July 9, 1968 A. L. REESE 3,391,657

WEAR COMPENSATING DIE

Filed May 1, 1961

Fig. 1.

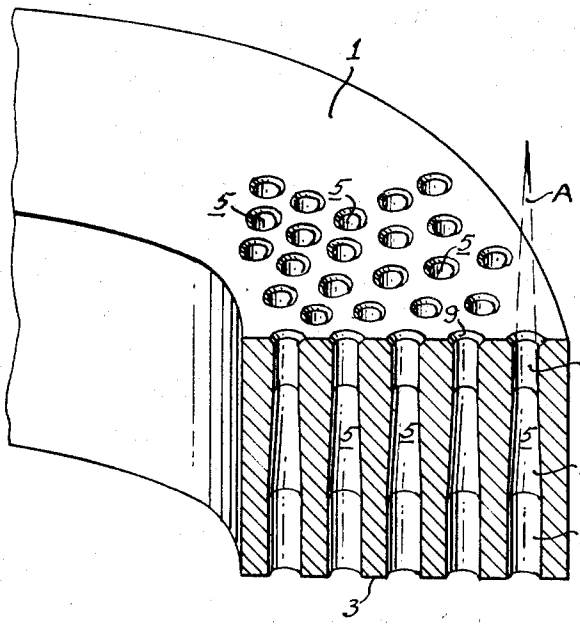
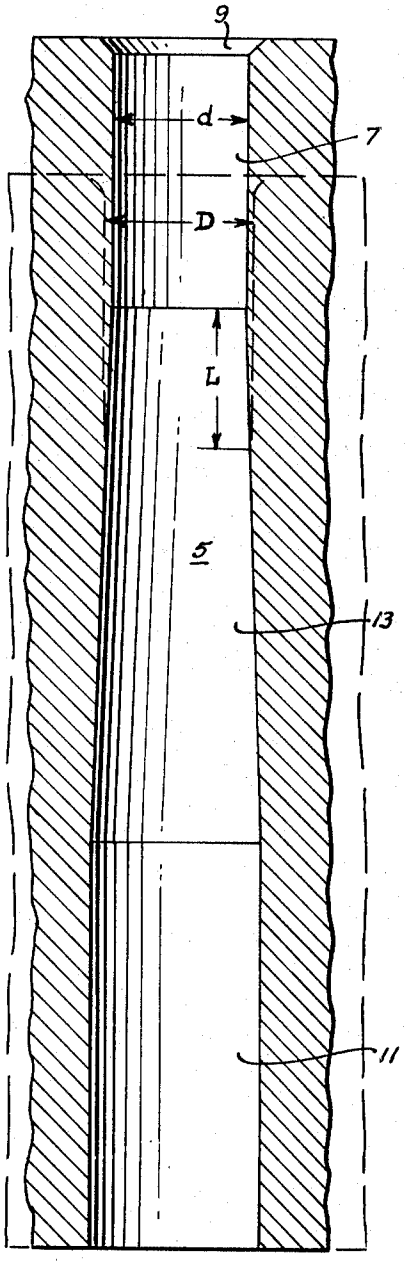


Fig. 2.



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WEAR COMPENSATING DIE

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7 Claims. (Cl. 107—14)

My invention relates to extrusion of material and formation of pellets and more particularly to a die for such purpose.

Dies of the type to which the present invention relates are for use primarily in pellet mills of the type illustrated and described in the patent to Edgar T. Meakin No. 2,240,660, dated May 6, 1941, for Extrusion Mill, though not necessarily restricted thereto, where otherwise applicable. Such a die may be in the form of a ring having a compression side and a discharge side, the compression side being normally traversed, in the operation of such mill, by extrusion means usually in the form of rolls, while the discharge side is the side from which emerge the extrusions which are severed into pellets as the extrusions emerge from the die.

In such a die, the diameter of the die holes is dictated by the diameter of the pellets desired, while the length of the die holes is determined by the desired firmness of the extruded product. If the holes be too short, the product will be too soft, while if the holes are too long, the product will be either too hard or the die holes may plug and fail to function. A countersink at the entrance to each die hole is often provided to facilitate the guidance of loose material into the die holes for extrusion, the number of die holes in a die being the maximum permissible and are usually sufficient closely spaced as to leave a minimum land surface between countersinks.

If the length of the die holes essential to produce a pellet of the proper consistency, is such as would otherwise result in a die of insufficient thickness to withstand the strains and stresses encountered in use, then the die must be made to a thickness sufficient to withstand such stresses and strains. To retain, under these conditions, the effective extrusion passage necessary to realize proper firmness of the extruded product, the die hole passages are counter-bored from the discharge side of the die sufficient to leave a working section of the proper length.

Material under extrusion in the working section, exits therefrom at elevated temperature and has a tendency to swell. The diameter of the counter-bore must be such as to permit of such swelling and substantially free discharge of the extrusion therethrough to the discharge side of the die.

