R. ABELL.

FLEXIBLE SHAFTING.

APPLICATION FILED DEC. 21, 1905. RENEWED MAY 19, 1909.

970,675. Patented Sept. 20, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

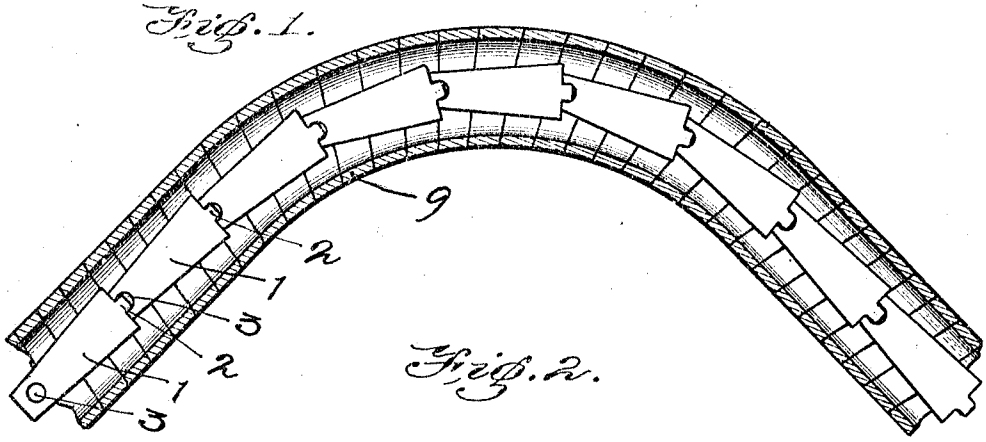


Fig. 2.

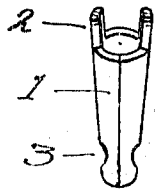


Fig. 3.

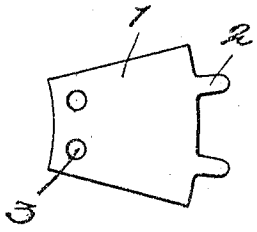


Fig. 6.

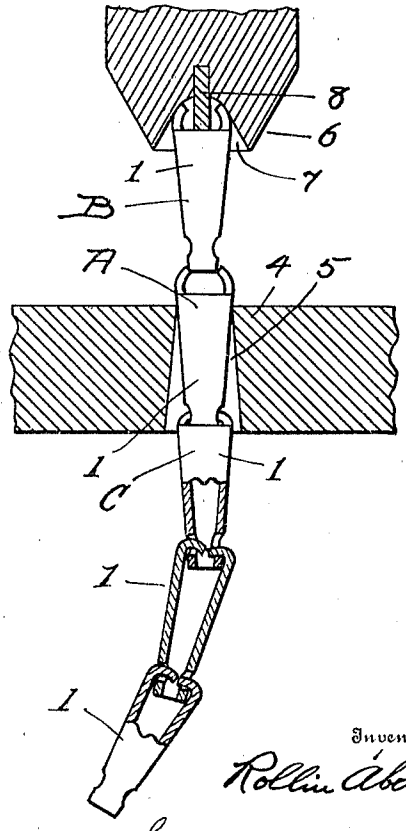


Fig. 4.

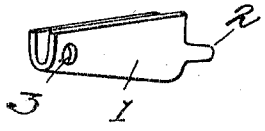
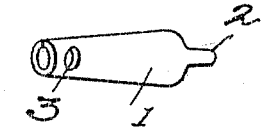


Fig. 5.



Witnesses

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2 SHEETS—SHEET 2.

Fig. 7.

