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(58) Field of search
F2U

(71) Applicants
BRD Company Limited (United Kingdom),
PO Box 2, Aldridge, Walsall, West Midlands WS98DT

(72) Inventor
Bertram Joseph Palmer

(74) Agent and/or Address for Service
Guest, Keen & Nettlefolds PLC, Patents & Licensing Dept,
PO Box 55, Ipsley House, Ipsley Church Lane, Redditch,
Worcs B98 0TL

(54) Shafts

(57) A shaft of a composite material, has a region 12 between the end portions 10, 11 thereof of greater diameter than the end portions. The shaft may be manufactured in two parts, secured together in its region of greater diameter. A higher bending stiffness is achieved to prevent whirling of the shaft, without increasing the space required for installation of the shaft at the ends thereof.

FIG. 1.

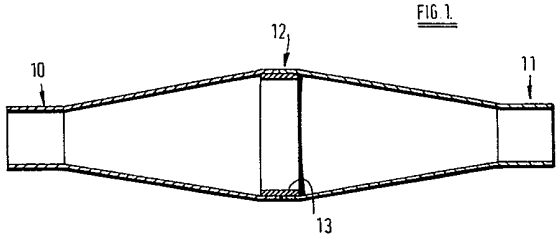

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FIG. 1.

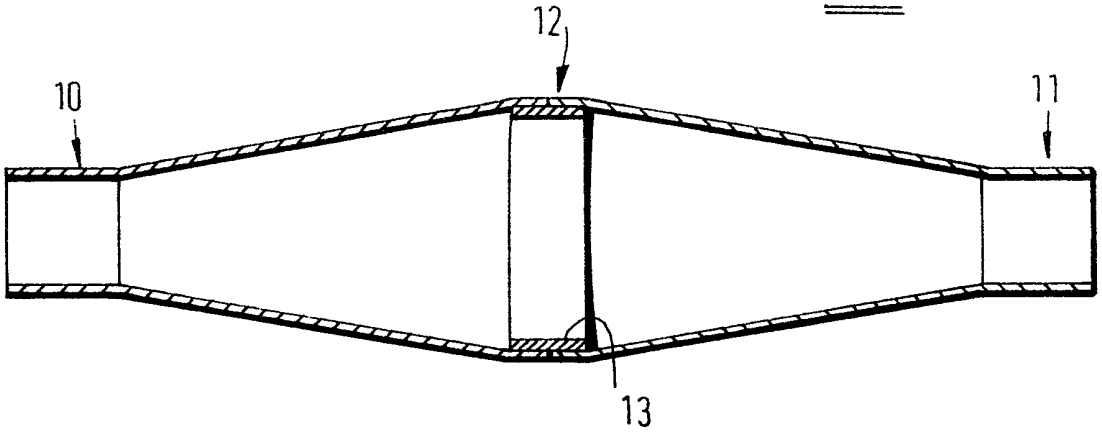
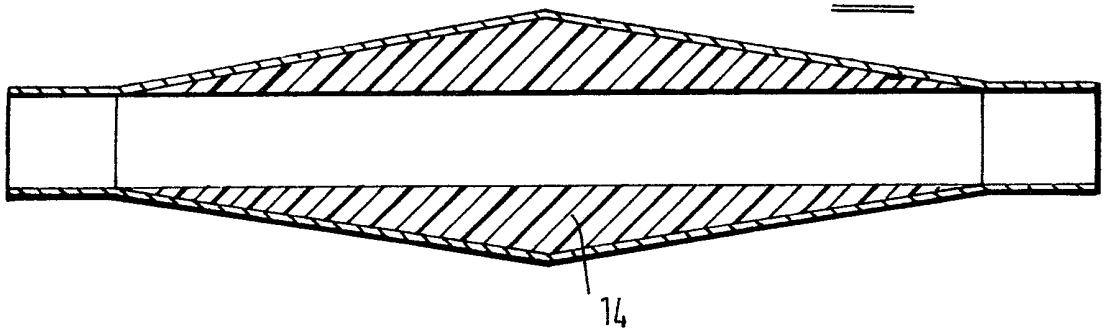


FIG. 2.



SPECIFICATION

Shafts of composite material

This invention relates to shafts made of composite, fibre reinforced resin, material. A shaft made according to the invention may be used, for example, as the longitudinal drive shaft (propellor shaft) of a motor vehicle.

