12th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

ON ELIMINATION OF INTERIOR RAIL JOINTS INCLUDED IN RAILWAY SWITCHES USING ALUMINOTHERMIC WELDING METHOD

Valentin-Vasile Ungureanu
Marius Botiş
Transilvania University of Braşov – Civil Engineering Faculty
5 Turnului, Braşov
Romania

ABSTRACT
Because the rail joints have gaps, impacts occur when a railway wheel encounters these discontinuities. In case of railway switches the vertical interaction forces between wheels and rail are amplified by presence of major discontinuities in frog of switch area. These large impact forces may cause damage to wheel, track and vehicle. A modern solution to clear up this problem is to eliminate the interior rail joints included in railway switches using aluminothermic welding method. In this paper is presented some aspect about the computation of length closure rails and the effect of weld cooling to ensure a good operating of railway switches after the elimination of interior rail joints.
Keywords: railway switches; welding process; rail joints

1. INTRODUCTION
A welded railway switch is a railway switch without inner (interior) rail joints, but which has the rail joints at the ends. The interior rail joints can be eliminated by the aluminothermic welding method or by the flash butt welding method. In this paper is presented a Romanian technology used for elimination of interior rail joints in a new isolated standard turnout, using aluminothermic welding method. The main problems in this case are the computation of the computation of length closure rails and the effect of weld cooling to ensure a good operating of railway switches after the elimination of interior rail joints. In this paper is presented an original method to solve these problems.
In Romania, the elimination of interior rail joints can be carry out only between 0°C and 40°C temperature into rails.
The behavior of inner rails of turnout are like a breathing zone of continuous welded rail track (with displacements) and the behavior of outer rails of turnout are like a central zone of continuous welded rail track (without displacements). Because the displacements of switch blade and stock rail are different and because exist device fork-tenon exist the danger to produce the buckling of the rails in front of turnout area, if the welds are not make in a correct manner.

2. CONDITIONS FOR WELDING OF SWITCHES AND CROSSINGS
Turnouts that are to be welded shall comply with the following main conditions:
- they have to ensure the water drainage in turnout area;
- the track platform must respect the requirements about bearing capacity of the distribution sub-layer;
- crushed stone prism shall be complete, having the correct dimensions and must be stabilized;
- the elements of the turnouts (switch rail, stock rail, linking rails, wings, crossing) will be measured and checked using ultra - sound detector and ORE pattern, the ones that are not in a good state of repair shall be replaced before welding. These checking should be written down in a "test results

record sheet" for each turnout separately, where they have to mention the turnout geometry before welding and the geometry and the final fixing temperature after welding the turnout.
- the geometry of the turnout and the running channel should comply with regulations;
- the turnouts should be endowed with a device to block the relative displacement between switch rail and stock rail (device fork-tenon);
- position of the switch rail point as compared to the stock rail should be marked by a sign on the middle stock rail (kerner = punch-mark), corresponding to a neutral temperature established by the turnout manufactures (usually t=+20^{0}C). This mark sign is "the neutral point".
- the distance between the neutral point and the toe of the switch rail should correspond to the temperature difference between the neutral temperature and that when they weld the points. Otherwise, the position of the switch rail as compared to that of the stock rail has to be adjusted before welding;
- the fastening system of the compound parts of the turnouts on the sleepers should be elastic and strength;
- the moment of tightening of the fastening elements should correspond to the technical prescriptions for fastening;
- the turnouts have to be endowed will G.I.J. (Glued Insulated Joints);
- point machine and shunting and locking devices should work normally according to prescriptions in force;
- checking in locking stroke;
- checking in joints corner angels/square at the turnout point;
- checking the distance between the point fastening bolt and the middle of the distance between the two bolts on the case;
- sleepers inside the turnouts (condition, layout, and diagram) should comply with the plan showing their layout, and with the provisions in regulation.
These conditions are not limitative, but they are the minimal conditions necessary to be respected for a good behavior of railway switches after the elimination of interior rail joints.

3. THE TECHNOLOGICAL FLOW FOR WELDING THE INSIDE JOINTS OF THE SINGLE SWITCH

The successions of technological operation are the following:

- The circulation of the trains is restricted;
- The preparing of the turnout for the elimination of interior rail joints:

- checking the geometry of turnout by all points of view (gauge, level, running channel dimensions, gaps, lengths of all turnout parts, etc.);
- the "test results record sheet" will be filled;
- checking if the clamp lock working;
- checking of the neutral point, corresponding to neutral temperature established by the turnout manufactures;
- the replacement of the elements of the turnouts that are not in a good state should be repaired before welding.

