No. 736,378. PATENTED AUG. 18, 1903.

G. E. GAY.

FLEXIBLE SHAFTING.

APPLICATION FILED JUNE 9, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

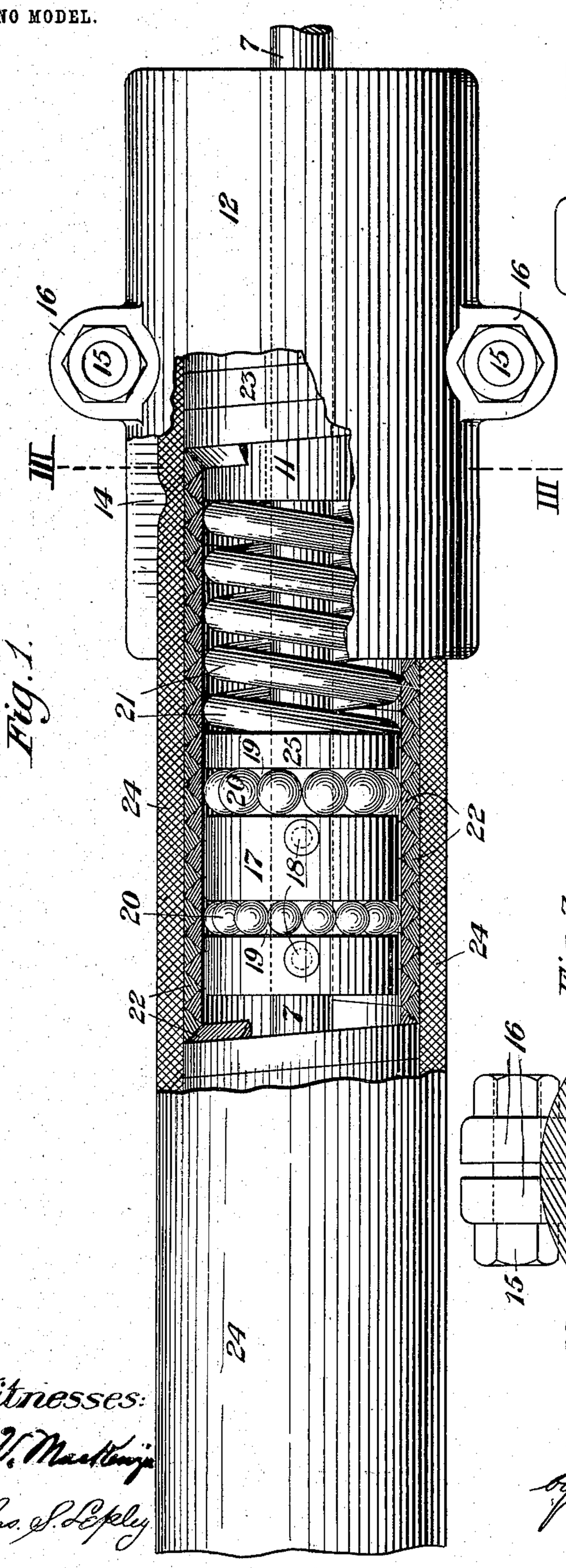

Fig. 1.

