

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) METHOD AND APPARATUS FOR MANUFACTURING BEARINGS

(71) We, JANOS KURUCZ of 21 Route Neuve, Orient, Vaud, Switzerland and ANDRE MATTHEY of 33 Les Jeannerets, Le Locle, Neuchatel, Switzerland, both Swiss citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process for manufacturing bearings that are to be used in the watchmaking industry and in small apparatuses. These bearings are made of a thermoplastic material directly moulded into the supporting body of the bearing.

According to one aspect of the present invention there is provided a process for manufacturing bearings usable in the watchmaking industry and in small apparatuses, wherein the bushing of the bearing is made of a thermoplastic material directly moulded in a supporting body of the bearing and which comprises installing the bearing body on a tapered end of a punch reciprocable along its longitudinal axis, said tapered end penetrating a small distance into the inside of said body, placing a piece of thermoplastic material on the body, heating body and material together at a heating zone until the material softens, moving said punch together with said bearing body and thermoplastic material towards a fixed member placed in direct vertical alignment with the tapered end of the punch, said moving of the punch allowing the piece of thermoplastic material to leave the heating zone before the final stage of the process which final stage comprises moulding by squeezing and crushing said material between the punch and the fixed member, the material being cooled instantaneously by contact with the fixed member during the moulding.

The fixed member may be heated to provide a temperature control of the ratio of the temperature of the bearing body and the movable punch to that of the fixed member

with regard to the nature of the thermoplastic material used for the moulding.

The temperature of the fixed member may be kept constant during the process.

According to another aspect of the invention there is provided a moulding device which comprises a punch reciprocable along its longitudinal axis and provided with a tapered end for receiving a supporting body of a bearing and a piece of thermoplastic material placed on said bearing, means for heating said bearing body and said piece of thermoplastic material at a heating zone when received by said tapered end and a fixed member in direct vertical alignment with the punch, moving of the punch allowing the piece of thermoplastic material to leave the heating zone before the moulding stage of the process.

The heating means may comprise radiation heaters.

According to one embodiment of the invention the heating means comprises ring-shaped heating elements having at their centre the tapered end of the punch when said punch occupies one of the two extreme positions define by its stroke.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is an axial sectional view of a device for manufacturing bearings for the watchmaking industry; and

Figure 2 is another magnified sectional view of a part of the same device showing the phase of moulding.

The device, pictured schematically, comprises a frame structure 1 having at the base a boring and a movable punch-bearer 3 therein. A tapered punch 4 is attached to the upper end of the punch bearer 3, which is arranged to be driven, in the direction of the arrows 5, by a master lever 6 located in a radial spacing 7 of the frame 1, and which is pivoted at 6a.

There is a hollow spacing 8 in the upper

part of the frame 1, containing an annular stationary heating body 9 which acts essentially at a level corresponding to the top of the punch 4 when the punch 4 is in its lower starting position as shown in Fig. 1.

The frame carries a fixed member 10 located coaxially to and facing punch 4.

The above device operates as follows:

10 An annular bearing-body 11 is installed on the tip of the punch 4; when punch 4 is in its lower position (fig. 1), the bearing-body engages slightly into the boring of the punch bearer 3 which accommodates the punch 4. A piece of thermoplastic material 12, preferably self-lubricating, is placed over the bearing-body 11 and both of these elements, 11 and 12, are heated together by the heater, or oven 9.

20 The heating temperature should be about 30 to 40°C less than the melting point of the thermoplastic material. It is therefore preferable that the heater be regulated in such a manner that the heating temperature does not go beyond the temperature at which the plastics simply softens, even if the punch 4 stays in its initial position longer than necessary. Therefore, the heating time is not critical and the working rate need not be predetermined.

30 Because of internal cohesion forces, the plastics material does not flow when heated at the right temperature but acquires the shape of a small shiny sphere which remains so, as long as the heating temperature is constant. This change is visible and informs the operator of the moment at which he should operate master lever 6 which moves up the carrier 3, the punch 4, the bearing body 11 and the plastics 12 in the direction of the member 10.

40 While being moved, the body 11 and the plastics 12 leave the heating zone of the oven 9, which heats by radiation, the heating of which becomes inoperative on the plastics at the very moment when it should stop, that is to say before the start of the phase of moulding and shaping of the thermoplastic material.

50 Just before the carrier 3 reaches the end of its stroke, the plastics 12 meets the front side of the stationary member 10; it is then squeezed and squashed between the punch and the fixed member and simultaneously force shaped into the body 11.

55 While this shaping operation is performed, the plastics is cooled instantaneously by contact with member 10; so it may be advantageous to choose for member 10 a material having a thermal conductivity suited for the purpose.

60 The cooling rate of the plastics during moulding and the moulding pressure are critical for obtaining, on the surface of the bushing 12 and particularly the surfaces form-

ing the central hole thereof shaped by the tip of the punch 4, a film having a harder structure than the rest of the material.

This film results from the cooling of the "skin" which exists around the molten plastics when the plastics is softened to give the shiny ball described above. The "skin" constitutes a "bag" which is simply shaped by fixed member 10; the "skin" is ruptured by the ring shaped edge 13 born by the front face of member 10, only at the moment when this edge contacts a flanged opening 14 in the inside of bearing-body 11.

80 However already then, the cooling effect produces a hardening of the "skin" which results in the formation of the hard surface film mentioned above which film imparts to the bushing 12 good shock absorbing properties.

85 Effectively, the structure of the material of the bushing is not hard enough to prevent its from responding elastically against the action of a side stress resulting from the operational presence of the bearing shaft. However, the surface film is hard enough not to be damaged by impacts from said shaft.