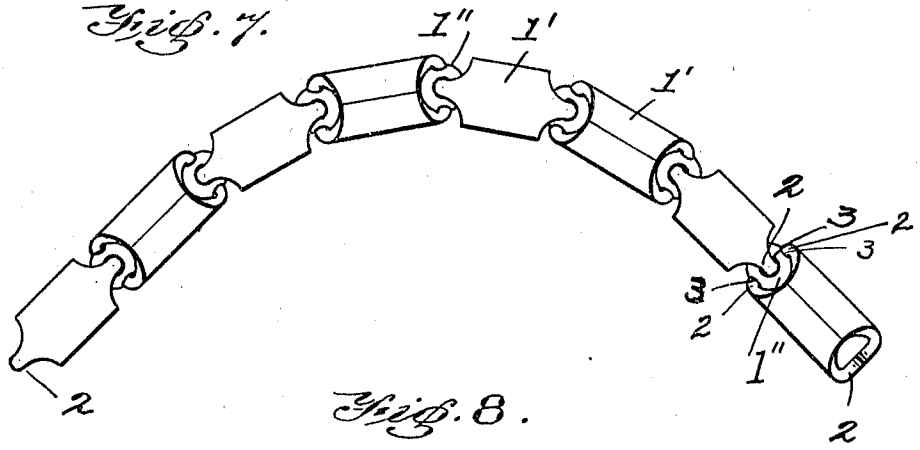


Fig. 8.

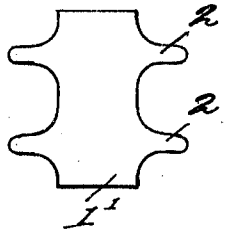


Fig. 9.

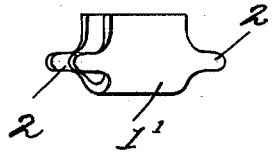


Fig. 10.

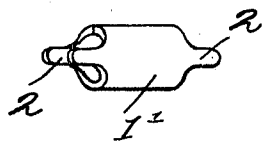
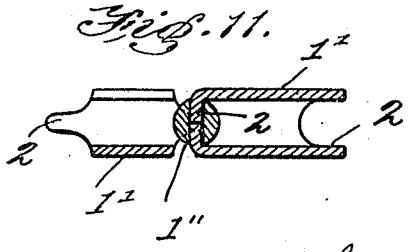


Fig. 11.



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UNITED STATES PATENT OFFICE.

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FLEXIBLE SHAFTING.

970,675. Specification of Letters Patent. Patented Sept. 20, 1910.

Application filed December 21, 1905, Serial No. 292,755. Renewed May 19, 1909. Serial No. 496,937.

To all whom it may concern:

Be it known that I, ROLLIN ABELL, citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Flexible Shafting, of which the following is a specification.

This invention relates to improvements in flexible shafts for transmitting power.

The objects of the invention are to produce a shaft of durable material not likely to break or become fragile by use and wear; to reduce the cost of manufacture of flexible shafts; and in general to produce a shaft having the other advantages incident to the invention hereinafter described. These objects are attained by constructing the shaft of successive unit links which fit together end to end in a cup-like manner, each joint between units being made by projections formed integral with one of such units engaging loosely in holes in the other unit. The units may be of various shapes and made in any suitable manner.

The features of the invention are illustrated herein by showing a unit formed of cold rolled or drawn sheet metal in conical shape. In this embodiment of the invention a blank is stamped from a sheet of steel, then is rolled or drawn into conical shape, and then the units are assembled end to end by bending the integral projecting fingers of one unit into holes provided to receive them loosely in the adjacent unit. As these fingers are integral with the material of the body of the link, they cannot work loose, as rivets are apt to do; the expense of inserting and fastening rivets or pins is saved; and being made of tenuous, untempered material they are not liable to crystallization and internal deterioration as coiled springs are under continued use. By suitably shaping the connecting projections the transmittal strength can be made stronger, in proportion to the weight and size of shafting, than is feasible if rivets or pins are used, for the reason that the presence of the hole in which the pin or rivet is set weakens the stock, while by the present invention, the fingers being integral with the stock, the full strength of the stock is saved. The stock can also be made of less thickness, because with integral projections the long setting required to hold a pin firmly is dispensed with.

In this embodiment of the invention which is shown in the accompanying drawings, Figure 1 represents in side elevation a piece of the completed shafting, an inclosing tubular case being indicated by dotted lines. Fig. 2 shows one unit of the shafting in perspective in its form before assembling. Fig. 3 shows a blank stamping for forming a unit. Figs. 4 and 5 show an intermediate stage and the completed stage of a unit formed from said blank. Fig. 6 shows in side elevation, partly in section, a method of assembling the units. Fig. 7 shows a modification in side elevation. Fig. 8 shows a blank stamping from which one of the units of the modification may be formed. Figs. 9 and 10 show stages in the formation of said unit from said blank. Fig. 11 shows, partly in section, a completed joint of the modified form.

