APPARATUS FOR MAKING HONES

 Filed Aug. 12, 1957

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

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The present invention relates to apparatus for making gear hones. The gear hones produced in accordance with the present invention are in the form of gears conjugate to gears be finished by a honing operation. At least the surface portions of the teeth of the hone are formed of a hard but slightly yieldable and highly resilient plastic material such as, for example, as a compound of epoxy resin having abrasive particles embedded therein. Epoxy resin has the characteristic of high dimensional stability and it is accordingly possible to produce by casting a gear-like hone which is extremely accurate as to all gear characteristics.

It is an object of the present invention to provide apparatus for producing extremely accurately gear-like plastic hones by casting.

More specifically, it is an object of the present invention comprising a base plate having a post projecting therefrom, an annular locater plate on said base plate concentric with said post, and a removable annular mold having a flange engageable with the outer surface of said annular plate and having inwardly extending teeth, said annular plate, post and mold together forming an annular cavity for the reception of plastic material in the production of a hone.

It is a further object of the present invention to provide apparatus as described in the preceding paragraph including a spring pressed headed pin carried by and extending beyond the end of said post and engageable with a removable clamp.

It is a further object of the present invention to provide apparatus as described in the foregoing in which means are provided for separating the end of the mold from the adjacent surface of the annular plate to prevent entrapment of air.

It is a further object of the present invention to provide apparatus as described in the foregoing in which said annular mold is provided with radially extending support pins in combination with a press including a rotatable head dimensioned to engage the hone while the mold is supported by said pins to press the hone out of the mold in an axial direction accompanied by the rotation necessitated by helical teeth on the mold and hone.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is a plan view of the apparatus employed in casting the hone.

FIGURE 2 is an enlarged sectional view on the line 2—2, FIGURE 1.

FIGURE 3 is a sectional view illustrating the removal of the base plate, bottom plate and post from the mold and cast hone.

FIGURE 4 is a sectional view similar to FIGURE 3 illustrating the removal of the hone from the mold.

FIGURE 5 is a fragmentary sectional view illustrating a detail of the mold.

In producing a hone for finishing gears and capable of finishing gears after they have been hardened, it is of course essential that the hone exhibit a very high degree of accuracy inasmuch as it operates to machine the work gears to a form conjugate to the hone. The hone is hard and contains abrasive particles so that it is not feasible to machine the hone to the required shape. It thus becomes a problem of producing the required accuracy in the hone by casting so that as cast the hone may be operated in mesh with work gears.

In the production of the hones a model identical with the desired hone is produced and the model is used to cast an annular mold which in turn is used in the production of the hones by casting.

The apparatus employed comprises a base plate 19 having a locating post 12 secured thereto as for example by screws 14. The post is hollow and is provided with an opening 16 in the end thereof through which extends the intermediate portion of a pin 18 having a head 20. Secured to the lower end of the pin 18 is a threaded extension 22 carrying an annular member 24 movable vertically in the hollow post and operating as a spring seat. Received within the interior of the post 12 is a compression spring 30 urging the pin downwardly in the figures.

Located on the base plate 10 is an annular locating bottom plate 32 having a cylindrical outer surface 34 which is concentric with the post 12.

An annular mold assembly 36 is provided including an outer annular member 38 having a depending flange 40 the inner surface of which fits exactly against the outer surface 34 of the plate 32 and hence, serves to locate the mold 36 concentrically with respect to the post 12. The annular member or ring 38 is provided with a pair of radially outward extending support pins 41. The mold assembly includes an annular tooth forming portion 42 which preferably is formed of a plastic, such for example as a compound of an epoxy resin. As illustrated in the figures, the plastic tooth forming portion 42 of the mold is mechanically interlocked with the outer metal ring, the interlock being illustrated as a dovetailed formation 44. In the operation of casting the hone the parts are assembled as illustrated in FIGURE 2, the mold 36 being retained in assembled position by clamps 46 urged by compression springs 48 which seat against the head of screws 50 in clamping relation.

The apparatus illustrated in the figures is useful not only in the production of hones, but is also useful in the production of the annular mold assemblies. In producing the mold assemblies a mold gear identical with the hone to be produced is positioned on the post 12. The mold gear may be retained in position on the post by means of a U-shaped clamp 52 engaged by the head 20 of the pin 18. The metal ring 38 is assembled on the plate 32. Thereafter, the annular cavity defined by the outer surface of the master gear or model, the bottom plate 32, and the metal ring 38, is filled with the plastic material which thus produces the plastic portion 42 of the mold. After the plastic material is cured the master gear or model is pressed out of the mold, leaving the mold assembly comprising the metal ring 38 and the plastic tooth forming portion 42 thereof.

By the foregoing method it is possible to employ a single very accurately formed master gear or model for the production of a plurality of molds. Also, each of the molds may be employed for producing a plurality of hones.

