March 22, 1938. A. WYZENBEEK 2,112,004

FLEXIBLE SHAFT AND CASING

Filed Feb. 20, 1937

Fig. 1.

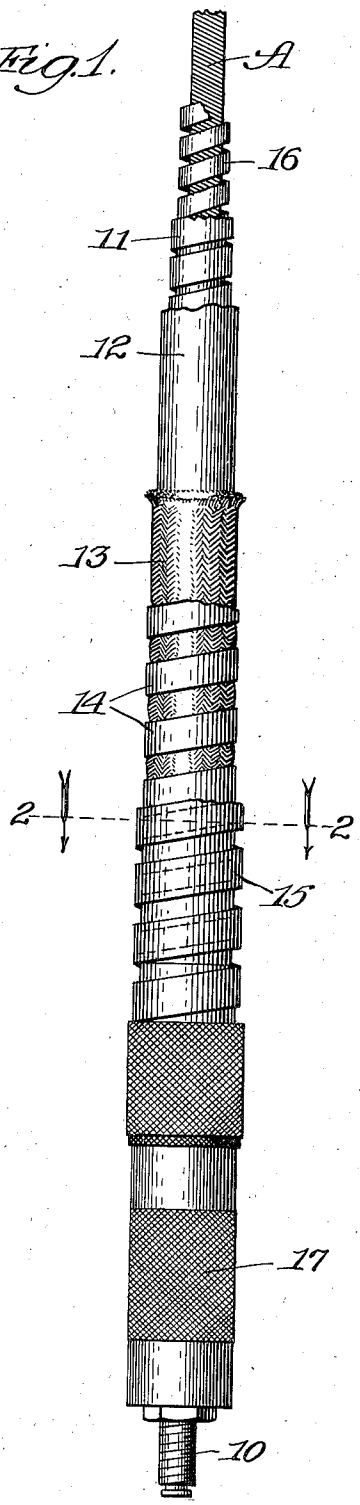
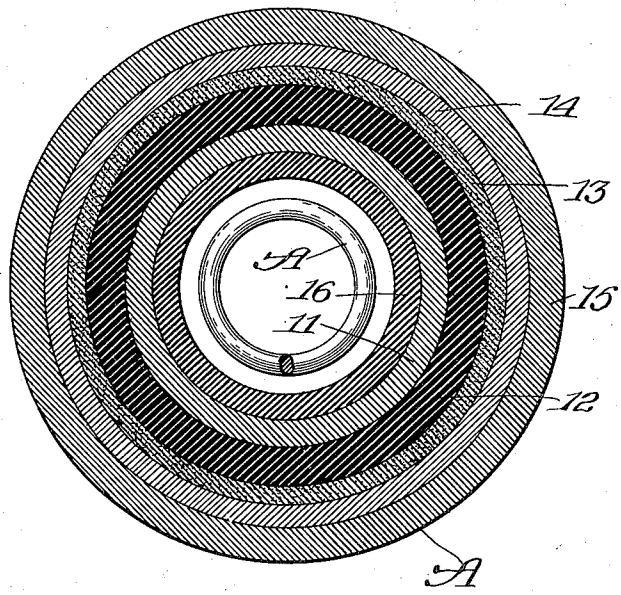


Fig. 2.



Inventor:
Andrew Wyzenbeek,
By Dyrenforth, Lee, Chritton & Wiles,
Attys.

Patented Mar. 22, 1938 2,112,004

UNITED STATES PATENT OFFICE

2,112,004

FLEXIBLE SHAFT AND CASING

Andrew Wyzenbeek, Chicago, Ill.

Application February 20, 1937, Serial No. 126,920

9 Claims. (Cl. 64—2)

This invention relates to a flexible shaft and casing and deals with the type of shaft which is adapted to rotate while maintaining a curved form and which is used to transmit torque in a curved path.

An object of the invention is to provide a shaft and a tubular enclosure in which the shaft may rotate freely though in curved form, and which does not become unduly worn or deteriorated through contact of the shaft with its casing.

Another object is to provide an enclosure for the flexible shaft which resists wear and provides the necessary rigidity, but which will not affect the properties of the shaft through contact therewith even after prolonged use. Other more specific objects will appear as the specification proceeds.

A flexible rotatable shaft is often employed to transmit power, and one of its characteristic advantages is that it need not be straight, but can be curved in any desired form, as the situation may require. The shaft is ordinarily encased in a tube which restricts its form and provides a channel in which it may rotate. Because the rotating shaft is in contact with the inside wall of the casing, it has been necessary to make the inside of the tubular casing of a firm wear-resisting material, and a material which meets this requirement has been found in metal armor. In the past a metal strip coiled to form a tube has been used on the inside of the enclosure and in contact with the rotatable shaft, and such has been satisfactory so far as rigidity and wear-resisting qualities are concerned.

However, after the shaft has been used for some time in a tube having an inside wall of metallic armor, the shaft has a definite tendency to crystallize, and after this crystallization has gone forward to some extent, the shaft will break and must be replaced. Heretofore it has been thought that the crystallization was due to the constant bending of the shaft while in use and could not be avoided. I have found, however, that this tendency to crystallize can be avoided by interposing between the metallic armor and the metallic flexible shaft a lining of vulcanized fibre. The specific structure of my improved shaft and tube will appear more clearly by reference to the accompanying drawing, in which—

Fig. 1 is a broken plan view of the shaft and tube, the parts and coverings being sufficiently broken away to show its structure; and Fig. 2, a sectional view taken as indicated at line 2—2 of Fig. 1.

