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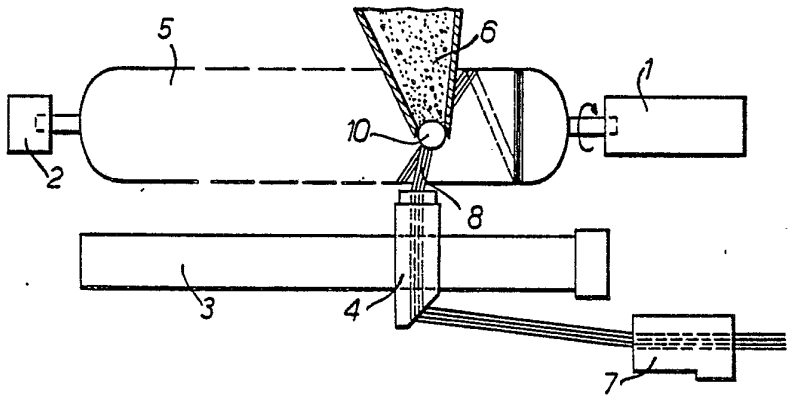

(57) Abstract

Bearing tube for a marine propeller shaft, and a method of making such a tube according to which polyacrylonitrile or other fibres (8) carrying a sticky resin (7) are wound onto a mandrel (5) and, at least at the bearing lining, wear resistant powder (6) or other compound is included with the fibres and resin to improve the properties of the bearing lining. Such a bearing tube comprising essentially a resin impregnated polyacrylonitrile fibres and the wear resistant compound can be easily machined to size without any health hazards, and can be lubricated by oil or water (even sea water) and is dimensionally stable.

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BEARING

This invention relates to plain bearings and methods of making them, and one object is to provide a method of making an improved marine stern tube bearing. Such bearings have been manufactured in the past from asbestos yarn impregnated with a resin, but that material has not been easily machined to fit the shaft with which it is to be used, and in any case it is undesirable to use asbestos in machining operations.

According to the present invention in a method of making a bearing tube, fibre carrying a sticky resin, is wound on a former and a wear resistant compound is added to the sticky resin, and then the resin is caused or allowed to solidfy.

The fibre which may be in the form of a number or bunch of fibres, possibly of polyacrylonitrile, can be passed through a bath containing the resin, for example an epoxy, phenolic, polyester, or cresylic, resin, and wound around the former so that the resin will cause the fibres to stick together to build up the complete bearing which is conveniently in the form of a tube. If the wear resistant compound is added at the point of winding of the resin-carrying fibre, for example, in the form of a powder, which may consist of one or more of the components P.T.F.E., graphite and bronze, the wear resistant compound will be carried into the body of the tube, and thus will be well distributed throughout the body of the tube, and leaves a tube which can be effectively machined to size while still leaving a good finish.

It is of course also possible for the wear

resistant compound, possibly in the form of a powder, to be included with the resin in the bath, but then the compound may not be added uniformly as the fibre is wound, and so it is preferred that the compound is added in powder form at a controlled rate at the point of winding so that the addition will be at a uniform rate.

A preferred wear resistant compound consists of between 50% and 70% by volume of P.T.F.E., between 10% and 30% by volume of graphite, and between 10% and 30% by volume of bronze, or of tin/bronze.

The invention includes a bearing comprising wound fibres bonded together by a resin which incorporates a wear resistant compound, conveniently the compound being in particle or powder form, more-or-less evenly distributed throughout at least the part of the bearing adjacent a bearing surface.

The amount of the wear resistant compound is conveniently between 5% and 20% by volume of the bearing material which itself consists of between 30% and 70% by volume of the sticky resin, and between 20% and 60% by volume of the fibre. The fibre can, for example, be polyacrylonitrile fibre sold under one of the Trade Marks " Courtelle", "Acrilan", and "Orlon".

One advantage of the bearing described is that it is resistant to oils and sea water without undue swelling.

The invention may be carried into practice in various ways, and one embodiment will now be described by way of example with reference to the accompanying

drawings; of which

FIGURE 1 is a sketch with parts cut away of a stern tube bearing made in accordance with the invention for a marine propeller shaft; and

FIGURE 2 is a sketch showing the tube of FIGURE 1 being made.

