Hydraulic Station for a Railway Track Welding Machine

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Abstract: *The welding head of the containerized and completely independent mobile machines for flash-butt welding of train and tram tracks is operated with the help of a hydraulically actuated rotary crane. The article shows a hydraulic station that provides the hydraulic energy needed to operate the rotary crane of a railway track welding machine.*

Keywords: *Hydraulic station, rail welding machine, rotary crane, flash-butt welding*

1. Introduction

Flash-butt welding of train or tram tracks is done by a complex mechanical - electrical equipment called "welding head" which has a hydraulically actuated mechanism for positioning and alignment of the rails.
The hydraulic installation of the welding head includes two hydraulic cylinders for vertical alignment of rails, two hydraulic cylinders for horizontal alignment of rails, and two hydraulic cylinders for positioning the rails so that between their ends the electric arc that makes the welding possible is created.
Positioning of the welding head above the rails, at the welding point, is performed by a rotary crane located on the platform of the mobile welding machine chassis.
The welding head is suspended from the crane hook.
The hydraulic installation of the rotary crane consists of two cylinders for the extension arm, two cylinders for the lifting arm and a rotary hydraulic motor with speed reducer for rotation of the crane arm.
Hydraulic power required for the welding head and rotary crane is given by the hydraulic station placed on the platform of the mobile welding machine chassis.
Below is presented the construction and operation of the hydraulic station of the railway track welding machine.

2. Technical characteristics and performance of the hydraulic station

2.1. Double electric pump

a) Main pump, PPA :
- Capacity ..... V_g 71 cm^3 / rev;
- Maximum flow rate ……..…... Q_{max} 104 l / min;
- Maximum pressure ……..…… p_{max} 250 bar;

b) Recirculation pump, PRD:
- Capacity ..... Vg 16 cm^3 / rev;
- Maximum flow rate ……... Q_{max} 24 l / min;
- Maximum pressure …… p_{max} 16 bar;

c) Electric motor:
- Power ……...… N 30 kW;
- Speed ……...…… 1460 rpm.

2.2. Emergency electric pump

a) Emergency pump (gear pump), PU

- Capacity ..... Vg 10.8 cm^3 / rev;
- Maximum flow rate ..... Q_{max} 16 l / min;
- Maximum pressure ..... p_{max} 250 bar;

b) Electric motor

- Power ..... 7.5 kW;
- Speed ..... n 1460 rpm;

2.3. Safety block, PP

- Nominal opening ..... Dn 10 mm;
- Maximum pressure ..... p_{max} 310 bar;

2.4. Safety block, PR

- Nominal opening ..... Dn 06 mm;
- Maximum pressure ..... p_{max} 25 bar;

2.5. Safety block, PU

- Nominal opening ..... Dn 06 mm;
- Maximum pressure ..... p_{max} 250 bar;

2.6. Reducing valves block

- Nominal opening ..... Dn 10 mm;
- Maximum pressure ..... p_{max} 250 bar;

