ABSTRACT OF THE DISCLOSURE

A wire-drawing block of the stepped-cone type having a tubular core of metallic material and several coaxial, axially offset rings of sintered ceramic material, the rings being secured by clamping elements which engage an outer cylindrical face of each ring while the inner ring faces are separated from the core by annular gaps, resilient packings being axially interposed between the ceramic rings and the metallic structure. Tensile stresses in the ceramic rings due to differences in thermal expansion coefficients are thereby avoided.

Background of the invention

This invention relates to wire-drawing equipment, and particularly to a block or capstan for drawing wire through a die.

Wire-drawing blocks have been made from unitary pieces of polycrystalline, sintered aluminum oxide. The hardness, wear resistance, and low coefficient of friction of this material when in contact with metals permit long, trouble-free operation, but it is difficult to make large pieces of sintered aluminum oxide and to finish them to exacting dimensional tolerances.

It has therefore been attempted hitherto to provide a metallic block core with annular aluminum oxide facings for contact with the wire being drawn. Such facings are not entirely successful, aluminum oxide has a coefficient of thermal expansion which is much smaller than that of the ordinary metallic materials of construction employed for making the core. As the block expands under frictionally generated heat, the alumina facings are subjected to tensile stresses which lead to their destruction long before they need to be replaced because of surface wear.

The object of the invention is the provision of a wire-drawing block having a metallic core and wear resistant rings of a material having a lower coefficient of thermal expansion, yet not subject to thermal tensile stresses because of contact with the metallic block elements.

Summary of the invention

The wire-drawing block of the invention has a metallic core member and a unitary ring having a coefficient of thermal expansion substantially smaller than that of the metallic material. A clamping element on the core member abuttingly engages an outer annular face of the ring, whereas an inner annular face of the ring and an opposite annular face of the core member define an annular gap extending radially therebetween over the entire axial height of the ring at all normal operating temperatures of the block, that is, between 0° C. and 100° C.

The advantages of this invention become of substantial economical importance if the material of the ring has a coefficient of linear thermal expansion which is not substantially greater than one half of the corresponding coefficient of the metallic core material. The advantages achieved are also directly related to the differences in ductility and hardness between the two materials.

These advantages are largely lost if the nonmetallic ring is tightly clamped between axially adjacent metal elements. A yieldably resilient material should be axially interposed between the ring and axially adjacent metal elements.

Other features and the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing.

Brief description of the drawing

The sole figure of the drawing shows a wire-drawing block of the invention in elevation, and partly in section on its axis.

Description of the preferred embodiment

The illustrated stepped-cone block has a tubular steel core 1 which is normally mounted on a coxial drive shaft, not shown. It carries three coaxial, axially offset, short, cylindrical rings 2, 3, 4 of polycrystalline, sintered alumina whose diameter decreases in the direction of the block axis from the ring 2 to the ring 4.

A disc-shaped clamping ring 5 is fastened to the core 1 by circumferentially spaced screws 12 and lock washers 13, only one screw and the associated lock washer being visible in the drawing. An annular, axially terminal edge of the alumina ring 2 is received in an annular recess of the clamping ring 5. A narrow face of the clamping ring 5 which is directed toward the block axis in the recess abuttingly engages the outer cylindrical face of the wire-drawing ring 2. A disc-shaped packing 8 of resiliently compressible cork composition is axially interposed between parallel radial faces of the rings 2, 5 in the recess.

An integral flange 14 of the steel core 1 has a recess which receives the other axially terminal edge of the alumina ring 2 as described with reference to the clamping ring 5 to limit radially outward movement of the alumina ring 2 while a resilient packing in the recess yeldably secures the axial position of the ring 2 on the core 1, and permits relative radial movement of the core 1 and the ring 2 during thermal expansion and contraction of the block.

An annular gap 21 radially separates the inner cylindrical face of the alumina ring 2 from an opposite approximately cylindrical outer face of the core 1. A pin 15 projects radially from the last-mentioned face into an oversized recess 14 of the ring 2, thereby limiting rotary movement of the ring 2 to the small clearance between the pin 15 and the walls of the recess.

