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Nileshwar

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[54] **PLUGS FOR USE IN TUBE-DRAWING**

[75] Inventor: **Vivek Baburao Nileshwar,** Four Oaks, Sutton Coldfield, England

[73] Assignee: **S.T.D. Services Limited,** Birmingham, England

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[51] **Int. Cl.** **B21c 1/24**

[58] **Field of Search** 72/283, 209, 478

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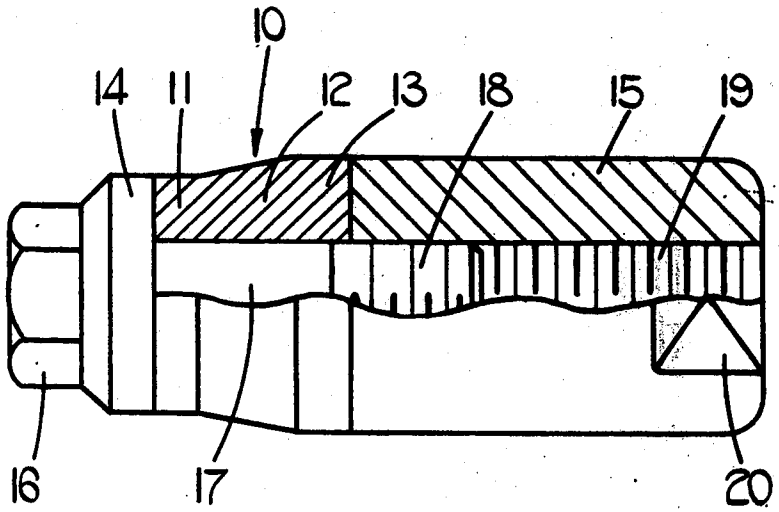
Primary Examiner—C. W. Lanham
Assistant Examiner—M. J. Keenan
Attorney, Agent, or Firm—Finnegan, Henderson, Farabow & Garrett

[57] **ABSTRACT**

A plug for use in tube-drawing operations wherein the plug is formed of a ceramic material and is provided with means whereby an axially-directed compressive stress is applied to the plug.

5 Claims, 2 Drawing Figures



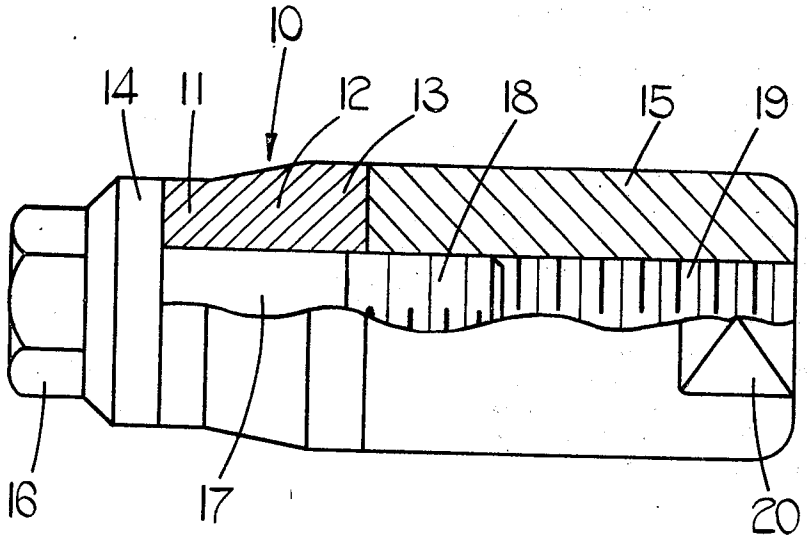


FIG. 1.

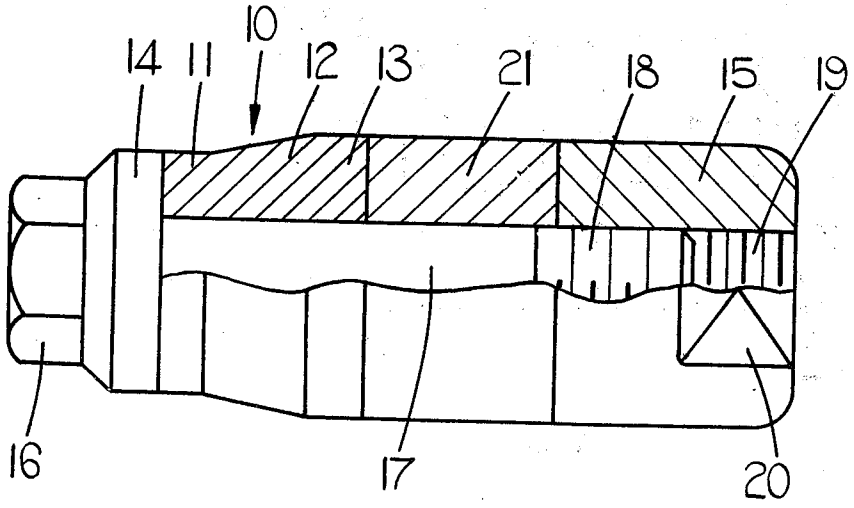


FIG. 2.

PLUGS FOR USE IN TUBE-DRAWING

This invention relates to plugs or mandrels (hereinafter referred to as plugs) which are used in tube drawing operations, the object of the invention being to provide such a plug in an improved form.