2.7. Oil cooling block

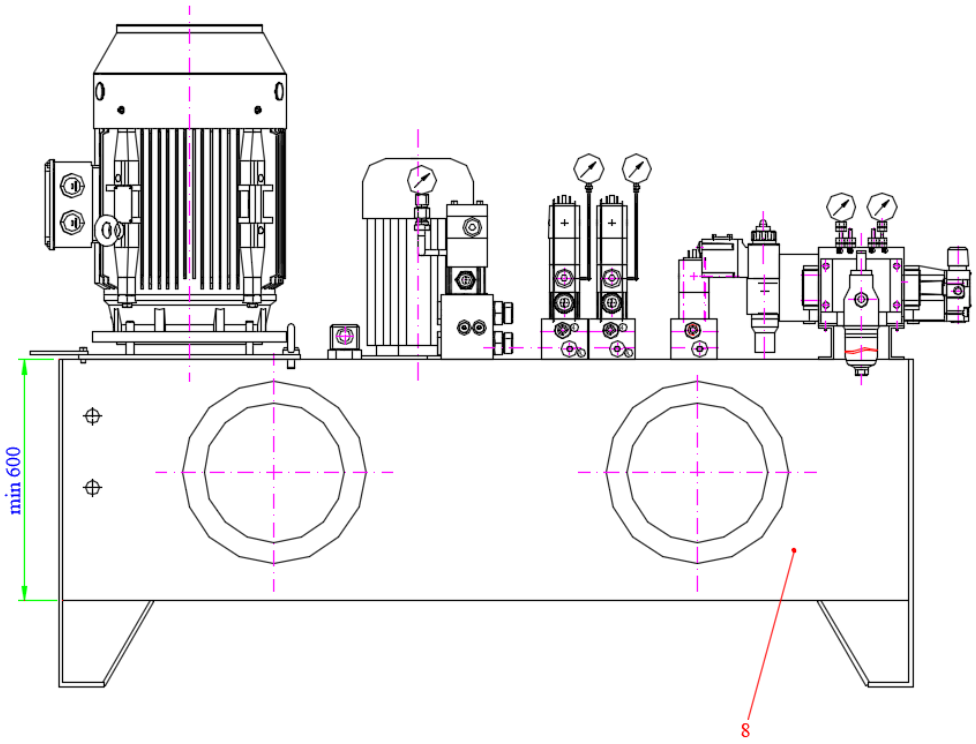
- Nominal opening ..... Dn 06 mm;
- Maximum pressure ..... p_{max} 25 bar;

2.8. Equipped tank

- Tank volume ..... V 400 l;
- Return filter flow rate ..... Q 100 l/ min;
- Return filter filtering fineness ..... 10 µm.

3. Structure of the hydraulic station

The hydraulic station (fig. 1) consists of eight subassemblies: pumping group - *1*; emergency electric pump - *2*; safety block, PP - *3*; safety block, PP - *4*; safety block, PU - *5*; reducing valves block- *6*; oil cooling block – *7* and equipped tank - *8*.