- The dismounting of all internal (inner) joints, from 1 to 8 (Fig. 1);

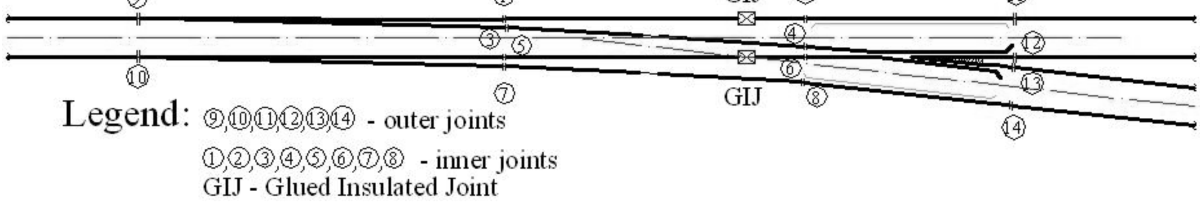

Figure 1. The turnout before to be welded

- The dismounting of the fastenings placed along of the switch blades, stock rails and closure rails to allow the displacements of switch blades;
- The aluminothermic weldings of inner joints will be prepared and worked out using **the symmetry principle** as follow:

- The right closure rail and stock rail are cut to assure the gap necessary to made the ordinary aluminothermic welding OW1, taking in account the effect of the weld cooling;
- The closure rail and runway rail from the outer curve of the turnout are cut to assure the gap necessary to made the ordinary aluminothermic welding OW8, taking in account the effect of the weld cooling;
- The closure rails are moved so that to assure the necessary gaps Δ to made the ordinary aluminothermic weldings OW1 and OW8;
- The inner joints 1 and 8 from the outer parts of the turnout are eliminated by the ordinary aluminothermic weldings OW1 and OW8 (Fig. 2);

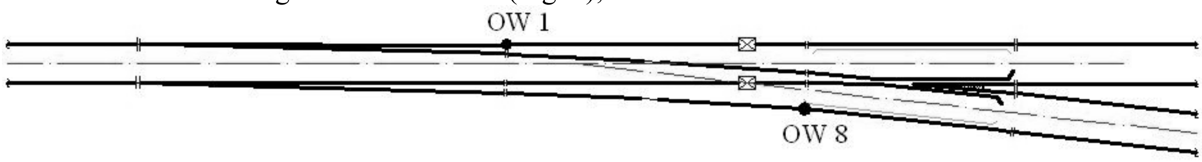

Figure 2.The turnout after first two ordinary welds

- The closure rail and curved stock rail are cut to assure the gap necessary to made the controlled aluminothermic welding CW7, taking in account the effect of the weld cooling;
- The closure rail and runway rail from the outer right part of the turnout are cut to assure the gap necessary to made the controlled aluminothermic welding CW2, taking in account the effect of the weld cooling;
- The closure rail which are in continuation of the part made of right closure rail and stock rail are moved so that to assure the necessary gaps Δ to made the controlled aluminothermic welding CW2;
- The part made of the closure rail and runway rail which are in continuation of the curved stock rail are moved so that to assure the necessary gaps Δ to made the controlled aluminothermic welding CW7;
- The inner joints 2 and 7 from the outer parts of the turnout are eliminated by the controlled aluminothermic weldings CW2 and CW7 (Fig. 3);

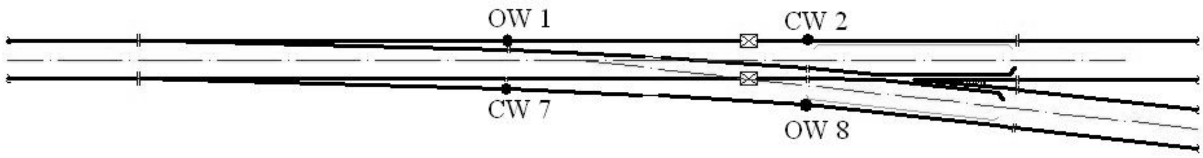

Figure 3.The turnout after first two controlled welds

- The right switch blade, the closure rail which are in continuation of the right switch blade and the wing rail which are in continuation of the right switch blade are cut to assure the gaps necessary to made the ordinary aluminothermic welding OW5 and the controlled aluminothermic welding CW6, taking in account the effect of the weld cooling;
- The curved switch blade, the closure rail which are in continuation of the curved switch blade and the wing rail which are in continuation of the curved switch blade are cut to assure the gaps necessary to made the ordinary aluminothermic welding OW4 and the controlled aluminothermic welding CW3, taking in account the effect of the weld cooling;
- The closure rail which is in continuation of the right switch blade is moved so that to assure the necessary gaps Δ to made the ordinary aluminothermic welding OW5;
- The closure rail which is in continuation of the curved switch blade is moved so that to assure the necessary gaps Δ to made the ordinary aluminothermic welding OW4;
- The inner joints 2 and 7 from the inner parts of the turnout are eliminated by the ordinary aluminothermic weldings OW4 and OW5 (Fig. 4);

