MACHINES BASED ON LATHES FOR MILL ROLL SURFACING

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Enterprises of a number of industries periodically need application of automatic arc surfacing for repair of wearing parts and components with using specialized machines. The work deals with approaches applied by a small enterprise in development and manufacturing of welding-surfacing equipment based on lathes of various types. Examples of fitting such machines and their application in surfacing of mill rolls are given. Upgrading and retrofitting of surfacing equipment fleet in this case involve minimum expenditure. 3 Ref., 6 Figures.

Keywords: *arc surfacing, worn parts and components, specialized machines, lathe, design and manufacture, upgrading, mill rolls*

Automatic arc surfacing is extensively applied in many industrial enterprises, so that the problem of replacement of completely rundown surfacing machines or expanding their fleet is urgent now. There is practically no serial production of such machines, and some enterprises apply surfacing machines based on lathes of various types for these purposes. Lathe type is selected, depending on the purpose and dimensions of the surfaced parts. Machines are fitted with automatic welding machines of A-1406, A-1416 type, and rectifiers with respective parameters [1, 2].

SPE REMMASH specializing in development and manufacture of welding-surfacing equipment, over the recent years has accumulated experience of development and upgrading of machines for mill roll surfacing, cooperating successfully with metallurgical plants of Ukraine. Development and manufacture of such surfacing equipment was performed using approaches applied by REMMASH in development of any installation [3]:

- analysis of current surfacing technology of the potential customer, development of its improvement variants with application of new surfacing consumables;
- analysis of the currently available similar machines;
- application of modular principle of machine fitting;
- more concrete determination of machine parameters to suit customer requirements;
- incorporating the principles of versatility into the machine;
- maximum fitting of the machine with required auxiliary equipment and rigging;
- maximum involvement of partner enterprises in equipment design and manufacture;
- involvement of customer specialists in the process of equipment development and manufacture.

Application of these approaches enables REMMASH performing «turnkey» manufacturing and commissioning of surfacing machines based on lathes in a short time.

As an example we can mention upgrading of the machine for surfacing rolls of billet mills of OJSC F.E. Dzerzhinsky DMK (Dneprodzerzhinsk, Ukraine). Before that rolls of these mills had been surfaced for a long time using surfacing machine based on roll-turning machine, developed internally by the works. Many years of operation led to extensive wear of the main components of the machine that resulted in a considerable lowering of surfacing operation quality.

Specialists of REMMASH and Chief Millman Service of OJSC Dneprovsky Metallurgical Works developed the concept and technical assignment (TA) for upgrading the currently available surfacing machine. TA defined the following main tasks:

- base roll-turning machine should be used only for fastening and rotation of mill rolls being surfaced;
- automatic surfacing machine should be fixed and should move in the mechanism, having no rigid mechanical coupling with the roll-turning machine; possibility of their removal from the zone of operation of hoisting mechanism for roll positioning and taking off should be envisaged;
- system of surfacing process control should incorporate a mechanism of automatic displacement of automatic surfacing machine nozzle for surfacing pass width;

