Dec. 30, 1969 D. M. HEYWOOD 3,486,480

APPARATUS FOR COATING A NONMETALLIC FIBRE WITH A METAL

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FIG.1.

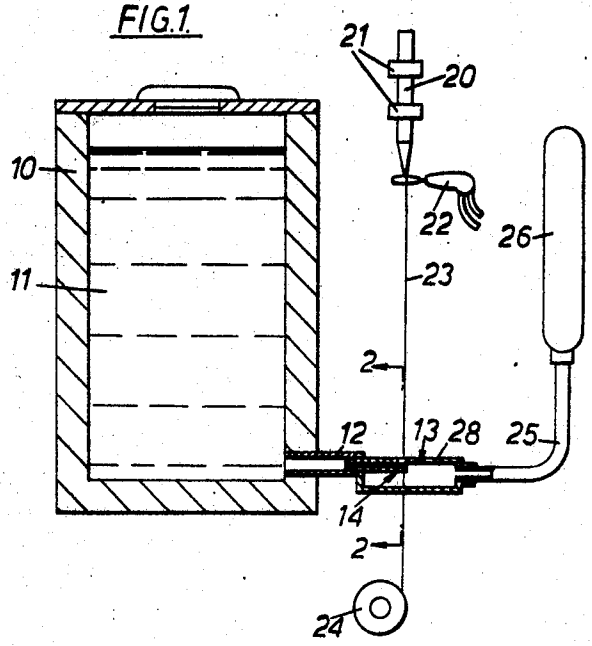
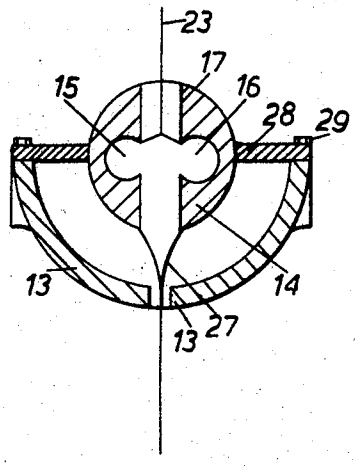


FIG.2.



Inventor

DAVID MAIN HEYWOOD

By

Cushman, Darby & Cushman Attorneys

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APPARATUS FOR COATING A NONMETALLIC FIBRE WITH A METAL

David Main Heywood, Derby, England, assignor to Rolls-Royce Limited, Derby, England, a British company

Continuation-in-part of application Ser. No. 425,775, Jan. 15, 1965. This application Oct. 25, 1968, Ser. No. 770,541

Claims priority, application Great Britain, Feb. 3, 1964, 4,577/64

Int. Cl. B05c 3/12

U.S. Cl. 118—401 2 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to metal coating of nonmetallic, e.g. silica, fibres by continuously passing the fibre through a slot in a nozzle having at least two axial passageways, the fibre passing through the slot transversely of the axes of the passageways. Molten metal is supplied through the passageways to the slot where it coats the fibre. The fibre is surrounded with a non-oxidising atmosphere after coating, and is exposed to oxygen at the entry thereof to the slot.

This invention concerns an apparatus for coating a nonmetallic fibre with a metal, and is a continuation-in-part of my application No. 425,775, filed Jan. 15, 1965, now abandoned.

According to the present invention there is provided an apparatus for coating a nonmetallic fibre with a metal comprising a reservoir adapted to contain molten metal, a coating chamber, means for supplying the said coating chamber with an atmosphere containing less than 5% oxygen by weight, a nozzle formed with substantially axial passage means through which molten metal from the reservoir is continuously discharged in operation, and a slot defined in said nozzle which has a fibre-entry end and a fibre-exit end and which intersects said passage means at a substantial angle, and means for drawing said fibre through said slot, said nozzle being so mounted that said fibre-exit end is positioned within the said coating chamber for communication therewith while said fibre entry end is positioned externally of the said coating chamber and communicates with normal atmosphere.

Preferably the said passage means includes at least two passageways which are substantially parallel and which communicate with each other.

The metal may be aluminium or an aluminium alloy, or indeed any metal or alloy e.g. cadmium which is prone to oxidation in air when in the molten state.

The fibre may be a silica fibre. Thus the fibre may be drawn from a rod of fused silica and through a high temperature flame. The flame may arise from the combustion of oxygen and coal gas.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a diagrammatic sectional view of apparatus according to the present invention for coating a nonmetallic fibre with a metal,

FIGURE 2 is a section on an enlarged scale taken on the line 2—2 of FIGURE 1.

Referring to the drawings, an apparatus for coating a fibre with a metal comprises a reservoir **10** which is adapted to contain molten metal **11** and which is provided with an outlet duct **12**. The molten metal **11** may be pure aluminium or may be an aluminium alloy containing 0.01% bismuth by weight. Means (not shown) are provided for keeping the metal **11** in the reservoir **10** molten.