Referring first to FIGURE 2, it can be seen how a mandrel or former 5, supported by a tail stock 2, is rotated by a motor and head stock 1, while fibres 8 are wound around the former. The fibres 8 first pass through a bath 7 of a sticky resin, and then covered with the sticky resin are led through a guiding head 4 to a point adjacent the surface of the rotating former. The head 4 is reciprocated along a guide 3 in synchronism with the rotation of the former from the head stock 1, so that the bundle or web of fibres 8 are wound in a desired wave form, as indicated generally in FIGURE 1.

Immediately after the fibres have been laid on the former, wear resistant powder is applied to the newly wound resinous fibre from a hopper 6 at a rate controlled by a rotary stop 10. For ease of illustration, the hopper 6 as shown on the opposite side of the former from the head, but in practice the hopper will be very close to the head 4 so that it can be reciprocated with the head. The powdered compound is retained by the sticky resin, and so is embodied throughout the body of the tube as winding continues until when winding is completed there is a proportion of the wear resistant compound more-or-less evenly distributed throughout the body of the material. The compound can give the tube a wear resistant surface and also a uniform composition throughout so that the tube

can be machined, and even after machining a wear resistant surface is revealed.

The wear resistance can be at least twice that of resin-impregnated asbestos material, which has previously been used for such tubes, and it does not swell in the presence of water or oil, so that either (even sea water) can be used for lubrication in use, and can be satisfactorily machined.

Although the tube has been described as being wound cold, it would be possible to heat the mandrel before winding, and also to heat the outside of the mandrel as it is wound with an infra-red heater.

The polyacrylonitrile fibre described as being suitable for building up the tube, could be partially carbonised to form black Orlon by heating in air at between 160 and 300°C prior to winding.

If a wear resistant bearing surface is required only on the inner cylindrical surface of the tube, then after a certain thickness, say ½ inch, has been wound on the mandrel, the wear resistant powder addition at 6 can be stopped. Alternatively, or in addition, the polyacrylonitrile yarn can be replaced by glass fibre, and a further thickness, say up to about another 1½ inches, can be wound around the lining already wound. Further lining without the wear resistant compound could consist of the same fibre and polyester resin.

Polyester and epoxy resins are preferred in the bath 7, because they can be used without solvents which tend to evaporate leaving a material which is too porous. For example, cresylic resins, which otherwise

are quite satisfactory, tend to need solvents.

The various types of polyacrylonitrile yarn, known by the Trade Marks, "Courtelle, Acrilan and Orlan" do not absorb water, and are wear resistant and so are eminently suitable for forming this invention.

Although the winding is described as an overlapping wave winding, straight, overlapping or helical, or other forms of winding can be used, and the particular form of the winding is not critical to the invention.

EXAMPLE 1

In one example, polyacrylonitrile yarn fibres, (Courtelle yarn 1.2 cotton count) were drawn through a bath 7 containing a teraphthalic-acid based, unsaturated polyester resin in styrene (sold by ICI as Impolex T504) with methyl ethyl ketone perodixe hardener dissolved in it. The fibres picked up about an equal volume of resin.

The wet, resin-impregnated rovings were then wound on the mandrel 5 with a diameter of 500 m.m., rotating at 10 rev/min. A solid lubricant mixture in the form of a dry powder was continuously added to the fibre covered rotating mandrel, as shown at 6 in FIGURE 2, at such a rate as to give a filler content of 10% by volume in the finished composite. The composition of this powder filler was :- PTFE 60%, 200 mesh 89/11 Tin/Bronze powder 20%, graphite 20% (all % by volume).

When a 2 inch thick layer of the fibre, resin, and powder, composite had been wound onto the mandrel the tube was

put aside overnight to set at ambient temperature (16°C).

Next morning the mandrel was removed and the fibre-reinforced resin tube so produced was cured for one hour at 150°C in an oven.

After curing the composite tube was machined to size.

The tube composition was

45% resin by volume;

45% fibre

6% PTFE

2% graphite

2% tin/bronze

EXAMPLE 2

A tube was wound onto a 500 mm mandrel in the same manner as described in EXAMPLE 1, except that the impregnating resin was a mixture of an epoxide resin, an amine accelerator and an anhydride hardener (Shell Epecote 828 100 parts, NMA 90 parts, BDMA 2 parts). The same dry powder was added at 6 until the tube wall was 3/4 inch thick.

Then 3/8 inch was added to the tube thickness using glass fibres instead of polyacrylonitrile, with the same resin, but no dry powder. The mandrel and tube were left overnight to harden at normal temperature and then, after removing the mandrel, cured for one hour at 100°C followed by six hours at 180°C.