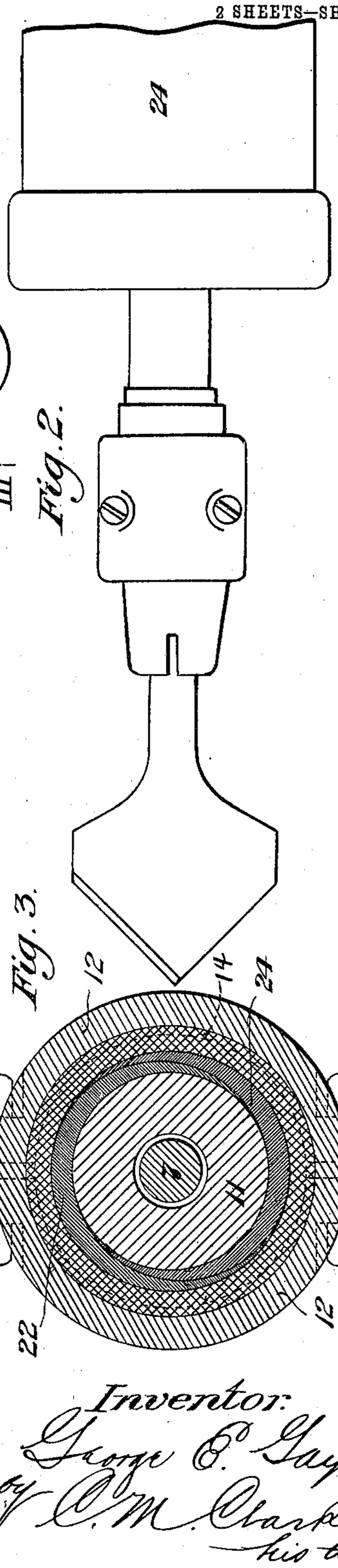

Fig. 2.

Fig. 3.

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Inventor:
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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 9.

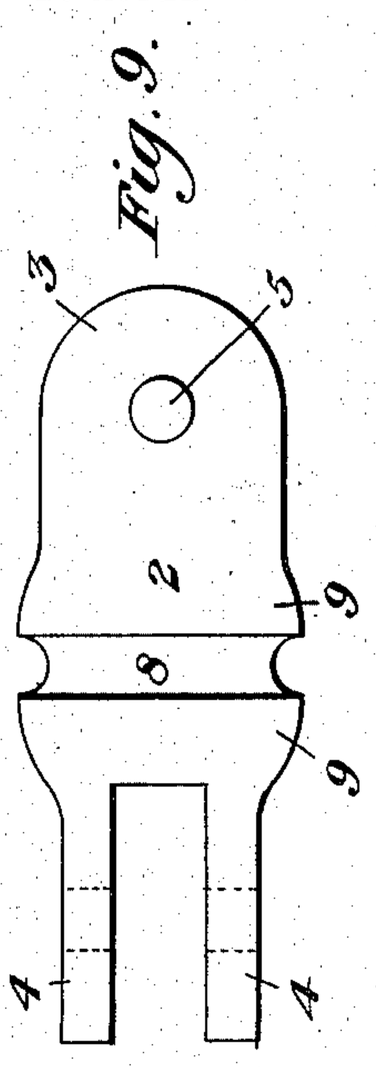


Fig. 8.

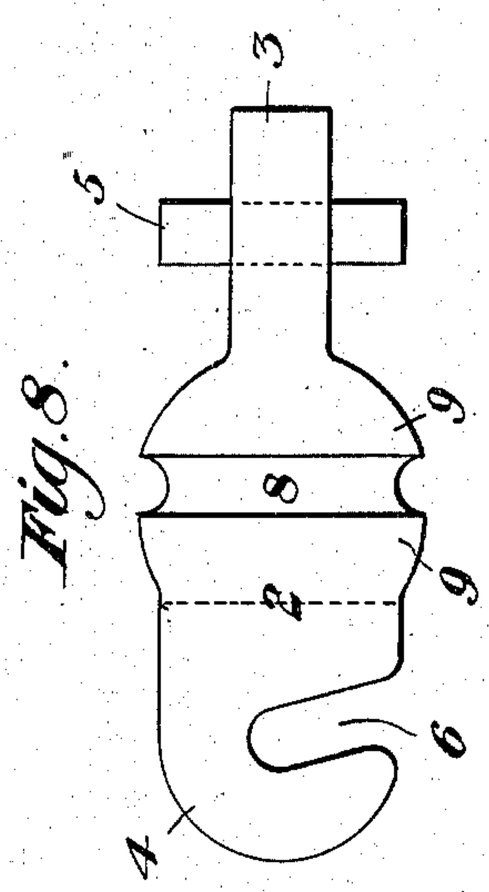


Fig. 4.

