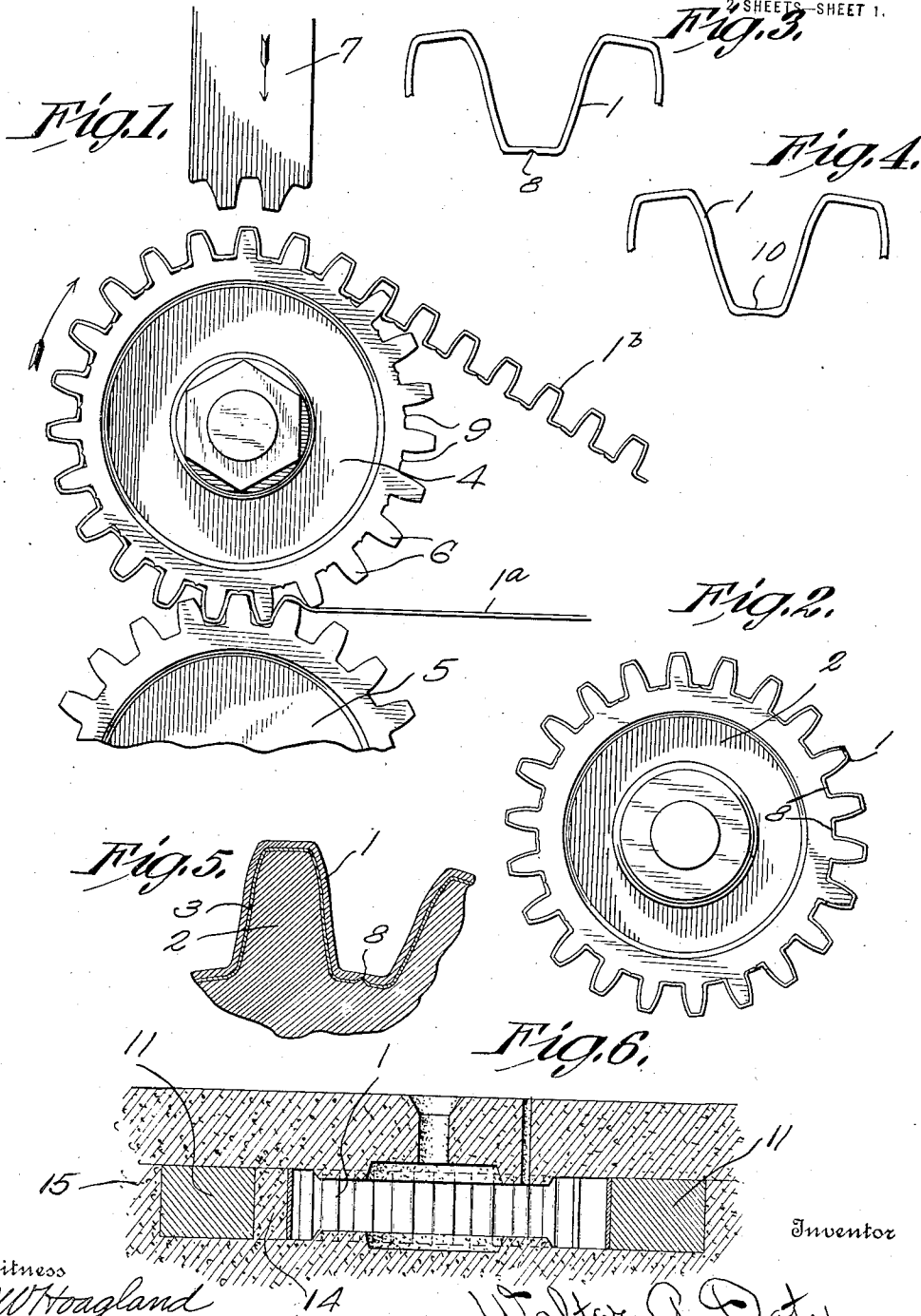


W. G. DOTY,
MACHINE ELEMENT.
APPLICATION FILED JUNE 25, 1917.

1,393,886.

Patented Oct. 18, 1921.

2 SHEETS—SHEET 1.



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Fig. 7.