Pellet mill dies of the type referred to, suffer from the abrasiveness of materials extruded therethrough, resulting in wearing down of the dies on the compression side thereof, thus shortening the extrusion length of the work section of the die hole.

Along with this, the abrasive character of the material produces a wearing of the walls of the working section of the die holes to cause an enlargement thereof.

Inasmuch as the forming of an extrusion to a desired firmness is a function of resistance to movement of material through the die hole, it follows that any reduction in such resistance will bring about a corresponding reduction in firmness of the extrusion of a particular material. The wearing of the die surface and the die hole walls, both function toward reducing such resistance, and consequently, a point is reached in the use of a die, when the extrusion and the resulting pellets no longer are of the desired firmness and the die is no longer usable for this purpose.

Among the objects of the present invention are:

(1) To provide a novel and improved pellet mill die;

(2) To provide a novel and improved pellet mill die which will have an extended life expectancy;

(3) To provide a novel and improved pellet mill die which will maintain substantially constant resistance to the extrusion of a material, over a longer period of use;

(4) To provide a novel and improved pellet mill die which will maintain an acceptable firmness of the pelleted product in spite of wear on the die;

(5) To provide a novel and improved pellet mill die which will inherently compensate for die wear to maintain an acceptable firmness of the pelleted product.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same, taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a fragmentary view, partly in section, of a die embodying the features of the present invention; and

FIGURE 2 is an enlarged view illustrative of a sectional portion of the pellet mill die of FIGURE 1 and depicting the details of a die hole therethrough incorporating the features of the present invention.

Referring to the drawing for details of my invention in its preferred form, the die has a compression side 1 and a discharge side 3 connected by a plurality of die holes 5 therethrough from its compression side to its discharge side. Each such die hole is made up of three sections: a working section 7 proximate the compression side of the die, the compression side of the die may include a countersink 9; a relief section 11 at the discharge side of the die; and an intermediate flaring section 13 connecting the working section to the relief section and which, in accordance with the present invention, must bear certain well defined relationships to the working section 7 of the die hole.

The diameter of the working section 7, in accordance with conventional practice, will be such as to produce a product of desired diameter, while the length of the working section will be such as to produce the desired firmness in such product. Wear on the compression side of the die will have the effect of shortening the length of the working section and thereby reduce the firmness of the extruded product. An increase in the diameter of the working section, due to wear of the walls thereof, will not only tend to further reduce the firmness of the product, but will also serve to slightly increase the diameter thereof. While such slight increase in diameter of the extruded product may be tolerated, the combined tendency to reduce the firmness of the product will ultimately result in a soft product which would not be acceptable.

With a flaring intermediate section of the die hole present, it will be appreciated that as the diameter of the working section is increased, say from d to D, the length of the working section will effectively be increased by an increment L, or in other words, will be caused to grow into the flared intermediate section, which growth will introduce resistance to movement of material through the working section, and thus will be in the proper direction to compensate for effects of wear on the die.

However, to realize effective benefits from this, the included angle A of the intermediate section, should be such as to create a growth in the working section of the die hole sufficient to match the rate at which the working section shortens due to wear on the compression side of the die, and preferably should exceed such rate of shortening, by an amount sufficient to also compensate for the increase in diameter of the working section of the die hole.

Illustrative of the magnitude of values and dimensions involved, one might cite as an example, a die developed for use on dried sugar beat pulp, wherein the

working section of each die hole is of an initial diameter of ¼ inch and an initial length of ½ inch, the thickness of the die is 2¼ inches, while the included or flare angle of the intermediate section of the die hole is of the order of 3°34′ and 48″.

With a die incorporating the features of the present invention, the life expectancy of the die will no longer be determined by the loss in firmness of the product of the machine, but will be determined, for the most part, by cross sectional enlargement of the working section of the die hole to a point where the wall surfaces become rough and pitted or the die becomes unduly weakened by the resulting thinning of the wall structure between holes.

Inasmuch as the die will, during the increased portion of its life expectancy, be functioning with the working sections of the die holes at increased diameters, the relief sections of the die holes will preferably be of slightly larger diameter than otherwise, in order to adequately accommodate and provide for extrusions under these conditions.

While one might conceivably run the flared sections to the discharge side of the die and thereby eliminate the relief section entirely, it will be appreciated that such flared sections would terminate at the discharge side of the die in openings of excessive diameter, and that to maintain conventional spacing between die holes in a conventional die under these conditions, would necessarily cause considerable overlapping of the flared sections as they approached the discharge side of the die, thereby structurally weakening the die. If such overlapping is to be avoided, it would necessarily mean a wide separation of the die holes and accordingly a corresponding reduction in the capacity of the die. For this reason, I prefer to terminate the flared sections in relief sections provided in the discharge side of the die.