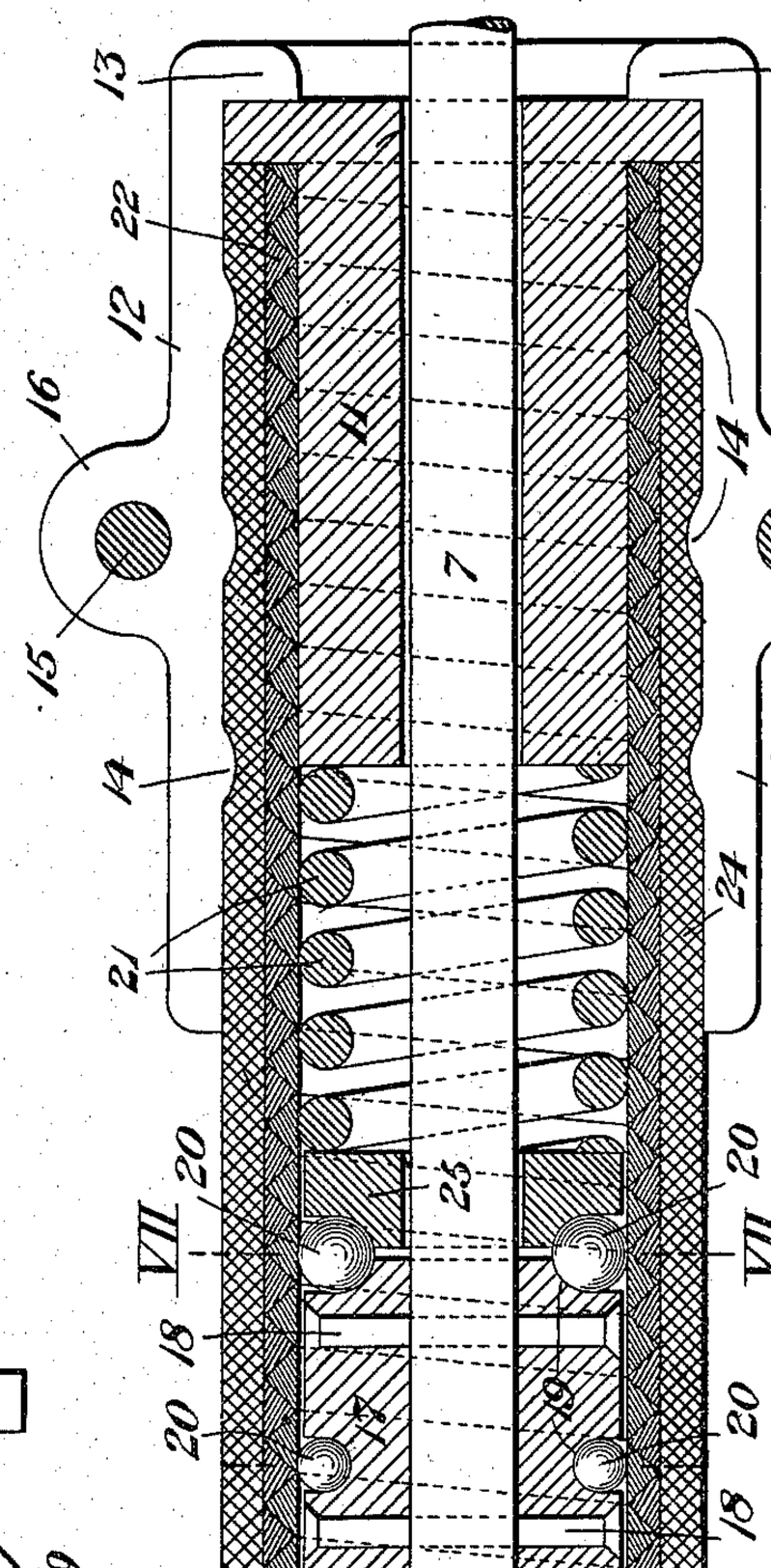


Fig. 7.

