operation. Here, too, the installation of the "Mectot" chromite hearth could give advantages.

3.00 General remarks for the improvement of the durability of the furnaces.

3.10 The refractories used.

3.11 The brick qualities and formats.

It is felt that e.g. for the pit type furnaces in the blooming not the correct qualities and formats are used, though they were available.

3.12 The mortars used.

There has already been drawn the attention to the problems of mortar stabilization for the covers of the pit type furnaces not only in the chrome-magnesite but also in the chamotte. For such difficult assemblies, as these covers, suspended arches etc. are, the mortar has an important function. With magnesite and chrome-magnesite, a wrong mortar may cause damages, and therefore, in SM-furnaces of today in many cases no mortar is used.

3.13 The ramming masses used.

The problem why the VATROSTALNA ramming mass used for the burners is suitable for the push type furnaces and fails in the forging found pit type furnaces, cannot be readily answered. It is not normal to use chrome-magnesite material for these purposes.

The burners in the pit type furnaces have a great influence on the degree of slag forming of the ingots, and therefore should be experimented with other masses.

3.20 Organization

The maintenance of all the furnaces in the Zenica Steel Plant has been accorded by contract to VATROSTALNA. Already the expert's opinion about the forging furnaces drew the attention to the fact that herewith the problems of the durability of the furnaces will be burdened with the natural stresses in the relations between supplier and customer.

At any case, VASTROSTALNA has, in the person of Mr. Šehalič, charged a very experienced and keen man with a high ability with the maintenance of the furnaces in the rolling mill and in the forging shop. But he feels to be quite alone and seems to be somewhat overcharged if the introduction of the new materials or f. i. the design of a water cooling installation are concerned.

Zenica maintains a very important stock of refractory bricks. By experience can be said that this large stock does not offer a guarantee that all the qualities and formats needed will be available at the right time. This guarantee can be given only by keeping a detailed and correct file. If three clerks would be employed exclusively for actualizing this file they would pay. Especially suitable for this work were qualified bricklayers which are no more fit for reasons of health, for they have the necessary experience and a sense for the material.

The durability of the rolling mill furnaces can be considerably extended with small hot repairs on the doors, door arches and

and uprights etc. For the suspended arches, the spraying of fire resistant material for maintenance purposes according to the Torkret process, as it is already used in the Steel Plant, is quite useful.

For the push-type furnaces in the wire, medium-sized and small rolling mill in Tetovo on one hand, and for the "Gipromez", "Ofag" etc. furnaces on the other hand it would be recommendable to delegate a bricklayer in order to observe the furnaces and to make small repairs resp. to arrange for same.

I have been told that, with its centre in the Steel Plant, a department shall be established that has to care for the maintenance of the furnaces Steelworks. This department shall not so much be the controller of VATROSTALNA than their partner with the goal to make available the vast experience of this firm to the Zenica Steel Plant.

This department should, therefore, be charged with the maintenance of the stock files. Overstocks could be reduced and the remaining stocks left after each reconstruction could be suitably used.

4.00 The existing projects.

4.10 The VATROSTALNA offer for the reconstruction of the "Siemens" furnaces in the medium sized mill 550 dia.

It can only be agreed to the proposal to replace the two rows of front burners by one row of correspondingly more efficient ones.

The pipe ducts for supporting the skid pipes seems to be more efficient as for the "Gipromex" furnace.

At all events, a square profile should be welded upon the skid pipes, and the insulation should not be omitted. Though the installation will take time, without same any attempt to operate the furnaces with a reasonable heat consumption will be useless.

With the contraction of the suspended arch, the spherical part should be reinforced and executed in a quality with a high alumina content, as described under item 2.31.

It is not usual to equip a rolling mill furnace with a 106 m stack. In spite of the power consumption it will be preferred to instal induced draught installations. Such one with indirect mode of operation has here in Salzgitter the following actual values:

Quantity of the flue gases behind the furnace	12,000 Nm^3/h
Quantity of cooling air for the recuperator	3,000 Nm^3/h
Flue gases and cooling air before the stack	15,000 Nm^3/h
Temperature of the flue gases before the stack	550° C
Quantity of the power air	15,000 Nm^3/h
Pressure of the power air	600 mm WG
Draught at the bottom of the stack	80 mm
ins. dia. bottom of stack	1,670 mm
ins. dia. contraction	560 mm
ins. dia. outlet	1,100 mm
nozzle for power air ins. length	480/220 mm

4.20 The VASTROSTALNA offer for changing the "Gipromez" furnace to oil firing.

Since only a few documents were available, only generalities can be said.

Fuel oil is a very suitable combustible for firing rolling mill furnaces. In contrast to gas it is non-poisonous and not explosive.

The big oil companies use to guarantee for heavy fuel oil (bunker C oil) only the calorific value with normally 9,600 kcal/kg. For large orders also additional guaranteed values are obtainable, e.g. a maximum sulphur content of 1% (otherwise 3-4%) and a uniform viscosity behaviour.

The heavy fuel oils made available for industrial purposes are tailings from the refineries. Its viscosity behaviour differs depending on whether the fuel comes from a distilling, cracking or hydrating plant. With temperatures above 105° C the viscosity of all these oils drops for 2-3° E, and therefore it is suitable for industrial oil burners.

It is quite correct to store the fuel on a central place and to conduce it to the different furnaces by means of steam-traced circulating pipelines. Small tanks near the furnaces tend to give troubles. It is not necessary to maintain the temperature for the whole quantity in the big storage tanks. It is sufficient to keep the temperature only in the environment of the tapping point.

It should be investigated whether hot water would not be more suitable for the trace piping than superheated steam. The latter has also to circulate in the trace piping or must be fed to consuming points. For repumping in the circulating line, a temperature of the oil of 50° C would be sufficient.

Steam is the most expensive atomizing agent. Additionally it decreases the flame temperature for more than 100°C and increases the quantity of the flue gases, decreasing thus, compared to e. g. compressed air as pulverizing agent, the efficiency of the firing process.

Fuel oil gives a short and hot flame. In that, the effect of the vapour atomization is even favourable in the rolling mill furnaces. As matters stand with the "Gipromez" furnaces, and in consideration of the load in the heating chamber, vapour pulverization is to be preferred to any other one.

The tap pipes to the burners shall be as short as possible. The front burners and the superior and inferior ones on each side shall be combined to groups and connected to the circulating oil piping. It is to be investigated where in this system the oil preheaters shall be located.

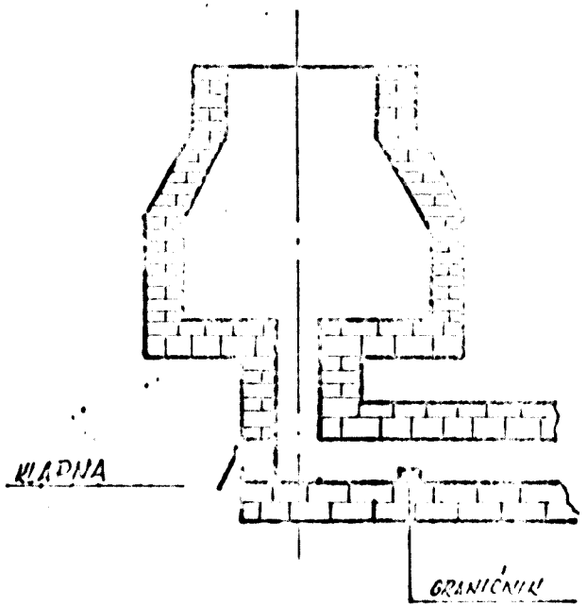
No problems should arise in the fire resistant lining as a consequence of the vapour atomization used.

5.00 Summary

In contrast to the Forge, the Rolling Mill furnaces seem not to be the narrowest bottleneck which influences the production level.

The cost for repair and herewith the expenses for fire resistant material and wages are elevated. Improvements could be achieved with small constructural modifications and a careful selection of materials, since chamotte, magnesite etc. of high quality are being produced in Yugoslavia.

From VATROSTALNA as a large scale enterprise cannot be expected that they enter into the details. Therefore will be recommended to establish a construction department which works directly under the direction of the management.



