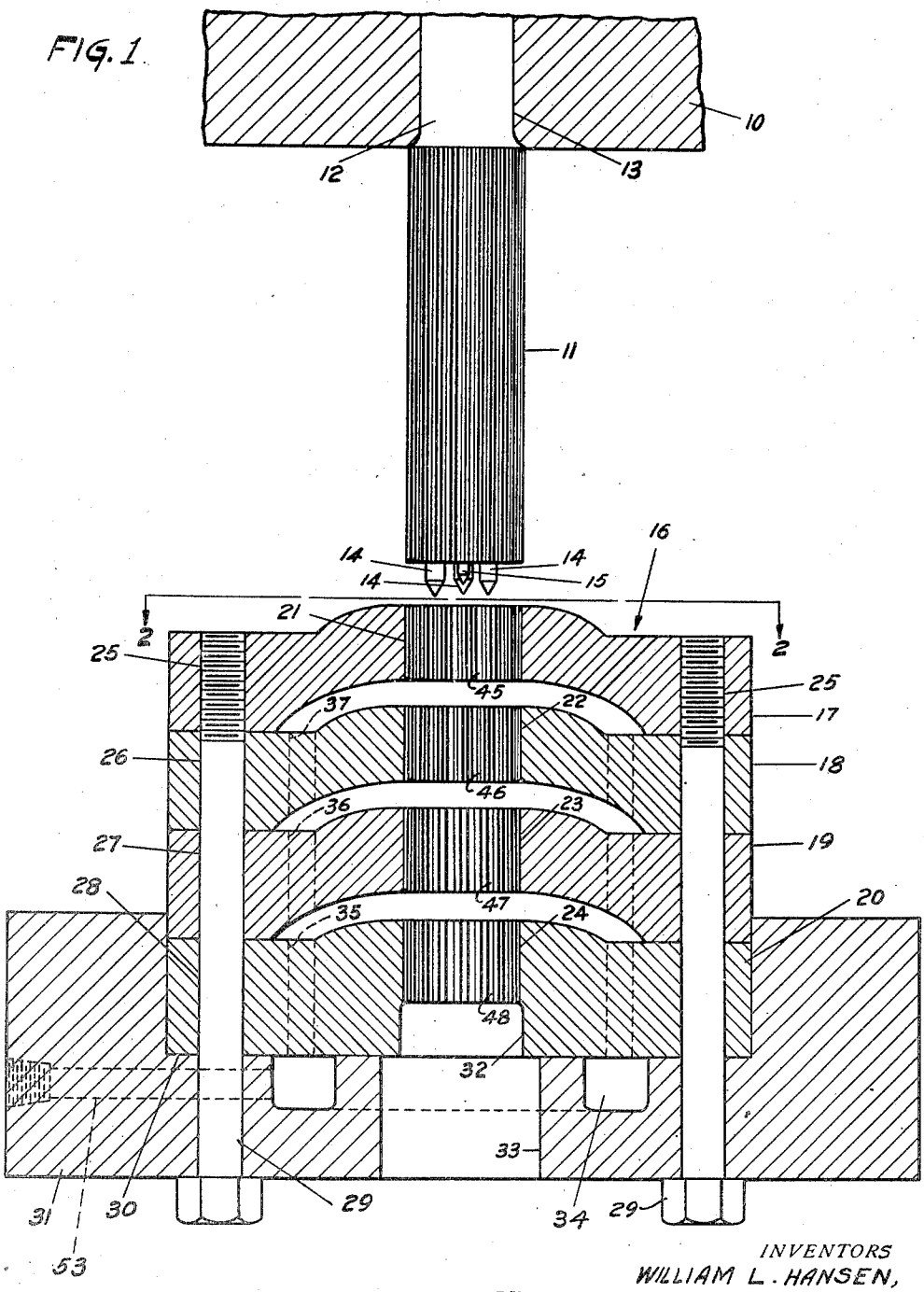
April 8, 1941. W. L. HANSEN ET AL 2,237,959

BROACHING MACHINE FOR GEARS

Original Filed March 15, 1937 3 Sheets-Sheet 1

FIG. 1.



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Original Filed March 15, 1937 3 Sheets-Sheet 2

FIG. 2.