The smaller alumina ring 3 is axially secured on the core 1 between recesses of the flange 14 and of another clamping ring 6 in the same manner as the ring 2, packings 9 being axially interposed between the brittle alumina of the ring 3 and the steel surfaces of the flange 14 and of the clamping ring 6, whereas the ring 3 is confined in a radially outward direction by direct abutting engagement with the flange 14 and the clamping ring 6, and is separated from the core 1 in a radially inward direction by a gap 30.

The clamping ring 6 is attached to the core 1 by screws 16 whose heads are accessible in another annular recess of the ring 6 which receives an edge portion of the third wire-drawing ring 4, the opposite edge portion being held by a clamping ring 7, the arrangement being generally the same as described with reference to the rings 2, 3, disc-shaped cork composition packings 10 being axially interposed between the ring 4 and the coning steel elements. The clamping ring 7 is held in position on the core 1 by screws 17 and by engagement of an annular shoulder 11 on the ring 7 with a corresponding face of the core 1.
The exposed outer cylindrical faces of the alumina rings 2, 3, 4 are ground and polished to close tolerances, and the radially inwardly directed faces of the clamping rings 5, 6, 7 and of the flange 1 which abuttingly engage the alumina rings are precisely centered in the block axis by the screws 12, 16, 17 and the shoulder 11. The apparatus is illustrated in its condition at ordinary room temperature. It normally is operated at elevated temperatures which may reach 1000° C. The coefficient of linear thermal expansion of the structural steel in the core 1 between 0° C. is approximately 12 to 14×10⁻⁶ per degree of the temperature rises during wire drawing, the width of the gaps 2', 3', 4' decreases, but the initial width of the gaps is sufficient to prevent their total disappearance at the highest temperatures which may prevail during operation.

Sintered aluminum oxide is extremely hard (1900-2000 Kg./mm²), much harder than the steel of the core 1, and has high compressive strength. However, it is very brittle and is not successfully employed when stressed in tension. The afore-described arrangement avoids tensile stresses in the rings 2, 3, 4 which would be due to contact with expanding metal.

Only one cylindrical surface of the rings 2, 3, 4 has to be finished to achieve the desired low friction in contact with the wire that is being drawn, and for the precise centering of the rings 2, 3, 4. The face of each ring which is directed toward the axis need not be finished, and is roughness cannot affect the operation of the block. Because of the very high wear resistance of sintered aluminum oxide, the outer annular faces of the rings 2, 3, 4 remain smooth even after long periods of operation. Because of the absence of contact with expanding metal, minute surface imperfections which may eventually develop do not cause significant stress concentration and the subsequent rapid destruction of the brittle alumina rings at the high operating speeds common in the drawing of fine wires.

While the invention has been described with reference to a wire-drawing block of the stepped-cone type, it will be appreciated that the number of alumina rings coaxially held on a common metal core is not critical, and that the advantages of this invention are available even with a single ring of brittle ceramic material.

The invention is equally applicable to other combinations of materials which differ greatly in their coefficients of thermal expansion. Bronze is commonly employed as a material of construction for blocks, and its coefficient of linear expansion is approximately 18×10⁻⁶ per degree C. Tungsten carbide is another non-metallic hard material which may be employed in the construction of the rings 2, 3, 4, and whose coefficient of thermal expansion is not substantially greater than one half of the coefficients of the afore-mentioned metallic materials.

The cork composition which constitutes the packings 8, 9, 10 may be replaced by another yieldably resilient material such as fabric reinforced rubber or leather. The axial position of the rings 2, 3, 4 need not be precisely maintained, and the packings take up the difference in axial thermal expansion between the metallic and non-metallic elements.

What is claimed is:
1. A wire drawing block comprising, in combination:
(a) a core member of metallic material having an axis and an annular face about said axis, said face being directed in a radially outward direction; and
(b) a unitary ring member of nonmetallic, brittle mate-

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