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DIES USED IN DRAWING, EXTRUSION, FORGING, SIZING
AND LIKE OPERATIONS
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FIG. 1.

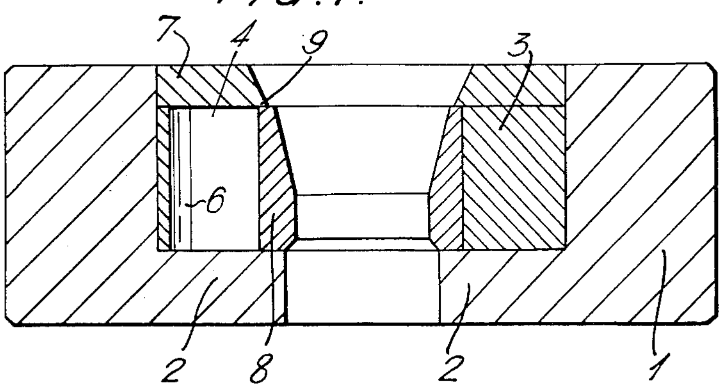

FIG. 2.

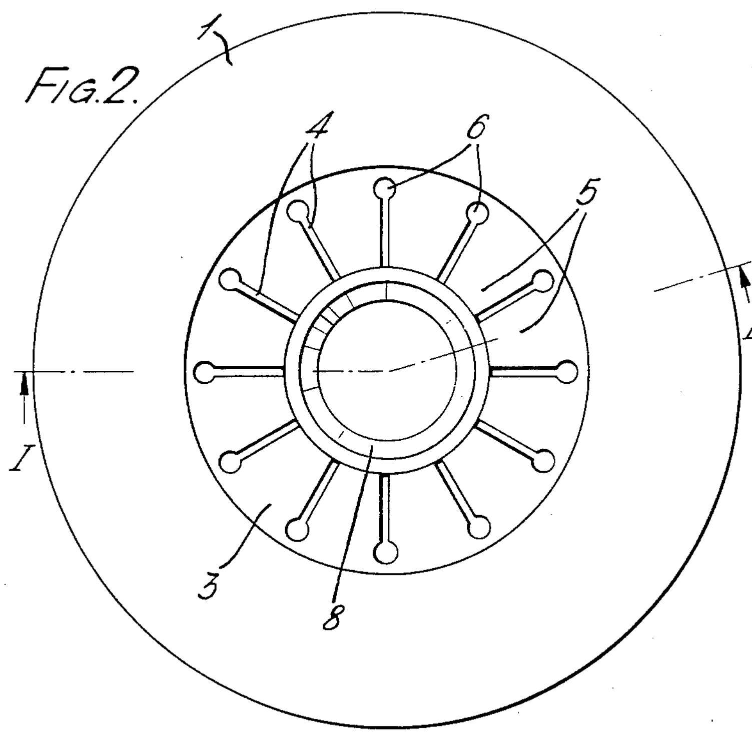

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FIG. 3.

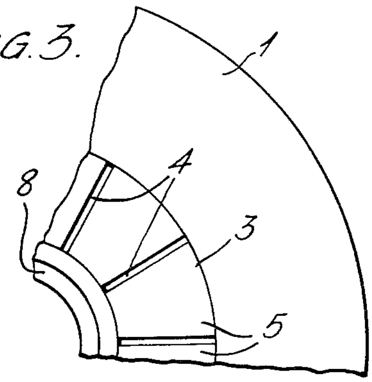


FIG. 4.

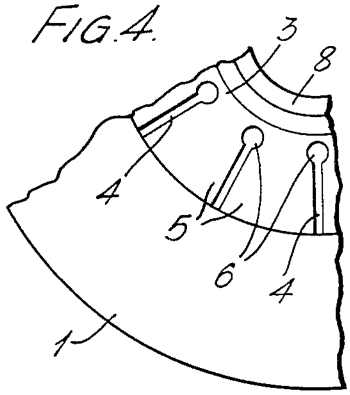


FIG. 5.

