(No Model.)

A. T. PORTER.

METHOD OF MAKING DIES FOR GEAR FORGING.

No. 521,179. Patented June 12, 1894.

FIG. 1.

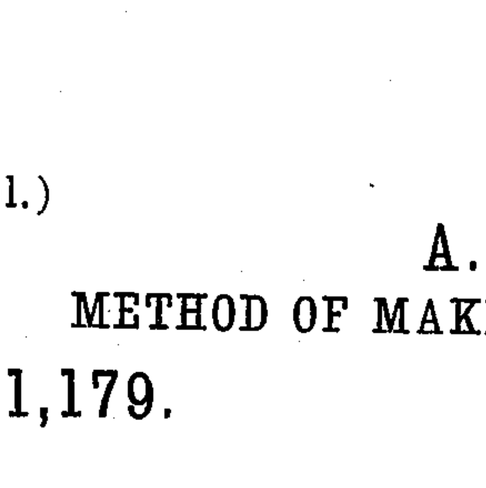


FIG. 2.

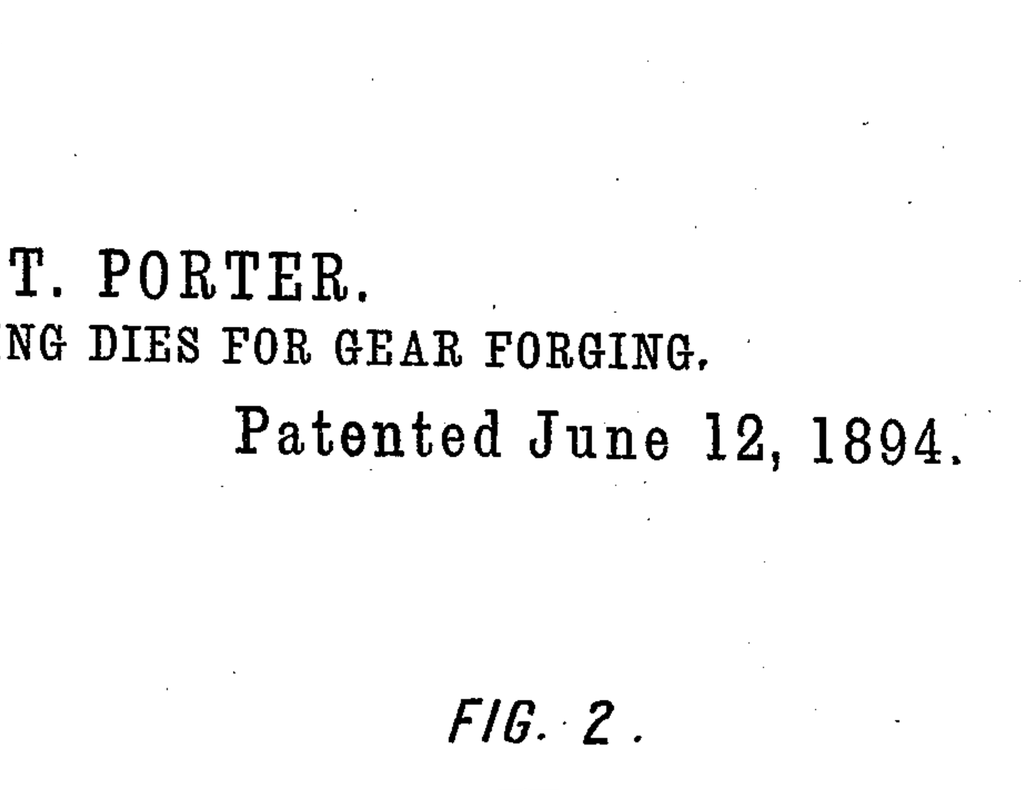


FIG. 3.

