A SILVER-FREE SOLDER FOR STAINLESS STEEL MEDICAL INSTRUMENTS

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Soldering in the manufacture of stainless steel medical instruments is often effected with a kerosene-air burner.

The solders used are standard silver solders, marks PSr 25, PSr 45, PSr 65, and nonstandard dental silver, containing 37% silver, 38% copper, 15% zinc, 5.2% manganese, 4% nickel, 0.5% cadmium, and 0.3% magnesium.

All the standard silver solders have relatively low melting temperatures (998-1048°C or 725-775°C). The melting temperature of the nonstandard dental solder is higher (1083-1123°C or 810-850°C).

One important disadvantage of all silver solders is the formation of a large number of pores in the soldered joint as a result of overheating of the melted solder in the soldering process.

Other nonstandard solders, with bases of copper, nickel, and manganese, and additions of silicon, iron, lithium, and boron, are used in addition to silver solders in the manufacture of stainless steel articles. Such solders include VPr 1, VPr 2, VPr 4, etc. A solder consisting of 61% copper, 20% manganese, and 19% nickel is used for the soldering of Kh18N9T stainless steel.

The disadvantages of these solders are their high melting temperatures and the great tendency for the joints to become porous when heating is effected with an oxygen-gas or a kerosene-air flame. The increased porosity of the joints in gas-flame soldering is due to the increased vaporization of manganese on overheating. Solid nonporous joints can be obtained by soldering in a protective medium or by heating the article in a high-frequency apparatus under ordinary atmospheric conditions, in which case the solder in the fluid state is not overheated.

The great difficulty experienced in the soldering of stainless steel medical instruments is due to the surface films of oxides of chromium, titanium, and other elements in the composition of the metals to be soldered. The oxide films, which may have been formed earlier or are formed in the process of soldering, have high thermal and chemical resistances, are difficult to reduce with fluxes, and therefore interfere with the production of good soldered connections in instruments.

When stainless steels which contain no titanium are being soldered at high temperatures, austenite is broken down, and chromium carbides are precipitated. This destroys the homogeneous structure of the metal in the zone exposed to high temperature and leads to intercrystalline corrosion. This defect in the soldering of titanium-free stainless steels can be avoided by strict control of the temperature and the duration of heating.

Another great danger is the development of brittleness at junctions of two metals as a result of repeated sterilization (autoclaving) at temperatures of 453-473°C (180-200°C). Cracks, which may extend deeply into the metal, develop at the junction of metal and solder. The only way in which the development of these cracks and other defects in instruments can be prevented is by the production of a more rational and better solder, with superior physicomechanical and technological properties.
So far, no high-quality solders, not containing silver, have been found for the soldering of stainless steel medical instruments. The occasional attempts that have been made to find such a solder with all the properties required have all been unsuccessful. In 1964 investigations were carried out in the All-Union Research Institute of Surgical Apparatus and Instruments with a view to the production of a new non-silver solder for the soldering of medical instruments made of stainless steel of the austenite and martensite classes. The properties of the new solder had to be such that they would ensure adequately strong and completely sealed junctions with high resistance to corrosion.

The replacement of silver by nonsilver solders would effect a saving in silver, which was in rather short supply for industry, and would improve the quality of soldered joints in medical instruments.

Various experimental solders, based on copper, with separate additions of nickel, manganese, tin, and silicon, were tested for their properties as solders for stainless steels types 3Kh13, 4Kh13 and Kh18-N9T in order to determine the best composition.

It was found that a solder consisting of copper to which had been added 4.5-5.5% nickel, 2.5-3.0% manganese, 2-2.2% tin, and 0.8-0.85% silicon had good mechanical properties and corrosion resistance.