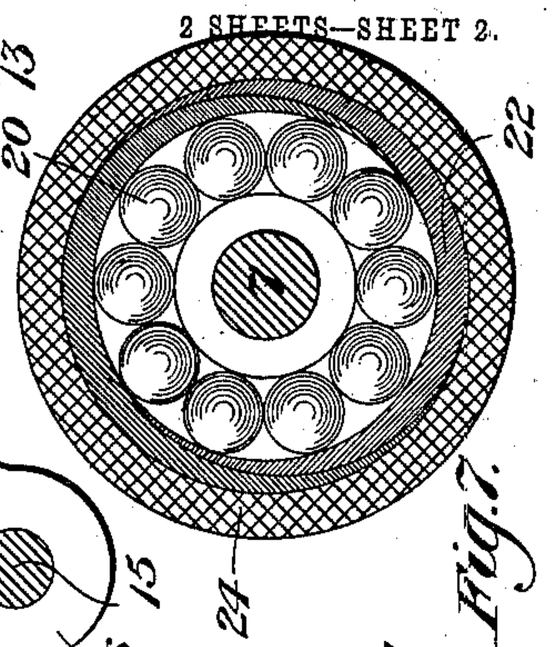


Fig. 6.

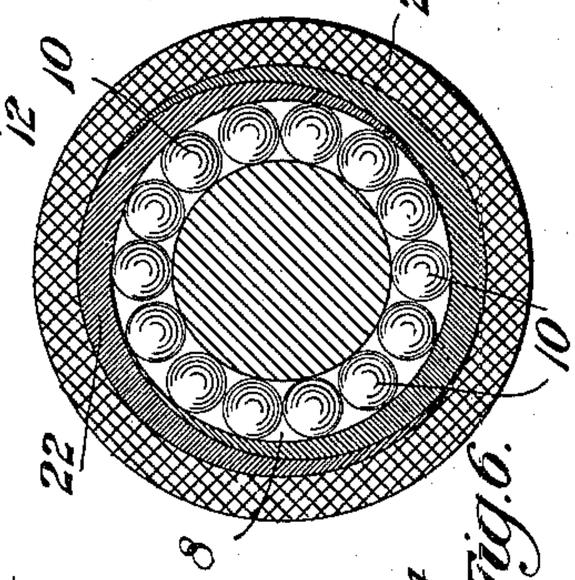
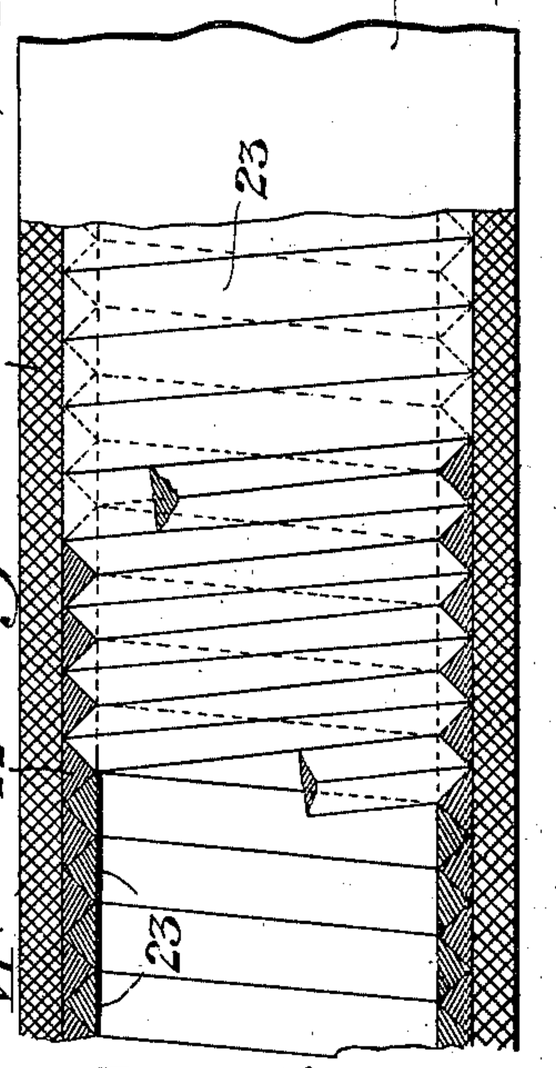


Fig. 5.



Witnesses:

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No. 736,378. Patented August 18, 1903.

UNITED STATES PATENT OFFICE.

GEORGE E. GAY, OF PITTSBURG, PENNSYLVANIA.

FLEXIBLE SHAFTING.

SPECIFICATION forming part of Letters Patent No. 736,378, dated August 18, 1903.