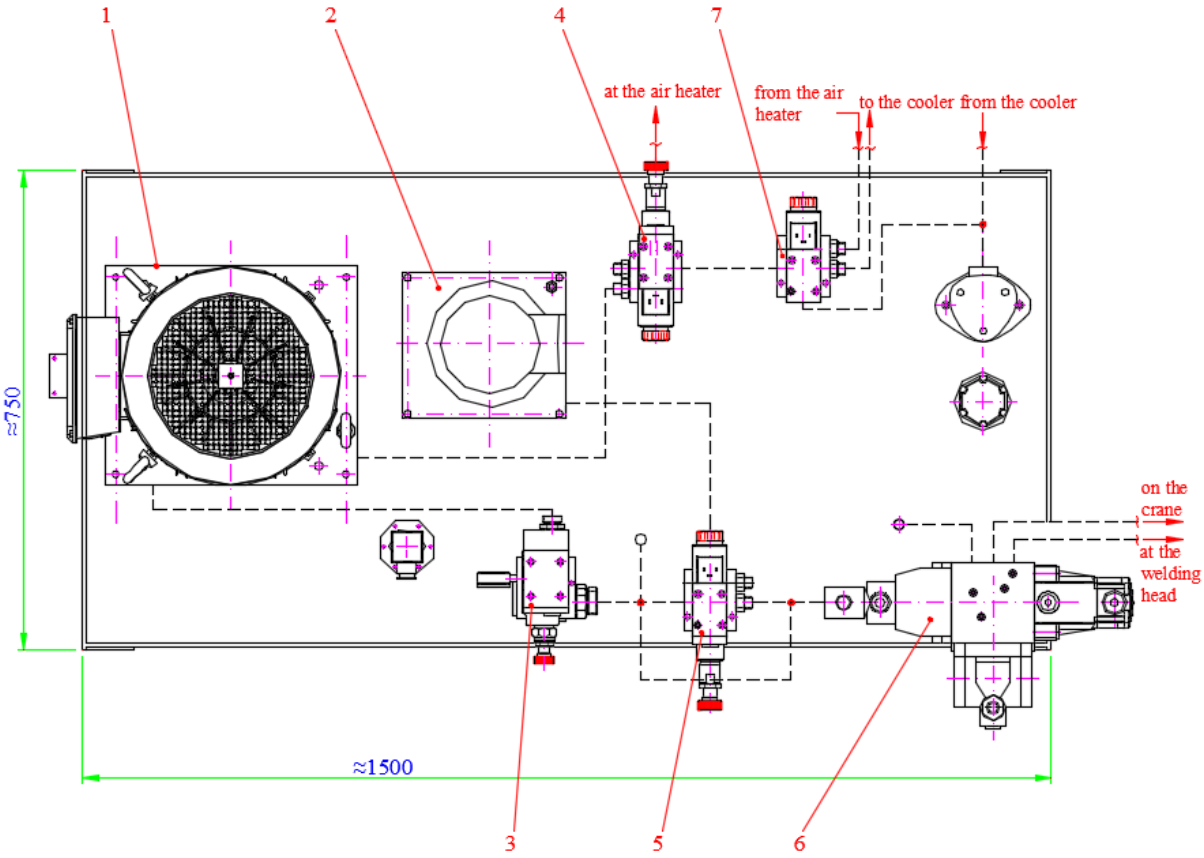


Fig. 1. Structure of the hydraulic station

1. Pumping group; 2. Emergency electric pump; 3. Safety block, PP; 4. Safety block, PR, 5. Safety block, PU; 6. Reducing valves block; 7. Oil cooling block; 8. Equipped tank

The pumping group *1* is fixed to the cover of the tank and provides hydraulic power (flow rate and pressure) for all hydraulically operated mechanisms. Pumping group contains a double pump, consists from an axial pistons pump and one with gears, both immersed in tank and is driven by an asynchronous electric motor of 30 kW at 1500 rpm.
Emergency electric pump *2* consists of a 7.5 kW asynchronous electric motor that drives at a speed of 1500 rot /min a gear pump with a capacity of 108 cm^3/ rot immersed in oil.
The safety block, PP - position *3*, contains devices that limit the maximum pressure on the main circuit: it is located on the oil tank cover.
The safety block, PR - position *4*, contains devices that limits the maximum pressure on the cooling circuit.
The safety block, PU - position *5*, contains the devices that limits the maximum pressure on the emergency hydraulic circuit.
The reducing valves block *6* contains two valves that maintain the working pressure at the set value on the two hydraulic circuits that supply the welding head and the rotary crane.
The oil cooling block *7* contains the devices that ensure the interconnection between the air/oil cooler and the water/oil cooler.
The equipped tank *8* contains the oil tank with the return filter and the filling and venting filter.
All subassemblies are located on the oil tank cover. The connections between the devices are done with metal pipes.

4. Hydraulic station operation

The role of the hydraulic station is to supply hydraulic power [1, 2, 3, 4, 5] to the welding head and the rotary crane.
The diagram of the hydraulic station is presented in fig. 2 below.

