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(54) A Method of Constructing Cored Tubular Shafting

(57) A method of constructing cored tubular shafting is disclosed, whereby the cored tubular shafting is dynamically balanced with respect to its ends. The shafting so constructed is especially useful in the transfer of rotary power from its point of generation to apparatus which is remote from that point. The method includes dynamically balancing a metallic tube 12 with respect to its ends 12a, 12b, and pouring a selected amount of a material such as urethane foam into the bore of the metallic tube, whereby the urethane foam expands to fill the bore and form a rigid core 24 therefor. The cored tubular shafting is then trim-balanced with respect to its ends.

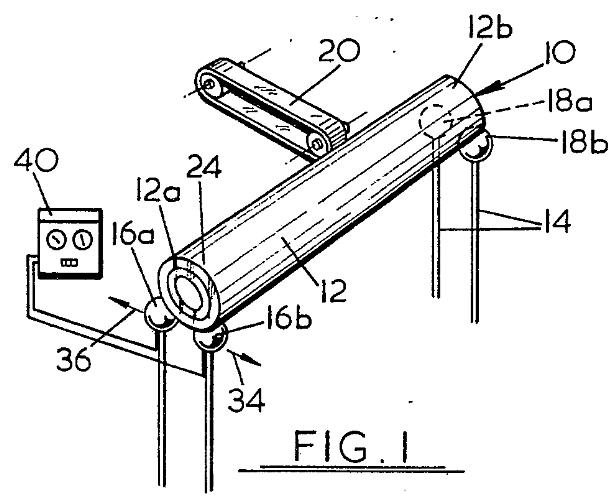

FIG. 1

The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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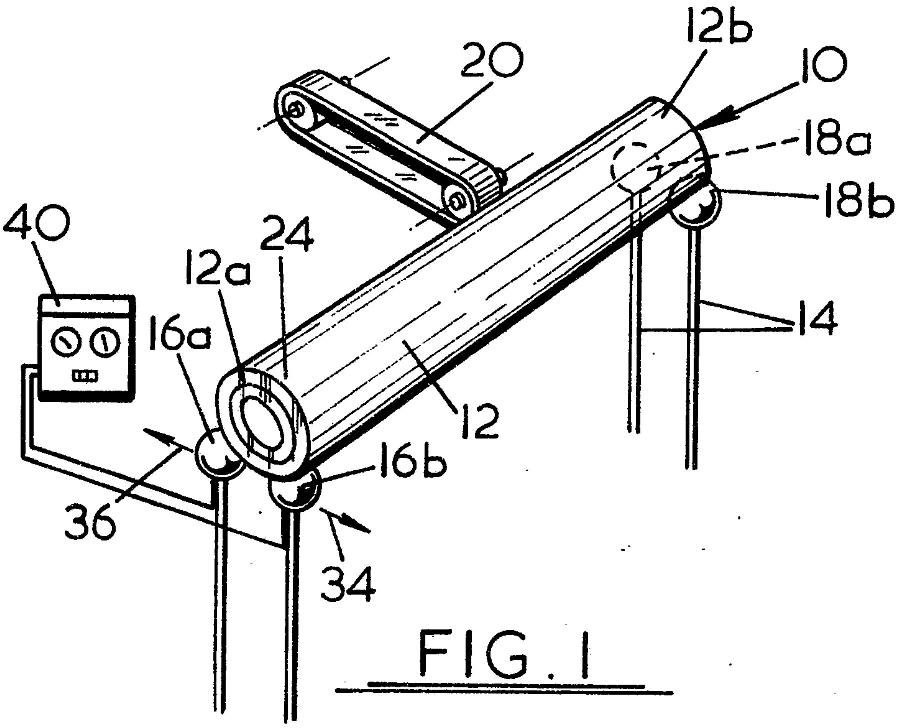