The flexible shaft A comprises a wire closely coiled into the form of a tube. When free and unrestricted, the shaft is straight and of cylindrical form, but it may be easily bent into curved form and may be easily turned while held in this curved form. At its one end shaft A is connected to some means such as short shaft 10 by which a torque may be delivered to this end of the shaft A. Similar means may be provided at its other end for receiving the torque delivered by the shaft A or, if desired, the other end may be connected directly to the appliance which is to be rotated. The coiled type of shaft, as here shown, has definite advantages when the torque to be transmitted is all in the same angular direction. With the wire coiled as shown in the illustration a clockwise torque applied to the short shaft 10 would tend to bring each of the turns of the coil into contact with each other and the effect would be much the same as in the case of a straight hollow tube. However, other types of flexible shafts may be employed when so desired. The casing about shaft A comprises the armor 11 which is in the form of a metallic strip coiled in the form of a tube. It is desirable that this armor be rather loosely coiled so that it may be more flexible and the casing may be bent more easily. Outside armor 11 is a layer of rubber 12 which is in close contact with the turns of armor 11 and tends to resiliently hold them in proper position. Outside rubber layer 12 is a fabric layer 13 and over this is a loosely coiled metal strip 14 forming an outer armor. The fabric 13 and its outer armor 14 form a substantial support for the inner structure and do not appreciably impair the flexibility of the tube. If desired, another metal strip 15 may be coiled about the exterior of the casing to serve as a guard.

Inside the metal armor 11 I provide a tubular lining 16 which is formed by coiling a strip of vulcanized fibre into the form of a tube. The lining 16 is placed against the inside of armor 11 and shields the metal armor from contact with the shaft. The vulcanized fibre is a fibrous material which has been treated with rubber and is a well-known product. This material, while pliable enough to be sufficiently flexible as here used, is very tough and easily resists the wear to which it is subjected. Other tough and non-metallic materials may also be used to form this lining, if desired. Lining 16 is preferably coiled rather loosely as illustrated in Fig. 1, to increase

its flexibility. Also, it is preferable that this lining be coiled in a direction opposite that of the flexible coiled shaft. By having the fibre lining coiled in a direction opposite that of the flexible shaft the tendency of the wire of the shaft to catch upon the edges of the fibre strip as the shaft turns is avoided.

At the ends of the casing bearings 17 may be provided and the short shafts 10 journaled in these bearings so as to relieve the flexible shaft of any unnecessary strain. In Fig. 1 only one end of the shaft and casing is shown but it is understood that the other end may be similarly equipped and adapted.

In the use of my improved shaft and casing the flexible shaft A rotates within the lining 16 and the lining frictionally engages the shaft to maintain it in position. The rubbing of the shaft against the vulcanized fibre lining does not affect in any way the physical properties of the shaft and the crystallization common in ordinary structures is altogether eliminated here.

While in the above description I have set forth a single embodiment of a specific structure as illustrative of my invention, it will be understood that many changes can be made therein without departing from the spirit of my invention. The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What I claim as new and desire to secure by Letters Patent is:

1. Apparatus of the character set forth, comprising a flexible metallic shaft adapted to rotate while maintaining a curved form, a flexible metallic casing about said shaft, and a non-metallic lining within said metallic casing, said lining being effective to prevent said shaft from coming into contact with said casing.

2. In combination with a flexible metallic shaft enclosed in a casing, a fibre lining within said casing and about said shaft.

3. Apparatus of the character set forth, comprising a flexible metallic hollow shaft, a metallic casing about said shaft, and a treated fibre lining within said casing and in contact with said shaft.

4. Apparatus of the character set forth, comprising a flexible metallic shaft adapted to rotate while maintaining a curved form, a tubular casing about said shaft comprising a coil of metallic armor, and a fibre lining within said casing and in contact with said shaft, said lining comprising a strip of vulcanized fibre material coiled into tubular form.

5. Apparatus of the character set forth, comprising: a flexible metallic shaft adapted to rotate while maintaining a curved form; a tubular casing about said shaft comprising an inner layer of coiled metallic armor and layers of rubber and fabric enclosing said coiled armor, and a lining of fibre within said casing and about said shaft, said lining comprising a strip of fibre coiled into tubular form.

6. Apparatus of the character set forth, comprising: a wire coiled to provide a flexible shaft, and adapted to rotate while maintaining a curved form; a casing about said shaft, said casing enclosing the coiled metallic strip forming a tubular armor; a treated fibre lining within said casing and about said shaft; and bearings secured to the ends of said casing, said shaft being journaled in said bearings.

7. Apparatus of the character set forth, comprising: a wire coiled to provide a flexible shaft, said shaft being adapted to receive a torque at one end and deliver said torque at its other end while maintaining a curved form; a casing about said shaft including an inner metallic armor, rubber and fabric layers over said inner armor, a non-metallic lining within said casing and about said shaft, said lining having a smooth inside surface, and an outer armor about said rubber and fabric layers; and a bearing secured to an end of said casing, said shaft being journaled in said bearing.

8. Apparatus of the character set forth, comprising: a flexible metallic shaft adapted to rotate while maintaining a curved form, a casing about said shaft, and a lining between said shaft and said casing, said lining being of hard non-metallic material having a smooth inside surface.

9. Apparatus of the character set forth, comprising: a flexible metallic shaft adapted to rotate while maintaining a curved form, a casing about said shaft comprising a coil of metallic armor, and lining comprising a coil of hard non-metallic material having a smooth inside surface.

ANDREW WYZENBEEK.