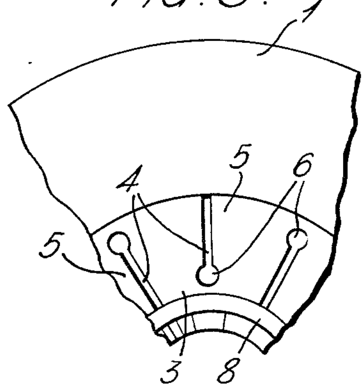
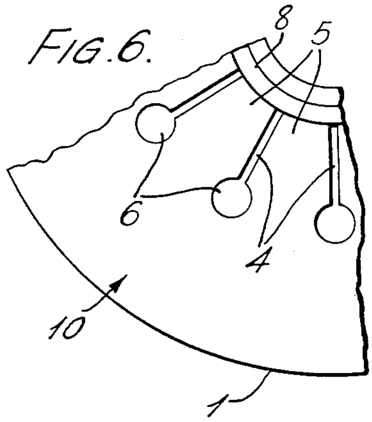


FIG. 6.



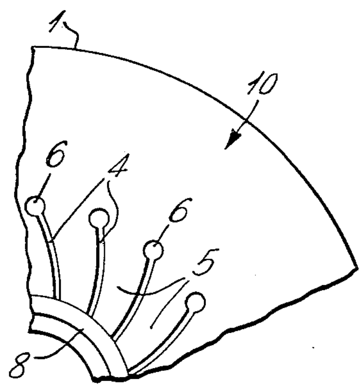


FIG. 7.

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DIES USED IN DRAWING, EXTRUSION, FORGING, SIZING AND LIKE OPERATIONS

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Claims priority, application Great Britain, Mar. 30, 1962, 12,342/62
3 Claims. (Cl. 72—467)

This invention relates to improvements in dies used in drawing, extrusion, forging, sizing and like operations, i.e., to unitary dies, as opposed to split dies, in which the workpiece is forced into or through the die aperture.

More specifically the invention is concerned with such dies of the kind (hereinafter termed "dies of the kind referred to") in which an insert forms the working portion of the die, i.e., the insert defines the die aperture, the insert being surrounded and supported by a bolster or case in which it is an interference fit so that the bolster or case places the insert in compression to withstand the bursting forces to which it will be subjected in use.

With dies of the kind referred to the materials of the insert and bolster are different and usually have appreciably different thermal coefficients of expansion. As a result of the differential expansion which occurs, the use of such dies at working temperatures considerably above or below normal room temperature is usually very restricted. For example, if the coefficient of expansion of the bolster is greater than that of the insert the compressive loading of the insert can rapidly be reduced to nothing at only a few hundred degrees above normal whilst at low temperatures the material of the bolster or insert may be stressed beyond the elastic limit.

It would be possible to overcome these difficulties by introducing the insert into the bolster after the bolster had been brought to the working temperature with a degree of interference appropriate at the working temperature to produce the required compressive loading of the insert and, if necessary, to prevent damage, removing the insert or reducing the compressive load on the insert before the bolster was allowed to assume normal room temperature. This however would, in general, be inconvenient in use and it is thus an object of this invention to provide a die of the kind referred to requiring no special procedure in its use, such as removing the insert at the finish of each period of use of the die but which overcomes or reduces the above-mentioned limitations on the use of dies of the kind referred to at temperatures considerably different from room temperature and particularly at elevated temperatures.

Thus according to the present invention there is provided a die of the kind referred to wherein the bolster or case is spaced from the insert and spacing means is disposed between the insert and the bolster or case, said spacing means being so constructed as to be incapable of being circumferentially stressed to exert any significant compressive loading on said insert and serving merely to transmit the compressive loading from the bolster or case to said insert.

The amount of interference between insert and bolster of a normally constructed die of the kind referred to, is limited by the yield strength of the materials from which the insert and the bolster or case are made. This may amount to only a few thousandths of an inch. The change in the effective interference produced by differential expansion of the differing materials with change in temperature can quickly become comparable with the initial interference and thus severely limit the working temperature range of the die as mentioned previously.

By providing a bolster or case with a means of spacing the inside of the bolster from the outside of the insert by suitable spacer means, the interference between the insert and the spacing means to stress the bolster or case to the desired degree is larger than if the same insert were mounted directly in the bolster or case. The increase in interference for the same stress factor in the bolster is roughly proportional to the increase in the inside dimensions of the bolster or case.

However the change in effective interference due to differential expansion of the insert and bolster or case upon changes of temperature is the same for dies of the kind referred to constructed in the conventional manner and for dies constructed in accordance with the invention (and utilising the same materials). The proportional change in interference with variations of temperature is therefore less in the case of a die constructed according to the invention than for a die of conventional construction and of the kind referred to, i.e., where the insert is mounted directly into the solid bolster or case. As a result the working temperature range of a die of the kind referred to can be very substantially increased by means of the present invention.