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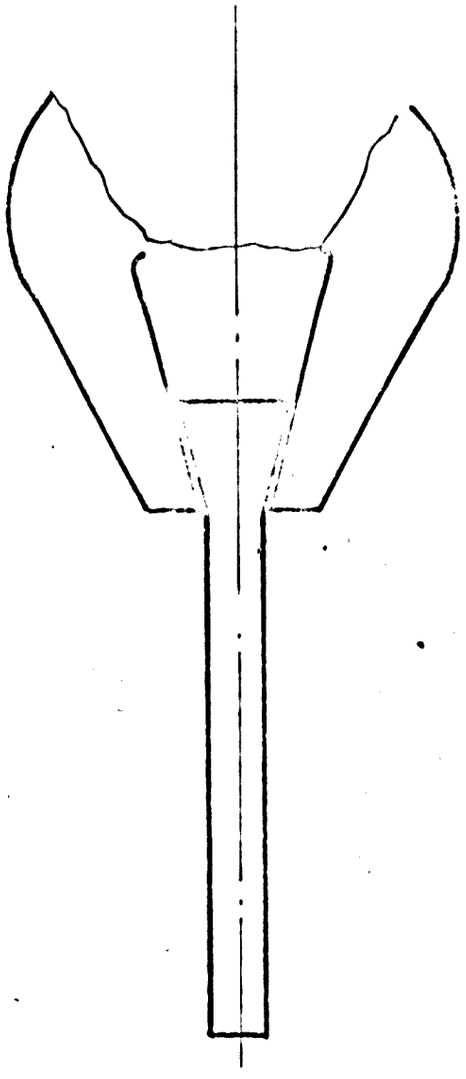

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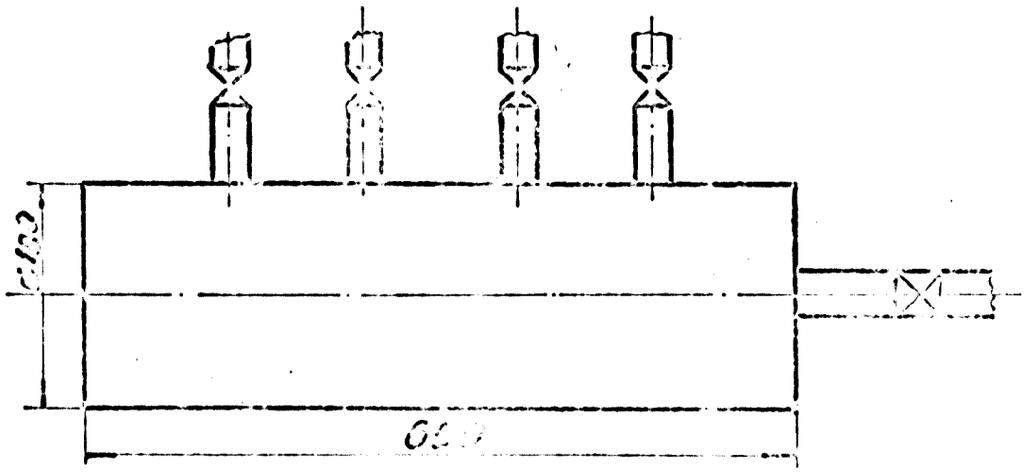

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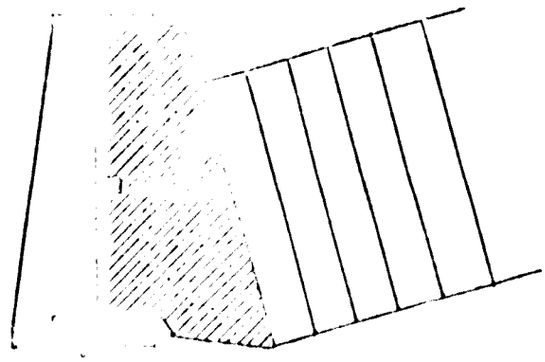

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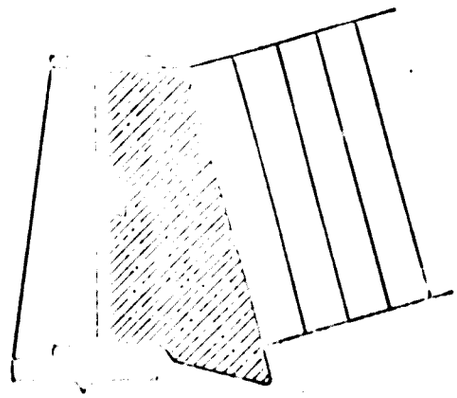

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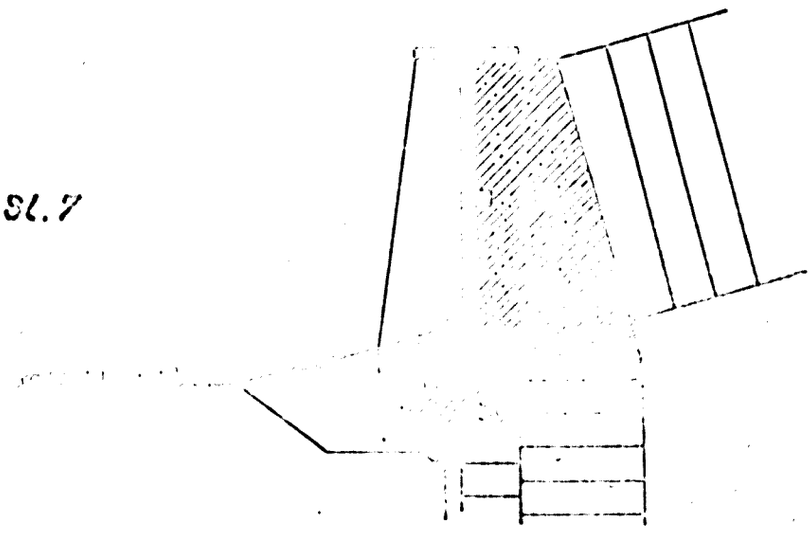

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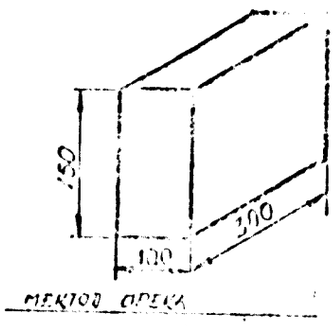

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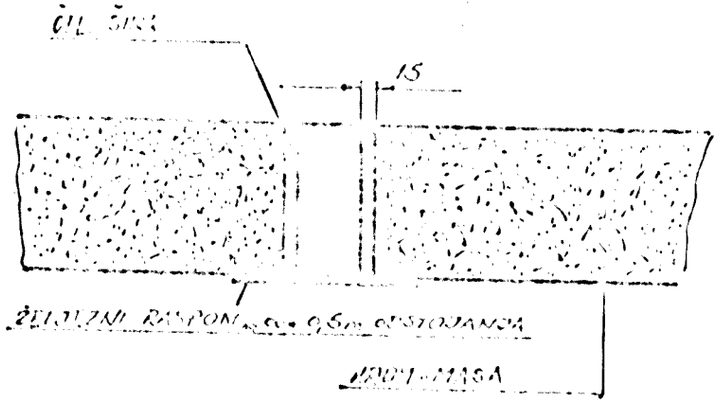