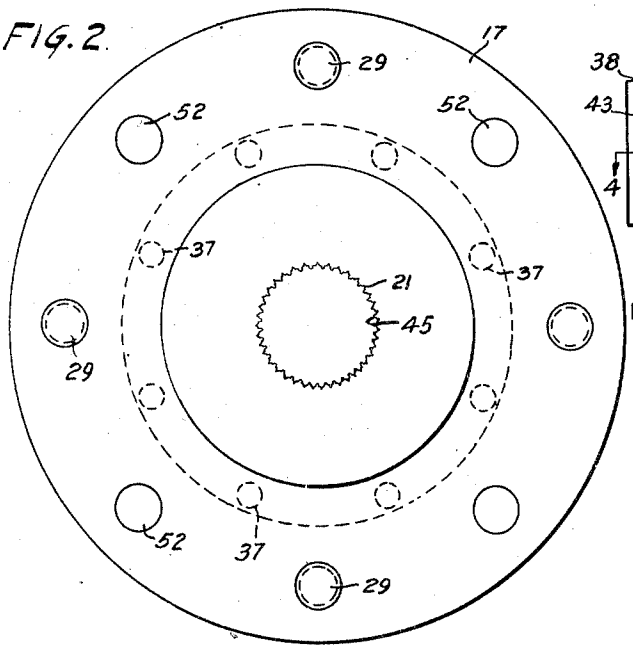


FIG. 3.

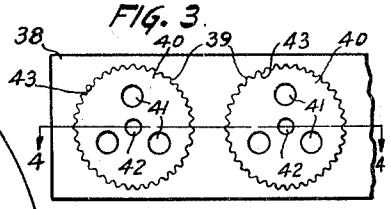


FIG. 4.

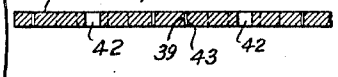


FIG. 6.

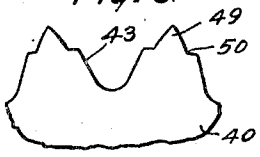


FIG. 7.

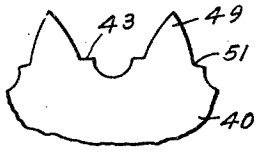


FIG. 5.

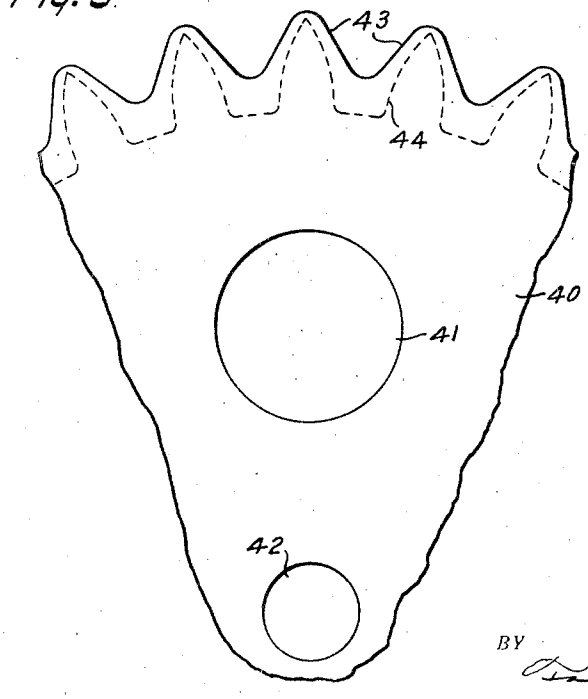


FIG. 8.



FIG. 9.