The determination of the optimum interference between the insert and the spacing means for any particular die is not essentially different from that for conventional dies of the kind referred to and presents no difficulty.

Apart from expansion, either positive or negative, due to changes in temperature, it will be appreciated that the spacing means will also expand and contract with changes in the compressive force acting thereon as a result of changes in the effective interference between the insert and the spacing means with such temperature changes. Thus if the effective interference decreases with change in temperature, the compressive forces acting on the spacing means will also decrease and the spacing means will expand and thus partly offset the change in effective interference. Conversely if the effective interference increases the spacing means will contract due to the increased compressive forces acting thereon and this again will partly offset the change in effective interference.

In certain circumstances it may be possible to provide spacing means of a material having a coefficient of expansion suitable further to offset the change in effective interference due to differential expansion of the insert and bolster or case. For example with a die intended for use at elevated temperatures and where the insert has a lower coefficient of thermal expansion than the bolster, spacing means of a material having a coefficient of expansion greater than that of the insert and bolster or case would serve this purpose.

The material of the insert will usually be chosen for its hardness and may, for example, be tungsten carbide, a cermet or ceramic. The coefficient of expansion of an insert chosen for hardness may be considerably less than that of the surrounding bolster which is conveniently made of steel.

The spacing means may be separate from or secured to or even integral with the bolster or case. Preferably the spacing means comprises several, e.g., ten to twenty, spacing members equi-spaced around the circumference of the insert. These members can be separate or for convenience weakly joined at their inner or outer extremities. They may be connected to the bolster or case permanently before the insert is introduced therein in any suitable manner. Such spacing members can also be integral with the bolster or case thus resembling inwardly projecting teeth and can be formed by slotting a ring or annular member at intervals therearound from the inside outwardly part way through its thickness, only the unslotted thickness thereof then serving as the bolster or case. The slots in this case may define non-radially extending spacing members deflectable under compressive loading for compensating large differential expansion between bolster and insert.

In a preferred construction the spacing members are connected in a separate ring, having been formed by slotting a ring at intervals therearound either inwardly or outwardly or alternately inwardly and outwardly. In all of the abovementioned arrangements of spacing members either no circumferential connections are provided between the spacing members themselves or such connections as are provided are such that the separate spacer ring so formed is incapable of being circumferentially stressed sufficiently to exert an significant compressive loading on said insert or to restrict the compressive loading from the bolster on said insert; the members thus serve merely to transmit the compressive loading from the bolster or case to the insert.

The spacing means is conveniently made of metal although other materials having suitable mechanical properties can be used.

Usually the bolster or case will be annular in shape and a separate spacer ring, if provided, will likewise be annular. Slots cut in such ring or in the bolster or case to form spacer members will preferably be radially arranged, so as to be substantially parallel to the lines of compressive force from the bolster and to be substantially perpendicular to the lines of circumferential stresses that might exist in the spacer ring save for the presence of said slots. The circumferential surface of the insert and the inner faces of the spacing members will then be either conical or cylindrical.

The insert can be introduced into the bolster or case and spacing means in the usual manner, i.e., by pressing or shrinking.

A multi-layer bolster or case may be provided, each layer being shrunk in turn on the preceding one as is well known to obtain greater compressive loading of the insert for a given size of bolster or case.

In order that the invention may be more fully understood a number of embodiments thereof will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a sectional elevation on the line I—I of FIG. 2 of one embodiment of a die in accordance with the invention;

FIGURE 2 is a plan view of the die shown in FIG. 1 with the cover plate removed;

FIGURES 3, 4 and 5 are fragmentary plan views of modifications of the die shown in FIGURES 1 and 2 and with their respective cover plates removed; and

FIGURES 6 and 7 are fragmentary plan views of further embodiments of a die in accordance with the invention with their cover plates removed.

Referring now specifically to FIGURES 1 and 2, there is shown a die of the kind referred to for use in the deep drawing of closed end steel cylinders at elevated temperatures and which comprises an annular steel bolster or case **1** of some 9″ internal diameter and 14″ outside diameter. One end of the aperture in the bolster is provided with an inwardly directed retaining flange **2**.

