APPARATUS FOR MOULDING HELICAL GEARS BY COMPRESSION OF POWDERS

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Filed: May 8, 1973

Iappl. No.: 358,426

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ABSTRACT

Helical gears are formed by powder compression by means of a die having a toothed internal profile corresponding to that of the gear to be molded, a movable punch having an externally toothed portion adapted to enter the die to compress the powder, and an internally toothed guide means to guide the portion with a helical motion into the die to cause the external toothing of the portion to mate correctly with the internal toothing of the die.

5 Claims, 4 Drawing Figures
APPARATUS FOR MOLDING HELICAL GEARS BY COMPRESSION OF POWDERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for molding helical gears by compression of powders, wherein an externally toothed movable punch is guided with a helical motion into an internally toothed die.

2. Description of the Prior Art

Apparatus of the aforesaid type is known. A first known apparatus comprises a non-rotatable die, the internal profile of which corresponds to the external profile of the gears to be moulded, and two opposed punches each having one end provided with helical toothing adapted to engage with the die. These punches are rotated during the compression operation, each by means of an internally and externally toothed sleeve, the inner part of which engages a helical toothing of the punch separate from that at the end of the punch itself, while the outer part engages another helical toothing which is non-rotatable. This apparatus does not allow equality to be obtained with sufficient precision between the pitch of the helical movement imparted by the sleeve to the punch and the pitch of the toothing of the die. In fact, in order to avoid the compacted gear having considerable flashes, the clearance between each punch and the die must not be greater than a few hundredths of a millimetre and, therefore, the set of toothings by which the two punches are rotated should be produced with tolerances of the order of ten thousandths of a millimetre. This cannot be achieved practically speaking and, therefore, to ensure the absence of an abnormal contact between the punches and the die it is necessary to leave a clearance greater than that desired, with the result of obtaining compacted bodies with considerable flashes and which are therefore inferior. Moreover, in view of the precision with which this set of toothings must be constructed, this known apparatus is very costly. Finally, with this apparatus it is necessary to add a third punch to be able to produce a helical gear with a hub, and on the latter it is not possible to form projections, such as, for example, keys integral with the hub itself.

A second known apparatus comprises a fixed helical die which is engaged by the ends of two helical punches movable in opposite directions. The punches are rotated through the agency of two racks and paired worms and worm wheels. The lower punch is arrested within the die to form the chamber into which the powder is loaded. Thereafter, the upper punch enters the die and compresses the power against the lower die, which remains stationary during the compression process. This apparatus is also very complicated and does not permit perfect equality between the pitch of the movement of the punches and the pitch of the toothing of the die. This is because of the practically speaking unrealistic precision with which the elements of the mechanisms by which the punches are rotated would have to be constructed so that between the punches and the die there may be a clearance which does not give rise to the formation of considerable flashes on the compacted body. Moreover, the compacting of the powder is not uniform inasmuch as the compression stroke is performed by the upper punch only.

If it is desired to form helical gears with a hub, a rotation of the powder within the empty spaces of the helical die is effected during the compression, while the friction between the punches and the remaining powder tends to keep the latter stationary. If frequency happens, therefore, that the gear which is formed breaks, especially in the dividing plane between the hub and the gear. This shortcoming is insurmountable in the case where the gear to be obtained has its hub provided with projections, such as, for instance, seats for keys or keys integral with the hub.

OBJECTS AND SUMMARY OF THE INVENTION

According to the present invention, there is provided apparatus for moulding helical gears by compression of a powder, comprising a die having a toothed internal profile corresponding to that of the gear to be moulded, a movable punch having an externally toothed portion adapted to enter the die to compress the powder, and an internally toothed guide means within which the said portion moves so as to guide the said portion with helical motion into the die and cause the external toothing of the portion to mate correctly with the internal toothing of the die.

BRIEF DESCRIPTION OF THE DRAWINGS

The following description presents, by way of example, a preferred embodiment and is given with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a gear to be moulded by the apparatus embodying the invention;

FIG. 2 is a median section of the moulding apparatus in the initial stage of its operation,

FIGS. 3 and 4 show the apparatus of FIG. 2 in two following stages of its operation.

DETAILED DESCRIPTION OF THE INVENTION

The gear 10 (FIG. 1) is to be produced by the powder compression and sintering process. The gear 10 has a part 11 with helical teeth and a hub 12 comprising a key 13. The gear 10 is moreover provided with a through bore 14.

The moulding apparatus includes an upper die 16 (FIG. 2) which is fixed and a lower die 17 movable in the axial direction. The upper die 16 has a profile corresponding to the external profile of the toothed gear part 11 and is provided with two locating pins 18. The pins 18 have their lower ends fast with the upper die 16, are provided with a tapered centering portion 27 at the upper end and project in a perpendicular direction from the upper surface of the die 16. From the upper die 16 there moreover project, four like bearing feet 26 (only two of which are shown in FIG. 2).

The lower die 17 has an internal profile corresponding to the external profile of the hub 12 and the key 13. A lower punch 19 which is hollow internally and has its external profile corresponding to that of the external surface of the hub 12 and the key 13 can cooperate with the lower die 17. The lower punch 19 is movable vertically. Moreover, a core 20 is housed in the hollow space of the lower punch 19 and is vertically movable with respect thereto for forming the hole 14.

The lower end 21 of an upper punch 22 which is hollow internally to allow the passage of the core 20 can cooperate with the upper die 16. The external profile of this end 21 corresponds to the external profile of the toothed gear part 11. The upper punch 22 is rotatable
in a support comprising an assembly of rolling bearings indicated generally by the reference 23 and is movable vertically together with the support 23.

