No. 665,897.

Patented Jan. 15, 1901.

# J. FRITZ.

## AXLE.

(Application filed May 25, 1899.)

(No Model.)

2 Sheets—Sheet 1.

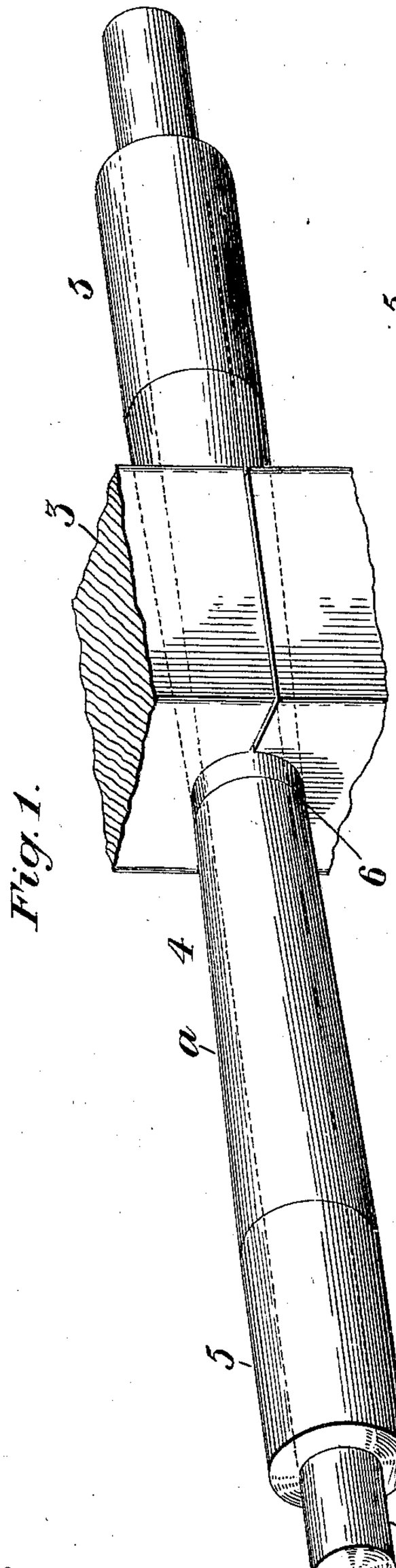


Fig. 1.

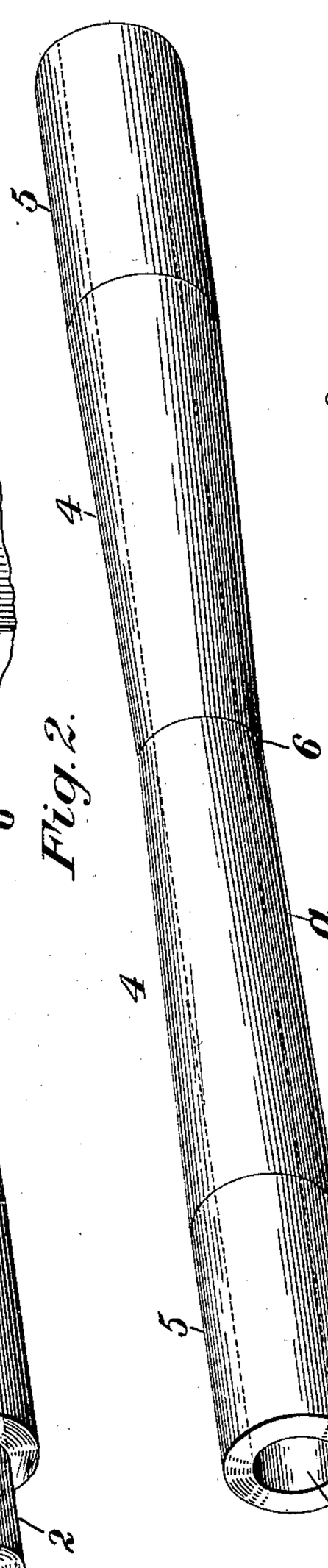


Fig. 2.