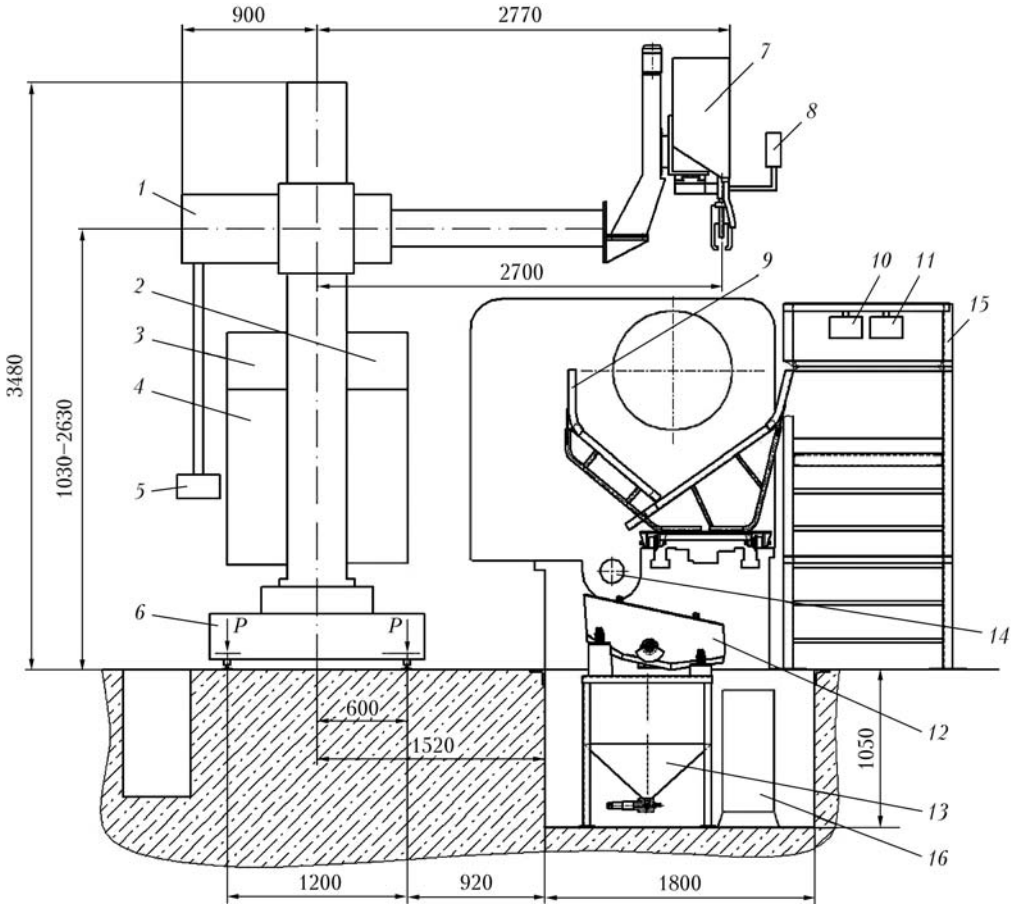

Figure 1. Schematic of upgraded machine for surfacing mill rolls of billet mills (here and in Figures 3, 5 and 6 for designations see the text)

• device for flux collection and feeding should ensure removal of unused flux, its cleaning from slag crust and reliable feeding into the flux hopper of automatic surfacing machine for reuse;

• during development and manufacture of new units and components, it is necessary to take into account the possibility for further upgrading of the machine.

Proceeding from the tasks defined in TA, a configuration of units and assemblies was proposed, which in combination with the base roll-turning machine allowed manufacturing a high-technology machine for surfacing mill rolls of billet mills (Figure 1). Mobile rotary column with cross-piece *1* was proposed as a device for fastening and displacement of automatic surfacing machine A-1406. Carriage *6*, on which the column is mounted, moves over rails, mounted in parallel to the longitudinal axis of the machine and mill rolls fastened in the machine. The column with the automatic machine can be moved into the working position before surfacing each roll pass. This enables removing the automatic surfacing machine from the working zone that is important at roll positioning and taking off.

The function of working displacement for surfacing width along the axis of the roll being surfaced was transferred to upgraded A-1406 automatic surfacing machine *7*, for which purpose the electric circuit of the automatic machine was improved. Flux feeder in the automatic surfacing machine was also replaced. KIU-1201 welding rectifier *4* was used as arc power source.

Flux feeder includes: carriage *9*, moving along machine bed guides into the surfacing zone (to collect the mixture of unused flux and slag); screw conveyor *14*; vibrating sieve *12*; storage hopper of sifted flux *13*; ejector ensuring flux feed by compressed air into the flux hopper of automatic surfacing machine; and slag collection container *16*.

Before surfacing start, carriage *9* is mounted under the roll being surfaced. During surfacing the used mixture of flux and slag is poured into the carriage, from which it comes to the receiving windows of screw conveyor. Conveyor feeds a mixture of slag and flux onto the vibrating sieve, which separates the mixture into slag pouring into the container for slag collection and the sifted flux, falling into the storage hopper. From this hopper the flux is fed by an ejector into the flux hopper of automatic machine A-1406 for reuse.