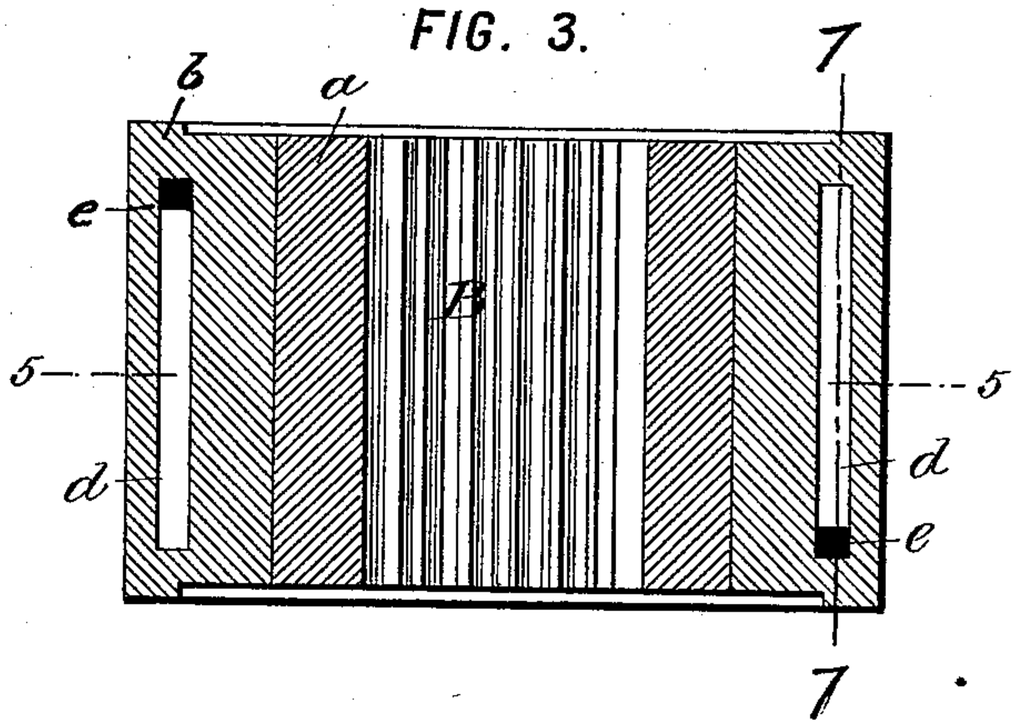


FIG. 4.

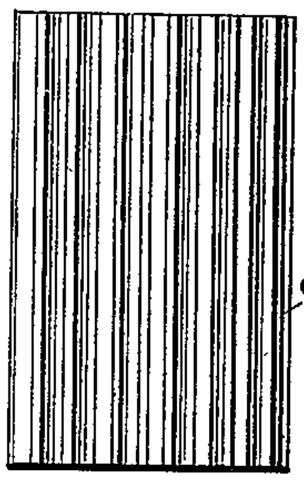


FIG. 5.

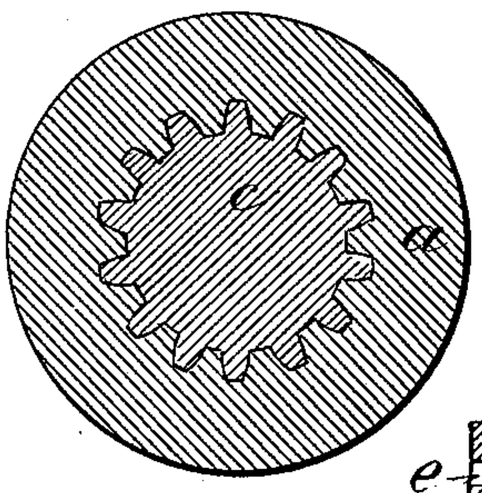


FIG. 6.