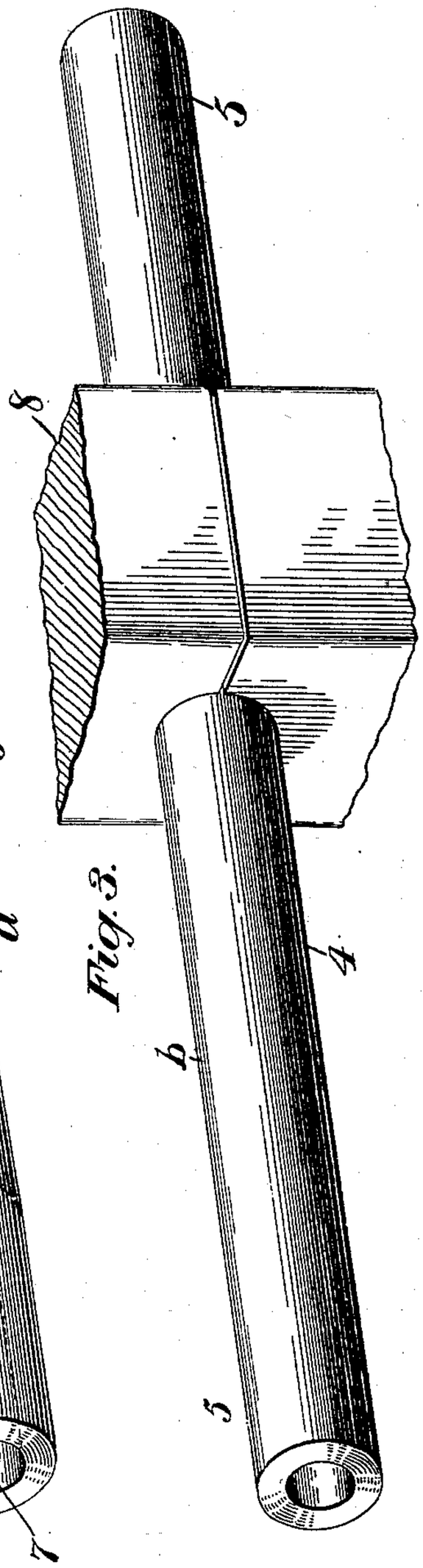


Fig. 3.

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No. 665,897. Patented Jan. 15, 1901

# J. FRITZ.

## AXLE.

(Application filed May 25, 1899.)

(No Model.) 2 Sheets—Sheet 2.