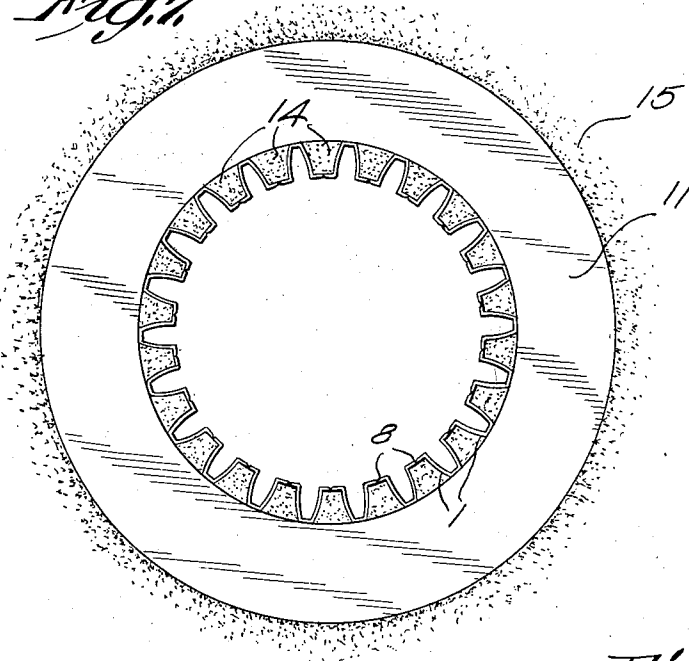


Fig. 10.

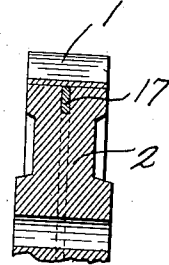


Fig. 8.

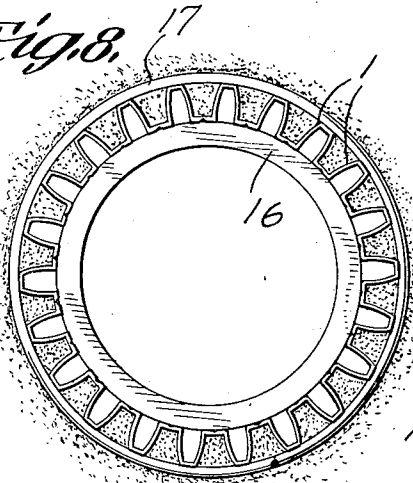


Fig. 9.

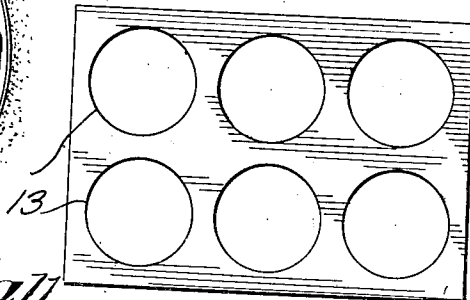
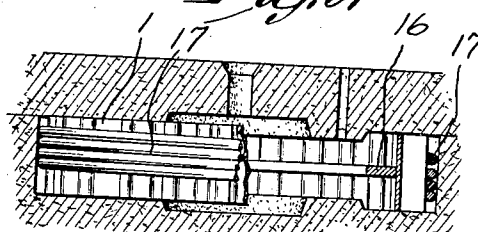


Fig. 11.

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UNITED STATES PATENT OFFICE.

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MACHINE ELEMENT.

1,393,886.

Specification of Letters Patent.

Patented Oct. 18, 1921.

Application filed June 25, 1917. Serial No. 176,870.

To all whom it may concern:

Be it known that I, WALTER G. DOTY, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Machine Elements, of which the following is a specification.

My invention relates to gear wheels and particularly to a process or method of producing finished cast metal gears, cams, slides, blocks, and other machine elements, without the necessity of machine operations.

The object of the invention is to improve the structure of cast metal gears and other machine elements as well as the means and mode of producing both internal and external gear wheels, whereby they will not only be cheapened in construction, but will be more efficient in use, more durable and uniform in operation, economical in manufacture, and unlikely to get out of repair.

A further object of the invention is to provide means for accurately forming the teeth of such gear wheels and affording smoothly finished working surfaces upon gears, cams, slides, and other machine elements, without the necessity of cutting or finishing such teeth or working surfaces by machine operations.