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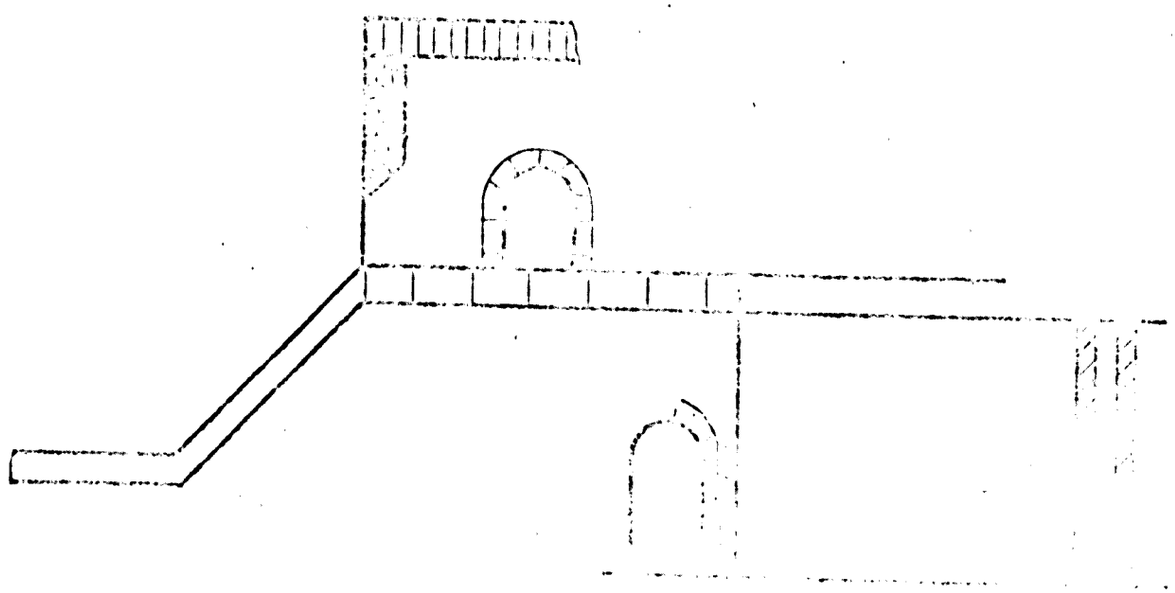

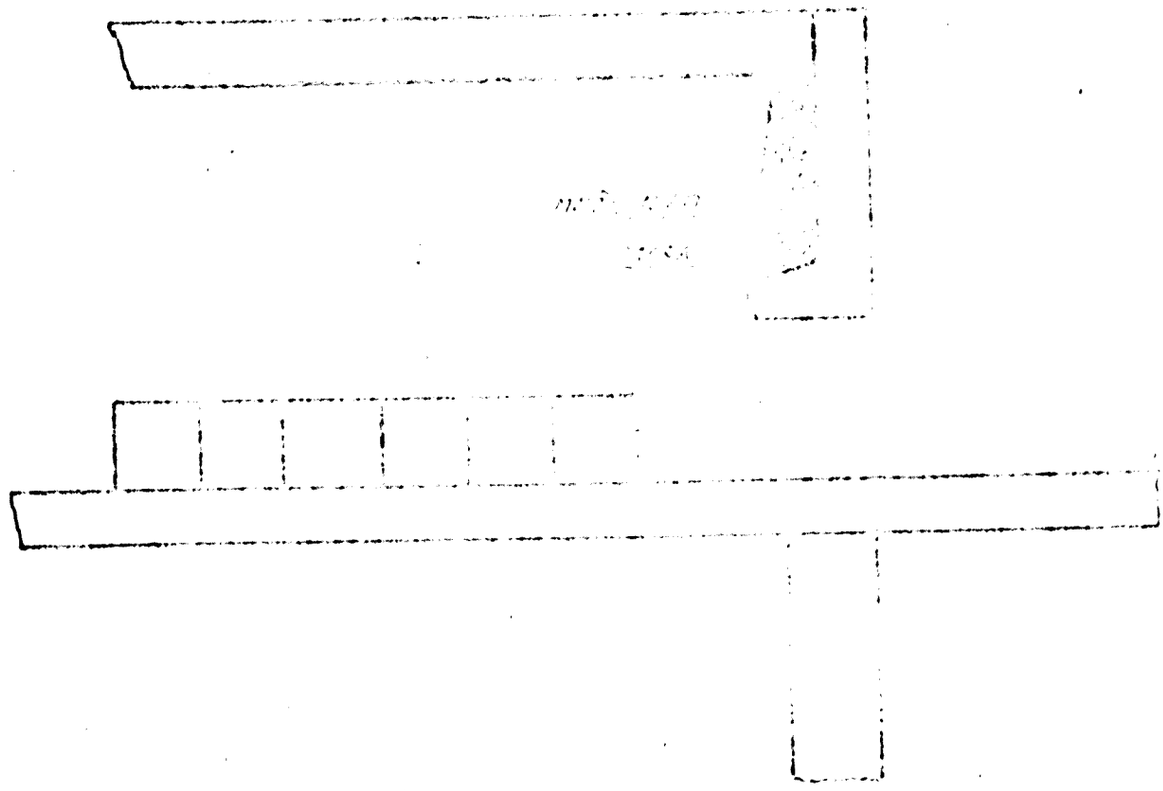

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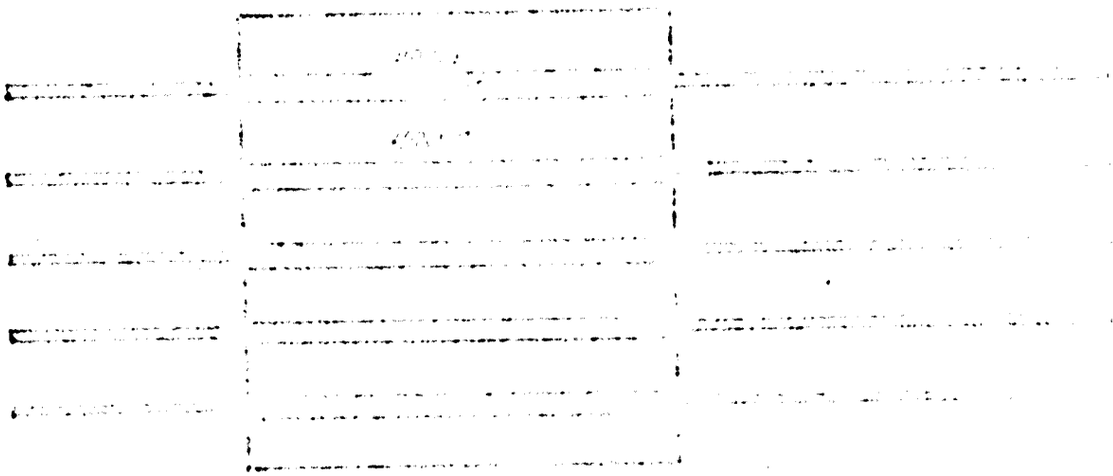

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SALZGITTER INDUSTRIEBAU GESELLSCHAFT MBH

SALZGITTER

EXPERT'S OPINION
FORGING SHOP FURNACES

YUG - 021 - E (SI)91
Zenica Steel Plant

Salzgitter Industriebau
Gesellschaft m b H

EXPERT'S OPINION

REGARDING

THE FURNACES OF THE FORGING AND PRESSING SHOP OF THE ZENICA STEEL PLANT

SALZGITTER INDUSTRIEBAU GMBH

Salzgitter Industriebau
Gesellschaft m b H

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On request of the Technical Management of the Zenica Steel Plant and on behalf of the United Nations Industrial Development Organization (ref. No. YUG - 021 - E (SIS)), investigations were carried out in December 1969 and January 1970 regarding the furnace conditions in the forging and pressing shop of the Zenica Steel Plant. I was also concerned with existing projects and offers in connection with the envisaged extension. In the following, my impressions and views are summarized in the form of an expert's opinion.

Salzgitter Industriebau
Gesellschaft m b H

CONTENTS

1.00 State of the Furnaces

1.10 The Car-hearth Furnaces 1-9

1.11 The Forging Furnaces 1 - 7

It is known that originally the forging furnaces 1 - 7 probably served other purposes than in Zenica. Today they are operated above capacity as regards the thermal conditions and the car-hearth construction. It is a disadvantage that there are doors at both ends. Their maintenance standard is good, but the sealing of the car-hearth by means of C and I-beam sections in its present state represents a constructional weakness also of the side walls.

1.12 The Heat-Treating Furnaces 7a and 8

The heat-treating furnace 7a answers its purpose and is in good repair. The furnace 8 is an efficient unit of great value. On the given conditions, the "brick curtain" is a good means to reach a uniform enough temperature over the whole furnace length. As the flue gases are escaping at this point through the car-hearth, and as the bogie of the car-hearth is cooled by means of purposely sucked in inleaked air, a good draught is particularly important for this furnace.

1.13 The Forging Furnace 9 "Gipromez"

This furnace is of very sturdy construction. The seal of the door as well as of the back side can be considered exemplary.
Its flame regulation is not very favourable and facilitates ingot scaling. It is however, possible to modify the flame regulation without large expenses.

1.20 The 2 OFAG-Rotating Hearth Furnaces

These furnaces are automated, efficient, and compact units which are still constructed today according to the same design.