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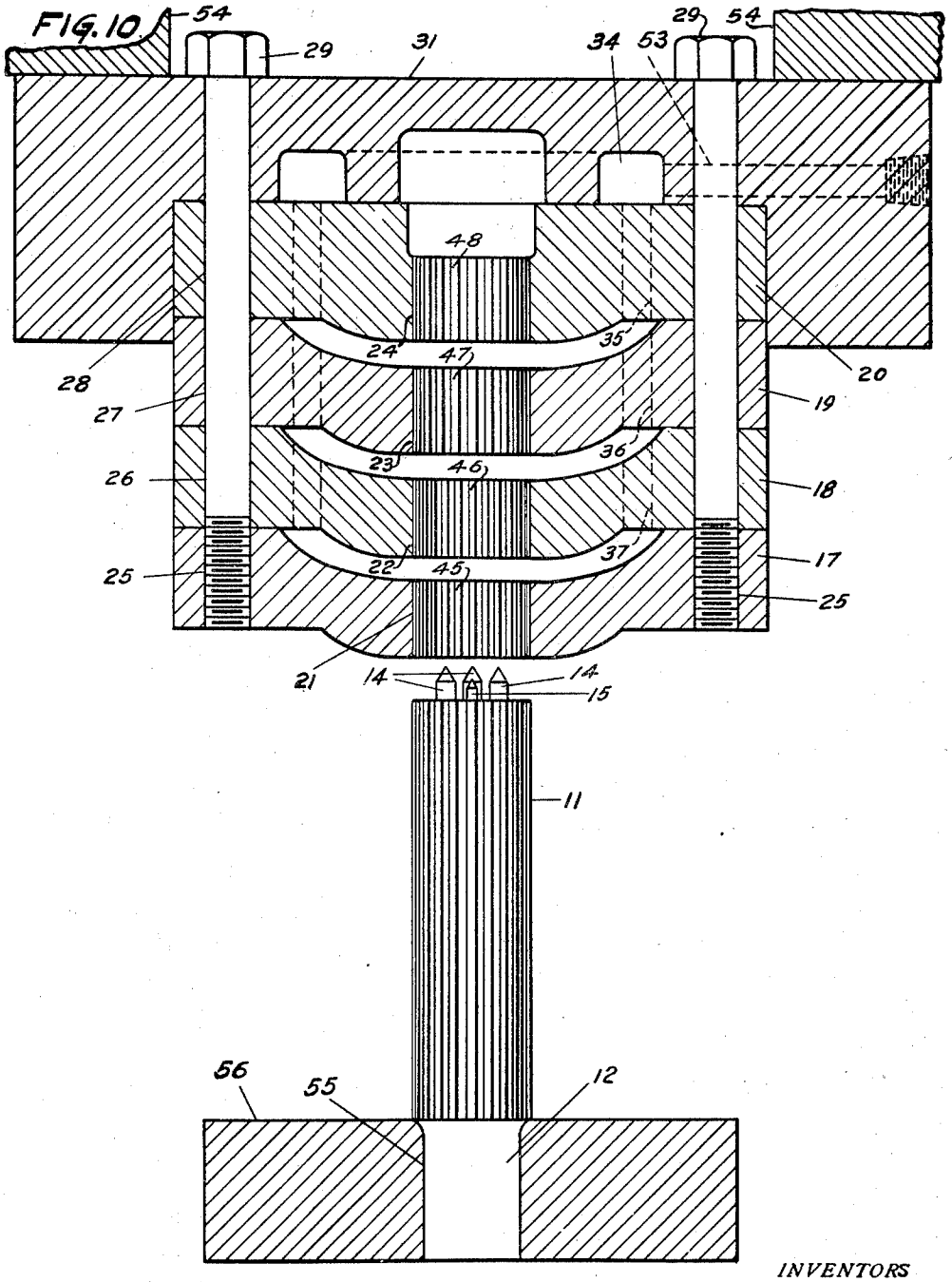
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FIG. 10.



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BROACHING MACHINE FOR GEARS

William L. Hansen and Ira N. Hurst, Princeton, Ind., assignors to Hansen Manufacturing Company, Inc., Princeton, Ind., a corporation of Indiana

Original application March 15, 1937, Serial No. 130,940. Divided and this application July 5, 1938, Serial No. 217,449

4 Claims. (Cl. 90—8)

This invention relates to the manufacture of gears and similar articles, and in particular, to the making of such articles by pressing operations.

One object of this invention is to provide a process of making gears, whereby a blank is forced through a plurality of dies, each die being arranged to form a portion only of a gear tooth.

Another object is to provide such a process, wherein the dies are arranged coaxially so that the blank follows a rectilinear path as it passes through the dies.

Another object is to provide a process of making gears, wherein a blank is formed with the rough outlines of the teeth, and thereafter forced through a plurality of dies, each of which forms a part only of the gear teeth so that the entire formation of the gear teeth is carried out in successive stages.

Another object is to provide a process of making gear teeth by pressing operations, wherein a blank is provided with aligning portions for engagement by an impelling member which impels the blank through a plurality of forming dies, each of which forms a part only of a gear tooth, the gear with its finished teeth being in a substantially complete condition after it leaves the final die.

One object of this invention is to provide a multiple die for making gears by having different portions thereof form parts only of each individual gear tooth as it passes through the several portions of the multiplie die.