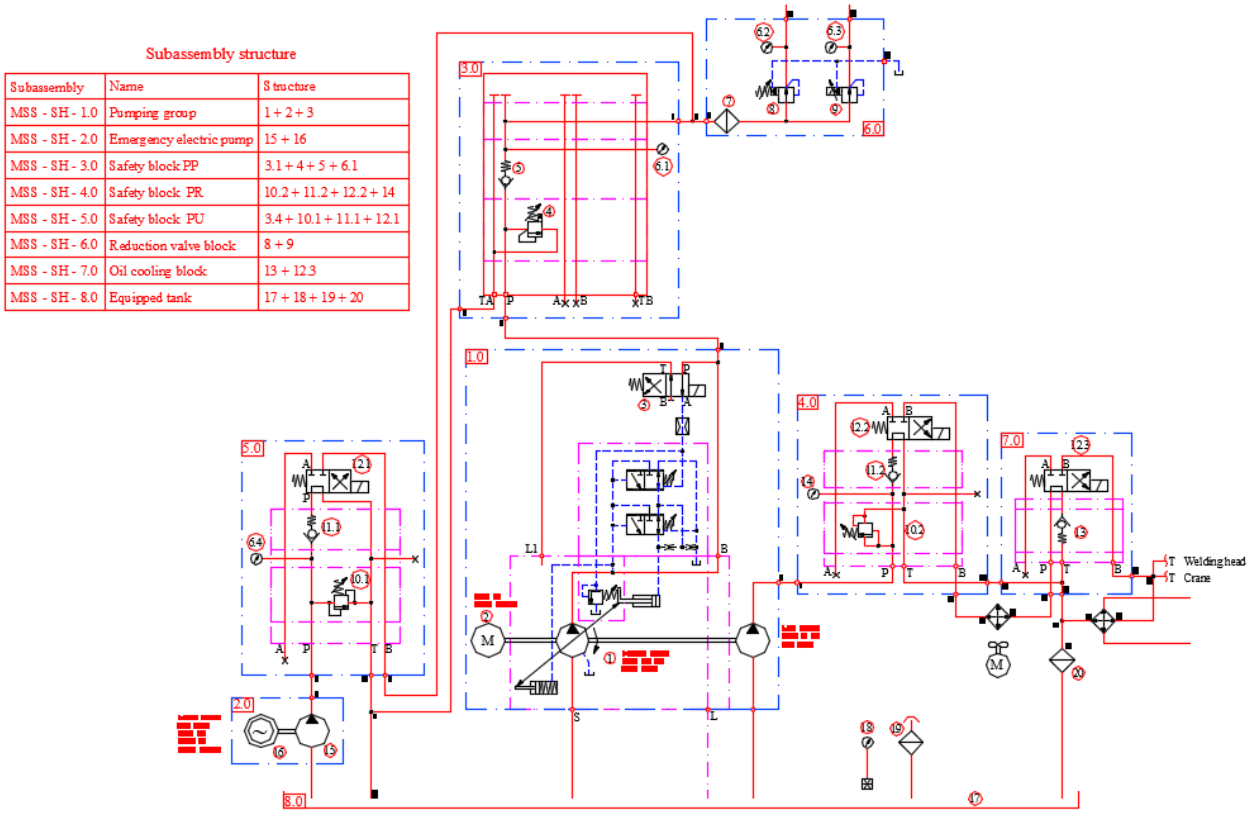


Fig. 2. Hydraulic diagram of the hydraulic station

4.1. Pumping group - 1.0

Pumping group [1] *1.0* consists of double pump *1*, electric motor *2* and directional control valve *3*. Double pump *1* consists of an axial piston pump with variable flow rate, PPA and gear pump, PRD. The PPA pump supplies hydraulic power (flow rate x pressure) to the two hydraulically operated pieces of equipment: the welding head and the rotary crane. The PRD pump ensures cooling and filtration of hydraulic oil. Directional control valve *3* switches the flow rate of the PPA pump to "zero" or "maximum".

4.2. Emergency electric pump - 2.0

The emergency electric pump goes into operation when the pumping group *1.0* fails during operation. Its role is to remove from load and bring to "zero" the mechanisms of the hydraulic head and rotary crane. It consists of gear pump *15* and electric motor *16*.

4.3. Safety block, PP - 3.0.

The safety block [2], PP consists of pressure valve *4*, one-way valve *5* and pressure gauge *6.1*. Safety valve *4* limits the pressure on the discharge circuit of the PPA pump. One-way valve *5* ensures the circulation of the working fluid in one direction, from the PPA pump to the two consumers - the welding head and the rotary crane. Pressure gauge *6.1* indicates the pressure on the discharge circuit of the PPA pump.

4.4. Safety block, PR - 4.0.

The functional role of the safety block [2], PR is to limit the pressure on the oil cooling and filtration circuit. The block consists of pressure valve *10.2*, one-way valve *11.2*, directional control valve *12.2* and pressure gauge *14*. Pressure valve *10.2* limits the pressure of the PRD pump. One-way valve *11.2* allows the working fluid to flow only from the PRD pump to the cooler and filter, not the other way around. If the oil has a temperature below 50° C, then it is directed by the directional control valve *12.2* directly into the filter *20*. If the oil temperature exceeds 50° C, then the directional control valve *12.2* is switched automatically and the oil is first passed through the air/oil cooler (air heater) and then, after cooling, it is filtered by filter *20*. Pressure gauge *14* indicates the pressure on the discharge circuit of the PRD pump.

