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DIE STRUCTURE FOR FORMING POWDER PARTICLES
INTO STRAND-SHAPED BODIES
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FIG. 1.

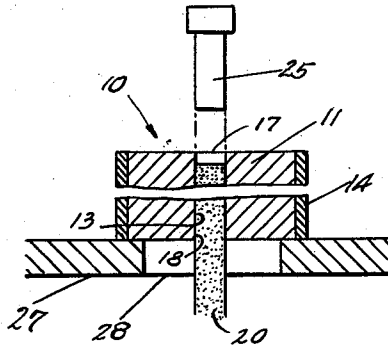
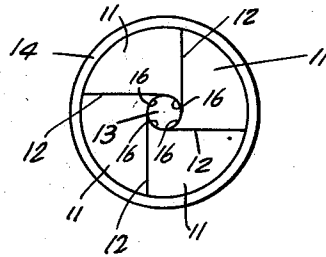


FIG. 2.



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DIE STRUCTURE FOR FORMING POWDER PARTICLES INTO STRAND-SHAPED BODIES

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2 Claims. (Cl. 18—12)

This invention relates to die structures for forming a mass of powder particles into strand-shaped, continuous, elongated bodies, and more particularly for forming metallic powder particles into a continuous, elongated, metallic strand. In the known arrangements for forming a mass of metal powder particles into continuous metal strands, incremental amounts of metal powder particles are delivered to an axially extending forming channel of a female die structure or matrix, the powder being compacted within the forming channel by successive strokes of a compacting plunger which compacts the delivered powder into a strand and advances the strand within the forming channel in a direction from the receiving end thereof towards the discharge end through which the compacted metal strand is discharged for use or further treatments.

In such known arrangements the movement of the compacted powder strand along the channel surfaces of the forming die provides the frictional resistance required in order to make it possible for the successive movements of compacting plunger to subject delivered incremental portions of the loose powder to the pressure required for compacting the powder particles into a relatively strong self-supporting strand-shaped metal body. It is inherent in the operation of such compacting arrangement that the frictional resistance between the compacted powder strand and the channel walls varies with successive impact cycles of the compacting plunger, since a slight increase of the frictional wall resistance developed in one compacting stroke will be incrementally increased with each subsequent impact stroke resulting in a rising increase of the frictional resistance between the compacted metal powder strand and the walls of the forming channel along which the strand is advanced towards the discharge end of the channel.

Although various arrangements have been proposed for overcoming this difficulty, none of them provided a satisfactory solution thereof.

Among the objects of the invention is a compacting die arrangement for forming out of powder particles and particularly out of metal powder particles, a continuous, compacted strand body while eliminating or minimizing the difficulties caused by the successive increase in the frictional resistance against movement of the compacted metal strand along the walls of the forming channel in which it is formed by successive impacts of the compacting plunger and advanced through the forming channel until it is discharged through the discharge end thereof.

In accordance with the invention, the female die structure of such compacting arrangement comprises a plurality of at least three complementary die segments held elastically restrained in contact engagement with each other along complementary junction surfaces extending outwardly from the curved inner forming channel formed by concave inner forming surfaces of the complementary die segments, the junction surfaces between adjacent die segments being so arranged that their inner regions merge tangentially into the adjoining concave shaping surfaces of the respective die segments.

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The foregoing and other objects of the invention will be best understood by the following description of an exemplification thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is a diagrammatic vertical sectional view of one form of a strand compacting arrangement of the invention; and

Fig. 2 is a plan top view of the female die structure of Fig. 1.

Referring to the drawings, there is shown a female die structure generally designated 10, comprising a plurality of die segments 11 engaging each other along segmental junction surfaces 12 and having inwardly facing complementary concave shaping surfaces 16 which define an elongated axially extending forming channel 13. In the arrangement shown, incremental amounts of metal powder are delivered to the upper receiving end 17 of the forming channel 13 wherein the delivered metal powder ingredients are compacted by successive downward impact strokes of the compacting plunger 25 shaped to enter and move into the interior of the receiving end 17 of the forming channel 13 for compacting the delivered metal powder into a metal strand 20 which is discharged through the discharge end 18 of the forming channel 13.

The female die segments 11 are held in their assembled position in which they maintain the desired shape of the forming channel 13 by an elastic restraining structure which is shown formed by a restraining metal ring 14 of elastic material, such as steel. The elastic metal ring 14 is designed to permit elastic expansion thereof under outward forces exerted thereon by outward movement of the die segments 11 away from their inward position in which they form the compacting channel 13, which, in the form shown, has a cylindrical shape.

In accordance with the invention, the individual die segments 11 of the female compacting die which define the forming channel 13, adjoin each other along segmental junction surfaces 12 the inner regions of which extend tangentially from or merge tangentially into the respective inward concave channel-forming segment at shaping surfaces 16. In operation, the metal powder which is to be formed into a continuous, long, compacted metal powder strand, is delivered in successive incremental amounts to the receiving end 17 of the forming channel 13. Each delivery of an additional amount of powder to the receiving end 17 of the forming channel 13 is followed by a stroke of the compacting plunger 25 on the so-delivered powder addition within the forming channel 13 wherein the delivered powder is compacted into a strand-shaped body 20 having the shape determined by forming channel 13. As each increment of metal powder delivered to the receiving end is compacted by the compacting plunger 25, the compacted powder body filling the deeper part of the forming channel 13 is advanced toward the discharge end 18 of the channel as a part of the formed strand which is discharged from the channel discharge end 18. With such arrangement, a continuous sequence of powder deliveries to the receiving end 17 of the forming channel 13 and the accompanying sequence of compacting movements of the compacting plunger 25 results in the production of the desired long, continuous, compacted metal strand 20 which is delivered from the discharge end 18 of the die structure.