Application filed June 9, 1902. Serial No. 110,782. (No model.)

To all whom it may concern:

Be it known that I, GEORGE E. GAY, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Flexible Shaftings, of which the following is a specification, reference being had therein to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a partial longitudinal view of one end of my improved flexible driving-shafting in elevation and section. Fig. 2 is a view of the terminal end, showing a tool attached. Fig. 3 is a cross-section on the line III III of Fig. 1. Fig. 4 is a partial longitudinal sectional view. Fig. 5 is a partial view of the inclosing wrapping in elevation and section. Fig. 6 is a cross-section in the line VI VI of Fig. 4. Fig. 7 is a similar view on the line VII VII of Fig. 4. Figs. 8 and 9 are detail views of one of the links detached.

My invention relates to improvements in mechanism for transmitting power by rotary motion through flexibly-connected elements constituting a power-imparting flexible shafting capable of deflection in any direction. The shafting consists of a series of interfitting connected link-sections 2, one end of which terminates in a lug 3, the other end terminating in double lugs or cheeks 4, adapted to embrace the lug 3 of the next adjacent section when coupled together. The parts are maintained in alinement by a pin 5, tightly secured in the lug 3 or in lugs 4, extending outwardly on each side thereof, over which pin the lug or cheeks 4 engage by means of the inclined slots 6, and such slots may be either in cheeks 4 or lug 3. When thus connected, a sufficient number of the sections 2 for the required length will constitute a continuous flexible shafting, so that the rotation of a driving-shaft 7, coupled to one end of the terminal section in the same manner as the sections are coupled together, as in Fig. 4, will impart rotary movement throughout the full length of the connected members to the point at which it is desired to utilize the rotary power. Each of the sections 2 is provided at its middle portion with an annular groove 8, the middle portion of the link-section being preferably enlarged, so as to provide retaining sides 9, while in the grooves is mounted an annular row of balls or bearing-rollers 10, adapted to just fill the space between the base of the groove and the inner surface of the surrounding metallic armor.

The shaft 7 is mounted at one end in a bushing 11, secured within the surrounding armor, hereinafter described, and held in position by an outer clamp 12, having end flanges 13, engaging the end of the bushing. The clamp is preferably composed of two separable halves interiorly corrugated, as indicated at 14, and held together by bolts 15 passing through lugs 16 on the opposite sides of the clamps. In advance of the inner end of the bushing 11 a thimble 17 is secured to the shaft 7 in any suitable manner, as by pins 18, which thimble is provided with one or more annular grooves 19, forming ways for the balls or rollers 20, adapted to bear against the inner surface of the surrounding armor, thereby providing against deflection and insuring the easy rotation of the shaft within the case.

Between the thimble 17 and bushing 11 is located a coiled spring 21, surrounding the shaft 7 and bearing at one end against the bushing and at the other end against a free washer 25, provided with an annular end groove adapted to bear against the ball-bearings of the thimble, thereby providing a resilient cushion to take up the shock of impact and to equalize and diminish longitudinal strains against the back portion of the apparatus.

For the full length of the shafting it is surrounded and covered by the inner lining or covering, constituting an armor, which consists of a tubular layer of spirally-wrapped wire 22 of triangular cross-section, as clearly shown in Figs. 1, 4, and 5. Such armor consists of an inner layer of triangular wire spirally wrapped for the full length, with the flat face 23 upon the inner side, which face as thus laid constitutes a smooth continuous cylindrical tube for the full length, while between the abutting sections in the triangular-shaped groove thus formed another layer of such triangular-section wire is spirally laid, the section just filling such intervening space and at the same time providing an outer

smooth surface by reason of the continuous series of outer flat faces 23 from end to end. As thus constructed this surrounding spirally-laid structure provides a tubular armor of great strength and flexibility and with smooth unbroken surfaces throughout the length of its outer sides. This feature is of great advantage in providing a smooth inner bearing for the bearing-rollers of the shaft-sections, as well as for the outer surrounding covering, in whatever position the shafting may assume. When covered, the openings of the outer curvature of the inner coils will be closed by the inner edges of the outer coil, and thus a bearing-surface for the link-section balls is always maintained. The outer covering consists of rubber webbing, leather, canvas, or other suitable material 24, laid over the outer surface of the spirally-laid armor in the manner usual in covering armored hose, which outer covering fully surrounds and protects the metallic tubing from damage, moisture, &c., while also confining it in its tubular form.