The resulting tube was machined to form a stern tube bush, the first wound solid lubricant filled layer forming the bearing surface with the glass/epoxide outer layer providing strength and dimensional

stability.

EXAMPLE 3

A tube was wound in the same manner as described in EXAMPLE 1 except that the polyacrylonitrile fibres had been oxidised by heating in air at 160°C rising to 300°C over a two hour period.

The resin used in this case was Dow Corning vinyl ester resin Derakane 411-45. The rest of the process was as in Example 1.

EXAMPLE 4

A tube was wound as in EXAMPLE I, the only change being the addition of 10% of 3 micron polishing alumina to the dry powder such that the final composite contained 1% by volume of alumina. In this case the solid filler was mixed into the resin into the impregnating bath instead of being added as a powder at the mandrel.

The fine alumina powder can protect the shaft in use without causing excessive wear, but helping the shaft to bed well in the bearing.

EXAMPLE 5

The wear resistant powder of EXAMPLE 1 was included in the bath 7 with the resin of EXAMPLE 1, in proportions by volume in the range 50:50 - 90:10 of powder to resin in the form of a smooth paste. The paste was pushed up by the polyacrylonitrile fibres in a proportion by volume in the range 60:40 - 40:60 for fibre to resin/powder mixture. Winding on the mandrel was as described in EXAMPLE 1 except that no powder was added at the winding point.

CLAIMS

1. A method of making a bearing tube in which a fibre carrying sticky resin is wound on a former, and a wear resistant compound is added to the sticky resin, and the resin is caused or allowed to solidify.

2. A method as claimed in Claim 1 in which a bundle or web of fibres are wound together.

3. A method as claimed in Claim 1 or Claim 2 in which the fibre is polyacrylonitrile.

4. A method as claimed in any of the preceding claims in which the sticky resin is an epoxide, pnenolic, polyester vinyl ester, or cresylic resin.

5. A method as claimed in any of the preceding claims in which the fibre is passed through a bath containing the resin before being wound on the former.

6. A method as claimed in any of the preceding claims in which the wear resistant compound is in the form of a powder.

7. A method as claimed in any of the preceding claims in which the compound comprises some or all of P.T.F.E., graphite and bronze.

8. A method as claimed in Claim 7 in which the wear resistant compound comprises a mixture in powder form

of 50%-70% P.T.F.E. by volume, 10% -30% graphite and 10% - 30% of bronze or tin/bronze.

9 A method as claimed in any of the preceding claims in which the compound is applied to the surface of the resin carrying fibre immediately after it has been wound on the former.

10. A method as claimed in any of the preceding claims in which after the resin has solidified the bearing is machined.

11. A method of making a bearing tube performed substantially as herein specifically described with reference to FIGURE 2 of the accompanying drawings.

12. A bearing tube comprising wound fibres bonded together by a resin which incorporates a wear resistant compound.

13. A bearing as claimed in Claim 12 in which the compound is in particulate form.

14. A bearing as claimed in Claim 12 or Claim 13 in the form of a tube.

15. A bearing as claimed in Claim 14 in which a part of the thickness of the tube contains the wear resistant compound, and the remainder of the thickness of the tube does not.

16. A bearing tube constructed and arranged substantially as herein specifically described with reference to FIGURE 1 of the accompanying drawings.

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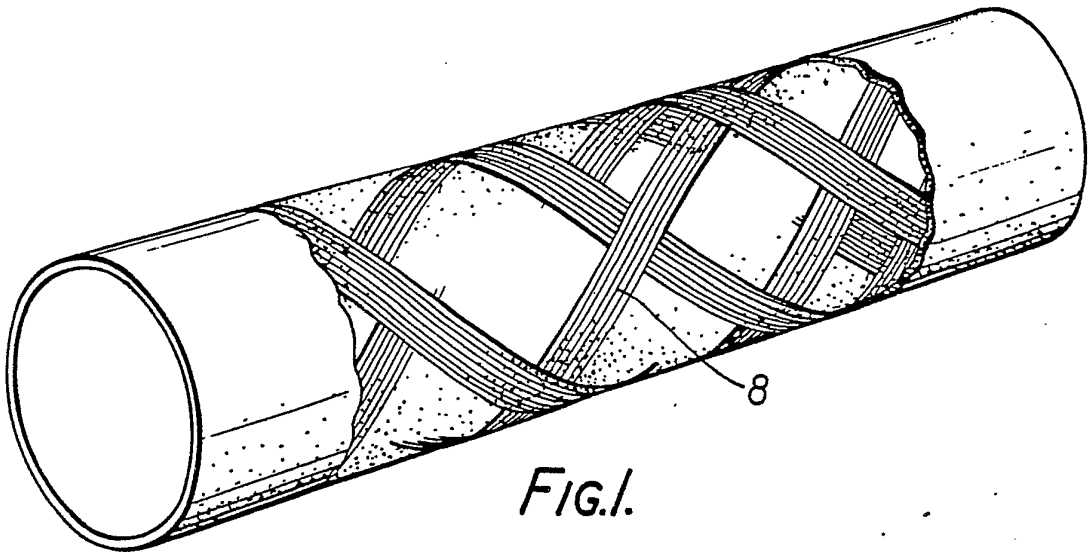