A further object of the invention is to provide means for reinforcing cast metal gears, cams, slides, and other machine elements, whereby they will have a less tendency to breakage while in use and whereby in the event of breakage the parts will be held together temporarily, thus reducing danger from flying pieces.

A further object of the invention is to provide a gear in which the vibrations will be materially dampened thereby rendering the gear less noisy.

A further and important object of the invention is to improve the method or process of manufacturing cast metal gears as hereinafter described.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention consists of the features of construction, the parts and combinations thereof and the process or mode of production and operation, or their equivalents, as hereinafter described and set forth in the claims.

Referring to the drawings, Figure 1 is a side elevation of the forming tools for corrugating the peripheral rim or facing strip. Fig. 2 is a side elevation of the finished gear. Figs. 3 and 4 are detail views of tooth forms of the peripheral rim. Fig. 5 is a detail sectional view of the completed gear tooth the several strata being enlarged or exaggerated. Fig. 6 is a sectional view of the sand mold for the gear, with the peripheral corrugated reinforcement and facing strip or rim positioned therein and the master form or ring inclosing the corrugated rim within the mold. Fig. 7 is a top plan view of the sand mold with the peripheral rim and master form or ring positioned therein. Fig. 8 is a similar view of a sand mold embodying a modification of the process or method of producing the gear. Fig. 9 is a sectional view of the sand mold for producing the gears in accordance with the process illustrated in Fig. 8. Fig. 10 is a detail sectional view of a portion of a gear, the result of the process illustrated in Figs. 8 and 9. Fig. 11 is a plan view of a modification of the master form.

Like parts are indicated by similar characters of reference throughout the several views.

The present method of manufacturing machine elements as particularly applied to the production of gears involves the use of an initial blank of either steel or cast metal in which the teeth are milled or cut by means of a suitable miller or hob. A steel blank affords gears for high duty or high efficiency where great durability, accuracy and wearing qualities are required, whereas for gears requiring less accuracy and wearing quality, the gears are cut from cast iron or other cast metal blanks. In some instances, gears have been cast with integral teeth, but the expansion and contraction of the metal while in the mold tends to distort the gears and results in misshaped and irregular teeth. Such cast gears necessitate additional machine operations to afford finished working surfaces upon the teeth.

The present invention is designed to afford commercial gears which may be cast in sand or other molds, the teeth of which will be formed sufficiently smooth and accurate in such molds as to obviate the necessity for machine operations. The smooth du-

erable wearing surface afforded upon the faces and flanks of the gear teeth is greater than that produced by the ordinary cast iron or other cast metal gear methods.

- 5 The finished product illustrated in Fig. 2 comprises a corrugated peripheral rim 1 preferably of steel but which may be of bronze or other suitable material or metal which incloses a body 2 of cast iron or other
10 cast metal. The body 2 conforms to the interior of the corrugated peripheral rim, whereby the corrugations of said rim form reinforcement faces for the gear teeth. Interposed between the rim 1 and main body
15 2 is a film or stratum 3 of softer material, such as tin which serves to dampen the rattle or clatter of intermeshing gears.

Not only do the corrugations of the peripheral rim form a more smooth and better
20 wearing surface for the gear teeth than that afforded by the cast metal of which the body 2 is composed, but it also serves to reinforce the body 2 against breakage or cracking. In the event that the body 2 is cracked
25 it holds the several pieces in close union, thereby preventing accidents and injury to the machine or to the operator.

- The corrugated peripheral facing rim 1 may be formed in any suitable manner such
30 as by passing a strip of the desired material between a succession of forming rolls, or by a succession of forming operations intermediate substantially straight dies and suitable coacting punches. In Fig. 1 there has
35 been shown a method in which the strip of material to be operated upon, indicated at 1^a, is passed intermediate two forming members 4 and 5, each provided with suitable gear teeth intermeshing with one another.
40 These teeth are adapted to initially or roughly form the corrugations in the strip 1^a.