They are largely worn and should be submitted to a general overhauling. It is recommended to make on this occasion minor constructional modifications (water seal).

1.30 The Cooling Pits

The state of the cooling pits - the large one as well as the two small ones - is not good.
The supply system of the burners (compressed air) should be modified as soon as possible, since it is possible that this great consuming unit represents a load for the compressed air network and is very expensive. The cover of the large pit is very heavy and should, with a view to better sealing, be so arranged that it will be suitable for vertical movement. The flues of all the pits are clogged and should be provided with clean-out holes. The side and front walls of all the pits should, with a view to improving their service life, be bricked with the surface being curved convexly.

1.40 The Forging Furnaces in the Hammer Mill

It is to be considered that these furnaces are producing a large part of the production.
As, however, the technological conditions will alter before long as a result of the startup of the GFM forging machine, it is not recommendable to make modifications or investments in this plant.

2.00 Ideas and Proposals regarding Possible Improvements

2.11 The Car-hearth Furnaces 1 - 7

The wearing conditions of the side walls and roofs show that the quality of the fire-clay bricks used is sufficient with regard to load.

The roofs are designed as tunnel or circular arch-type roofs. It is not necessary to have special support shapes for the roofs, which is an advantage. An improvement of the roof life could be obtained if end arch bricks of the Q-shape were used instead of wedges of the shape 2 G, since the Q-shape is less affected by the shrinking of the fire-clay bricks. Both shapes are contained in the catalogue of RIS-Arandelovac. In this case, both ends of the roof should be provided with a G-shape ring of 11/2 bricks of the shapes 2 G and 4 G.

In spite of the thermal load given in Zenica, the roofs and side walls should have a service life of at least three years, and the parts provided with burners and flues of at least one year.

Burners and flues should be rammed. Owing to the joints, bricked burners never have a long service life. As far as observation has shown, ramming is carried out correctly.

The ramming mass used seems not to be suitable for its purpose. Its refractoriness is sufficient, but it does not set up correctly and becomes flawy and short. The use of the PLIBRICO mass Superal X AL would certainly involve an improvement. It is, however, recommended to try DEWESIT of Messrs. D. W. Schulte, Plettenberg, Westphalia, Western Germany.

The back doors which are not made use of are very disadvantageous, in particular as regards a later pressure regulation in the hearth. For the remaining furnaces, they should be replaced by a structure according to Fig. 1. In this connection the "Gipromez" furnace 9 can serve as an example.

At the front sides, the doors are attached direct to the brickwork; this fact seems to be less disadvantageous to me. The installation of water-cooled door frames would be expensive and involves heat losses and regular cost of operation. In the

last analysis, it is required only that the doors fit a plain surface. This can be obtained also with refractory material, in particular because in this case a repair, e. g. by means of ramming mass, is always possible.

The installation of water-cooled door frames would be "modern", but it is questionable whether such an installation can be justified for this old furnace.

The sealing of the car-hearths against the side walls is a structural failure. A possible modification is represented in Fig. 2. In Germany, the car-hearths are higher so that the gap between the car-hearths and the side wall is longer and that less heat can pass. The sand gutters are welded of normal steel sections and are not cooled.

It is urgently recommended to use instead of the granulated blast furnace slag 4 - 6 mm quartz sand for the sealing. In Germany, DM 25. - is paid for one ton of this sand, ex mine, washed and screened. Here, this sand could be supplied by VATROSTALNA. If this material is used for the whole forge, the annual consumption would amount to 5 t/a.

The furnaces 1 to 6 are provided with automatic temperature regulation devices regulating the gas and air quantities through KENT compressed air-servomotors. For the remaining furnaces, a hearth pressure regulation should be added to this automatic regulation. In this connection, the KENT material from the furnaces to be demolished could be used. According to the statements of Dipl. -Ing. G u r k a a great deal of such material, servomotors, etc. are available in the stock of his department. It will possibly be necessary to buy only transmitters.

The pressure regulation in the hearth would efficaciously complement the temperature regulation. The pressure should be adjusted to 0.8 mm water column, measured at half the height of the side wall.

This pressure control is, however, effective only if adjustment from a draught of at least 20 mm water column - or better 50 mm - is possible. In order to generate this draught, indirectly acting forced draught fans could be installed. It is to be checked carefully whether such an investment would pay for this old furnace.

The furnaces 7 and 7a are provided only with temperature measuring devices. When the furnaces 1 and 2 or 5 and 6 will be demolished, the controls of these furnaces could be installed in the furnaces 7 and 7a. Furnace 7 with its considerable length is, without any doubt, important for the forge.

The sheet-metal chimneys of all the furnaces of the forge are provided with roofs, which looks ugly and hampers the draught. The chimneys should be provided with conical superstructures with a length of 4 D and an angle of 8 to 11° which would produce, owing to the expansion, an increase of the draught by 10 %. Rain and snow are not to be taken into consideration.

2.12 The Heat-treatment Furnaces 7a and 8

There are no problems in connection with furnace 7a.

Furnace 8 was carefully inspected by the fuel and power department. This inspection showed that over the whole length there are temperature differences of up to 150°C.

The proposal of the fuel and power department to replace the burners of this furnace by high-speed burners provided with open/close control can only be agreed with. They would very much improve the maintenance of the required temperature and reduce scale formation, since a controlled atmosphere could be adjusted.

As such burners with open/close control operate intermittently, problems arise in connection with the pressure control in the hearth. As regards furnace 8, this would not be of importance, since this furnace is so designed that it sucks in a great deal of inleaked air for cooling the gear, which acts as a buffer. A strong draught which obviously would have to be generated artificially (forced draught) would be all the more important for this furnace.

Although the modification of the burners would still take a long time, it is recommended to undertake soon a test regarding the indirect draught generation by means of a fan. The calculation bases are to be found in FLUEGEL, Berechnung von Strahlapparaten, VDI-Forschungshefte 395, 2nd ed. 1951.

According to the proposal of Dipl.-Ing. J e k a u c , the regulating slide valve in the stack flue should be replaced by a rotary slide valve in accordance with Fig. 3 so that the servomotor is freed from lifting the slide valve.

2.13 The Car-hearth Furnace 9 "Gipromez"

The flame regulation of this furnace could be improved by arranging the burners on one side at a higher level, which results in a rotation of the gases in the furnace. In this case, a modification of the location of the flues would not be required; it would, however, be necessary to use supporting blocks of a sufficient height, the minimum being 200 mm.

2.20 The OFAG Rotating Hearth Furnaces

After abt. 20 years' operation, these furnaces are worn and need a general overhauling which is already planned by VATROSTALNA.

The two furnaces are rated for a capacity of 8 to 9t/h each, which can be required if 180 tyres are produced in seven hours. On the other hand, 8 x 7 x 300 is 16,800 t/a with single shift operation, which means that these furnaces represent a considerable idle capacity.

It would be possible to use one of these furnaces as a spare furnace in connection with the rocker-bar type furnace to be erected. This would be possible from the point of view of space or by means of a lift truck. Although, owing to charging etc., this would not be simple, it would be possible to operate both furnaces on the basis of good organization simultaneously - at least temporarily. In this connection, it would be to be studied whether a second sheet-metal chimney which represents only a minor investment would be required.

If the decision is taken to have one of the furnaces working in the new hall, one of them could even be so turned that charging and discharging would be located on the other side. In the last analysis, these furnaces are so expensive because of the foundation and the mechanism. The zoning could be modified by VATROSTALNA. This proposal is to be considered only as a recommendation to make the best of the existing equipment.

The modification of the rotating furnace sealing by changing over to a water seal as is provided by VATROSTALNA would contribute to the modernization of the furnaces. Within the scope of the general repair, it is important to

<u>reinforce the steel substructure and the rotating furnace</u>

which both have weakened and loosened as a result of the permanent operation. They must also be levelled and adjusted by means of a theodolite.

The modification of the outer edge of the rotating furnace is less concerned. Without any doubt, the furnaces can be so lined with refractory material that the durability will be one year, the repair lasting not longer than 10 days. The general overhauling of one of these furnaces would last abt. one month, if the preparatory work is not delayed.