Referring to the drawings: Fig. 3 shows a blank stamping marked 1, having projections 2 arranged at one end suitable for the purposes hereinafter described, and holes 3 near the other end. This blank is then bent into the form shown in Fig. 4, and then into the form shown in Fig. 5, in which it is a conical shell, having the holes 3 diametrically opposite each other near one end, and the projections 2 standing out at the other end, likewise diametrically opposite each other. Fig. 2 is a view of the other end of the same piece. It will be observed that the base of the projections 2 may be made wider than the tips, as shown in the drawings, these projections being slightly pointed in shape. By thus broadening the bases of these integral projections a considerably greater cross section of material can be employed in them than if the projections were merely pins or rivets, not integral with the body of the unit; and at the same time a bracing or strengthening effect is secured in the base of the projection itself. After completion to this stage it is well to smooth the corners of the units by tumbling them in a barrel, or by some other suitable method. A process of assembling these units into shafting is shown in Fig. 6. 4 represents a die plate having a hole 5, the top of which is carefully made of the precise size needed for the operations hereinafter described, the remainder being cut of larger diameter for clearance. 6 is the pressing chamber of the die, having a depression 7 on its face, which may be of conical or a suit-

able curved shape, as indicated, and has a block 8 set in the center across the depression in such form as to bear upon the end of a unit 1 inserted therein, without touching the projections 2, as hereinafter described. A unit 1 is placed in the hole in the die block in the position marked A, its fingers 2 having been bent slightly inward so that another unit will rest upon them in the position B without falling between, as indicated in the drawing. Such other unit being so placed, the punch is moved toward the die block and encounters the fingers 2 of the upper unit, engaging them with its recessed surface 7, which presses at such an angle that it bends them inward. This continues until the central block 8 encounters the end of the unit 1 and imposes the pressure of the punch directly upon the body of the said unit. As movement of the punch continues the further downward pressure causes the lower end of the unit B to slip between the fingers 2 of the supporting unit A, which fingers then slip into the holes 3 of the unit B and encounter the upper edges of those holes. Continued pressure causes these upper edges to bear down upon these fingers of unit A and to bend them farther inward until they resist further bending so powerfully that the entire upper rim of this unit A yields and is compressed a little and is pushed through the die block, and falls to the position next below, indicated by the letter C. When this occurs the unit B takes the place originally occupied by unit A; a fresh unit is then placed on top of B, which has now become unit A; and the operation may be repeated. Thus the shaft is made, unit by unit, of any desired length. The projections 2 fit loosely into the holes 3, with some play room; and the small end of each unit fits loosely into the large end of similar units, with some play room. This makes a sort of universal joint, limited by the limit of play room allowed.

It will be observed that in the form illustrated the fingers 2 are approximately oblong or rectangular in cross section, while the holes 3 are round. In operation the strain of transmitting the power comes upon these oblong parts of the fingers near the bases of the fingers, and herein appear several advantages of the invention: by having these rectangular instead of round a larger cross section of material can be utilized by saving the corners; fingers can be made at one operation of punching, the expense of turning down the corners, to make the fingers round, being saved;—and by making them oblong a larger cross sectional area is obtained. Being oblong or rectangular, they do not fit the holes, but this is no detriment, and in fact is an advantage because with this method of construction it is not essential that the fingers fit. When first placed in operation the corners of the fingers wear off a little, increasing the play room and thus increasing the flexibility of the shaft. An extra wear at any point serves to increase the flexibility there without materially weakening the transmitting power.

A casing 9 is provided to inclose the shaft, and this may be of any ordinary or suitable type. A lubricant may be inclosed in the casing as is customary. If it is preferred, the parts may be case-hardened after the shafting has been formed, thus preventing wear; or in some cases it may be better to defer case-hardening until the corners have been worn smooth.