Another object is to provide a machine for making gear teeth by pressing operations, comprising a movable plunger and a series of dies arranged to form the teeth of the gear by small changes brought about in a series of stages.

Another object is to provide a multiple die for making gears having different portions thereof adapted to form parts only of each individual gear tooth, these different die portions having means for conducting pressure fluid thereto to clean out the die after the production of gears, thereby removing the cuttings or shavings from the die.

This application is a division of our application Serial No. 130,940, filed March 15, 1937.

In the drawings:

Figure 1 is a central vertical section through a preferred embodiment of the multiple die of this invention.

Figure 2 is a top plan view looking in the direction of the arrows 2—2 in Figure 1 of the multiple die of this invention.

Figure 3 is a top plan view of a portion of a material strip, showing a pair of gears which have been stamped to their approximate form, and replaced in the strip for further operations by the multiple die of this invention.

Figure 4 is a vertical section taken along the line 4—4 in Figure 3.

Figure 5 is an enlarged portion of one of the gear blanks shown in Figure 3, showing in dashed lines the finished form of the gear teeth.

Figure 6 is an enlarged view of a portion of the blank shown in Figures 3 and 5, after it has passed through the first portion of the multiple die to form the tips of the gear teeth.

Figure 7 is a view similar to Figure 6, of the portion after it has passed through the second portion of the multiple die to form an additional part of the gear teeth.

Figure 8 is a view similar to Figures 6 and 7, but showing the gear teeth after the blank has passed through the third portion of the die, thereby forming the major part of the gear teeth.

Figure 9 is a view similar to Figures 6, 7 and 8, but showing the completed form of gear teeth after the blank has passed through the fourth portion of the die.

Figure 10 is a view, similar to Figure 1, but showing a modified arrangement wherein the multiple die is mounted upon the platen of the press and the punch upon the bed thereof.

In general, the machine of this invention consists of a multiple die having a series of portions, each of which cuts a part only of the gear teeth so that each entire tooth is produced in a series of stages rather than in a single operation as has been the case in the prior art. In particular, the multiple die by which the gears are made consists of a plurality of die portions of different configurations and arranged to form the gear teeth in a series of steps rather than in a single step, as in the prior art. Preferably, these die portions are arranged coaxially so that the blank is forced through the entire series by the single thrust of a plunger. The multiple die is especially valuable for the production of very accurately made gears, such as are used in fine clocks or instruments.

The blank used with this invention may be either circular with a plain rim, or it may have approximately shaped teeth formed by a preliminary blanking operation. In the present inven-

tion, the thickness of the stock has no influence upon the accuracy of the process.

Hitherto, gears have been cut a single tooth at a time, or by stamping the entire gear with its teeth at a single blow of a press. The production of gears at a single blow will not produce a sufficiently accurate gear wheel for fine clocks, or instruments, and this process also cannot be used for punching thick wheels of small pitch. Ordinarily, it is impractical to punch any hole or tooth in a piece of material smaller than the thickness of the material. Varying thicknesses of the stock, by such prior processes, cause the punch or mounting mandrel to bend sufficiently to make it impossible to cut all of the gear wheels accurately and perfectly.

Referring to the drawings in detail, Figure 1 shows a preferred embodiment of this invention, and consists of a platen 10 having a fluted punch 11 with a neck portion 12 inserted in an aperture 13 of the platen 10. The punch 11 is provided with peripheral and central aligning pins 14 and 15, respectively. Arranged beneath the plunger 11 and coaxial therewith is the multiple die, generally designated 16, and consisting of die members 17, 18, 19 and 20. The flutes on the punch 11 extend behind and thereby provide support for the gear tooth portions during the formation thereof.

These die members are provided with coaxial apertures 21, 22, 23 and 24, and peripheral apertures 25, 26, 27 and 28, adapted to receive the cap screws 29 which hold the multiple die member within the recess 30 of the die support 31. Certain of the upper apertures 25 formed in the upper die member 17 are threaded to receive the upper ends of the cap screws 29. The lower die member 20 is provided with a slightly enlarged extension 32 of its forming aperture 24, through which the finished gear passes. The finished gear drops through an aperture 33 in the support 31, and thence into a suitable container or collecting means. Arranged between the aperture 33 and the lowermost die member 20 is an aperture enlargement 34, with which the apertures 35, 36 and 37 communicate. In each set of apertures 35, 36 and 37 the individual apertures are arranged coaxially (Figures 1 and 2).