*Fig. 4.*

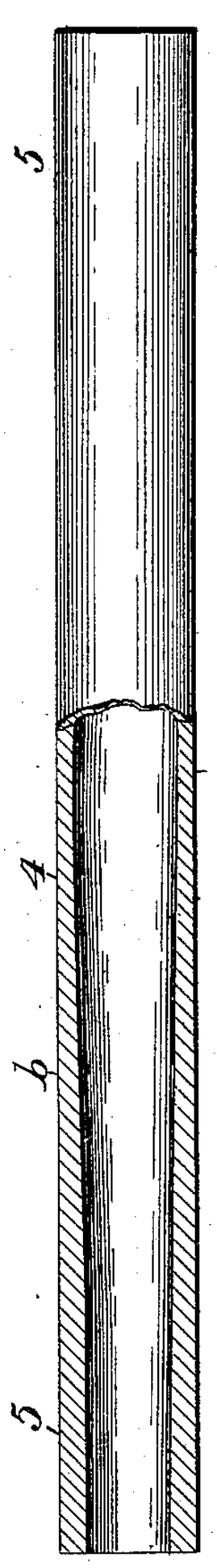



*Fig. 5.*

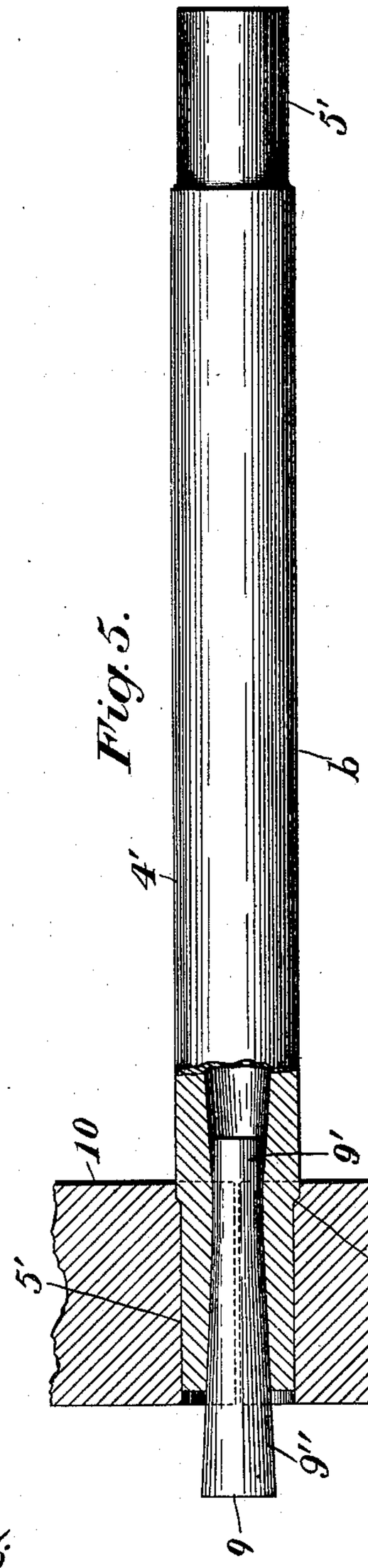
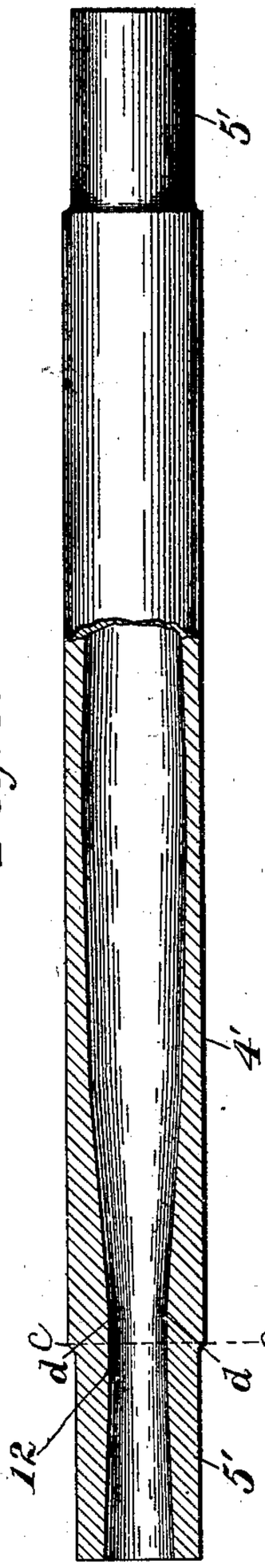



*Fig. 6.*

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# UNITED STATES PATENT OFFICE.

JOHN FRITZ, OF BETHLEHEM, PENNSYLVANIA.

## AXLE.

SPECIFICATION forming part of Letters Patent No. 665,897, dated January 15, 1901.

Application filed May 25, 1899. Serial No. 718,215. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN FRITZ, a citizen of the United States, residing in Bethlehem, in the county of Northampton and State of Pennsylvania, have invented a certain new and useful Improvement in Axles, of which the following is a specification.

This invention relates to axles, and more particularly it relates to hollow homogeneous steel axles especially adapted for use with rolling-stock—such, for instance, as locomotives, railway-cars, electric motors, &c.—one object of the invention being to furnish a hollow axle of peculiar qualities and having exceptionally high power of resistance to the severe strain and shocks to which axles in such work as specified are particularly subjected.

A further object of the invention is to provide a hollow axle in which, owing to its structure and the particular mode of making the same, the metal will be so distributed throughout the axle that those portions thereof which are subjected to the greatest strain will be able to sustain the same with superior effectiveness.

In carrying out my present invention I treat a hollow member of a tube of a length to form the completed axle to furnish it with different external diameters, whereby a part thereof has a tapered formation, while maintaining substantially the same internal diameter throughout the length thereof, after which this tubular member is so treated that this tapered exterior surface is transferred to the interior of the tube, whereby the tube has the same external diameter throughout the length thereof, while it is of different interior diameters, after which this so-formed member is subjected to treatment to form the completed axle. By this mode of treatment I am able to provide a homogeneous hollow axle in which the metal has been so distributed that the product is capable of withstanding great strain and is of superior effectiveness and durability and has its elastic limit materially increased and one in which the crystallization of the metal at the points where fracture usually occurs is avoided.

In the drawings accompanying and forming part of this specification, Figure 1 is a view illustrating a tubular member subjected to one mode of treatment to form it of different external diameters, while maintaining its bore of the same internal diameter. Fig. 2 is a view of said member so formed. Fig. 3 is a view illustrating the tubular member subjected to further treatment to form it with the same external diameter from end to end thereof, but of different internal diameters. Fig. 4 illustrates, partly in section, the tubular member so treated. Fig. 5 is a view, partly in section, of a mode of treating the member to form the journal thereof; and Fig. 6 is a view, partly in section, of the completed axle.

