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Signora

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[54] **APPARATUS FOR MOULDING HELICAL GEARS BY COMPRESSION OF POWDERS**

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[51] **Int. Cl.** **B22f 3/02**; B22f 5/08

[58] **Field of Search** 425/78, 354, 443

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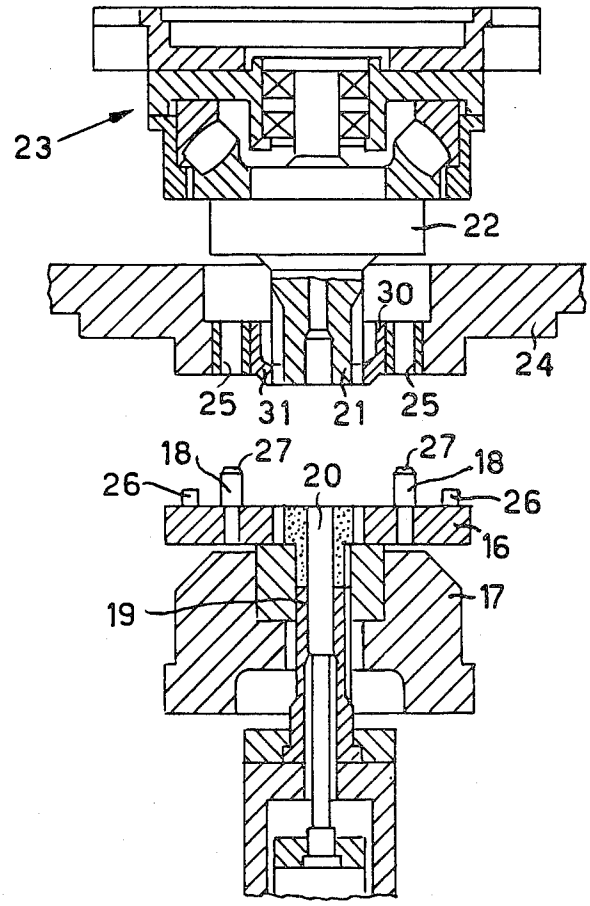
[57] **ABSTRACT**

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



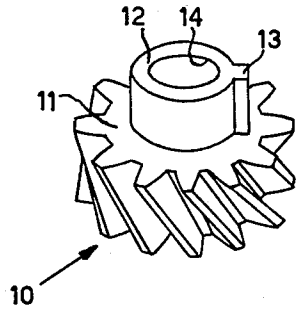


Fig. 1

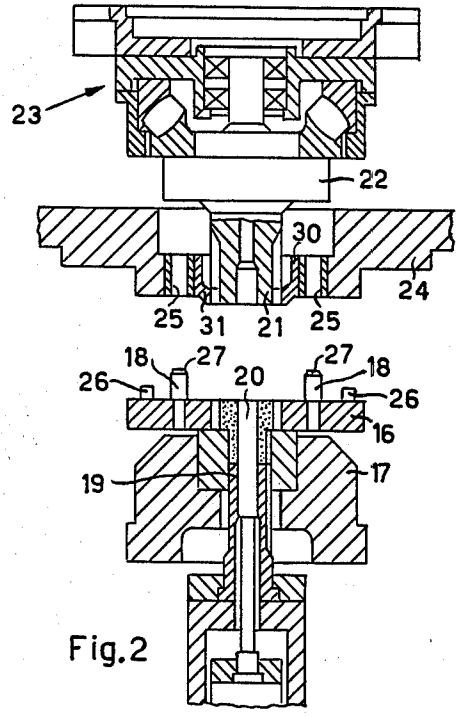


Fig. 2

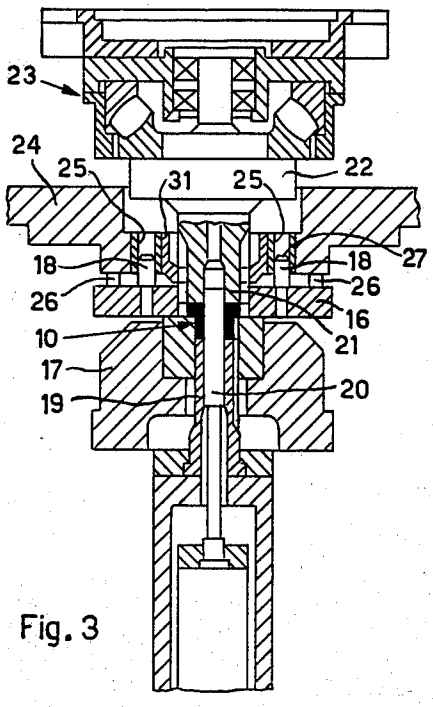


Fig. 3

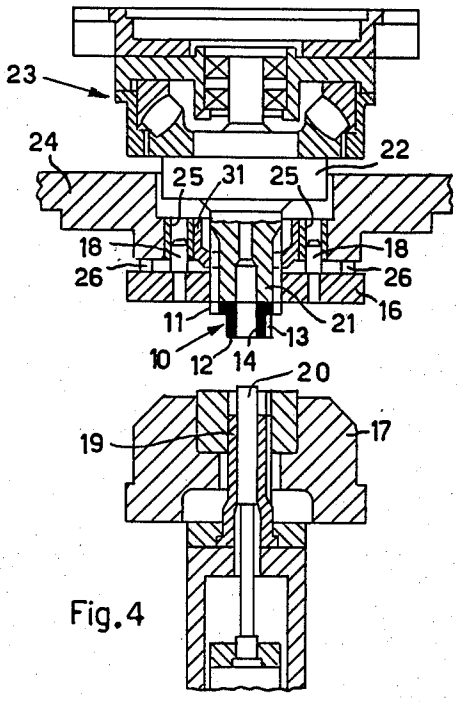


Fig. 4

APPARATUS FOR MOULDING HELICAL GEARS BY COMPRESSION OF POWDERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for moulding 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 a abnormal contacts 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 stationery 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 unrealizable 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 frequenlty happens, therefore, that the gear which is formed breaks, espacially 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 own 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 **12** 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 then, together with the lower die **17** and the core **20**, is brought to the lowest position of extraction, as in FIG. **4**. 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 apparatus is now 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 surface 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, wherein said 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 separate 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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