One problem encountered in design of shafts of composite material is that a shaft may have sufficient torque transmitting capability but not be sufficiently stiff in bending to avoid a phenomenon known as whirling. This occurs above a critical rotational speed, at which the shaft bends so that its central region rotates eccentrically. One way in which this problem can be overcome is for the bending stiffness of the shaft to be increased by increasing its diameter, but in typical installations the space available at the ends of the shaft is very limited so that this expedient cannot be adopted. If the diameter of the shaft cannot be increased, its wall thickness must be increased which adds to its weight and cost of manufacture, or high modulus fibres such as carbon fibres can be incorporated in the shaft construction. This again adds to cost of manufacture. It is the object of the present invention to overcome or reduce these disadvantages.

According to the invention, we provide a shaft of composite material and including a portion, intermediate end portions thereof, of a diameter greater than that of said end portions.

A shaft according to the invention thus achieves, by virtue of its greater diameter in its intermediate portion, a greater bending stiffess than if it were of the same diameter as its end portions throughout. However, the end portions of the shaft remain of a conveniently small diameter for installation purposes.

The shaft may be of substantially constant wall thickness throughoyt its length and may taper uniformly from the intermediate portion to its end portions. Alternatively, its diameter may decrease in steps from its intermediate portion to its end portions.

Shafts of fibre reinforced resin material are normally made by winding fibres, impregnated with resin, over a mandrel. Because of the impossibility of removing a mandrel from the interior of a one piece shaft according to the invention, the invention provides that the shaft may be in two parts, secured together at said intermediate portion. The two parts may be secured together, for example, by being adhesively secured to an internal or an external connecting sleeve.

It would, however, be possible for the shaft to be made in one piece if a former were used which remains in position in the interior of the shaft.

The invention will now be described by way of example with reference to the accompanying drawings; FIGURE 1 and FIGURE 2, which are diagrammatic sections through embodiments of shaft according to the invention.

Referring firstly to Figure 1, there is shown a shaft comprising two end portions 10, 11 and an intermediate portion 12. The end portions 10, 11 are cylindrical, and the intermediate portion 12 is also cylindrical with a larger diameter than the end portions. Between the intermediate portion and the end portions, the shaft tapers uniformly.

The shaft is made in two parts, connected together at intermediate portion 12 by adhesively securing the two parts to an internal connecting sleeve 13. The parts would be manufactured by winding resin impregnated fibre on appropriately shaped mandrels, from which they are removed after the resin has been cured to form the finished shaft parts. The parts can subsequently be secured to the connecting sleeve 13 by use of suitable adhesives.

Figure 2 shows an alternative form of shaft, which again has short cylindrical end portions and uniformly increases in diameter to an intermediate portion therebetween. In this case, however, the shaft is made in one piece by winding fibres on a cylindrical mandrel which fits between the end portions thereof, and a former 14 fitting on such mandrel and remaining in position in the finished shaft. The former may, for example be made of a lightweight plastics material which does not unduly increase the weight of the finished shaft.

The illustrated tapered configurations of shaft are simplest to manufacture. However, it would be possible for the diameter of the shaft to increase in steps to its intermediate portion, or possibly even to vary in accordance with the bending moment diagram of an elongate element subjected to bending stress. By way of example only, the diameter of the intermediate portion of the shaft may be 3 to 4 times the diameter of the end portions thereof. The invention is of particular advantage when applied to relatively long shafts, where the phenomenon of whirling is a significant problem.

The shaft may incorporate at its end portions components forming part of or adapted for connection to universal joints or shaft couplings.

CLAIMS

1. A shaft of a composite material including a portion, intermediate end portions thereof, of a diameter greater than that of said end portions.

2. A shaft according to Claim 1 of substantially constant wall thickness throughout its length.

3. A shaft according to Claim 1 or Claim 2 wherein said diameter tapers uniformly from said intermediate portion to said end portions.

4. A shaft according to Claim 1 or Claim 2 wherein said diameter decreases in steps from said intermediate portion to said end portions.

5. A shaft according to Claim 1 or Claim 2 wherein said diameter varies in accordance with the bending movement diagram of an elongate element subjected to bending stress.

6. A shaft according to any one of the preceding claims comprising two parts, secured together at said intermediate portion.

7. A shaft substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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