The die apertures 21, 22, 23 and 24 of the multiple die 16 are so configured as to form the gear teeth in successive steps, better shown by a consideration of Figures 3 to 9, inclusive. Figure 3 shows a strip of material 38 having apertures 39, from which gear blanks 40 have been punched and replaced therein, after punching. The blanks 40 are provided with marginal and central recesses or apertures 41 and 42, respectively, for the reception of the aligning pins 14 and 15 of the plunger 11. Optionally, the blanks 40 may be provided with precut corrugations 43 on the peripheries thereof, as better shown in Figure 5. The latter indicates by the dashed line 44 the exact contour of the finished gear teeth, in contrast with the preliminary corrugated portions 43. If desired, however, a circular die may be used for this pre-cutting operation, thereby providing a blank 40 with a smooth periphery.

The material for making the gears by this process and arrangement may be of any desired nature, such as metal or synthetic resin, the invention having been successfully carried out with both of these materials.

The successive die members 17, 18, 19 and 20 are provided with corrugations 45, 46, 47 and 48 on the walls of the apertures 21, 22, 23 and 24, and corresponding to the number of teeth to be formed on the gear wheel blank 40. These corrugations are formed, however, so that each corrugation takes only a small portion of material out of the contour of the tooth. Accordingly, the apertures 21 to 24, inclusive, and their corrugations 45 to 48, inclusive, are arranged to take off from .001 to .005 inch, thereby producing a gear tooth which in every way equals a slowly cut gear tooth formed by a milling or similar operation. The gear wheels formed by the present invention, however, are produced with a single stroke of the punch press, or at the most, with two strokes, one for the blanking operation and the other long stroke for the forming by means of the multiple die.

The material may be of any desired thickness, and is unaffected by the size of the aperture, in contrast with prior art arrangements. For example, it is possible to produce excellent gear wheels with teeth only .019 or .020 inch in width, from stock which is .040 inch in thickness. The present arrangement, moreover, has been found to be the only suitable way by which accurately formed synthetic resin gear teeth can be produced, where these gear teeth are to have perfectly formed tips which are absolutely unbroken. Accordingly, with this process and arrangement, any thickness of material may be used for producing a gear wheel with any pitch of tooth.

In operation the blank 40, either with or without the preliminary peripheral corrugations 43, is placed in the arrangement shown in Figure 1, with its aligning apertures 41 and 42 in engagement with the aligning pins 14 and 15 of the plunger 11. The press is then operated to cause the platen 10 to descend, thereby forcing the blank 40 successively through the forming apertures 21 to 24, inclusive, of the die members 17 to 20, inclusive.

As the blank 40 passes through the first die member 17, the tips of the gear teeth 49 are formed as far as the point 50 (Figure 6), the remainder of the corrugated portions 43 being left untouched. This preliminary formation of each tooth 49 is brought about by the corrugations 45 of the forming aperture 21. As the blank 40 passes through the corrugations 46 of the forming aperture 22, in the second die member 28, the tips of the gear teeth 49 are given a further partial formation, this time as far as the point 51 (Figure 7). Only small portions of the corrugations 43 now remain untouched. As the blank passes through the corrugations 47 of the aperture 23, in the third die member 19, these die corrugations form still further portions of the gear teeth 49, thereby giving the appearance shown in Figure 8. Finally, when the blank 40 is impelled through the final corrugations 48 of the aperture 24 in the last die member 20, the bases of the teeth 49 are formed in such a manner as to complete the gear teeth and present the appearance shown in Figure 9.

Thus, by a succession of steps performed at a single operation, the teeth of the gear wheels are formed. In this manner very little strain is placed upon an individual gear tooth, so there is practically no tendency for the blank to bend or the gear tooth to be forced into a deflected position from which it may be deviated later when the pressure is removed. There is no tendency, also, for the thickness of the material to affect adversely the production of the apertures or teeth because each tooth is formed, not at a single step but by a succession of steps in differ-

ent dies. Each die is thereby subjected to but a slight strain, in contrast with the great strain placed upon a die used in the production of a gear wheel at a single stroke.