In the production of the hone it is of course possible to form the entire body of the hone from the same plastic material. However, it is more economical and convenient to employ a core 54 which may conveniently be of plastic and as illustrated in the figures, is provided with an outwardly directed V-shape as indicated at 56. The core 54 is provided with a central opening 58 fitting over the post 12. The core is retained in position by the U-shaped clamp 52 which is urged downwardly by the compression spring 30. The mold assembly 36 is mounted on the plate 10 with the radial inner surface of its flange 40 engaging
the outer surface 34 of the bottom locating plate 32. Thus, the mold assembly is in the same position it occupied when its tooth forming portion 42 was initially cast and accordingly, its tooth forming portion 42 is located with a high degree of accuracy concentric with the post 12. The mold assembly is retained in assembled relation by means of the clamps 46 urged downwardly by the springs 48.

At this time the plastic composition is poured or distributed into the cavity defined by the outer surface of the core 54, the upper surface of the bottom plate 32, and the inner surface of the tooth forming portion 42 of the mold assembly 36. It is essential to prevent entrapment of air in the mold cavity and for this purpose the bottom flange 40 of the metal ring 38 of the mold assembly 36 is made slightly longer than the thickness of the bottom plate 32. This condition is illustrated in exaggerated form in FIGURE 5 and has the effect of leaving a space 60 into which air which would otherwise be entrapped in the bottom of the cavity may escape. In practice, when the plastic hone forming material is pressed into the cavity, a thin film of the plastic material extends into the space 60.

The plastic material is mixed with abrasive particles such as for example as silicon carbide, and this mixture takes place just before the plastic composition is poured into the mold cavity to avoid settling of the particles. It is essential to provide a vigorous stirring of the particles in the plastic composition to insure uniform distribution thereof. This stirring has a tendency to produce entrapment of air bubbles within the plastic material. It is of course desirable that the finished hone be substantially dense and solid and free of air bubbles. Accordingly, in the preparation of the plastic material for pouring into the mold cavity, the mixing operation is carried out in an evacuated chamber. This has two important results. In the first place, it appears that the formation of air bubbles in the plastic material, due to the evacuation of the chamber, is substantially eliminated. Secondly, whatever bubbles are introduced into the plastic material under the extremely low pressure condition existing within the chamber are compressed when the plastic material is subjected to normal atmospheric pressure.

The introduction of the plastic material into the mold cavity may also be carried out in an evacuated chamber with desirable results. Entrapment of air is reduced to a minimum and again, the space occupied by any air bubbles may be entrapped under the low pressure existing within the evacuated chamber is greatly reduced when the plastic material is subjected to normal atmospheric pressure. When the plastic material, which is indicated at 62, is introduced to fill the mold cavity, an excess of material is provided which is caused to overlap the upper surface of the tooth forming portion 42 of the mold as illustrated at 64.

After the mold is filled to the condition illustrated in FIGURE 2, it is introduced into a curing chamber and subjected to an elevated curing temperature for an interval sufficient to effect cure of the composition. After the plastic composition is completely cured the assembly is mounted on supporting posts 66 by pins 41. The U-shaped clamp 52 is removed and the structure comprising the base plate 10, bottom plate 32, and post 12 is pressed out of the structure made up of the mold 36, the core 54, and the cast plastic portion 62 of the hone by a press member 68. The support of the excess material 64 overlying the tooth forming portion 42 of the mold assembly 36 is not apparent. This material serves as an abutment which prevents the hone from being pushed out of the mold assembly by this operation.

Thereafter, the assembly comprising the mold 36 and the hone 70 is inverted and is again supported by pins 41 and supporting posts 66. At this time the press is provided with a head 72 having a lower portion 74 of a diameter just slightly smaller than the root diameter of the hone and connected to an upper portion 76 by anti-friction means such as ball bearings indicated at 78. It will be appreciated that the hone in many cases will be in the form of a helical gear so that as the hone is pressed out of the mold assembly in an axial direction, rotation is imparted thereto in accordance with its helix angle. With the parts in the position illustrated, the head 72 is moved downwardly and presses the hone out of the mold assembly 36. It will be observed that the hone at this time includes the excess material 64 and this material may be trimmed away with a diamond leaving the hone in condition for use.

The mixing and preferably the pouring of the mixture of plastic and abrasive grains is carried out in a chamber evacuated to the highest degree practical and hence the operation may be said to be carried out in a substantial vacuum. While under these conditions atmospheric pressure is sufficient to produce the solid dense material required, curing may if desired be carried out at an elevated pressure.

The drawings and the foregoing specification constitute a description of the improved apparatus for making hones in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. Hone making apparatus for making annular gear-like hones comprising a base plate having a post projecting upwardly therefrom to receive and locate an annular core, a headed pin partly received in said post and movable longitudinally thereof, a spring in said post urging said pin inwardly, and an open-sided core clamp engageable by the head of said pin, an annular plate on said base plate concentric with said post, an annular mold having a locating flange engaging an annular surface of said annular plate and having inwardly extending teeth, said annular plate and mold forming with a core on said post an annular cavity for receiving plastic material in the casting of a gear-like hone.