4.5. Safety block, PU - 5.0.

The functional role of this block [2] with devices is to limit the maximum pressure on the hydraulic discharge circuit of the emergency electric pump and to ensure starting on no-load, disconnected from the load of electric motor *16*. The safety block, PU contains pressure valve *10.1*, one-way valve *11.1*, directional control valve *12.1*, and pressure gauge *6.4*. Safety valve *10.1* limits the pressure on the discharge circuit of pump *15*. One-way valve *11.1* allows oil to flow only from the pump to the consumer. Directional control valve *12.1* ensures starting on no-load of electric motor *16* because on its P to T field, the pumped discharge oil is sent to the tank without load. Manometer *6.4* indicates the pressure on the discharge circuit of emergency pump *15*.

4.6. Reducing valves block - 6.0.

The functional role of this block is to reduce the pressure exerted by the PPA pump or pump *15* to the value required for functioning of the welding head and rotary crane mechanisms. The block contains filter *7*, proportionally controlled reducing valves *8* and *9*, as well as pressure gauges *6.2* and *6.3*. Filter *7* ensures the filtration of the oil that enters the proportional valves to a fineness of 10 µm. Reducing valve *8* is dedicated to the hydraulic circuit of the control head, while reducing valve *9* is dedicated to the hydraulic circuit of the rotary crane. The pressure on the two circuits is measured by means of pressure gauges *6.2* and *6.3*.

4.7. Oil cooling block - 7.0.

When the oil heating is strong and the air/oil cooler (air heater) does not cope, the water/oil cooler enters the circuit, too [3]. This function is performed by the oil cooling block with the help of directional control valve *12.3*. On the P to T field of the directional control valve, the oil is only cooled by the air/oil cooler. On the other side of the directional control valve, the air/oil cooler is linked in series with the water/oil cooler and thus it increases the oil cooling capacity. Check valve *13* allows oil to flow only from the PRD filtration and cooling pump to oil tank *17*.

4.8. Equipped tank - 8.0.

The working fluid is stored in oil tank [4, 5] *17*. On the cover of tank *17* there is also level and temperature transducer *18*, filling and venting filter *19*, and return filter *20*. Level and temperature transducer *18* signals the situation in which the oil level in basin goes down below the minimum level and commands the activation of the cooling circuit if the oil temperature rises above 50° C.
The oil is introduced into the tank through filter *19*, which also allows the circulation of ambient air from the outside to the inside of the tank and vice versa due to the variation of the oil level, which is caused by handling of the hydraulic cylinders. Return filter *20* retains the impurities with which the hydraulic oil is contaminated during the functioning of the welding head and rotary crane hydraulic installation.

5. Conclusions

The hydraulic station for a railway track welding machine is designed so that:

- It ensures the operation of the hydraulically actuated mechanisms of the welding head and the rotary crane at optimal parameters;

- It ensures operation in case of failure to complete the duty cycle;
- It ensures the filtration and cooling of the hydraulic oil for a long and trouble-free operation of the railway track welding machine.

Acknowledgments

This paper has been developed in INOE 2000-IHP, as part of a project co-financed by the European Union through the European Regional Development Fund, under Competitiveness Operational Programme 2014-2020, Priority Axis 1: Research, technological development and innovation (RD&I) to support economic competitiveness and business development, Action 1.2.3 – Partnerships for knowledge transfer, project title: *Development of energy efficient technologies in niche applications of the manufacture of on-demand mechanical-hydraulic subassemblies and maintenance of mobile hydraulic equipment*, project acronym: MENTEH, SMIS code: 119809, Financial agreement no. 6 /25.06.2018, subsidiary contract no. 46 /17.01.2022.

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