A substantially semi-cylindrical coating chamber **13** has an upper wall **28** which as a coating nozzle **14** mounted centrally therein. The nozzle **14** has two substantially parallel ducts or axial passageways **15**, **16** which communicate with each other, and each of which communicates with the outlet duct **12**. Thus the passageways **15**, **16** are arranged to receive molten metal from the reservoir **10**. The nozzle **14** is also provided with a slot **17** which has an upper fibre-entry end and a lower fibre-exit end which communicates with the passageways **15**, **16**. The wall **28** is bolted to the remainder of the chamber **13** by bolts **29**.

A rod of fused silica **20** is clamped in position by support members **21**. Disposed adjacent the lower end of the rod **20** is a torch **22** which is supplied with oxygen and coal gas by means not shown. The flame from the torch **22** softens the lower end of the rod **20** and permits a fibre **23** to be drawn by hand from the lower end of the rod **20**.

Alternatively, the fibre **23** may be drawn from a source (not shown) of molten silica, or the fibre **23** may be a previously formed silica fibre.

The fibre **23** is passed through the flame from the torch **22** and through the slot **17** and is then wound around a take-up roller **24**. The fibre **23**, in passing through the slot **17**, becomes coated with the metal **11**.

The coating chamber **13** communicates by way of a pipe **25** with a bottle **26** of a gas such for example as nitrogen or any one or more of the gases argon, hydrogen, helium, carbon dioxide, carbon monoxide, hydrogen sulphide, ammonia or chlorine. The pipe **25** may be provided with a valve (not shown) for controlling flow therethrough and with a flow meter (not shown).

The fibre **23**, in passing through the slot **17**, will sometimes pick up a sac **27** of aluminium. It has been found that fibres coated with metal with the apparatus described so far, but without the use of a protective atmosphere of any sort, have a matt grey appearance when viewed from a distance and have, at irregular intervals along their length, spherical "blobs." These blobs grow near the apex of a conical sac of metal which forms under the tip of the coating nozzle and through which the fibre passes.

Blob formation is believed to be due to the presence of an oxide skin on the sac of metal (e.g. aluminium). The movement of a coated fibre down the sac will tend to set up a circulation in the aluminium giving rise to a tension in the alumina skin which surrounds the sac. This tension will vary considerably and will be affected by a number of factors, but it will from time to time be sufficient to rupture the alumina skin and allow the outflow of some metal. Once outside the sac, the aluminium is not affected by the movement of the fibre and is free to take up a spherical form. A blob may then grow until it reaches the apex of the sac when the moving fibre will interfere with its growth and tear the blob off. Alternatively, the original rupture may increase in size until the sac is so weakened that it cannot support the weight of the blob.

The above theoretical explanation suggests that if formation of the oxide could be suppressed, the formation of blobs might be prevented. This was found to be the case if an inert gas blanket was maintained over and around the entire coating nozzle, but it was found that, in a typical example, the fibre strength dropped from 450 kg./mm.$^{-2}$ for the "blobby" fibre to only 140 kg./mm.$^{-2}$ for the blob-free material.

It has been postulated that the explanation for this phenomenon is that the inert gas blanket excludes the oxygen from the molten aluminium and prevents the formation of a protective skin of alumina which would otherwise be continuously drawn down between the

aluminium and the silica fibre as the fibre enters the coating nozzle.

Accordingly, and with particular reference to FIGURE 2, the protective atmosphere is provided to cover only the bottom half of the coating nozzle **14**. Thus it will be seen that the upper or fibre-entry end of the slot **17** is open to normal atmosphere and the aluminium is thus allowed to oxidise and form a protective alumina skin on the fibre. Experiments have confirmed this and mean strengths of 563 kg./mm.$^{-2}$ have been recorded on small batches of coated fibres.

The protective atmosphere is thought also to make a contribution to high strength by acting as a constant temperature enclosure and by preventing draughts from affecting the coating nozzle temperature. The composition of the protective atmosphere was found not to be critical, provided it was substantially oxygen-free, i.e. contained less than 5% oxygen by weight. It was also found that the coated fibres had a lustrous appearance.

I claim:

1. Apparatus for coating a nonmetallic fibre with a metal comprising a reservoir adapted to contain molten metal, a coating chamber, means for supplying the said coating chamber with an atmosphere containing less than 5% oxygen by weight, a nozzle formed with substantially axial passage means through which molten metal from the reservoir is continuously discharged in operation, said passage means including at least two passageways which are substantially parallel and which communicate with each other, and a slot defined in said nozzle which has a fibre-entry end and a fibre-exit end and which intersects said passage means at a substantial angle, and means for drawing said fibre through said slot, said nozzle being so mounted that said fibre exit end and substantially all of the delivery end of said parallel passageways are positioned within the said coating chamber for communication therewith while said fibre entry end is positioned externally of the said coating chamber and communicates with normal atmosphere.

2. Apparatus as claimed in claim **1** wherein the coating chamber is substantially semi-cylindrical, the said coating nozzle being mounted substantially centrally of its planar wall.

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MORRIS KAPLAN, Primary Examiner