2.30 The Cooling Pits

In connection with the cooling pits, it is important to modify the supply of the burners with air from the compressed air system. After the demolition of the car-hearth furnaces 1 and 2 or 5 and 6, suitable fans would be available, but it is not recommendable to wait so long. Compressed air is a form of energy and much too expensive for this purpose. The whole compressed air system is affected by this permanent consumption, or the supply of the burners with air is insufficient so that a great quantity of CO escapes into the hall.

The cover of the large pit is very heavy. It should be lined with bricks of the quality PORIT 10 from Arandelovac. In this way, the driving motor would be relieved.

In order that the cover seals well, it must be mobile also in the vertical direction. A cover lifting bogie would be most appropriate. Another solution would be to lay the rails with an ascending incline of 0.5 %, with the cover remaining in the horizontal (see Fig. 4). In this case, it would be necessary to have the drive supported by a motor winch. The existing drive would then serve as a "slack-rope" protection against rope-breaking.

It can be objected to VATROSTALNA that all the walls of these cooling pits are not appropriately bricked. In order that, owing to the dilatation, they do not bend to the inside and require permanent repairs as it is the case, they must be bricked with

a bend to the outside. The curvature can be obtained with mortar, it is, however, more appropriate to lay after every 6th to 10th brick an end-arch brick Q 4 or Q 6. The vertical plane should also have an incline to the outside of 0.5 to 1 %. VATROSTALNA should apply these old masons'rules also in the Zenica forging shop. The walls of rectangular American pit furnace chambers have a much stronger curvature.

The flues of all the cooling pits are difficult to clean and partly clogged. It is recommended to construct man-holes. This is simple in the case of the small pits, but it must also be possible for the large one.

The possibility is to be investigated of placing all the burners in the cooling pits at a higher level - abt. 500 mm from the covers - in order that the pieces are not touched by the flame.

As regards the material for the sand gutters, in this case, too, quartz sand of 4 to 6 mm grain size should be preferred to the granulated blast furnace slag used.

2.40 The Forging Furnaces in the Hammer Mill

These small furnaces are manufacturing a large part of the production. When the forging machine will be in operation, they will become less important. A careful selection of the refractory material by VATROSTALNA and minor structural modifications could improve their durability.

3.00 General Remarks regarding the Improvement of the Durability of the Furnaces

3.10 The Refractory Materials Used

3.11 The Brick Qualities and Shapes Used

The fire-clay brick works RIŠ at Arandelovac is probably able to supply Zenica to an absolutely sufficient degree with bricks of the most different shapes of high quality. It seems that VATROSTALNA does not make use of these possibilities to a sufficient extent.

3.12 The Mortar Used

The impression is prevailing that the mortar types used are rather simple. In any case, it must not occur that the mortar does not fill the joints entirely so that fire passes through the bricks. The mortar should have adhesive properties. Arandelovac and VATROSTALNA (having an own mortar works) will certainly be in a position to offer appropriate materials.

It is not always correct to brick roofs with very narrow joints.

3.13 The Ramming Masses Used

Ramming is a modern, but very expensive technique, since a solid formwork, pneumatic rammers etc. are required. The main advantage is that instead of the various brick shapes only some kinds of ramming masses are to be available. In general, the ramming performance per man-hour is lower than the bricking performance. For this reason, pouring of refractory concrete is more and more applied today.

The car-hearths in the forging shop could also be poured. The refractory concrete should be very coarse-grained, up to 40 mm, the grains being oblong. It must contain only raw fire-clay and no broken bricks. The granulometric composition must correspond to that of ordinary concrete. Aluminous cement is the binding medium.

In the long run, no modern steel mill will do without the technique of spraying refractory materials. In this way, hot repairs can be carried out, and the durability of the furnaces

can be improved extraordinarily. This will be particularly important for the new furnaces to be erected which will be provided with rammed roofs and covers.

In the case of burners, flues, door-posts etc., ramming masses offer real advantages, since they ensure a jointless construction. The composition of such masses which is based on the experience of decades must be controlled carefully. Arandelovac and VATROSTALNA should be given the opportunity of carrying out tests with the masses produced in their own factories at one of the front burners which can be rapaired from the door.

As far as i know, PLIBRICO masses are supplied in a plastic state, which is a modern method of supplying such masses. The mass arrives in the form of blocks which are wrapped in normal or welded plastic foils and are capable of being rammed. Save that the supplies contain much water, these blocks are difficult to store. It cannot be avoided that the foil tears occasionally. As all masses of high quality are hardening, a great deal gets spoiled in the course of three or four months.

According to the experience I have gained, plastic masses are advantageous if they are supplied at call. As this does not apply to Zenica because of the distance, it would be better to supply the masses in a dry state.

Masses of high quality which resist to expansion and contraction are composed of precious corundum which is produced in small quantities in connection with the manufacture of abrasive corundum. It differs from ordinary corundum or alumina only as regards the crystalline structure, but not in the analysis.

DEWESIT is supplied in a dry state and conditioned with very small water quantities, e.g. 0.5 l water per 50 kg bag in order that a rapid heating, e.g. in the course of 24 hours, is possible. The addition of water is to be made mechanically, e.g. in a

small concrete mixer, or better in a special mixer. Then the mass is hardly earth-damp. As it is also the case for the plastic masses, compacting must be carried out by means of pneumatic rammers.

If the flues and burners are situated close to one another as it is the case for the "Gipromez" furnace 9, they can be treated as a unit in the ramming process so that homogeneous rammed parts are produced. In this case, savings of mass can be made by embedding light fire-clay bricks (approx. according to Fig. 5) so that only abt. 150 mm mass is exposed to the fire.

3.20 Organizational Questions

The relation between the forging shop and VATROSTALNA which is entrusted by contract with the maintenance of the furnaces is rather strange. It appears that VATROSTALNA neglects the forging shop because for VATROSTALNA the forge represents a narrow market.

Such furnaces must be maintained. Within the scope of a repair, the furnace will never be lined as it has been before, but only small improvements, structural modifications etc. will be carried out. Achievements can be made also by carrying out tests with other materials.

The furnaces thus are subject to a development keeping them without any risk in accordance with the latest technical standard. E. g., in the case of the car-hearth sealing, only one side of a small furnace could be modified in order to find out whether the change is better than the old state. In the last analysis, the reconstruction of the rotating hearth furnace proposed by VATROSTALNA involves a risk.

In my opinion, the maintenance of the numerous furnaces of the forging shop would be a full-time occupation for an engineer. In Germany these positions are frequently occupied by technicians, but there, too, certificated engineers are more and more preferred to technicians. The utilization of the literature of all the industrial countries - even of small notices and photos - would be of great use. Possibly this engineer could be entrusted also with the supervision of the furnaces of the forging shop and rolling mills.

Above all, this engineer could modify the relationship between Zenica and VATROSTALNA. He could control the employment of the workers, and would be a partner for discussions. In the last analysis, VATROSTALNA must know which problems are particularly urgent for the plant. VATROSTALNA is a strong partner having the whole know-how at its disposal. The attempt should be made to make it available to the forging shop.

On the other hand VATROSTALNA developed from the building shop of the Zenica Steel Plant. Its successes in Yugoslavia and in foreign countries must be appreciated, but the question arises whether a steel mill of the size of the Zenica Steel Plant can do in the long run without a building shop of its own which is under the control of the own Management. The reestablishment of such a shop would do away with the strained relations involved in the relationship between customer and supplier in connection with the maintenance of the furnaces.

4.00 The Further Extension Projects

4.10 The "RUMAG" Project regarding a Cooling Pit

The project has been carefully calculated and is based on exact documents. Owing to its strong steel reinforcement, the cooling pit will be sturdy and durable.

In any case, the tipping cover construction does not require much space.

The heating through the covers is not riskless. The hoses would have to convey coke-oven gas, which would involve security problems. A uniform distribution of temperature is not ensured. It is recommended to consider whether high-speed burners with open/close regulation should be installed instead at the sides.

These high-speed burners with open/close regulation were designed for heat-treatment furnaces, and in the last analysis, a cooling pit is a heat-treatment furnace. If it is decided to suck off the flue gas by means of a fan, it will be necessary to install a by-pass duct. Even at a flue gas temperature of only 250°C, the bearing or the shaft must be cooled. An indirect suction by a fan would be preferable.

The project pressures of gas and air are equal. Usually the air pressure is by 20 % higher, since in the bur[illegible]e air has to overcome a higher resistance and a better mixture of gas and air is thus obtained.