90 It should be noticed that the annular plastic residue 12', which is cut off from the material 12 by the ring edge 13 of the fixed member 10, remains around member 10 when punch 4 withdraws, wherefrom this residue 12' can be easily brushed off.

95 The work-up of the present process may involve some problems resulting from variations in softening and melting points of different plastics and due to the fact that these temperatures must be carefully controlled during work-up.

100 For instance it has been noticed that the cooling conditions have to be accurately controlled, and modified when one sort of plastics is replaced by another one, otherwise the crystallization of the plastics is incomplete and the finished product is unsatisfactory, its properties changing with age.

110 The above difficulties are removed by the present invention.

115 The keeping of the fixed member at a constant temperature during operation prevents said member from being at an improper temperature when it contacts the molten plastics. The ratio between the temperature of the punch with the bearing-body and that of the fixed member can then be optimized with regard to the thermoplastic material chosen.

120 The provision of a ring-shaped heating element to heat the fixed member enables the temperature control to be obtained either by varying the supply voltage, or by an axial displacement of the heating element along the member, or by modifying its diameter, i.e. its distance to the member. Evidently the same control means can be applied to the

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punch which permits a fine setting of temperature ratios.

The heater of the punch can also be provided with a metal tube which extends the heating action almost right up to the fixed member. The size and the shape of this tubular part can be chosen as a function of the desired temperature ratio.

Concerning said ratio, it can be said that for instance when the thermoplastic material is polyethylene terephthalate, the temperature of the punch, bearing-body and plastics can vary from 240° to 280°C, the optimum value being about 260°C, whereas the fixed member should be between 130 and 150°C, the optimum being around 140°C.

In the case of polyacetals, the punch temperature can be between 150 and 180°C, the optimum being at 160°, whereas the fixed member should be between 40 and 60°C, the optimum being 50°C.

It is thus possible to have very fine adjustments of the temperature ratios; this is extremely important where the manufacture of micro-bearings with a total volume of only a few tenth of a cubic millimeter is concerned.

WHAT WE CLAIM IS:—

1. A process for manufacturing bearings usable in the watchmaking industry and in small apparatuses, wherein the bushing of the bearing is made of a thermoplastic material directly moulded in a supporting body, the process comprising installing the body on a tapered end of a punch reciprocable along its longitudinal axis, said tapered end penetrating a small distance into the inside of said body, placing a piece of thermoplastic material on the body, heating body and material together at a heating zone until the material softens, moving said punch together with said bearing body and thermoplastic material towards a fixed member placed in direct vertical alignment with the tapered end of the punch, said moving of the punch allowing the piece of thermoplastic material to leave the heating zone before the final stage of the process, which final stage comprises moulding by squeezing and crushing said material between the punch and the fixed member, the material being cooled instantaneously by contact with the fixed member during the moulding.

2. A process as claimed in claim 1, wherein the fixed member is heated to provide a temperature control of the ratio of the temperature of the bearing body and the movable punch to that of the fixed member with

regard to the nature of the thermoplastic material used for the moulding.

3. A process as claimed in claim 1 or claim 2, wherein the temperature of the fixed member is kept constant during the process.

4. A moulding device for carrying out the process of claim 1, which comprises a punch reciprocable along its longitudinal axis and provided with a tapered end for receiving a supporting body of a bearing and a piece of thermoplastic material placed on said bearing, means for heating said bearing body and said piece of thermoplastic material at a heating zone when received by said tapered end and a fixed member in direct vertical alignment with the punch, moving of the punch allowing the piece of thermoplastic material to leave the heating zone before the moulding stage of the process.

5. A device as claimed in claim 4, wherein the heating means comprises radiation heaters.

6. A device as claimed in claim 4 or claim 5, wherein the heating means comprises ring-shaped heating elements having at their centre the tapered end of the punch when said punch occupies one of the two extreme positions defined by its stroke.

7. A device as claimed in any one of claims 4 to 6, which includes means to heat the fixed member.

8. A device as claimed in claim 7, wherein the heating means for the fixed member are electrical.

9. A device as claimed in claim 7 or claim 8, in which the said electrical heating means are movable along the longitudinal axis of the fixed member.

10. A device as claimed in any one of claims 7 to 9, wherein the electrical heating means have a modifiable shape so that their heating action on the fixed member is adjustable by changing the distance between an element of the heating means and the fixed member.

11. A process for manufacturing bearings substantially as hereinbefore described.

12. A device for manufacturing bearings substantially as hereinbefore described with reference to the accompanying drawings.

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2. A process as claimed in claim 1, wherein the fixed member is heated to provide a temperature control of the ratio of the temperature of the bearing body and the movable punch to that of the fixed member with

regard to the nature of the thermoplastic material used for the moulding.

3. A process as claimed in claim 1 or claim 2, wherein the temperature of the fixed member is kept constant during the process.

4. A moulding device for carrying out the process of claim 1, which comprises a punch reciprocable along its longitudinal axis and provided with a tapered end for receiving a supporting body of a bearing and a piece of thermoplastic material placed on said bearing, means for heating said bearing body and said piece of thermoplastic material at a heating zone when received by said tapered end and a fixed member in direct vertical alignment with the punch, moving of the punch allowing the piece of thermoplastic material to leave the heating zone before the moulding stage of the process.

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7. A device as claimed in any one of claims 4 to 6, which includes means to heat the fixed member.

8. A device as claimed in claim 7, wherein the heating means for the fixed member are electrical.

9. A device as claimed in claim 7 or claim 8, in which the said electrical heating means are movable along the longitudinal axis of the fixed member.

10. A device as claimed in any one of claims 7 to 9, wherein the electrical heating means have a modifiable shape so that their heating action on the fixed member is adjustable by changing the distance between an element of the heating means and the fixed member.

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