Similar characters of reference indicate like parts in all the figures of the drawings.

I am aware that a number of patents have been issued for hollow axles. I am also aware that in experiments with hollow axles they have proved unsuccessful, which failure has been largely due to the mode of manufacturing the axle and to the structure thereof as manufactured.

In actual practice the axle usually breaks or becomes fractured at the juncture-point of the journal with the body, and while many plans have been devised to prevent this I am aware of none which so far has proved effective with hollow axles. I am also aware that a patent has been issued for a hollow axle in which the body portion thereof intermediate the journals has different internal diameters and is of tapered formation; but this patent covers the axle not as an integral structure nor as treated to first give it a tapered exterior surface, while maintaining a uniform interior surface, but as one made in sections or halves and welded together and lacking that distribution of material which, I apprehend, is essential to turn failure into success in the manufacture of hollow axles.

In the manufacture of hollow homogeneous axles, while I may utilize tubular members already formed, yet in order to insure a homogeneous axle I preferably take a block of metal and convert the same into a tube of the required axle length and of substantially uniform internal and external diameters, respectively, from end to end thereof. This step in the process may be performed in any desired manner—as, for instance, by the use of a suitable matrix and a mandrel driven

into said block while in the matrix to thereby form it into a tube, whereby there is secured by this step such a distribution of the metal in the different parts of the tube longitudinally thereof as will in the succeeding stages of manufacture result in giving to the finished axle the required distribution of the metal therein for securing the requisite characteristics of the finished article. This tube so formed is then placed upon an arbor 2, substantially corresponding with the desired internal diameter thereof, and is then treated by some suitable instrumentality 3—such, for instance, as by means of a press—thereby to forge the same with different external diameters, while maintaining a uniform internal diameter from end to end thereof. By this procedure the tubular member *a* is furnished with a pair of end sections 5 of uniform external diameter and an intermediate section 4 of external tapering formation, said intermediate part tapering from each end section 5 to its center 6, whereby said member is of different external diameters, while the bore thereof is of the desired uniform diameter throughout the length of said member. During this step the metal is effectively distributed in such manner as to materially increase the strength and durability of that part of the axle which is subjected to the greatest strain in use. The tubular member *a* so formed, it will be seen from an inspection of Fig. 2, now has its bore 7 of the same internal diameter throughout the length thereof, while its external diameter gradually increases in opposite directions from its center 6 to the end sections 5, each of which is of uniform diameter to the end of the member. This partially-formed axle is then subjected to a further forging treatment, thereby to form the tubular member *b* with a substantially uniform external diameter throughout its length and of different internal diameters, whereby the tapered form of the structure is transferred from the exterior to the interior thereof. This result may be effected by the use of some suitable instrumentality 8—such, for instance, as a press—whereby during the forging operation the member is furnished with a substantially uniform external diameter throughout its length, while the intermediate section 4 has its bore of tapering formation, gradually increasing from the center in opposite directions to the end sections 5, each of which has its bore of substantially uniform diameter.

By a comparison of Figs. 2, 3, and 4 it will be seen that the tubular member *a*, having a uniform internal diameter and different external diameters, has been transformed into a member *b* having a substantially uniform external diameter, less, however, than that of the member *a*, owing to the compression of the metal, and different internal diameters, whereby there is obtained during this procedure a still further distribution of the metal, so that the elastic limit of the product and the strength of the axle are materially increased at those parts thereof which are subjected in use to the greatest strain and most liable to fracture. By this step it will be seen that the interior surface of the member *b* is brought into tapering formation from the end sections 5 to the center of the member, while the bore of each end section is of uniform diameter, less, however, than that of the end sections 5 of the member *a*, whereby there is given to the axle the least amount of metal in the middle portion thereof, where the least power is required, while the thickness of the walls is gradually increased from such middle portion to the end sections 5, from which the journals are formed and where the greatest power is required.

