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Some important developments in the industrial application of the hydrostatic extrusion technology

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The ASEA production presses have a maximum press force of 40 MN and are of the same basic Quintus® design for both cold and hot hydrostatic extrusion. Their main parts are the press frame and the container (figure 1). When load is applied during press operation, the columns become partly relieved but are still kept under compression even at the maximum press force. The container consists of a steel cylinder, which is prestressed by numerous layers of cold-rolled high-strength steel wire. The cylinder has a tapered bore in which a replaceable liner is inserted. This liner is so dimensioned that it acquires the desired tangential prestressing. The container is designed for an extrusion pressure up to 1400 MPa. High pressure seals are placed at the rear ends of the liner. The axial force on the seals by the high pressure fluid is balanced by four hydraulic rams. A floating piston is mounted in the liner bore. When fluid is pumped in, this piston is forced against the billet and firmly holds the billet and the die centred in the bore. The floating piston has relief valves which let fluid through to fill the space surrounding the billet.

A set of curves showing run-out extrusion pressure as a function of extrusion ratio for the cold hydrostatic extrusion of several materials is shown on figure 2. Aluminium and aluminium alloy allow extrusion ratios high enough for most practical applications. A billet for the extrusion of copper-clad aluminium consists of a core of aluminium enclosed in a copper tube. As the copper tube is usually thin-walled, the extrusion pressure is close to that for pure aluminium (figure 3). The copper tube and the aluminium billet are tapered at one end by milling, and annealed. They are then lined up and a pneumatic ram passes the aluminium bar into the copper tube. A steel plug is inserted into the rear end of the copper tube. The nose at the front of the copper tube is hydraulically upset in order to keep the loosely contained aluminium billet in position. The billet and die angles are chosen so that the pressure medium cannot escape in-between. Depending on the shape of the die orifice, rectangular sections (bus-bars) and round sections (wire) can be produced.

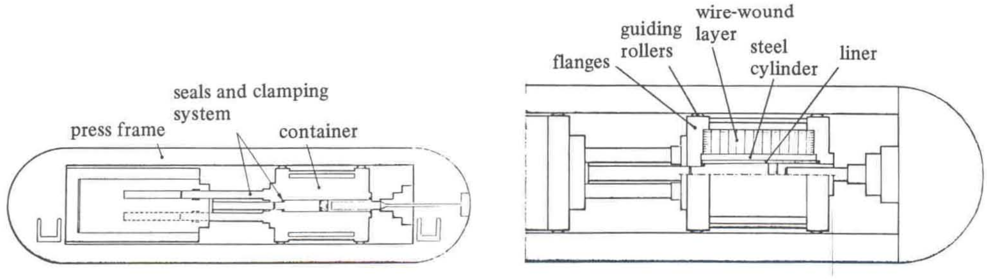

Figure 1. Cut-away views of the QUINTUS® hydrostatic extrusion press (left) and the container (right).

When busbars are extruded, they are cooled and guided through flying shears, which cut them into 20 m long lengths. They pass next to a straightening machine, after which they are cut into lengths and bundled. The extruded wire is guided through a cooling section and then up a guide tube in a loop and down into a steel drum, where it coils itself automatically. When the coiling has been completed, the steel drum and the coil are transferred to a joining station where the joining is accomplished by cold pressure welding. This station also contains a coiler for recoiling the joined wire into coils about 3 tons in weight.

The products produced have a high standard of surface finish and close tolerances. A fully satisfactory bond between copper and aluminium is obtained owing to the heavy deformation. Copper-clad aluminium has proved to be an excellent material for electrical conductors, combining the low price of aluminium and the good and reliable contact properties of copper.

For materials with higher resistance to deformation than aluminium and aluminium alloys, for instance copper and copper alloys, the extrusion ratio which is required for economical production of simple sections and tubes cannot be achieved with billets at room temperature. By increasing the billet temperature during extrusion to about 350°C the extrusion ratio is increased from 50 : 1 to about 1000 : 1 at 1400 MPa for copper, which is high enough for most practical applications (figure 4).

In the ASEA system for hot hydrostatic extrusion the pressure medium is charged into the container at low temperature and under comparatively high pressure (this permits the use of the pressure medium above its normal boiling temperature); only the billet and the die are preheated; and the quantity of pressure medium heated by the billet is kept to a minimum.

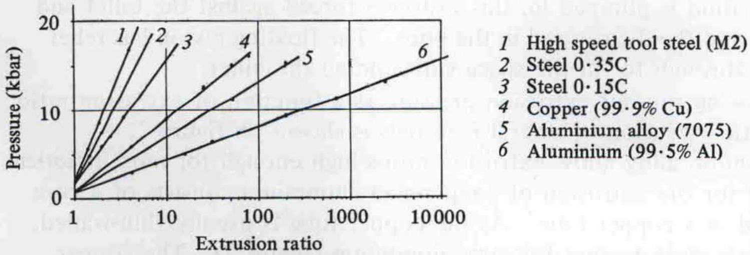

Figure 2. Pressure versus extrusion ratio for some common materials.

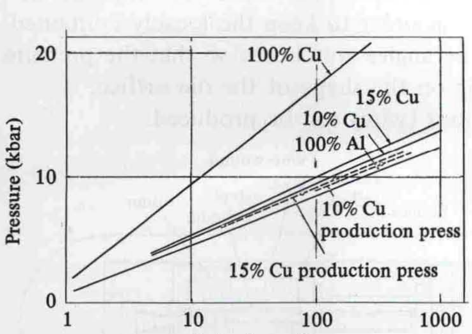

Figure 3. Extrusion pressure versus extrusion ratio for copper-clad aluminium with 100 mm billets (solid lines) and 170 mm billets (dashed lines). The percentages shown relate to the cross-section area.

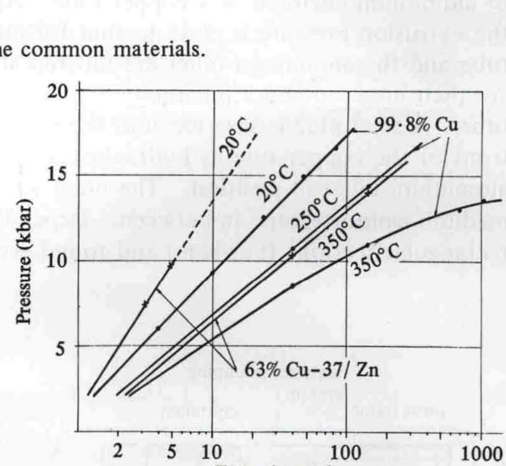

Figure 4. Extrusion pressure versus extrusion ratio for copper and brass at different temperatures.