- To produce the desired effect, the teeth 6 of the forming roll 4 are of less dimensions than the desired teeth to be produced upon
45 the finished gear. Having determined the size and pitch of the finished gear product, the master form 4 is cut or machined from a suitable blank in the usual manner. As shown in the drawing, the teeth of the forming
50 member 5 are of normal dimensions, while the teeth of the forming roller 4 are of less than normal dimensions, being equivalent to the normal tooth less the thickness of the strip 1^a acted upon about the entire periphery of the tooth. Thus when the
55 strip 1^a is accurately formed about the teeth 6 by action of the forming punch herein-after mentioned, the teeth 6 plus the strip 1^a extending thereabout becomes substantially equivalent to a normal tooth.
60

Intermeshing teeth of the shape shown in Fig. 1 will not form the strip 1^a accurately to the contour of the tooth. The strip will be only roughly shaped or corrugated by the
65 rolling or intermeshing action of the teeth

of the forming members 4 and 5. However, there is provided a reciprocatory forming member or punch 7 coacting with the toothed member 4. The toothed forming member 4 is advanced intermittently or
70 through a step by step movement by any suitable mechanism and during the intervening intervals of rest, the reciprocatory forming tool or punch 7 is brought into engagement with each succeeding tooth there-
75 by closely setting the initially or roughly corrugated strip 1^a into close conformity with the tooth 6 of the forming roller 4. As thus set or conformed upon the tooth 6 the exterior line of the corrugation will conform with the outline of the desired tooth
80 to be produced upon the finished product. The finished corrugated strip illustrated at 1^b may be formed of any desired length and pieces may be subsequently cut therefrom
85 of sufficient length to form the gear rims of desired dimensions. If these corrugated or finished strips are to be used only in the production of gears of a size equal to the forming member, 4, little or no distortion
90 would occur in bending the corrugated strip into annular form preparatory to casting the gear body 2 therein. However, to obviate any distortion of the tooth forms in bending the corrugated strip the said strip
95 may be weakened intermediate the roots of succeeding teeth as indicated at 8, Fig. 3. This is effected by providing a slight rib or bead 9 upon the forming member 4 intermediate the teeth 6 upon which the strip is
100 forcibly driven by the action of the forming tool or punch 7. There is thus formed in the inner side of the strip an indentation, as indicated at 8. The corrugated strip being thus weakened at points intermediate
105 the succeeding tooth forms upon the subsequent bending of the strip will yield at these points instead of yielding within the tooth corrugations and thereby obviates any tendency toward distortion of the tooth shape.
110

In lieu of the localized indentations 8 produced by the bead or rib 9 as shown in Fig. 3, the same effect may be obtained by weakening the interconnecting portion of the strip intermediate the succeeding teeth forms
115 as shown at 10, Fig. 4. In this form of rim in lieu of the indentation 8 a gradual variation of thickness of the strip is shown extending throughout the entire intermediate connecting portion of the strip between the roots of the succeeding tooth forms. This is produced by correspondingly shaping the opposing faces of the forming member 7 and the forming member 4.

Such weakening or indentations in the strip are especially desirable when the tooth forms are produced in straight dies by ordinary punch and die methods or when produced upon rotary forming members differing in diameter from that of the finished

product. It will be obvious, however, that in either event the degree of distortion due to the subsequent bending of the corrugated strip to annular form may be computed and sufficient allowance be made in the forming operation to compensate for the subsequent distortion. In such event the indentations 8 or the weakening of the strip shown at 10 may be omitted.

10 The corrugated peripheral strip being thus formed by any suitable method whereby tooth shapes properly spaced and proportioned are produced, sections of said corrugated strip containing the desired number of tooth forms or shapes are bent to annular form to ultimately comprise the exterior faces or working surfaces of the teeth of the finished gear product. These sections of corrugated strips or peripheral gear rims as they may now be termed are coated or plated with a suitable soft metal deposit or film such as tin. This may be effected by subjecting the peripheral rim to acid baths such as diluted sulfuric acid or diluted muriatic baths in order to thoroughly cleanse the rim and then submerging it in a bath of molten metal, or by otherwise fusing the metal on rim. In lieu thereof such coating or film may be deposited by any of the well known electroplating methods.