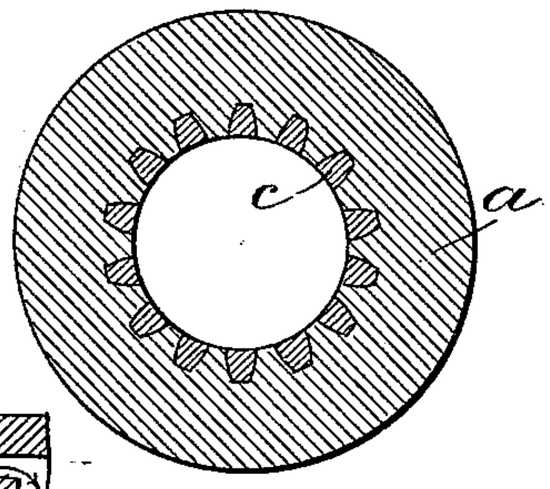
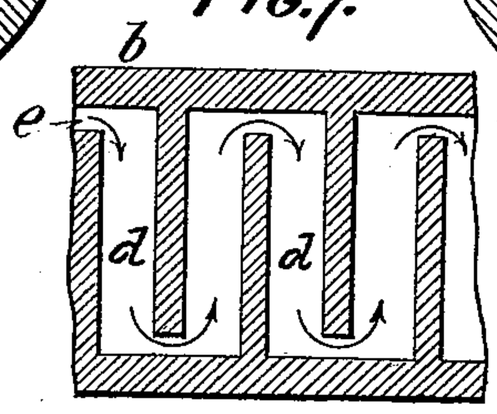


FIG. 7.



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METHOD OF MAKING DIES FOR GEAR-FORGING.

SPECIFICATION forming part of Letters Patent No. 521,179, dated June 12, 1894.

Application filed December 26, 1893. Serial No. 494,705. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR T. PORTER, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Methods of Making Dies for Gear-Forging, &c., of which the following is a specification.

This invention relates to the making of dies from which to forge gear wheels or pinions, &c., of steel or wrought iron or other metals of the character described in the patent of E. W. Bliss, No. 472,664, dated April 12, 1892. In making such gears a heated billet of metal is placed in a female die and subjected to hydraulic or other heavy pressure transmitted through a male die or punch which enters the female die, the pressure being sufficient to cause the billet to flow and expand into and fill the teeth formed within the female die, whereby is formed a compressed gear or pinion having its teeth ready finished and of great strength and toughness. The gear thus formed is forced out through the die.

My present invention provides an improved means for making or preparing the dies to be used in such forging of gear wheels and the like. Such a die requires to be made with internal gear teeth conforming in every respect to the external teeth to be formed on the gear or pinion, except that they are made enough larger to allow for the shrinkage of the metal of the gear in cooling, and the die is made of a sufficiently greater height than the length or thickness of the gear or pinion to be made. The internal surface of the die requires to be of chilled cast iron in order to afford such extreme hardness as will resist the cutting or tearing tendency of the billet during the formation of the compressed gear and its expulsion from the die. The inner surfaces of the die must be exceedingly hard and smooth, and the walls of the die must be amply strong to resist the bursting strain or pressure. The internal teeth in the die cannot be cut or finished by machinery because of the extreme hardness of the chilled surface, so that it is practically necessary to cast them originally of the exact form and with the requisite degree of smoothness. To accomplish this result is the object of my invention, which I will now proceed to describe with reference to the accompanying drawings.

Figure 1 is a perspective view of a forged gear or pinion made according to the said Bliss patent. Fig. 2 is a plan view of the die. Fig. 3 is a transverse section thereof on the line 3—3 in Fig. 2. Fig. 4 is an elevation of the cast iron blank from which the die is formed. Fig. 5 is a horizontal section through the cast iron portion of the die on the line 5—5 in Fig. 3, showing a stage in the formation of the die. Fig. 6 is another similar cross-section showing a further stage in the formation of the die. Fig. 7 is a vertical section on the line 7—7 in Fig. 3.

The forged gear A, (Fig. 1) is made in the female die B (Figs. 2 and 3), by placing this die on the bed of a hydraulic press, heating a billet of steel which is large enough to drop within the die, placing it therein, placing on top of it a male die or punch formed with teeth and conforming to and adapted to enter the female die B, and forcing this male die into the female die by hydraulic pressure so as to compress the heated billet and cause its metal to flow, whereby it is expanded and fills all portions of the internal teeth of the female die, and conforms itself accurately thereto. The pressure is then released, and by pressure subsequently applied, the forged gear or pinion is forced out of the female die in either direction. For a further description of the operation, reference may be made to the said Bliss patent. In the manufacture of forged gears or pinions according to this method, considerable difficulty has been encountered in the proper formation of the female die. Its teeth must be perfectly smooth, as otherwise the teeth of the forged pinion will be torn, scratched or injured in forcing it out of the die. The inner surfaces of the die must also be extremely hard in order to resist injury during the forcing of the hot billet to flow against them, and during the subsequent expulsion of the pinion. The requisite hardness of the inner surfaces can be attained only by forming the inner portion of the die of chilled cast iron, but as this material has not sufficient resistance to bursting strain, it is necessarily reinforced by shrink-