Since in practice it is usual to form the journals 5′ of less external diameter than the body 4′ of the axle, I subject the axle to further treatment, so as to still further distribute the metal, whereby the juncture portion of such journals 5′ with the body 4′ will be of superior elasticity, and thereby of increased strength and durability. In accomplishing this end according to one mode I insert into the end section 5 of the member *b* (see Fig. 5) a mandrel 9, having a part thereof, as 9′, of uniform diameter and another part thereof, as 9″, of tapering formation, and upon this mandrel the end section 5 is then forged down by some suitable instrumentality, as 10, whereby there is formed a journal 5′, which, while having substantially the same external diameter from end to end thereof except at the shoulder 5″, has different internal diameters. By this step there is formed at the juncture-point *c* of each journal 5′ with the body 4′ an increased thickness of metal, and a journal is provided the interior wall of which at the juncture-point of such journal with the body and for a distance at each side of such juncture-point is substantially straight, as at 12, whereby the journal-bore is of the least diameter at this point and from which the bore of the journal gradually increases in size to the end thereof. From this it will be seen that at the points marked *c* and *d*, which are the ones where fracture usually occurs, the metal is of greater thickness than at any other point of the axle and that this reinforcement at these points is due not alone to the quantity of metal, but to the quality thereof, resulting from the manner in which such increased amount of metal is obtained.

In ordinary practice after the procedure set forth I prefer to subject the entire axle to a tempering operation, this being preferably an oil-tempering process, whereby the entire mass of metal will be tempered and refined, thereby increasing the ultimate strength and power of the axle and at the same time improving the quality of the friction-surfaces of the same, this form of axle permitting the oil-tempering thereof with the best possible

results, since there is no part of the axle which will be left untempered, as is the case with solid axles or with hollow axles the metal of which has been merely increased in thickness at vital points without any particular treatment to increase its elastic limit or strain-resisting qualities.

In conclusion it will be seen that I provide an improved hollow axle the metal of which during the process of manufacture has been so distributed that, I apprehend, its elastic limit at its vital parts has been so materially increased as to exceed the strain which will ordinarily come thereon, so that those portions of the axle which in use are subjected to the greatest strain are rendered of superior effectiveness and increased power. Moreover, it will be seen that I have provided an improved hollow axle which, while having its body and journals, respectively, of substantially uniform external diameter, has the bore of such body and journals, respectively, of different internal diameters, each of tapering formation, whereby the metal has been effectively worked from the center of the axle and from the ends of the journals into a wall of superior effectiveness at the juncture portions of said journals and body, and this without the formation of sharp or abrupt corners or angles in the bore of the axle at and adjacent to the juncture of the journals with the body.

As hereinbefore stated, while I am aware that hollow axles have been patented I am not aware of any axle having the formation herein set forth or produced in the manner herein described, and I believe that I am the first to supply in the art an axle of higher efficiency than heretofore known, when considered in relation to the quality of metal therein and to the weight and strength of the respective portions of the axle, and to supply an axle of great value to the public, since it will reduce the accidents which have frequently occurred by providing against a weakness from which such accidents arise.

It may be found in practice that the object of this invention may be accomplished other than by a forging operation—as, for instance, by cold-compressing—and therefore it is to be understood that I do not limit myself to a forging treatment, since any treatment or mode of procedure which will produce the axle herein set forth is within the scope of my invention.

Having described my invention, I claim—

1. A hollow, integral, homogeneous axle comprising a body of uniform external diameter having a bore of gradually-increasing diameter from points adjacent to its ends to its center, and a pair of journals, each having a bore comprising a cylindrical portion at and adjacent to its juncture with said body and a portion of gradually-increasing diameter extending from said cylindrical portion to its outer end.

2. A hollow, integral, homogeneous axle comprising a body of substantially uniform external diameter having a bore tapering in opposite directions from its center, and a pair of journals, each having one part of its bore of uniform diameter and another part thereof tapering.

3. A hollow, integral, homogeneous axle comprising a body of uniform external diameter, and a pair of journals of less external diameter, the bore of said axle tapering outwardly in opposite directions from its center toward the journals and inwardly from the outer ends of said journals, said tapering surfaces merging, without the formation of sharp or abrupt angles or corners, into straight surfaces extending on each side of the junctures of said journals with said body.

4. A hollow axle comprising a body of substantially uniform external diameter, and a pair of journals, the bore of said axle tapering in opposite directions toward the journals and terminating at the inner side of the juncture of said journals and body in a cylindrical portion, and also tapering from the outer end of each of said journals and terminating in said cylindrical portion at the outer side of said juncture of the journal and body.

5. A hollow axle comprising a body, and a pair of journals, the bore of said body tapering in opposite directions toward the journals, and the bores of said journals tapering inwardly toward the body, with an intermediate surface connecting the tapered bores of the body and journal.

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Witnesses:
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