A guide plate 24 is movable vertically and is provided with an opening 30 in which is inserted a block 31 having a toothed internal profile, that is to say a nut, exactly like the profile of the upper die 16. The end 21 of the upper punch 22 is always in mesh with the block 31. The plate 24 is provided with two locating holes 25 adapted to engage over the pins 18 of the upper die 16.

The apparatus operates in the following manner. In the first stage, the charging stage, the lower die 17 is in the highest position with its upper surface in contact with the lower surface of the upper die 16. The lower punch 19 is inside the lower die 17, the core 20 is in the highest position, substantially level with the upper surface of the upper die 16. The plate 24 is located in the highest position and the upper punch 22 is located in the most elevated position with respect to the plate 24 itself, that is to say substantially in line with the bottom surface of the block 31. This is the situation illustrated in FIG. 2.

The metal powder is charged into the dies 16 and 17 in manner known per se. After the charging operation, the upper punch 22 (FIG. 3) and the plate 24 descend together vertically until the plate 24 is arrested against the upper die 16 by bearing against the feet 26. In the last part of this movement the two pins 18 centre the holes 25 by means of the tapered portions 27 and then insert themselves therein and position the plate 24 angularly, so that when the latter is arrested against the feet 26 of the upper die 16, the toothed profile of the block 31 and that of the upper die 16 are exactly in phase with one another. The locating pins 18 therefore correct any possible angular displacements of the plate 24 which may occur during the preceding movements. The feet 26 are necessary in order to avoid any powder which may possibly have fallen on to the upper die 16 during the charging operation altering the stop position of the plate 24, with consequent angular displacement of the profile of the block 31 with respect to that of the die 16. To this end, the feet 26 are made higher than the charging level of the powder, which coincides substantially with the upper surface of the upper die 16.

When the plate 24 is arrested, the upper punch 22 continues to descend with a helical motion, guided by the block 31 of the same plate 24. The end 21 of the punch now engages with the upper die 16 to compress the powder in the die 16, while the lower punch 19 moves simultaneously in the opposite direction without rotating to compress the powder in the die 17, reaching the position shown in FIG. 3.

It is necessary to note that the internal profiles of the block 31 of the plate 24 and of the upper die 16 can be obtained exactly alike, since these last-mentioned parts are substantially two plates which are superimposable and, therefore, machinable at the same time with the same tool. The end 21 of the upper punch 22 therefore moves within the upper die 16 with a motion exactly equal or corresponding to the helix of the die 16. Moreover, rotary movements do not occur between the powder compressed in the upper die and the powder which forms the hub of the gear, so that the part formed does not present weak zones.

The extraction of the compacted part 10 now begins. First of all, the core 20 is lowered. When it has cleared the hole 14, the lower die 17 descends below the hub 15 of the gear 10, which in the meantime is held up by the lower punch 19, which has remained in the highest position adopted at the end of compression, as in FIG. 3. The lower punch 19 is then lowered and, together with the lower die 17 and the core 20, is brought to the lowest position of extracting as in FIG. 2. The upper punch 22 is then lowered further and pushes the gear 10 out of the upper die 16. Suitable means (not shown in the drawings) are pre-arranged to be introduced below the gear 10 for the purpose of receiving it and removing it from the moulding apparatus.

The apparatus is then returned to the initial charging position shown in FIG. 2. The guide plate 24 is ready to receive a new charge of powder.

It is obvious that the gear 10 is only illustrative, it being possible to produce gears of different form, for example helical gears with the hub provided with openings having axial symmetry in addition to being provided with keys, or with special shapings of the base such as that of the hub, etcetera.

I claim:

1. Apparatus for moulding helical gears by compression of a powder, comprising a die member having a toothed internal profile corresponding to that of the gear to be moulded, a movable punch having an externally toothed portion adapted to enter the die member to compress the powder, a guide member adapted to cause said portion to move with a helical motion with the same pitch as the said profile, said guide member comprising a female threaded member directly in engagement with the portion of the punch, and being movable towards the die member, and means for angularly positioning the guide member in an angular position fixed with respect to said die member, means for effecting angular positioning comprises at least one pin adapted to be introduced into a corresponding hole during movement of said guide member towards said die member, one of said members being provided with said pin and the other of said members being provided with said hole, stop means for the guide means being carried by one of said members and being such that when the guide is arrested by the stop means, the means for effecting angular positioning align the toothing of the punch portion with the toothing of the die.

2. Apparatus as in claim 1, wherein said stop means comprises at least three bearing feet disposed in the same plane parallel to the surface of the die and being adapted to arrest said guide means with a clearance between said guide means and said die.

3. Apparatus as in claim 1, wherein said pin is carried by said die member and said hole is provided in said guide member.

4. Apparatus for moulding helical gears by compression of a powder, comprising a die member having a toothed internal profile corresponding to that of the gear to be moulded, a movable punch spaced from the die member and having an externally toothed portion adapted to enter the die member to compress the powder, and guide means for angularly positioning said externally toothed portion with respect to said toothed internal profile for allowing the portion to enter the die member, said guide means comprising a female threaded member separated from the die member and directly in engagement with said externally toothed portion of the punch.

5. Apparatus as in claim 4, wherein said female threaded member is movable towards the die member and wherein said guide means further comprises means for angularly positioning said female threaded member in an angular position fixed with respect to said die member.

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