A modified form of the invention is shown in Figs. 7, 8, 9, 10 and 11. In this form two kinds of units are used:—the unit 1′ which is cylindrical and provided with integral projecting members 2 at each end, and the unit 1″ which is spherical, provided with four holes 3 into which fingers 2 from the units 1′ on each side of it hook as in the form hereinbefore described. These holes are set ninety degrees apart in the medial plane, passing through the ball perpendicular to the axis of the shafting when the shafting is arranged in a straight line. Fig. 8 shows a blank stamping from which the unit 1′ may be made by rolling first into the form shown in Fig. 9, and afterward into the form shown in Fig. 10. In Fig. 11 the joint between the adjacent units is shown in section. The members 2 projecting from the unit 1′ on one side of the unit 1″ are set quartering with the fingers from the unit 1′ on the opposite side. In order that these fingers may not interfere when all four are turned into the ball, it is well to round their ends. If desired, the projecting members instead of being left in rectangular form, as heretofore described, may be swaged round. By so doing the parts may be made with closer fit, play room not being necessary with the double pivot form of joint shown in this modification.

As various other modifications of the shafting may be made without departing from the scope of the invention, the patent is not to be limited to the specific forms here shown and described.

I claim:

1. A flexible shaft, comprising a series of units of circular cross section, having joints between the units formed by members projecting integrally from opposite sides of one unit and constituting axles journaled by hooking loosely into holes in the adjoining unit.

2. A flexible shaft, comprising a series of similar units, each having holes set in opposite sides near one end, and being formed at the other end into members projecting integrally from the body of the unit constituting axles journaled by engaging loosely in

similar holes in the adjacent unit, in combination with a flexible circular casing surrounding the series of units.

3. A flexible shaft, comprising a series of similar hollow round units, each having one end large enough to receive the smaller end of a similar unit, and having holes set laterally at one end and at the other end being provided with parts projecting integrally and constituting axles journaled loosely in similar holes in the adjacent unit.

4. A flexible shaft, comprising a series of units composed of ductile metal formed into hollow conical shape; the smaller end being adapted to enter the larger end of an adjacent unit; there being lateral holes near one end, and members at the other end integral with the body of the unit, and fitting loosely into the similar holes of the adjacent unit.

5. A flexible shaft, comprising a series of units, having joints between the units composed of members projecting integrally from opposite sides of one unit and constituting axles journaled by being hooked loosely into holes in the adjoining unit, the sides of each member converging from the base of the member toward its tip within the hole.

6. A flexible shaft, comprising a series of units of circular cross section, having joints between the units formed of members projecting integrally from opposite sides of one unit, having approximately rectangular cross section, and constituting axles journaled by being hooked loosely into round holes in the adjoining unit, the corners of the rectangle bearing against the circumference of the holes, in combination with a flexible circular casing for the series of units.

7. A flexible shaft, comprising a series of shells, having joints between the shells formed by members constituting axles projecting integrally from opposite sides of one shell through holes in the adjoining shell and journaled therein, said projecting members being arranged to make contact with the adjacent shell only within the holes through which they pass.

8. A flexible shaft, comprising a series of units, having joints between the units formed by members constituting axles projecting integrally from opposite sides of one unit and journaled by hooking loosely into holes in the adjoining unit, the portions of said members which project through being arranged to permit movement of a unit in any angular direction from the axis of the adjoining unit.

9. A flexible shaft, comprising a series of sheet metal coniform units, there being integral projections from the ends of the units for linking the units together, and each unit having a longitudinal seam on one side of the unit formed by opposing edges of the sheet of metal of which the unit is formed.

10. A flexible shaft, comprising a series of units composed of ductile metal formed into hollow tubular shape with one end larger than the other; the smaller end being adapted to enter the larger end of an adjacent unit; there being lateral holes near one end, and membes at the other end integral with the body of the unit, and fitting loosely into the similar holes of the adjacent unit.

In testimony whereof I affix my signature, in presence of two subscribing witnesses.

ROLLIN ABELL.

Witnesses:
OLIVER P. SCHOONMAKER,
ELLIOTT B. CHURCH.