The machine also includes the mechanism of displacement of machine tool dead head used as

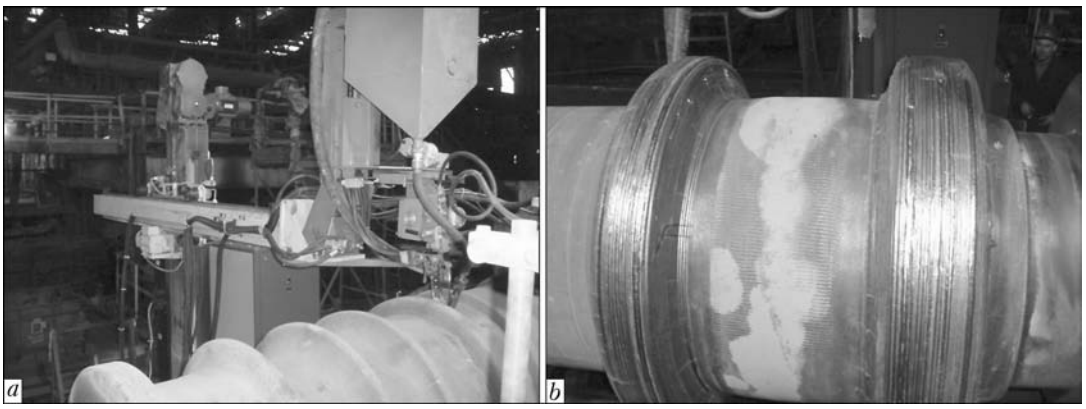

Figure 2. RM-11 machine for surfacing forming rolls of billet mills (*a*), and fragment of surfaced forming roll (*b*)

the second support for the roll being surfaced. Mechanism, consisting of electric winch and a set of blocks, allows moving the dead head when installing rolls of different length into the machine.

Machine operation is controlled from several panels, using control cabinets *2* and *3*. Main control panel *8* is fastened on automatic surfacing machine. It is used to conduct on-line control of three main units of the machine: mobile rotary column, roll-turning machine and automatic surfacing machine. Functions of auxiliary control of the machine, not requiring quick measures, in order to unload the main panel, were transferred to two more panels *10* and *11*, located on the railing of surfacing operator platform *15*. Panel *10* is used to control the vibrating sieve, screw conveyor and pre-setting displacement of the roll to be surfaced. Compressed air feed into the flux feeder ejector is switched on and controlled from panel *11*. Additional panel *5*, located in the area of the platform with control cabinets, is designed to control the rotary column during preparatory and repair operations.

Figure 2, *a*, shows the general view of RM-11 machine designed for surfacing the rolls of billet mills, and Figure 2, *b* gives the fragment of a mill roll surfaced in it.

REMMASH made for OJSC EVRAZ-Petrovsky DMZ the RM-12 machine, based on DXW 1000/3×5000 RK-1 lathe for surfacing rolls of billet and section hot rolling mills. Machine drive was upgraded and ensured roll rotation with the surfacing speed. Machine sliding carriage was removed from the working zone used for surfacing.

In addition to DXW 1000/3×5000 RK-1 lathe *1*, surfacing machine (Figure 3) also included such units as A-1416UKhL4 automatic welding machine *5* as a set with welding rectifier KIU-1201. The machine was fitted with remote control panel, which duplicates the basic elements of the stationary control panel. This allows control of the surfacing process (monitoring it) from surfacing operator's platform *7*; control of flux hopper of 250 dm^3 volume; post *8* for placing the roll of wire of up to 1 t weight; self-propelled carriage *4* for positioning and displacement of automatic welding machine based on frame *3*.

A programmable controller is used to ensure the required working speed of carriage displacement, allowing selection of the required speed in the range of 1–30 mm/min.