4.20 The "RUMAG" Project regarding a Forging Furnace K 30

The design of this furnace considers the latest constructional trends.

Owing to the fact that gas and air are tangentially pressed in, the flame is pressed outwardly to the wall, which leads to a good burning-out without any atmospheric oxygen. It is thus possible to work with the theoretical gas/air mixture and to obtain a good protective gas effect, which reduces scaling to a minimum.

According to the eddy flow depression principle, the flame gases are moved in spirals outwardly in direction of the door and are led to the central flue in a second internal eddy to which the ingots and forgings are exposed. The heat transfer by convection is thus favoured while simultaneously the curved cover is strongly radiating.

These flow characteristics can, however, be observed only if the burners are operated to approximately full capacity. In the case of partial capacity - below about 40 % -, it may happen that the flame gases take the shortest way to the flue. The door zone would then be less heated than that part of the furnace which is nearer to the flue.

As regards its design, the furnace is very suitable for rapidly heating up heavy ingots and forgings, but much less for exactly maintaining the temperature during a standstill. It is recommended to contact the suppliers in this connection.

It is not very favourable to transfer the flue gas slide-valve - as provide in the drawing - to the outlet zone of the furnace. The slide-valve could impede the formation of the spiral flow, particularly in the case of partial capacity.

Moreover, this slide-valve should be controlled automatically. Should it be difficult to keep static and dynamic pressure in the furnace cavity separate, it would be possible to have the impulse from a place in the flue if it is decided - as recommended above - to install the slide-valve at a certain distance from the furnace.

It is to be examined whether in view of the heat prices at Zenica a recuperator would be profitable at least for air preheating.

4.30 The "RUMAG" Project regarding a Rocker-bar Type Furnace

Within the socpe of this project, only one drawing could be examined.

The mechanical properties of the rocker bars having each one hydraulic main for vertical and horizontal movement seem to be absolutely reliable. The sealing details, too, are showing that the suppliers have experience in this field.

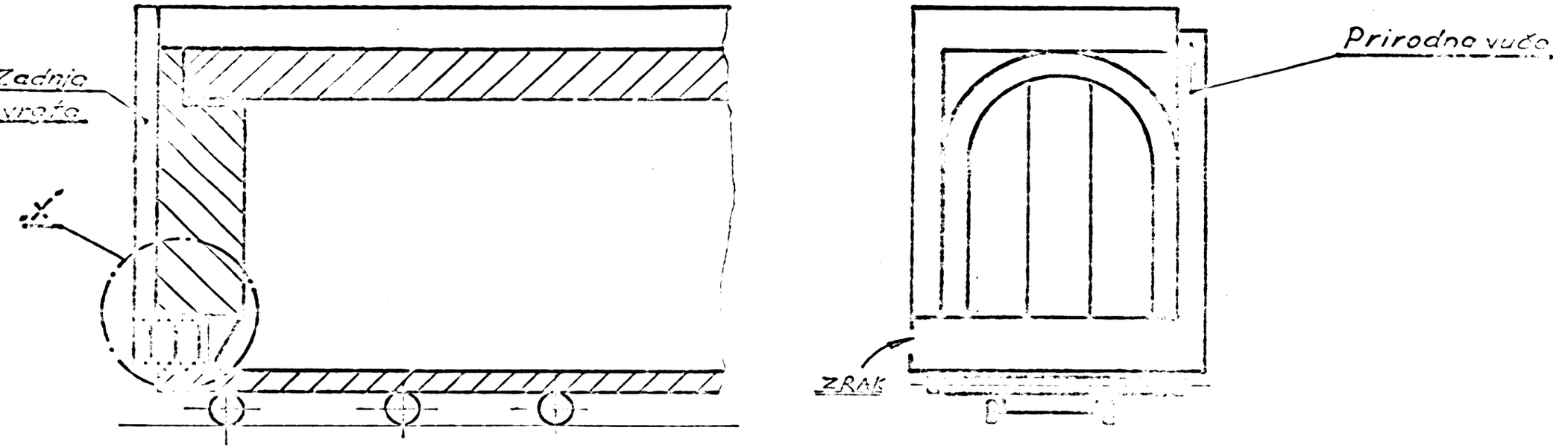
As far as can be recognized, the temperature balance zone is equipped with numerous high-speed burners with open/close regulation. An exact maintenance of the forging temperature would thus be possible. In this way also a good protective gas effect could be obtained.

In the heating zone, the first burners are situated very close to the flue. It should be examined whether at the desired capacity these burners are required, or whether the burner capacity would be sufficient for the second zone so that the flame gases would have enough time for the heat exchange.

The furnace should not involve any problems. If the rocker bars and the fixed hearth are affected by a higher degree of wear, tests could be performed later on with molten-poured high-alumina bricks (MAGMALOX, KORVISIT, SICEDISON) which could be embedded in the ramming mass.

W. [illegible]

Slika 1



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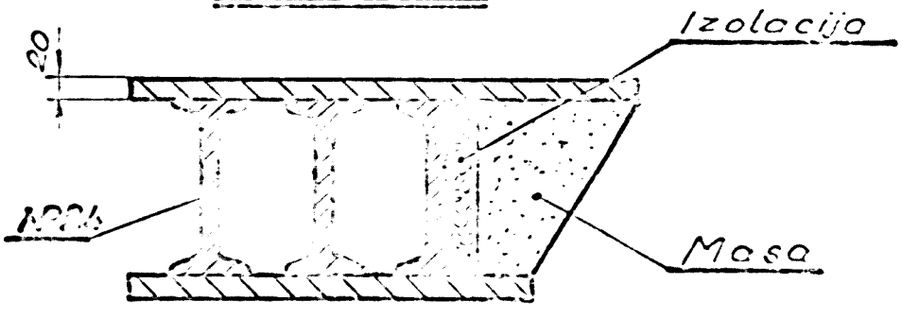

Sl. 8.

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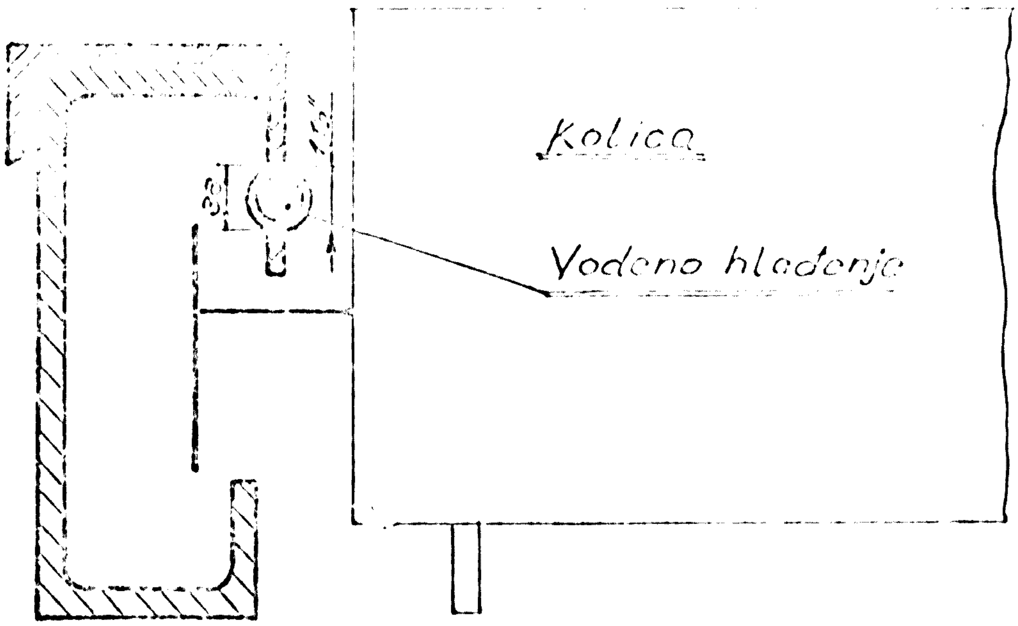