30 The ends of the corrugated rim sections may be joined one at the other either before or after the tinning operation if so desired. It has been found in practice, however, not essential that the ends should be so joined when employing the master form or ring hereafter described. The corrugated rim section bent to annular form is positioned within the master form or ring 11 the interior of which is accurately shaped and proportioned to the gear to be produced. This master form or ring 11 is preferably of considerable mass and extends the full width of the face of the gear. While a separate or independent master form or ring is desirable for gears of large size, a multiple master form having therein a plurality of circular openings or spaces 13 as shown in Fig. 11 will be found more convenient and economical in the production of small gear pinions.

After having been positioned within the master form or ring 11 with the points or crowns of the teeth in contact with the inner periphery of the master form the intervening spaces between succeeding teeth are filled or packed with sand as indicated at 14, Fig. 7. The sand mold 15 is prepared in the usual manner employing a pattern conforming to the external dimensions of the master form or ring 11 or the plate 12 as the case may be, and having thereon in properly spaced relation relief configurations corresponding to the hub boss and marginal flange of the gear. This pattern

is "rammed up" in the flask filled with sand to produce the usual intaligo form in the sand. The master form 11 with the inclosed corrugated gear rim 1 with the spaces intermediate the teeth packed with sand is then deposited in said sand mold and the top or cope of the mold is adjusted to position in the usual manner. The gear body 2 is then cast within the corrugated peripheral rim 1 by pouring molten metal within the mold.

Molten metal and particularly iron when in molten state, possesses the peculiar characteristics of initially expanding when poured into the mold and subsequently contracting to a degree greater than its initial expansion. Inasmuch as the corrugated rim 1 is firmly held by the surrounding master form or ring 11 against expansion, advantage is taken of the initial expansive tendency of the molten metal, to insure perfect contact between the body 2 of cast metal and the peripheral rim 1. This expansive tendency of the metal when initially poured into the mold results in a compression or condensation of the molten metal within the tooth forms of the rim therefore producing tooth bodies of increased density. This effect is not attainable in ordinary casting methods where the metallic body is free for lateral expansion. The rigid confinement of the metallic body within the master form or ring thereby produces a new result. The master form or ring 11 being of considerable mass does not become quickly heated from the molten mass within the corrugated rim and therefore serves to chill the points of the teeth rendering them somewhat harder and more durable than the body of the gear. The contact of the molten metal with the metallic film or coating of the inner side of the corrugated rim, fuses the metallic coating and serves to firmly unite the rim with the central body 2. The rim 1 and central body 2 thereby become an integral mass embodying an intermediate film or stratum 3 of metal of different physical characteristics which not only serves as a union between the rim and the central body 2 but also serves as a dampening element to interrupt the vibratory motion of the gear when in use and thereby deaden the clatter and rattle of intermeshing gears rendering them less noisy in operation. The contraction of the central body 2 as it cools also tends to contract with it the corrugated rim 1 with which it is fused during the casting operation, thus enabling the easy removal of the gear which has now become a single integral body from the master form or ring 11.

In Figs. 8 and 9 there is illustrated a modification of the process heretofore described in which the external master form or ring 11 is dispensed with and in which

an internal annular form or retaining member 16 of sheet metal is employed in lieu of the external master form or ring 11. This internal annular form 16 serves to retain the true circular form of the corrugated rim which is compressed into contact with the internal form 16 by inclosing helical spring coils 17 which tend to contract upon the periphery of the corrugated rim 1. In operating this modified method the internal annular form 16 and the inclosing helical coils 17 together with the corrugated rim 1 are preferably assembled in their relative positions prior to the tinning or metal coating operation as hereinbefore described. While this coating or deposit of a metal film upon the corrugated rim has been termed "tinning" it is to be understood that it is not limited to the application of metallic tin alone, but other metals or substances may be employed in lieu of tin.

The annular support or form 16 and the inclosing coils 17 are preferably, though not necessarily, temporarily secured either by soldering, brazing, electric welding, or are attached without direct engagement, by wiring them to the rim.