A separate steel spacer ring **3** is provided divided by equi-spaced outwardly extending radial slots **4** into twelve spacer members. These slots **4** terminate in bulbous portions **6** just short of the outer surface of the spacer ring **3** which is thus continuous. Because of its continuous form, the spacer ring can be accurately machined and measured prior to the assembly of the die. The external diameter of the spacer ring **3** is approximately 9″ and its mean internal diameter 6″.

The spacer ring **3** is disposed within the bolster or case **1** against the said retaining flange **2** thereof and is by an annular plate **7** press fitted into the other end of the opening in the bolster or case **1** after a tungsten carbide insert **8** has been introduced into the spacer ring **3**. An inwardly directed lip **9** of the cover plate **7** overlies the end of the insert **8**.

The mean internal diameter of the tungsten carbide insert **8** is of approximately 4″. The insert **8** is pressed or shrunk into the spacer ring in known manner.

It is found that at temperatures of around 550° C. the compressive loading on the insert 8 of the die is still sufficient for its use whereas had the insert been mounted directly in a bolster or case in conventional manner, such a die would have become unusable at such temperatures, because of the great reduction or even virtual disappearance of the compressive loading on the insert due to the differential expansion of insert and bolster or case.

FIGURE 3 shows a modification of the embodiment shown in FIGURES 1 and 2 in which the outwardly radial slots **4** extend through the outer surface of the spacer ring **3** and thus form twelve completely separate spacing members **5** between the bolster **1** and the insert **8**.

FIGURE 4 shows a further modification wherein the radial slots **4** extend inwardly from the outer surface of the spacer ring **3** and divide the spacer ring **3** into twelve spacer members **5**. The slots **4** terminate in the bulbous portions **6** just short of the inner surface of the spacer ring **3**.

Yet another modification is shown in FIGURE 5, where the radial slots **4** extend alternately from the inner surface and from the outer surface of the spacer ring **3** which is thus divided into twelve spacer members **5**. Here again the slots terminate in bulbous portions **6** just short of the outer or inner surface as the case may be.

In FIGURES 6 and 7 are shown dies in accordance with the invention in which the spacing means is formed integrally with the bolster.

Referring to FIGURE 6, radial slots **4** extend outwardly form the inner surface of an annular member **10**, terminating therewithin in bulbous portions **6**, and thus dividing the inner part of the member **10** into twelve spacing members **5** which separate the insert **8** from the outer part of the member which thus serves as the bolster **1** of the embodiments of FIGURES 1 to 5.

In the embodiment shown in FIGURE 7 the slots **4** extending outwardly from the inner surface of the member **10** are curved as shown and divide the inner part of the member **10** into eighteen spacing members **5**. This embodiment is of use where additional compressibility across the spacing means is required for compensating large differences of expansion between the bolster and the insert, and may be used, for example, in exceptionally high temperature work such as the extrusion of metals at very high temperature where the insert is formed from a non-metallic material to withstand oxidation and the bolster is formed, for instance, of a suitable high temperature metal alloy.

I claim:

1. A die assembly comprising: an annular bolster member; a die insert within and radially spaced from said annular bolster member; substantially rigid spacing means between said die insert and said bolster member comprising annular means having inner and outer peripheries, said spacing means bearing against both said bolster member and die insert to transmit radial compressive forces therebetween and comprising at least 10 circumferentially spaced spacer portions, each of said spacer portions being joined to an adjacent spacer portion only at the extremity thereof adjacent one of said peripheries, said portions being substantially uniformly spaced around said die insert whereby to engage said insert and bolster throughout nearly their entire peripheries to transmit radial compressive forces therebetween in all radial directions while being incapable of imposing compressive forces on said insert due to circumferential expansion or contraction.

2. A die assembly comprising: an annular bolster member, a die insert within and radially spaced from said annular bolster member, substantially rigid spacing means between said die insert and said bolster member, said spacing means comprising integral portions of said bolster member and comprising at least ten circumferentially spaced spacer portions, said portions being substantially uniformly spaced around said die insert whereby to engage said insert throughout nearly their entire peripheries to transmit radial compressive forces therebetween in all radial directions while being incapable of imposing compressive forces on said insert due to circumferential expansion and contraction.

3. A die assembly as defined in claim 2 wherein said integral portions extend inwardly from said bolster in a direction oblique to the corresponding radius.

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H. D. HOINKES, *Examiner.*