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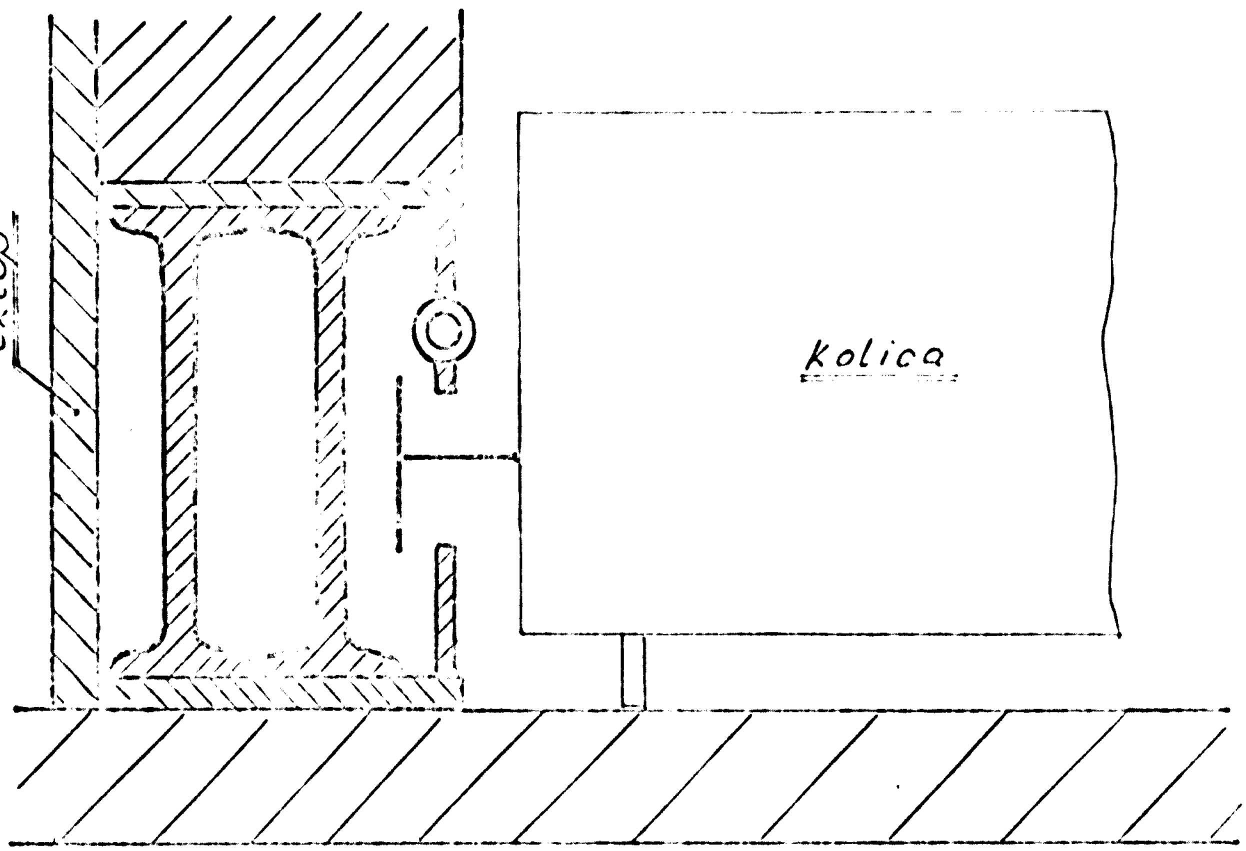

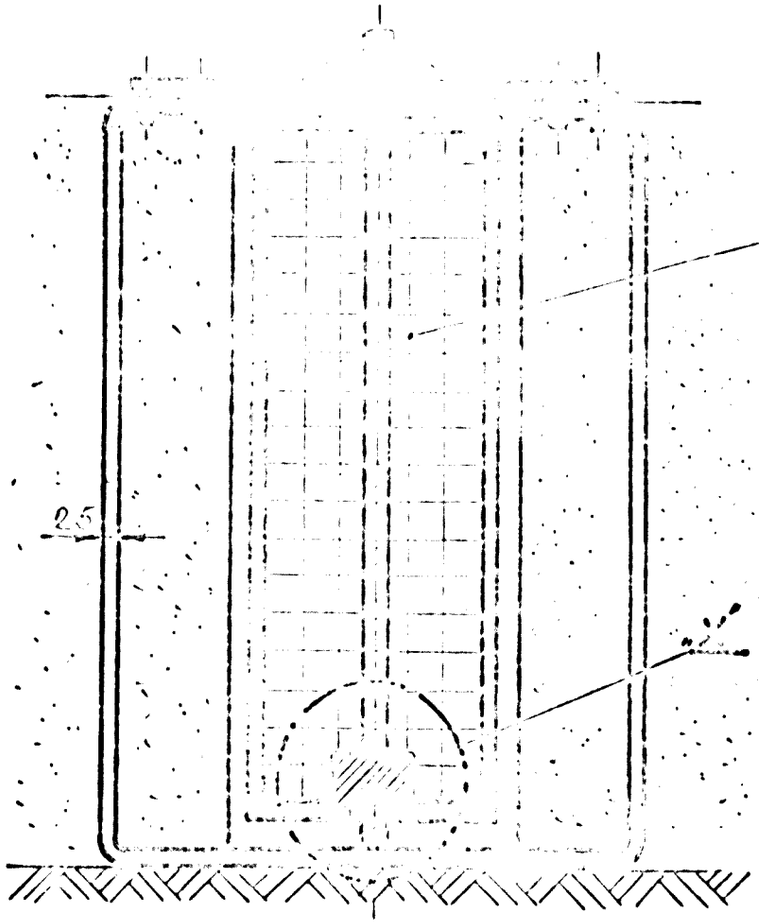

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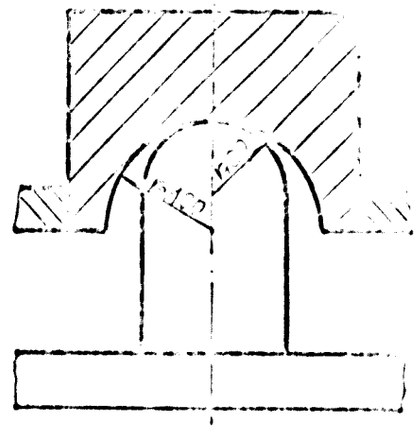