From the foregoing description of my invention in its preferred form, it will be apparent that the same fulfills all the objectives of my invention. The minimum spacing between die holes and consequently the maximum capacity of the die may be maintained, while materially increasing the life expectancy of the die.

Accordingly, while I have illustrated and described my invention in its preferred form, the same is subject to alteration and modification without departing from the underlying principles involved, and I accordingly do not desire to be limited in my protection to the specific details illustrated and described, except as may be necessitated by the appended claims.

I claim:

1. An extrusion die having a compression side and a discharge side, a die hole therethrough defined by a hole wall extending from its compression side to its discharge side, said die hole including a working section proximate the compression side of said die and of a diameter to produce an extrusion of a desired cross section, and means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising a flaring section, said flaring section having a wall surface defining an angle of flare from said working section such as to cause said working section to grow at a rate commensurate with the rate of wear of said die on its compression side, to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die.

2. An extrusion die having a compression side and a discharge side, a die hole therethrough defined by a hole wall extending from its compression side to its discharge side, said die hole including a working section proximate the compression side of said die and of a diameter to produce an extrusion of a desired cross section, a relief section adjacent the discharge side and of larger cross sectional area than said working section, and means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an intermediate flaring section connecting the working section with said relief section, said flaring section having a wall surface defining an angle of flare from said working section such as to cause said working section to grow at a rate at least equal to the rate of wear of said die on its compression side, to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die.

3. An extrusion die having a compression side and a discharge side, a die hole therethrough defined by a hole wall extending from its compression side to its discharge side, said die hole including a working section proximate the compression side of said die and of a diameter to produce an extrusion of a desired cross section, a relief section adjacent the discharge side of said die and of larger cross sectional area than said working section, and means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an intermediate flaring section connecting the working section with said relief section, said flaring section having a wall surface defining an angle of flare from said working section such as to cause said working section to grow at a rate sufficient to compensate for enlargement of said hole and wear of said die on its compression side, to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die.

4. An extrusion die having a compression side and a discharge side, a die hole therethrough defined by a hole wall extending from its compression side to its discharge side, said die hole including a countersink in the compression side and a working section adjacent said countersink of a length adequate to produce an extrusion of desired firmness, means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an outwardly flaring section intermediate said working section and discharge side of said die and having a wall surface defining an angle of flare such that enlargement of the cross section of said working section and wear of the die on the compression side in use, will be effectively compensated by an inherent growth of said working section at the expense of said tapered section, to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die.

5. An extrusion die having a compression side and a discharge side and a thickness sufficient to withstand working stresses during extrusion of material through said die, a die hole therethrough defined by a hole wall from its compression side to its discharge side, said die hole including a working section of a desired diameter proximate the compression side of said die and of a length to produce an extrusion of a desired firmness at said diameter, a counter-bore relief section adjacent the discharge side of said die and of a diameter to permit substantially full expansion of material entering said relief section for the life of said die, and means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an intermediate flaring section connecting said working section to said relief section and having a wall surface defining an angle of flare such that the rate of growth of said working section in the longitudinal direction resulting from normal increase in diameter through use, will compensate for normal wear on the compression side of said die.

6. An extrusion die having a compression side and a discharge side and a thickness sufficient to withstand working stresses during extrusion of material through said die, a die hole therethrough defined by a hole wall from its compression side to its discharge side, said die hole includ-

ing a countersink in the compression side and a working section of a desired diameter adjacent said countersink and of a length to produce an extrusion of a desired firmness at said diameter, a counter-bore relief section adjacent the discharge side of said die and of a diameter to permit substantially full expansion of material entering said relief section for the life of said die, and means to prevent the shortening of said working section to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an intermediate flaring section connecting said working section to said relief section and having a wall surface defining an angle of flare such that the rate of growth of said working section in the longitudinal direction resulting from normal increase in diameter through use, will compensate for both said increase in diameter and normal wear on the compression side of said die.

7. An extrusion die having a compression side and a discharge side, a die hole therethrough defined by a hole wall extending from its compression side to its discharge side, said die hole including a working section proximate the compression side of said die and of a diameter to produce an extrusion of a desired cross section, a relief section adjacent the discharge side of said die and of larger cross-sectional area than said working section, and means

to maintain a desirable consistency of material extruded through said die and thereby extend the normal useful life of said die, said means comprising an intermediate flaring section connecting the working section with said relief section, said flaring section having a wall surface defining an angle of flare from said working section such as to cause said working section to grow at a rate sufficient to compensate for enlargement of said hole to maintain deasirable consistency of material extruded through said die and thereby extend the normal useful life of said die.

References Cited

UNITED STATES PATENTS

2,059,486	11/1936	Payne et al.	107—8.35
2,902,715	9/1959	Norman	18—12
2,984,173	5/1961	Roche et al.	100—93

FOREIGN PATENTS

205,253	1/1957	Australia.

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