Device for flux and slag collection *6*, consisting of carriage and tray, is placed under the roll being surfaced and moved along the axis of DXW 1000/3×5000 RK-1 lathe.

RM-12 machine (Figure 4) was introduced at EVRAZ-Petrovsky DMZ and has been successfully used for more than two years now for surfacing the mill rolls.

Preliminary and concurrent heating, as well as tempering or delayed cooling after surfacing, are mandatory technological operations in surfacing of mill rolls from medium- and high-carbon steels. As a rule, surfacing of mill rolls is performed using induction heating or gas torch heating. Both these methods have their advantages and disadvantages, and the enterprise itself takes the decision on which of them should be used in each specific case.

For Arcelor Mittal Krivoj Rog Company, which traditionally applies inductors for roll heating, REMMASH developed and manufactured an inductor, which allows heating the mill rolls in the entire range of their diameters from 690 up to 910 mm.

Inductor (Figure 5) consists of a coil made from copper tube *4*, mobile *6* and stationary *1* magnet cores made from plates of core iron, caseframe *2* consisting of welded sectors and terminal plate *3*. Inductor coil is assembled from two sections, the ends of which are taken to the terminal plate. Cooling water is circulating inside the copper current-carrying tube (outer diameter of 14 mm, inner diameter of 10 mm). Each of the coil sections is insulated by varnished cloth, and