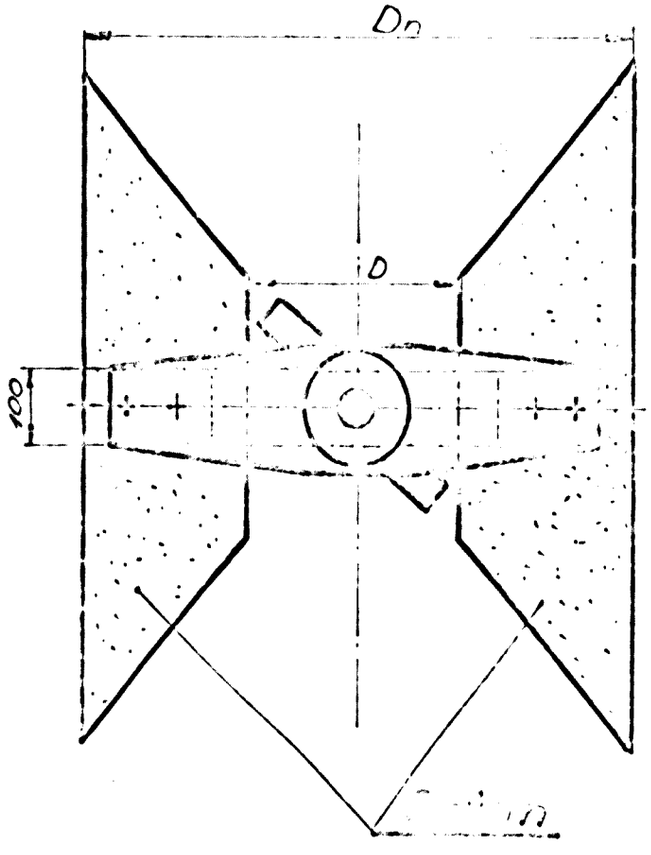

Lehrad-Skizze

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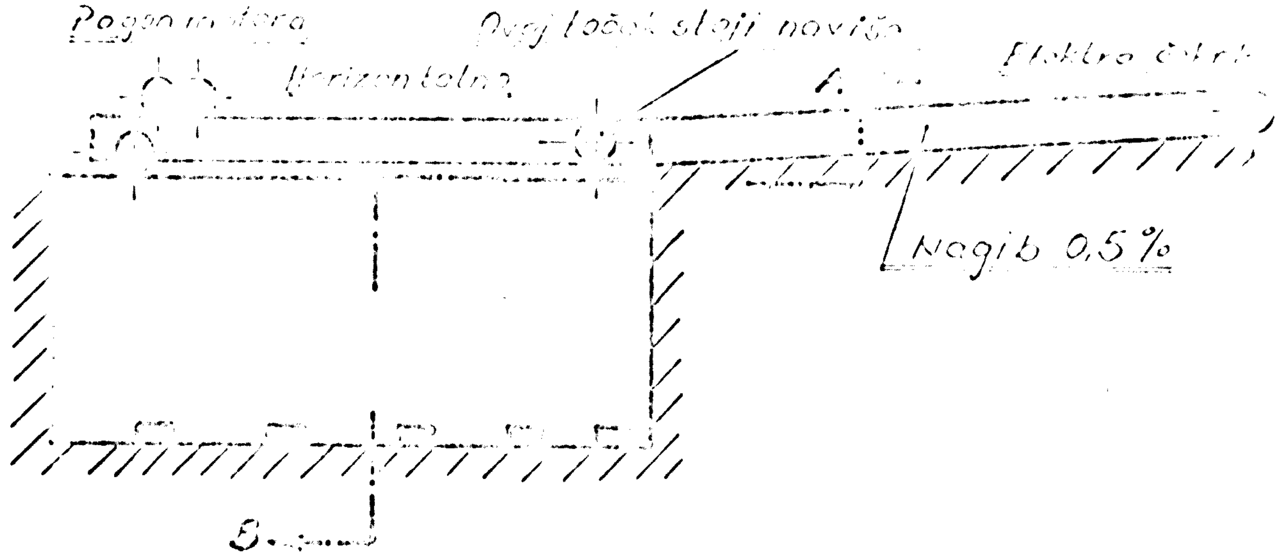

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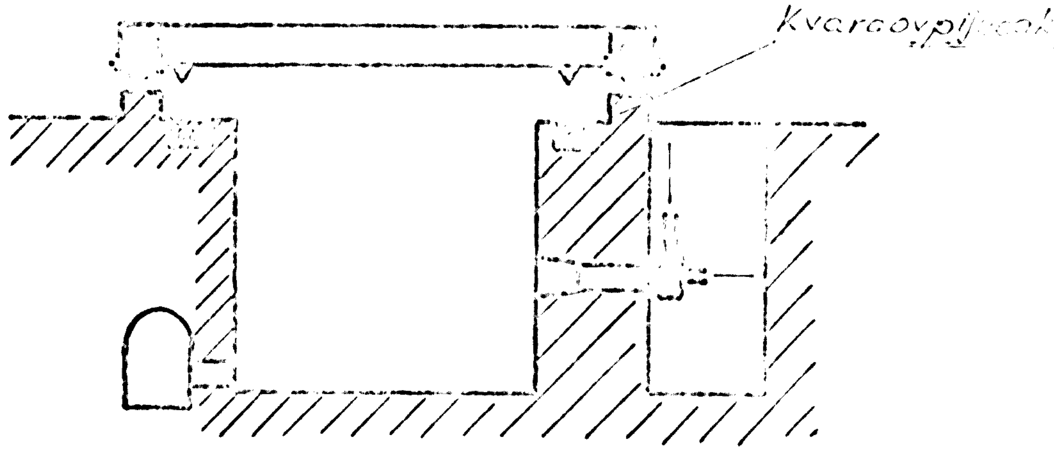

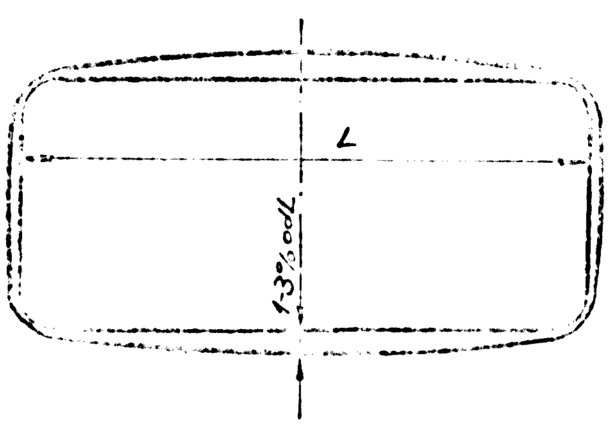

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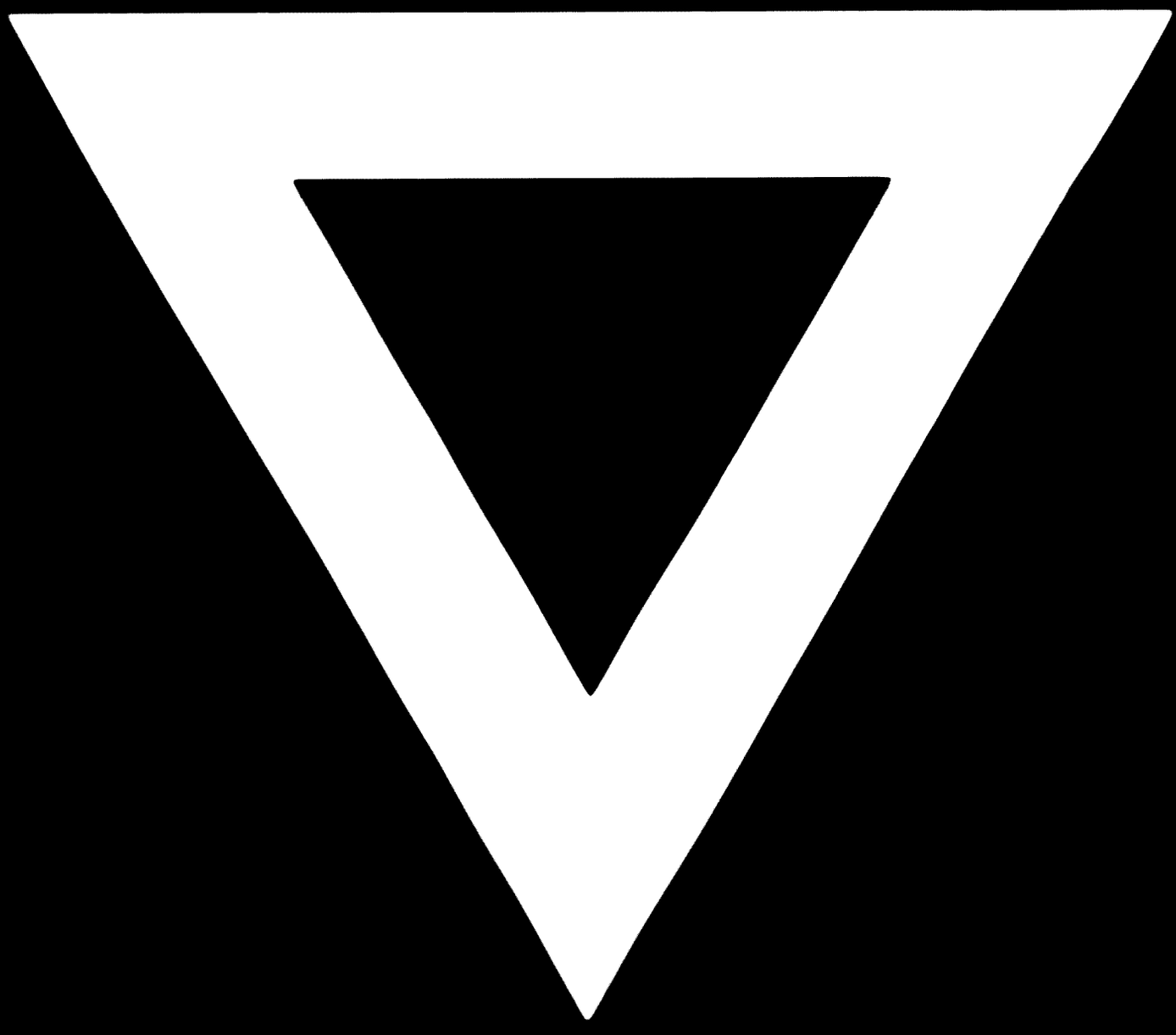

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