As thus constructed the flexible shafting is very compact and strong, and the bearing portion of the separate connected link members are provided at their greatest diameter with non-frictional bearings adapted to roll against the inner surface of the surrounding inclosing tube at whatever position the shafting may assume, and it will be observed that by thus providing such middle roller-bearing the connected engaging ends are free to oscillate to a considerable extent within the tube without coming into contact with it.

As thus constructed the jointed or meeting portions of my shafting are in suspension and free to move laterally within the armor, thus giving great freedom and ease of action. The interfitting ends—that is, the lug on one end and the cheeks on the other—are not limited as to size and may be of such a cross-section as is necessary to transmit power without enlarging the tube. Inasmuch as the sections are comparatively short, the deflection, even with short radii, will be comparatively limited and the transmission of power through the shaft will be easily accomplished with a minimum amount of friction and with a minimum diameter of shafting having a maximum cross-sectional strength. It will be observed that the lug 3 on one end is located as to the cheeks 4 on the other end of each section at right angles thereto, thus providing for easy interengagement and adapting the joints in any position to the curvature of the shafting; but it is obvious that the relation of the lug at one end as to the cheeks at the other end may be varied as to its relative angle of arrangement, and I do not desire to be confined to such specific construction, but to include any variation therefrom which may be desirable.

In connecting the members of the shaft the first section is partly inserted into the armor, the balls 10 placed in position, when the next section is hooked onto the pin 5, straightened out, and pushed into the tube to a point where the next row of balls may be inserted, and such operation is continuous until the full length of sections have been thus connected, the first section projecting outwardly beyond the other end of the surrounding tubing sufficiently far for the attachment thereto of any tool or mechanism which it is desired to operate rotatably. It will thus be seen that the entire shafting may be withdrawn from the armor for repair, &c., and quickly and easily replaced. The connection of the members is facilitated by the slot 6, while the connected members when straightened out will be securely held in engagement with each other and cannot be disconnected except by first withdrawing them from the tube.

It will be understood that changes or variations may be made by the skilled mechanic in the shape, size, proportions, or other details of the construction without departing from my invention, since I do not desire to be specifically confined to such features as I have shown and described, but to include as within the scope of the following claims all such changes and variations.

Having described my invention, what I claim is—

1. In combination, a revoluble flexible shafting formed of interfitting connected link members, a power-shaft connected to said shafting, a thimble secured to the shaft, a bushing for the shaft, a flexible armor surrounding the shafting and the shaft, and bearing-rollers between the thimble and the armor; substantially as described.

2. In combination, a revoluble flexible shafting formed of interfitting connected link members, a power-shaft connected to said shafting, a thimble secured to the shaft, a bushing for the shaft, a flexible armor surrounding the shafting and the shaft, bearing-rollers between the thimble and the armor, and means for limiting the longitudinal movement of the shaft; substantially as described.

3. In combination, a flexible shafting comprising interfitting connected link members, peripheral bearing-rollers for said members, a surrounding armor, a connected shaft, a bushing for the shaft, a thimble secured to the shaft, peripheral bearing-rollers for said thimble, and a cushioning-buffer between the bushing and thimble.

4. In combination, a flexible shafting comprising interfitting connected link members, peripheral bearing-rollers for said members, a surrounding armor, a connected shaft, a bushing for the shaft, a thimble secured to the shaft, peripheral bearing-rollers for said thimble, a free washer surrounding the shaft, and a cushioning-buffer between the bushing and the washer.

5. In combination, a flexible shafting comprising interfitting connected link members,

peripheral bearing-rollers for said members, a surrounding armor, a connected shaft, a bushing for the shaft, a thimble secured to the shaft, peripheral bearing-rollers for said thimble, a cushioning-buffer between the bushing and thimble, and a surrounding clamp engaging the bushing at the end.

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

GEORGE E. GAY.

Witnesses:
R. H. McLARN,
C. M. CLARKE.