2. Hone making apparatus comprising a base plate having a post fixed thereto projecting upwardly therefrom to receive and locate an annular core, an annular plate on said base plate concentric with said post, said plate having an annular locating surface, an annular mold having a locating flange engaging an annular surface of said annular plate and having inwardly extending teeth, said annular plate and mold forming with a core on said post an annular cavity for receiving plastic material in the casting of a gear-like hone, said mold having an annular surface spaced slightly above the surface of said annular plate to provide an annular space for the escape of air.

3. Hone making apparatus for making annular gear-like hones comprising a base plate having a post projecting upwardly therefrom to receive and locate an annular core, an annular plate on said base plate concentric with said post, an annular mold having a locating flange engaging the outer surface of said annular plate and having inwardly extending teeth, said annular plate and mold forming with a core on said post an annular cavity for receiving plastic material in the casting of a gear-like hone, said mold being removable from the assembly consisting of the base plate, annular plate and post, said mold having a pair of outwardly projecting support pins, support truncations for supporting said mold in normal position, a press for pressing said base plate and pin downwardly from said core, a hone, said annular mold, said mold being invertible on said truncations to provide a forward removal by said press of said core and hone from said mold.

4. Hone making apparatus for making annular gear-like hones comprising a base plate having a post projecting upwardly therefrom to receive and locate an annular core, an annular plate on said base plate concentric with said post, an annular mold having a locat-
ing flange engaging the outer surface of said annular plate and having inwardly extending teeth, said annular plate and mold forming with a core on said post an annular cavity for receiving plastic material in the casting of a gear-like hone, said mold being removable from the assembly consisting of the base plate, annular plate and post, said mold having a pair of outwardly projecting support pins, support trunnions for supporting said mold by said pins in normal or inverted positions, and a press including a head movably axially of said mold while said mold is supported by said pins in said trunnions, said head being mounted for free rotation about the axis of said mold to facilitate removal of helically formed hones therefrom.

5. Apparatus for making annular gear-like hones comprising a base plate having a centrally located post and an annular locating surface concentric with said post, said post being dimensioned to receive and locate an annular hone core, an annular permanent mold having an inwardly extending circular array of teeth, the locating surfaces of said plate and mold being engageable to locate said mold in exactly concentric relation to the post and hence to the opening in an annular mold core received on said post.

6. Apparatus for making annular gear-like hones comprising a base plate having a centrally located post and an annular locating surface concentric with said post, said post being dimensioned to receive and locate an annular hone core, an annular permanent mold having an inwardly extending circular array of teeth, said mold having an annular locating surface concentric with the axis of said teeth, the locating surfaces of said plate and mold being engageable to locate said mold in exactly concentric relation to the post and hence to the opening in an annular mold core received on said post, and yieldable core clamp means carried by said post and engageable with an annular core to press the core firmly against said base plate.

7. Apparatus for making annular gear-like hones comprising a base plate having a centrally located post and an annular locating surface concentric with said post, said post being dimensioned to receive and locate an annular hone core, an annular permanent mold having an inwardly extending circular array of teeth, said mold having an annular locating surface concentric with the axis of said teeth, the locating surfaces of said plate and mold being engageable to locate said mold in exactly concentric relation to the post and hence to the opening in an annular mold core received on said post, yieldable core clamp means carried by said post and engageable with an annular core to press the core firmly against said base plate, and yieldable clamp means carried by said base plate and selectively engageable with said annular mold to retain said mold in assembled relation on said base plate.

8. Apparatus for making annular gear-like hones comprising a base plate having a centrally located post and an annular locating surface concentric with said post, said post being dimensioned to receive and locate an annular hone core, an annular permanent mold having an inwardly extending circular array of teeth, said mold having an annular locating surface concentric with the axis of said teeth, the locating surfaces of said plate and mold being engageable to locate said mold in exactly concentric relation to the post and hence to the opening in an annular mold core received on said post, said mold having radially outwardly projecting pins, a trunnion for said pins to support said mold in upright or inverted positions, and a press having replaceable heads engageable selectively with an end of said post and with the periphery of a hone including the core and hone material cast in the space between the core and said mold to first separate the base plate and post as a unit from the hone including the core and mold, and then to separate the hone from said mold.

9. Apparatus for making annular gear-like hones comprising a base plate having a centrally located post and an annular locating surface concentric with said post, said post being dimensioned to receive and locate an annular hone core, an annular permanent mold having an inwardly extending circular array of teeth, said mold having an annular locating surface concentric with the axis of said teeth, the locating surfaces of said plate and mold being engageable to locate said mold in exactly concentric relation to the post and hence to the opening in an annular mold core received on said post, said mold having radially outwardly projecting pins, a trunnion for said pins to support said mold in upright or inverted positions, and a press having replaceable heads engageable selectively with an end of said post and with the periphery of a hone including the core and hone material cast in the space between the core and said mold to first separate the base plate and post as a unit from the hone including the core and mold, and then to separate the hone from said mold, the press head engageable with said hone being mounted for rotation about an axis concentric to said mold to facilitate removal of helical gear-like hones.

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