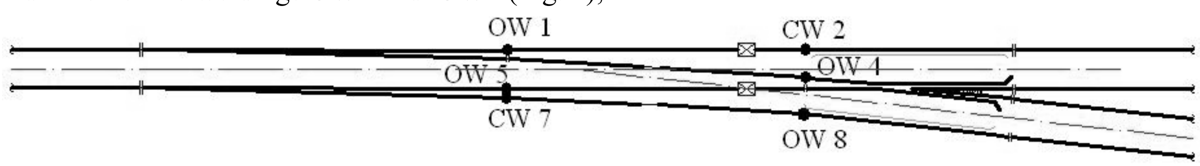

Figure 4.The turnout after last two ordinary welds

- The curved switch blade is moved so that to assure the necessary gaps Δ to made the controlled aluminothermic welding CW3;
- The part made of the curved switch blade and the closure rail which are in continuation of the curved switch blade are moved so that to assure the necessary gaps Δ between this welded part of turnout and the wing rail which are in continuation of its made the controlled aluminothermic welding CW6;
- The inner joints 3 and 6 from the inner parts of the turnout are eliminated by the ordinary aluminothermic weldings OW3 and OW6 (Fig. 5);

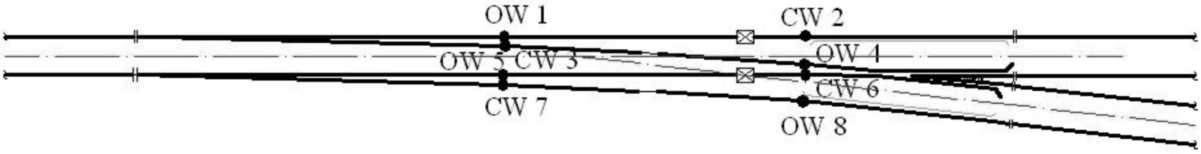

Figure 5.The turnout after last controlled welds (after elimination of all inner rail joints)

- The refixed of the fastenings;
- The cast seams are removed and the welds are grinded on the running rail surfaces and gauge face of rails.
- The turnout is measured and checked again and the results are written down in "test results record sheet".
- The circulation of trains will be opened at three hours after the finish of last weld.

4. COMMENT

The ordinary aluminothermic welding (OW) is the weld for which is not important the consuming of rail and the controlled aluminothermic welding (CW) is the weld for which take to obtain one part of turnout by two running rail parts of turnout with a desired length, so for CW is important the consuming of rail. CW is called, sometimes, the finish welding.

To assure the necessary gap Δ to make the aluminothermic welding and to take into account the effect of weld cooling, the length of closure rail should be the following:

$$l_p = l + d_1 + d_2 + r_1 + r_2 - 2 \cdot (\Delta - \delta) \qquad \text{... (1)}$$

in which: l is the length of existing closure rail, in mm, measured at the working temperature of rail when the joint are dismounted;

α = 0,0000115 is thermal coefficient of expansion for rail steel;

d_1, d_2 are the parts of rail which are eliminated by cut from the running parts of the turnout;

r_1, r_2 are the values of gaps, in mm, measured at the working temperature of rail when the joint are dismounted;

Δ is the value of the casting gap, in accordance with regulations of the Thermit provider;

δ is the effect of weld cooling (usually 2 mm for aluminothermic welding).

So, for appraisal the position of cutting signs at the end of turnout parts out of running rail and making the cuts, the distance between the sign and the cutting end of the running rail should be equal with (Δ - δ) mm.

5. REFERENCES

[1] Radu C., Ciobanu C.: Eliminarea joantelor interioare la schimbătoarele simple montate în cale, Primul simpozion național de căi ferate, Bucureşti, 24-25 octombrie 2002.,

[2] Ungureanu V.V.: Modernizarea centrului de testări feroviare Făurei. Proiect pentru execuția lucrărilor de sudare a liniei şi a aparatelor de cale, Faza: Detalii de execuție, Bucureşti, iunie, 2005.