FIG.1.

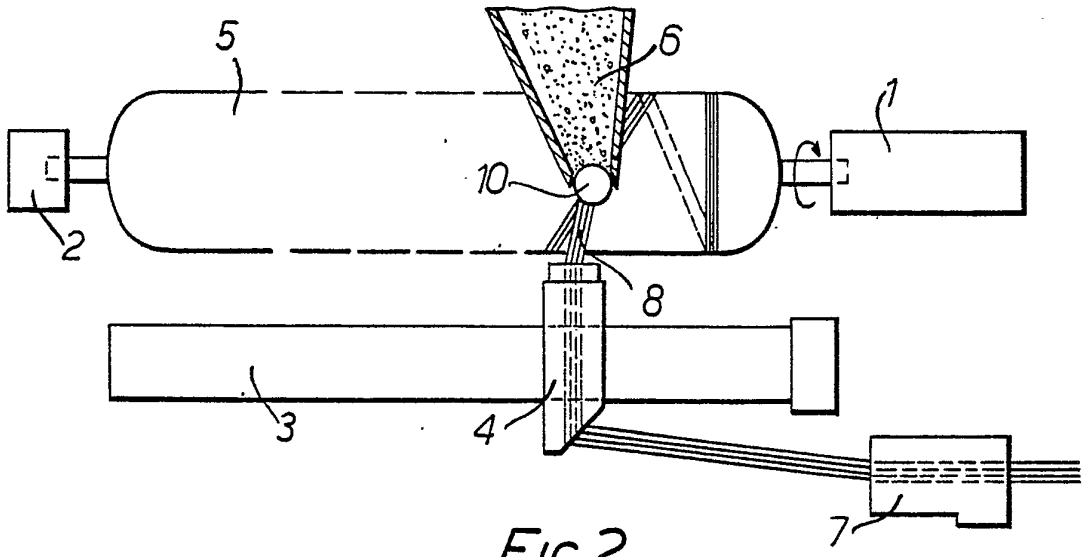

FIG.2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 79/00046

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

F 16 C 33/20; B 29 D 23/12

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl.[2]	F 16 C 33/20; F 16 C 33/26; F 16 L 9/12; F 16 L 9/16; F 16 L 57/00; B 29 D 23/12; B 29 D 3/02

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
	US, A, 3635256, published January 18, 1972, see column 1, lines 8-22, lines 52-59; column 2, lines 6-14, line 50, J.L. McLarty	1,2,4-7,12-14
	International Metallurgical Reviews, 1973, volume 18, Review 174; "Materials for Bearing" by G.C. Pratt see page 81a; page 82, table IX; page 83c	1,4,6,7,8,10, 13
	GB, A, 1203083, published August 26, 1970, see page 1, line 74 - page 2, line 13, Helm Universal Corporation	1,4,6,7,12-14
	FR, A, 2237083, published February 7, 1975, see page 3, lines 7-14; page 4, lines 2-23, line 36 - page 5, line 5, line 36, claims, Garlock	7,8
A	GB, A, 1163423, published September 4, 1969, I.C.I.	
A	DE, A, 1966882, published January 9, 1975, Glyco-Metall-Werke Daelen + Loos	
A	GB, A, 1453289, published October 20, 1976, Pavel Mikhailovich Ivanov	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
21th June 1979	28th June 1979
International Searching Authority [1]	**Signature of Authorized Officer [20]**
European Patent Office	G.L.M. Kruydenberg

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