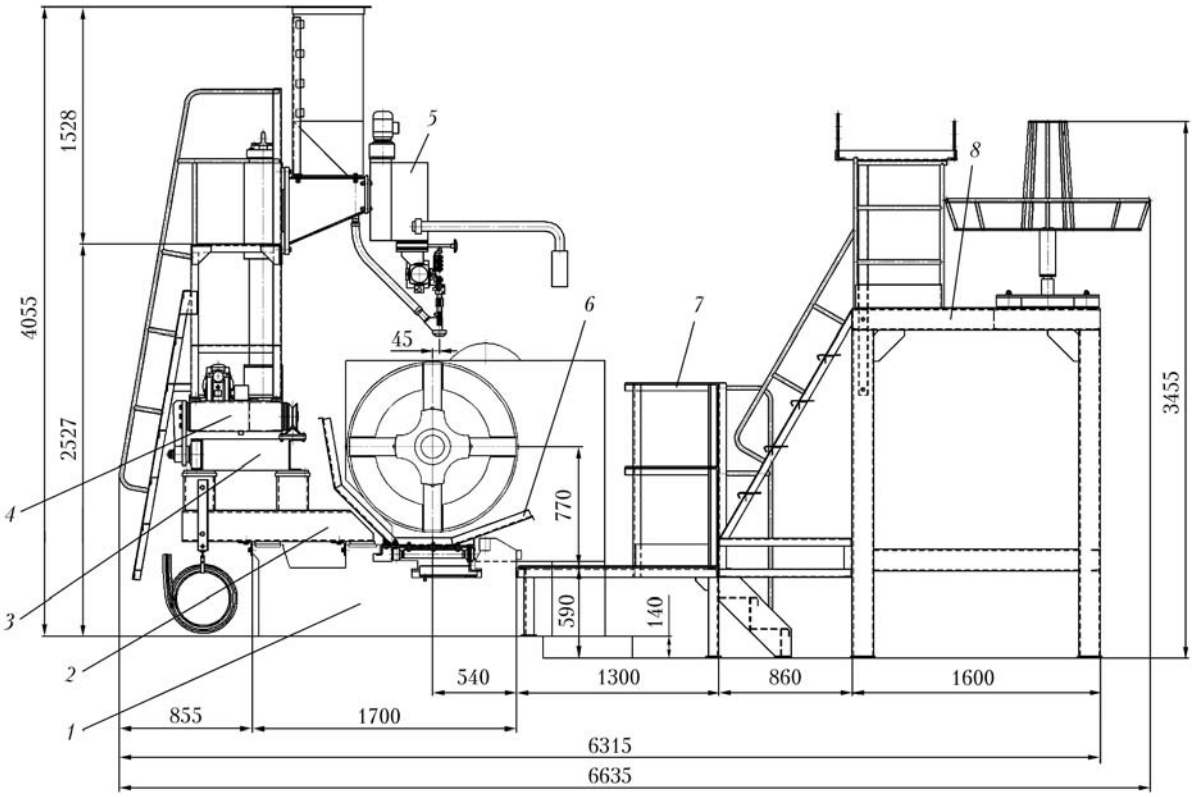

Figure 3. Schematic of RM-12 machine based on lathe DXW 1000/3×5000 RK-1

the entire as-assembled coil is insulated with asbestos cloth impregnated with varnish. Electric layers of the coil are connected in sequence, and hydraulic layers are connected in parallel. Nozzles are soldered to the start and end of each layer, which are taken to terminal plate *3*. Insulation is of class F, admissible winding temperature should not exceed 200 °C. Water flow rate at heating of a roll of 910 mm diameter up to 500 °C is equal to 7.2 l/min, and for a roll of 690 mm diameter it is 6.5 l/min. In the mode of maintaining the roll temperature during surfacing (400–420 °C), the flow rate is not more than 5.0 l/min.

Magnet cores are located in the case-frame radially in six sections around the frame circumference, every 60°. Each section consists of one stationary magnet core *6*, mounted in the frame middle part, and two mobile magnet cores *1*, mounted from two sides on the frame periphery. When items of different diameters (690–910 mm) are placed into the inductor for heating, mobile magnet cores move in the yokes to create an optimum air gap between the surface of the item being heated and end faces of mobile magnet cores. At selection of gap width between the mobile magnet cores and heated item surface, it is necessary to bear in mind that absence of such a gap is inadmissible. Excess narrowing of the gap leads to magnet core overheating, and increased width leads to longer heating time. Therefore, for each roll typesize, such a gap, at an average value of 10–20 mm, is selected experimentally. Time of heating of a roll section 490 mm long from 250 up to 400 °C is equal to 1.5 h. Main characteristics of the inductor are as follows: 380 V rated mains voltage, 260 A rated current and 0.506 power factor.

The inductor is used with success in the roll-turning shop of Arcelor Mittal Krivoj Rog Company for preliminary, concurrent and post-surfacing heating of all the surfaced steel rolls of 690–910 mm diameter.

For heating of rolls surfaced in RM-12 machine (EVRAZ-Petrovsky DMZ) a stand was developed with air torches as a heating element. The stand (Figure 6) consists of drive *1* and