ing over it a steel ring. In the drawings, *a* shows the inner portion of the die which is of chilled cast iron, and *b* the outer portion or steel ring which is shrunk upon it. The internal teeth of the die cannot be cut or finished by machinery according to any usual methods because of the extreme hardness of the chilled surface. Consequently it is necessary to cast them originally of the exact form required, and with the requisite degree of smoothness. To accomplish these results, I prepare the die in the following manner: I first make a blank gear or pinion of cast iron, cutting it accurately with teeth of the same diameter and pitch as those in the gear or pinion to be forged, except that it is made enough larger to allow for shrinkage. This cast iron blank is also made longer than the gear or pinion to be forged, its length being equal to or exceeding the height of the die. This cast iron blank is shown in Fig. 4, being lettered *c*. Its teeth are finished with the amount of smoothness or polish required. This cast iron blank is then used as a core, being placed in the mold in which the inner portion *a* of the die is cast, and the latter is then cast around it in the ordinary way, so that the cast iron blank *c* serves as a chill-core, to impart the requisite hardness to the inner surfaces of the die. Fig. 5 is a section of the casting thus produced around this core or chill *c*. The core or chill is then bored out in the manner shown in Fig. 6, with as large a bore as can be made within the hard metal of the casting. This leaves the teeth of the chill still embedded between the teeth of the casting, but they are easily removed by driving them out, thereby leaving the die perfect in shape and size, and with its teeth smooth and finished. Its outer surface being then turned down if necessary, the cast steel ring *b* is shrunk upon it, thereby completing the die, as shown in Figs. 2 and 3. Instead of making the outer ring *b* of solid steel or wrought iron, as heretofore, I now form in it a tortuous channel for the circulation of water to cool the die. To this end the ring *b* is formed preferably of cast steel with a series of upright channels or passages *d d* cored out in its outer portion, and connected together alternately at top and bottom by cross passages or openings *e e*, as shown best in Fig. 7. The water is admitted by a pipe *f* (Fig. 2) and flows alternately up and down through the successive passages *d*, finally being conducted away by a pipe *g* (Fig. 2.) By means of this water circulation the die is kept cool, and its life is thereby greatly prolonged. Without the cooling effect of this water jacket, the die would soon become heated to redness, and so weakened that under the heavy strain it is necessary to put upon it in use, the inner portion *a* would crack between the teeth, dividing into segments, the slight separation of which would throw the teeth slightly out of line and form an imperfect pinion, and the die would soon become so injured as to be practically useless. These difficulties are entirely overcome by the provision I have made for cooling the die by a circulation of water through its outer strengthening ring, and by means of the construction of the water passages *d* to extend vertically, with solid connecting walls *h h* between them, whereby all necessary strength for the steel ring *b* is retained without making it of unduly large diameter.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. The improved method of making a die in which to forge gear wheels, consisting in cutting a cast iron blank with gear teeth of the diameter and pitch required for the gears to be forged except enough larger to allow for shrinkage, and of a length equal to the die to be made, then casting the die around said blank as a chill-core, and then boring out said blank and driving out its teeth, leaving the die of the exact shape, size and finish required.

2. The improved method of making a die in which to forge gear wheels, consisting in cutting a cast iron blank with gear teeth of the diameter and pitch required for the gears to be forged except enough larger to allow for shrinkage, and of a length equal to the die to be made, then casting the die around said blank as a chill-core, and then boring out said blank and driving out its teeth, and finally shrinking a steel ring around the exterior of said cast die.

3. The improved method of making a die in which to forge gear wheels, consisting in casting the inner portion of the die around a cut blank as a chill-core, then boring out and removing said blank, casting a steel ring with connected water passages cored out around its upper portion, and finally shrinking said ring around the exterior of said cast die.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ARTHUR T. PORTER.

Witnesses:
ARTHUR C. FRASER,
GEORGE H. FRASER.