In accordance with the invention there is provided a plug for use in tube-drawing wherein said plug is formed of a ceramic material and is provided with means for applying to the plug an axially-directed compressive stress.

The term "ceramic material" as used in the preceding paragraph and in the remainder of this specification is to be taken to mean a suitable material which is formed mainly or wholly from an oxide, carbide, nitride or boride of a metal or semi-metal such as silicon. Furthermore, the term "axially-directed" is to be taken as referring to a direction which, when the plug is in use, is parallel to the axis of the tube which is being drawn.

Conveniently, said means for applying an axially-directed compressive stress to the plug comprises screw actuated means and may embody a pair of abutments disposed respectively at the opposite axial faces of the plug.

The invention will now be more particularly described with reference to the accompanying drawing wherein

FIG. 1 is an elevation, partly in section, of one example of a tube-drawing plug formed in accordance with the invention, and

FIG. 2 is also an elevation, partly in section, of an alternative embodiment of a tube-drawing plug in accordance with the invention.

Referring firstly to the construction seen in FIG. 1 there is shown therein a plug **10** which is formed from any suitable ceramic material as hereinbefore defined. Said plug comprises a generally cylindrical portion **11**, a frusto-conical portion **12** and a further generally cylindrical portion **13**, the portion **12** integrally connecting the portions **11** and **13**.

The plug is also provided with means for applying an axially directed compressive stress to the plug and in the example shown said means includes a pair of abutments **14** and **15** which are each formed of metal such as steel. The abutment **14** comprises an end cap from one axial end of which projects a non-circular extension **16** and from the other axial face of which projects a stem **17** which extends through a central unthreaded bore formed in said plug **10**. Furthermore, the exterior of said stem **17** at its end remote from the abutment **14** is formed with a screw thread **18** which engages a threaded central bore formed in the abutment **15**. Thus, said abutment **15** has a bore which is aligned with the bore formed in the plug **10** and which is provided with a screw thread **19**. The exterior of said abutment **15** is formed with flats such as that indicated by reference numeral **20** or is otherwise shaped to receive a tool whereby it can be held or turned.

The above-described parts can therefore be assembled so that the plug **10** is located between the two abutments **14** and **15** whereas the abutments themselves are interconnected by means of the screw thread **18** formed on said stem **17** and the coacting screw thread **19** formed in the bore of the abutment **15**. The noncircular projection **16** and flats **20** can be used to grip the abutments **14** and **15** whilst they are turned relative to one another in such a direction as to cause the compressive force to be applied to the plug **10** thereby imparting to said plug an axially directed compressive stress, namely a compressive stress which extends in the direction of the length of said stem **17** which will of course be parallel to the axis of the tube being drawn when the plug is used in conjunction with a die on a drawing bench in a known manner. After stressing, the projection **16** can if desired be removed before the plug is used. The outer end of the screw thread **19** of the abutment **15** is used for screwing the assembly on to the end of a plug bar which again forms part of the known tube drawing apparatus.

Conveniently, the plug **10** will be pre-stressed by the aforementioned compressive stress to such an extent that said compressive stress will be balanced or substantially balanced by the tensile stress that will be applied to the ceramic plug in use. The net tensile stress thus applied to the plug in use will, at worst, be relatively small so that the inherent weakness of a ceramic plug in tension will be obviated and so other desirable properties of ceramic materials, such as, for example, the low frictional forces that will be generated in use, can be utilised. The invention can also be applied to a plug which does not have the frusto-conical portion **12** but which is generally cylindrical throughout.

In the alternative embodiment shown in FIG. **2**, there is provided a spacer **21** which is inserted between the abutment **15** and the plug **10**. Said spacer **21** is also formed of metal but the metal used is chosen so that it has a higher coefficient of thermal expansion than that of the metal used for the abutments **14** and **15**. Thus where the latter are formed from steel, the spacer **21** can be formed for example of brass or copper. Such a spacer will then compensate for the differential thermal expansion of the abutments **14** and **15** on the one hand and the plug **10** on the other hand, it being appreciated that in use the plug **10** may attain a temperature of up to **200°C** so that at such temperatures and without the spacer **21** as above-described the differential expansion of the steel abutments and the ceramic plug may result in an undesired relaxation of the initial compressive stress.

I claim:

1. A mandrel having a plug for use in tube-drawing comprising a plug formed of a ceramic material and means on said mandrel for applying to the plug an axially-directed compressive stress equal to the tensile stress that will be applied to the plug in use to counteract the tensile stress generated against the plug during tube-drawing.

2. A plug as claimed in claim **1** wherein said means for applying an axially-directed compressive stress to the plug comprises screw actuated means.

3. A plug as claimed in claim **2** wherein there is provided a pair of metallic abutments which are threadably connected together.

4. A plug as claimed in claim **3** wherein said pair of metallic abutments respectively engage the opposite axial faces of the plug.

5. A plug as claimed in claim **3** wherein one of said abutments engages one axial face of the plug and wherein there is provided a spacer which is inserted between the other abutment and the other axial face of the plug so as to engage said other axial face of the plug, said spacer being formed of a metal having a higher coefficient of thermal expansion than that of the metal from which said abutments are formed, said spacer being confined between said other abutment and other axial face to produce an expansion force between the abutment and face when the temperature of the mandrel, plug and spacer is raised in use to apply the axially directed compressive stress to the plug.

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