Like the preceding described method, a pattern is employed for forming in the sand of the mold an intaligo design equal in diameter to the external diameter of the inclosing coils 17 and having thereon surface configurations corresponding to the hub boss and marginal flanges of the gear. The rim 1 with the assembled support or annular form 16 and inclosing coils 17 are deposited in the intaligo design or pattern formed in the sand mold and molten metal is poured within the mold as before described. This molten metal flows over and around the annular reinforcement or supporting member 16, inclosing said annular member 16 and firmly uniting therewith and with the interior walls of the corrugated peripheral rim 1 of the gear. The result is the formation of an integral body of which the corrugated peripheral rim 1 forms an external stratum. Intermediate this external stratum or rim and the central gear body is an interposed stratum of metal of different physical characteristics which as before mentioned serves as a dampening element to deaden the rattle or sound of the gears. This same dampening stratum will extend also about the annular support or form member 16. This form member 16 is permanently embedded in the body 2 of the gear where it forms an additional reinforcement member serving to distribute the unequal strains to which the gear is subjected and preventing the disintegration and breakage of the gear. In this mode of procedure, the intervening spaces between the succeeding teeth may if desired be filled or packed with sand, but are preferably left open to provide intervening air

chambers which serve to chill or cool the metal forming the bodies of the teeth. The encircling coils 17 about the rim being preferably firmly attached to several of the tooth corrugations and being in contact with the corrugated rim only at the points of the teeth, does not readily absorb the heat from the molten mass within the corrugated rim and therefore tends to resist the expansion of the mass as before described. By the time that the encircling coils 17 have absorbed sufficient heat to materially expand them, the body of metal within the tooth corrugations of the rim has cooled sufficiently to have passed beyond its expansive state and the only result of the heating of the encircling coil 17 is to separate the coils from the corrugated rim at their points of attachment, whereby said coils and the gear rim which is now an integral part of the cast gear will fall apart upon their removal from the sand mold. The coils 17 serve to hold the corrugated rim in close contact with the form or support 16, thereby insuring a perfect circular formation of the rim. The resulting gear will be similar to that produced by the first described method. Such gear will possess smooth uniform teeth and will be capable of being placed in operation without the necessity of special machining or finishing operations. Such gears will possess unusual tensile strength and inasmuch as their vibration is interrupted or deadened by the embodied zone or stratum of characteristically different material, they will be found less noisy in operation. While for illustrative purpose the invention has been particularly described in its application to the production of gears, it is to be understood that it is not so limited but may be utilized for other machine elements such as internal and external cams, slides, bearing blocks, or other parts which it may be desired to provide with either a smooth surface, a finished face, or a reinforcement as herein set forth.

It is to be understood that the term "gear" as it appears throughout the description and claims is not limited to spur gears and pinions but is to be interpreted as including internal gears, bevel or miter gears, gear racks, segmental and other gear elements. While cast iron is the material usually employed at this time for the main or supporting body, other metals or alloys may be used as may also other rigid non-elastic or non-yielding materials such as phenolic condensation products or self-hardening materials capable of being molded.

From the above description it will be apparent that there is thus provided a device of the character described, possessing the particular features of advantage before enumerated as desirable but which obviously is susceptible of modification in its form,

proportion, detail construction or arrangement of parts, without departing from the principle involved or sacrificing any of its advantages.

5 While in order to comply with the statutes, the invention has been described in language more or less specific as to certain structural features, it is to be understood that the invention is not limited to any specific details, 10 but that the means and construction herein described comprise but one mode of putting the invention into effect, and the invention is therefore claimed broadly in any of its possible forms or modifications within the 15 scope of the appended claims.

Having thus described my invention, I claim:—

1. As an article of manufacture, a gear 20 comprising a cast metal body, sheet metal rims for the teeth and an interposed stratum of metal of different physical characteristic, said cast metal body, sheet metal rim and

interposed stratum of different metal being integrally united into a conjoint body.

2. A machine element comprising a fluted 25 strip constituting a succession of tooth forms, said strip being weakened at points intermediate successive tooth forms and flexed into an outline shape of the finished 30 product, such flexing occurring at such weakened points without material distortion of the tooth forms, and a supporting body inclosed within such flexed strip.

3. As an article of manufacture, a gear 35 comprising a cast metal body, a continuous sheet metal tooth rim and an interposed stratum of soft metal all united into a conjoint body, substantially as specified.

In testimony whereof, I have hereunto set my hand this 2nd day of June, A. D. 1917. 40
WALTER G. DOTY.

Witnesses:

MARVEL HOAGLAND,
F. L. WALKER.