Figure 4. RM-12 machine for surfacing mill rolls

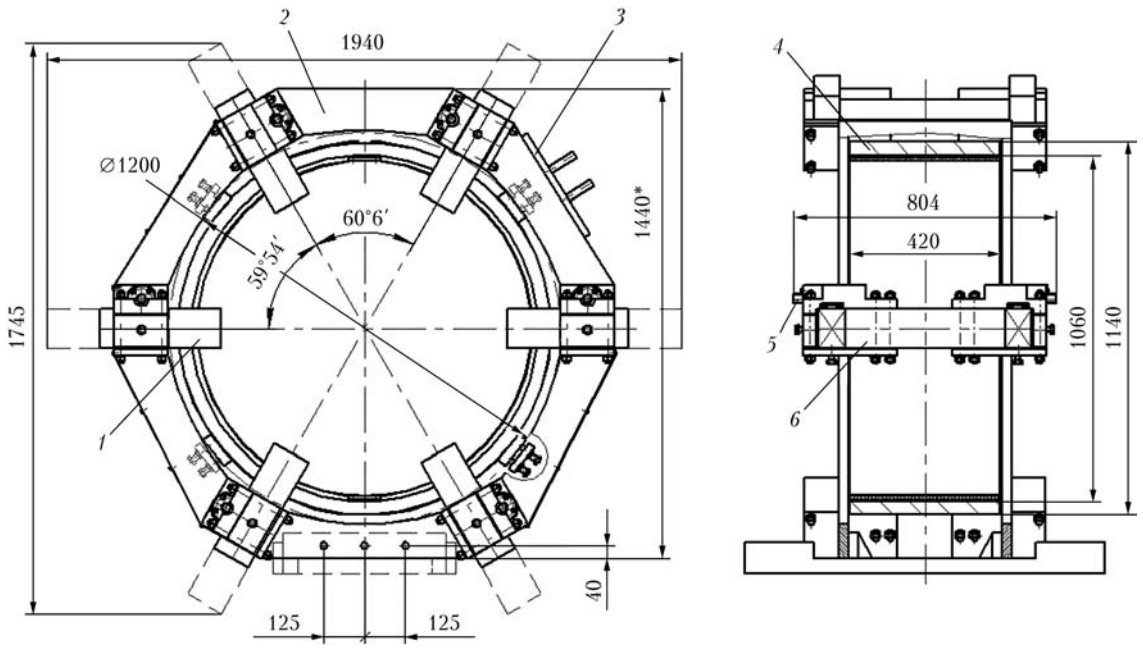

Figure 5. Schematic of electromagnetic inductor RM-6

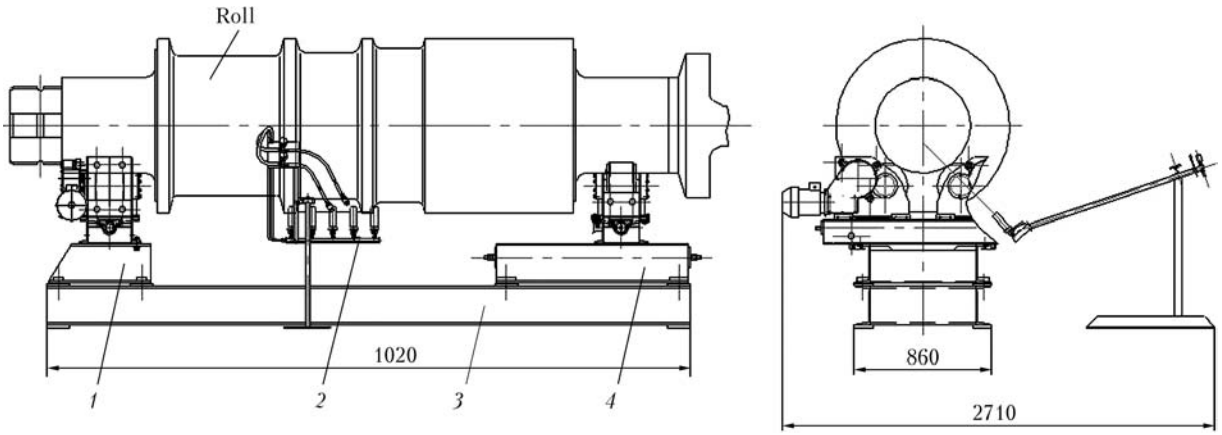

Figure 6. Schematic of RM-14 stand for heating mill rolls before surfacing

driven *4* sections of roller supports and set of air torches *2*.

Drive section is a frame, which carries two drive roller supports, as well as a screw used for bringing the roller supports together and apart at readjustment for different diameters of rolls being heated. Control of roller support rotation drives is performed from the common control cabinet, mounted on the frame. Driven section is a frame, carrying two driven roller supports, as well as a screw, the functions of which are similar to those of the screw from drive section. In addition, they have a screw mechanism for displacement in the axial direction relative to the drive section (for heating rolls of different length). The drive and driven sections are mounted on common frame *3*.

The set of air torches *2* consists of five torches GV-VK2, one collector for five torches, post and panel of torch control. Torches use natural gas (0.08 MPa pressure) and compressed air (0.3 MPa pressure). Number of air torch sets is selected by the customer or calculated by the developer (Customer provides the technical requirements on heating of mill rolls or other parts).

The approaches to development described in this paper and given examples of manufacture and introduction of surfacing equipment show one of the directions that allows upgrading and retrofitting the equipment for mill roll surfacing at minimum cost.

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