The frictional resistance developed by movement of the compacted strand 20 along the deeper surfaces of the forming channel 13 provides the backing required for enabling the compacting plunger 25 to develop near the discharge end of the forming channel 13 the pressure necessary for compacting each delivered increment of metal powder into a strong self supporting metal strand 20. However, as explained above, difficulties have

been encountered in the past because the frictional resistance between the compacted metal powder strands and the walls of the forming channel along which the strand is advanced towards the discharge end, is incrementally increased with each successive compacting stroke. In accordance with the invention, these difficulties are overcome or radically reduced and minimized by making it possible for the individual die segments 11 to yield outwardly in case of an excessive frictional pressure, without materially deforming the shape of the continuous, curved channel-shaped surface of the forming channel 13. This is achieved by shaping the outwardly extending junction surfaces 12 along which the female die segments are held in their assembled channel forming position so that the inner region of the junction surfaces 12 merge tangentially in a continuous way into their respective concave inner channel-forming surfaces 16 which define the shape of the compacting channel. This arrangement assures that slight outward displacement of the die segments 11—under excessive friction pressure developed by successive impacting cycles—will not cause formation of openings or gaps along facing junction surfaces 12 of adjacent die segments 11. Furthermore, with such tangential junction-surface arrangement, when excessive frictional resistance causes the die segments to move outwardly against the radial restraining forces of the elastic restraining loop or ring member 14, the elastic forces of the restraining member 14 return the segments to their inward position without permitting any powder material to enter into gaps between adjacent facing die segment junction surfaces 12.

According to the invention, the die structure 10 is combined with a specially shaped backing support 27 on which the outer peripheral regions of the assembled die segments 11 of the die structure 10 rest. The backing structure 27 is provided with an opening 28 underlying a major part of the radial length of the die segments 11 of the die structure 10. The opening 28 of the backing structure 27 is sufficiently wide so that when excessive friction forces are developed incident to the movement of the compacted powder strand 20 along the channel surfaces of the forming channel 13 in the direction toward the discharge opening 18, the elastic restraining ring 14 permits the die segments 11 to move, not only in outward direction, but also to tilt with their inward central bottom edge region, as seen in Fig. 1, in downward direction into the space of the backing opening 28. Such elastically restrained movement of the die segments 11 in generally outward and slightly downward direction, although very minute, has been found very effective in overcoming the difficulties caused by excessive rise of frictional resistance encountered with prior arrangements for compacting metal powder bodies into continuous, long, self-supporting metal-powder strands.

Although the invention was evolved in connection with the problem of forming metal powder particles into a strong, continuous, compacted metal strand, the principles of the invention are also applicable to forming powders of other materials, such as ceramic powders into a strong, continuous self supporting strand body. To facilitate the compacting of powder bodies into a long strand-shaped body, the metal, ceramic or similar powder which is to

be compacted, may have admixed therewith lubricating additions such as a camphor-ether mix, paraffin, or wax-like substances.

The features and principles underlying the invention described above in connection with specific exemplifications will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claims shall not be limited to any specific feature or details thereof.

I claim:

1. In a die for forming out of powder particles of solid material a continuous self-supporting compacted strand of said material, a female die structure formed of a plurality of at least three adjoining complementary die segments having complementary inwardly facing concave shaping surfaces bounding an axially extending die channel, said concave shaping surfaces defining a continuous curved channel surface in which powder particles entering the receiving end of said channel are compacted into a strand which is advanced to the opposite discharge end of said channel, a cooperating plunger for compacting powder particles delivers to the receiving end of said channel into a strong, compacted strand-shaped body and advancing the compacted strand in the direction to the discharge end of said channel and discharging therefrom the so-formed strand, said die channel being of sufficient length for developing along its channel surfaces frictional resistance sufficient to provide the required powder compacting pressure at the discharge end of said die channel, said segments having junction surfaces extending outwardly from said channel, an elastic restraining structure engaging outer surfaces of said segments and elastically restraining said segments in their inward position in which said segments maintain mutual engagement along said junction surfaces, the inner end regions of said junction surfaces adjoining said channel surface merging tangentially into adjoining concave shaping surfaces of the respective die segments, and in combination therewith, a strong backing structure supporting and underlying the discharge side of said die structure and having a backing surface against which the facing radially outward regions of said segments rest, said backing structure having a backing opening underlying the facing radially inward regions of said die segments, each of said die segments being of substantial radial length, the radially inward regions of each of said die segments having a length at least half of their radial length extending over said backing opening whereby said die segments will be caused to tilt with their radially inward regions into said backing opening under excessive rise of the frictional forces developed along said channel surfaces.

2. In a die as claimed in claim 1, said die segments being surrounded and held biased to their radially inward position by a continuous elastic metal ring proportioned to undergo elastic expansion under outward forces exerted by said segments.

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