Accordingly, therefore, the machine of this invention permits a blank to be forced through a series of forming apertures, each aperture forming a portion only of each gear tooth so that the gear tooth is produced by a plurality of cuts or forming engagements rather than by a single cut, as in the prior art. The fact that all partial cuts upon the blank are made substantially simultaneously entirely around the periphery of the blank, results in an even pressure being applied to the blank, so that there is no tendency for an eccentric gear to be produced as where a gear wheel is produced by cutting a single tooth at a time. In order to facilitate the alignment of the several parts of the die, dowel rods **52** are provided (Figure 2) at spaced positions around the periphery thereof.

The space **34** thus forms an annular chamber from which a passageway **53** leads outwardly to a source of pressure fluid, either gaseous or liquid, by which the shavings or cuttings can be expelled and the dies cleared regularly by way of the apertures **35**, **36** and **37**. This improves the quality of the product by preventing any damage to the gears by the action of chips or shavings already in the die. Where the press employed is actuated by pressure fluid for punching out the gear wheels, the exhaust fluid therefrom may be directed through the passageway **53** to expel the cuttings and clear the die.

In the modified construction shown in Figure 10, the multiple die support **31** is mounted upon the platen or ram **54** of the press, whereas the punch **11** is mounted in a bore **55** in the press bed **56**. By this arrangement it is possible to cut an individual blank of a size which is not practical to push back into the strip. In this modification, the punch does not move into the die members or portions, as in Figures 1 to 9, but the die members move down over the punch. After the gear wheel has been punched out by these multiple dies, it is pushed through the aperture **32** at the top, and may be removed therefrom either mechanically or by being blown out by compressed air. As before, the blank may be properly located by the use of the pins **14** and **15** mounted on the punch. In this modification, however, the punch is stationary and the die members or portions are movable by being attached to the platen or ram. Furthermore, by the use of the locating pins **14** and **15** it is possible to make larger gears than it is possible to cut in a single operation. The locating pins enable the operator to take the same blank through any number of dies without danger of its being dislodged because the blank is always properly located by means of the pilot holes or apertures **41** and **42** in the center of the blank **40**.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims and the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A machine for producing gear wheels comprising a plurality of die members with corrugated apertures arranged in succession, the apertures being successively configured to remove a part only of each gear tooth portion by a given die member, and a punch having plural aligning members adapted by mere engagement thereof with guide holes in the gear wheel blank to guide the tooth portions of the gear wheel blank in rectilinear paths during the formation thereof, means for spacing the working surfaces of at least two of said dies from each other to form a circular space between said dies, a closed passageway communicating with said space at one end of said passageway and having means at its other end for connection to a source for removal of the die cuttings.

2. A machine for producing gear wheels comprising a series of apertured die members having corrugated walls of differing characteristics, the walls of the earlier die members in the series being adapted to form one part only of each gear tooth and the walls of the later die members being adapted to form a different part only of each gear tooth, and a punch having projections arranged to extend behind the gear tooth portions whereby to provide support for said gear tooth portions during the formation thereof, means for spacing the working surfaces of at least two of said dies from each other to form a circular space between said dies, a closed passageway including apertures through said dies communicating with said space at one end of said passageway and having means at its other end for connection to a source for removal of the die cuttings.

3. A machine for producing gear wheels comprising a series of spaced apertured die members having forming elements associated therewith, the forming elements of the earlier die members of the series being arranged to form the tip parts only of each gear tooth and the later forming elements being arranged to form the base parts only of each gear tooth, and a punch having projections arranged to extend behind the gear tooth portions whereby to provide support for said gear tooth portions during the formation thereof, means for spacing the working surfaces of at least two of said dies from each other to form a circular space between said dies, a closed passageway communicating with said space at one end of said passageway and having means at its other end for connection to a source for removal of the die cuttings, one of said die members having a circular aperture enlargement communicating with said closed passageway and located intermediate the ends thereof.

4. A machine for producing gear wheels comprising a series of spaced apertured die members having forming elements associated therewith, the forming elements of the earlier die members of the series being arranged to form the tip parts only of each gear tooth and the later forming elements being arranged to form the base parts only of each gear tooth, and a punch having projections arranged to extend behind the gear tooth portions whereby to provide support for said gear tooth portions during the formation thereof, means for spacing the working surfaces of at least two of said dies from each other to form a circular space between said dies, a closed passageway including longitudinal apertures through said dies communicating with said space at one end of said passageway and having means at its other end for connection to a source for removal of the die cuttings.

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