FIG. 1

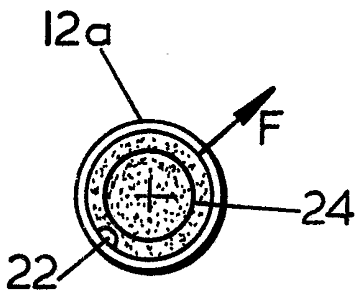

FIG. 2

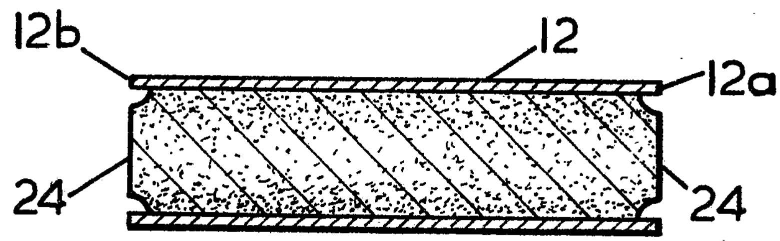

FIG. 3

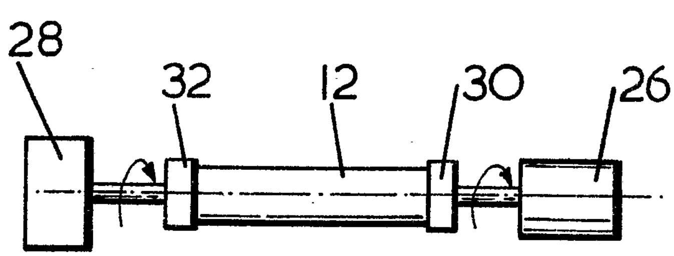

FIG. 4

SPECIFICATION

A Method of Constructing Cored Tubular Shafting

The present invention relates to a method of constructing and balancing cored tubular shafting, and, more particularly, to a method of dynamically balancing cored tubular shafting with respect to its ends.

In may instances, it is desirable to transfer rotary power which is generated at one location to apparatus which is located remote from that point of generation. To accomplish this result, shafting is used, with one end of the shafting coupled to the source of rotary power and the opposite end coupled to the apparatus to be powered. Appropriate couplings are utilized to couple the respective ends of the shafting to the generation source and the utilization apparatus.

Shafting utilized in the transfer of rotary power should meet several design criteria. First, the lateral stiffness of the shafting should be as great as possible so that the resonant frequency of the shafting is as high as possible. Second, the weight of the shafting should be as low as possible to minimize the load on the source of rotary power. Third, the "whirling speed" of the shafting, i.e. the speed at which the shafting tends to rotate about a line other than its true geometric centerline, should be as high as possible. Finally, the responsiveness of the shafting to outside excitation, e.g. motor imbalance, should be minimized. In view of these criteria, it has been found desirable to use shafting comprising a metallic tube having a resinous core.

When rotary power is to be transferred as described above, it is also desirable that the shaft between the generation apparatus and the utilization apparatus be balanced. Any imbalance which exists could produce harmful effect on the couplings at each end of the shaft, the generation apparatus, and the apparatus which is utilizing the rotary power.

Various techniques have been proposed for balancing tubular shafting, for example by balancing the shafting along its entire length.

The object of the present invention is to provide an improved method of constructing balanced tubular cored shafting which eliminates necessity to balance the shafting along its entire lengths.

According to a first aspect of the present invention there is provided a method of constructing a length of cored tubular shafting which is balanced with respect of its ends, which comprises the steps of:

dynamically balancing a metallic tube with respect to its ends;

filling the bore of the metallic tube with a material to form a rigid core for the tubular shafting; and

dynamically balancing the tubular shafting with respect to its ends.

According to a second aspect of the present invention there is provided a length of cored tubular shafting which has been dynamically balanced according to the method of the first aspect of the present invention.

The present invention will now be described by way of example with reference to the accompanying drawing in which:—

Fig. 1 is a perspective view of a length of cored tubular shafting constructed in accordance with the method of the present invention and apparatus used in the balancing of said tubular cored shafting;

Fig. 2 is an end view of the tubular cored shafting shown in Fig. 1;

Fig. 3 is a cross-sectional view of the cored tubular shafting shown in Fig. 1; and

Fig. 4 is a perspective view of a system employing to the tubular cored shafting shown in Fig. 1.

Referring to Fig. 1, there is illustrated a length of cored tubular shafting 10 which includes a metallic tube 12. In accordance with the method of the present invention, the magnitude and direction of the resultant force at each end of the tube are determined, and these resultant forces are nulled. To accomplish this result, a balancing machine 14, which, for example, may be a Stewart and Warner belt-driven type balancing machine is used. The balancing machine 14 includes two pairs of rollers, 16*a* and 16*b*, and 18*a* and 18*b*, at its respective ends, and these rollers are initially in a rigid position. A metallic tube 12 is placed on the balancing machine 12 in contact with those rollers, as shown.

The balancing machine 14 also includes a belt drive 20, which operates at a high speed. The belt drive 20 is brought into engagement with the metallic tube 12, and this engagement causes the tube 12 to rotate. One pair of rollers, e.g. 16*a* and 16*b*, are released from their rigid position, which results in them being able to move in the direction of arrows 34 and 36. Any resultant force which exists with respect to an end 12*a* of metallic tube 12 results in a displacement of rollers 16*a* and 16*b* from their normal position. Rollers 16*a* and 16*b* include a coil and a magnet disposed in the coil (not shown), and the displacement of the rollers by the resultant force at end 12*a* causes the magnets to move. This movement produces an electrical signal, which is coupled to a console 40. This electrical signal is displayed on the console 40 and is indicative of the magnitude of the resultant. The location of the circumference of the end 12*a* at which the resultant force exists is determined with stroboscopic techniques.

With reference now to Fig. 2, assume that the resultant force, F, with respect to end 12a is located as shown in Fig. 2. An appropriate weight 22 is then placed on the inner wall of the metallic tube 12 at its end 12*a*, which weight 22 preferably comprises epoxy putty. The weight of putty which is used is equal to the magnitude of the resultant force F. Accordingly, by this process, resultant force F with respect to end 12*a* is nulled.

The rollers 16*a* and 16*b* are then returned to their rigid position, rollers 18*a* and 18*b* are released from their rigid position, and the above-described process is then repeated for the other end 12*b* of metallic tube 12, (connections between rollers 18*a* and 18*b* and console 40 are not shown in Fig. 2 for clarity). The result of this process is the net force on each end of metallic tube 12 has been nulled.

Metallic tube 12 is then removed from balancing apparatus 14 and is stood on one end. A resinous rigid core 24 is formed typically by pouring urethane foam, which typically may, for example, be "2 pound rigid urethane", into the bore of the metallic tube 12, and this foam expands to fill the entire bore. Subsequent to this expansion, any excess urethane which extends beyond the ends 12*a* and 12*b* of metallic tube 12 is removed such that the resinous rigid core 24 is flush with the ends of the tube, as shown in Fig. 3. A small amount of the resinous core 24 which is proximate the inner wall of metallic tubing 12 is removed at each end, as also illustrated in Fig. 3. If desirable the core 24 may also be made of tubular form by means of a central removable mould piece.

The tubular cored shafting comprising the metallic tube 12 and the resinous core 24 is then placed on the balancing machine 14, and the above-described balancing process is repeated to trim-balance each end 12*a* and 12*b* of metallic tube 12. This trim-balancing process is necessary since any non-uniformity in the composition of resinous core 24 could produce a resultant force with respect to the ends of metallic tube 12.

The tubular shafting is then balanced with respect to each of its ends and may be utilized in the transfer of rotary power. For example, as illustrated in Fig. 4, the source of rotary power may include a motor 26 and apparatus 28 to be powered may be located some distance from motor 26. The tubular cored shafting constructed in accordance with the above described process may be utilized to transfer the rotary power between these two devices, couplings 30 and 32 at each end of the tubular shafting being provided to couple the shafting to the rotary members of the motor 26 and the apparatus 28.

Claims

1. A method of constructing a length of cored tubular shafting which is balanced with respect to its ends, which comprises the steps of:
dynamically balancing a metallic tube with respect to its ends;
filling the bore to the metallic tube with a material to form a rigid core for the tubular shafting; and
dynamically balancing the tubular shafting with respect to its ends;

2. A method as claimed in claim 1, wherein the material is a foam which expands to fill the bore of the metallic tube.

3. A method as claimed in claim 2, wherein the foam is a urethane foam.

4. A method as claimed in claims 1 to 3 wherein the balancing steps include a determination of the magnitude and location of the resultant forces at each end of the shafting.

5. A method as claimed in claim 4, wherein the balancing steps include the addition of a counter-balance weight at each end of the tube.

6. A method as claimed in claim 5, wherein each counter-balance weight comprises an epoxy putty.

7. A length of cored tubular shafting which has been dynamically balanced with respect to its ends according to the method as claimed in any of claims 1 to 6.

8. A method of constructing a length of cored tubular shafting which is balanced with respect to its ends substantially as hereinbefore described with reference to the accompanying drawing.

9. A length of cored tubular shafting which has been dynamically balanced with respect to its ends substantially as hereinbefore described with reference to the accompanying drawing.

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