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(54) Drive shaft

(57) In a tubular drive shaft with splined end portions 9 for engagement with universal joint members, the main portion 2 of the shaft between said end portions has a greater outside diameter than the end portions and a lesser wall thickness. The wall thickness of the main portion of the shaft is in the range 1/8 to 1/15 of the diameter thereof.

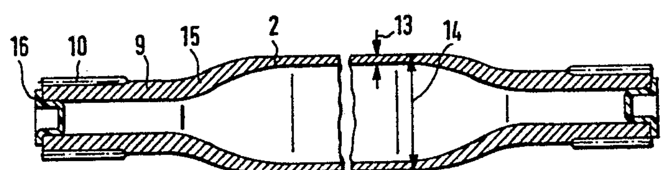

FIG. 2

GB 2 071 272 A

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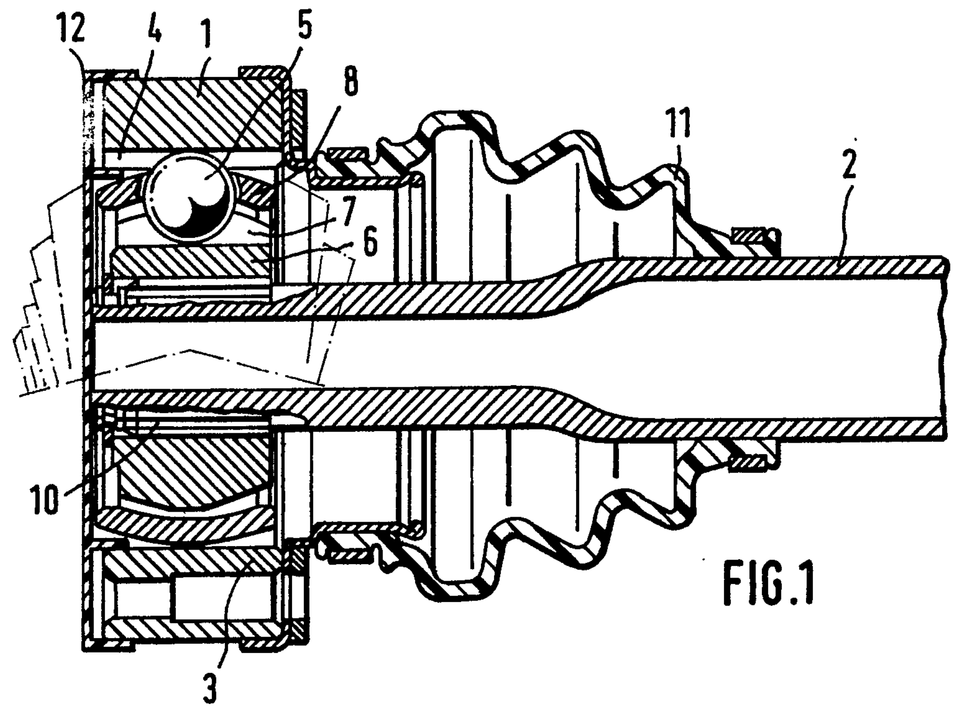

FIG.1

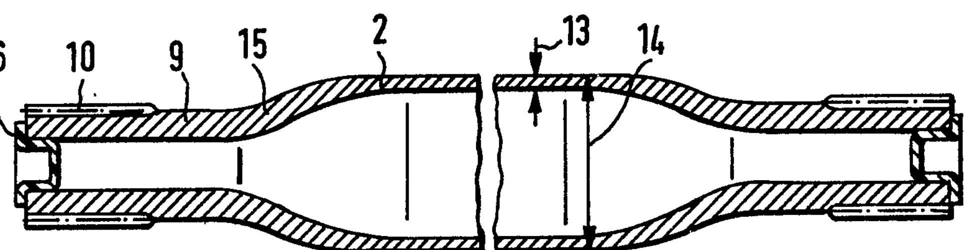

FIG.2

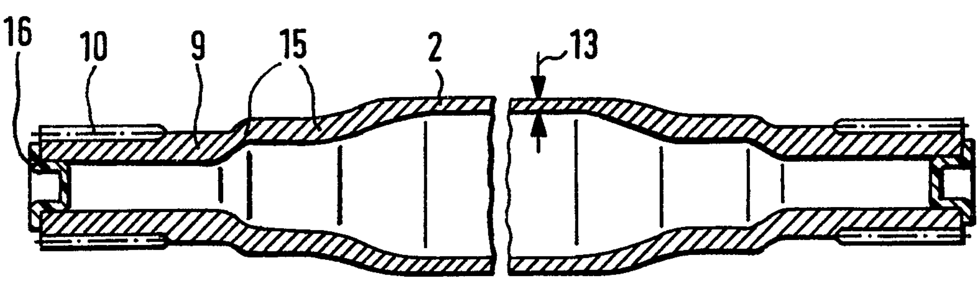

FIG.3

SPECIFICATION
Drive shaft

This invention relates to a drive shaft which may be used in a motor vehicle.

In broad terms, the desirable characteristics for a motor vehicle drive shaft are that it should be of light weight whilst being capable of transmitting relatively high torque, and be capable of being produced at reasonable cost.

Drive shafts have been proposed, e.g. in German Patent Specification 2,135,909, which are of tubular form. The shaft has end portions which are externally splined to engage with universal joints, and the wall thickness of the tube at these end portions is greater than that of the main part of the shaft. The outside diameter of the shaft, however, including the end portion, is constant. The result of this is that the shaft weighs more than would be necessary if all parts of it were dimensioned according to their torque transmitting requirements. A further disadvantage is that it can only be manufactured by a process involving cutting or metal removal.

It is an object of the present invention to provide a drive shaft with adequate strength and capable of production by methods not involving removal of material by chip forming process.

According to the invention, we provide a drive shaft for a motor vehicle, of tubular form and including a main portion and at least one end portion splined for torque transmitting engagement with a universal joint member, wherein the outer diameter of the main portion of the shaft is greater than that of said at least one end portion and the wall thickness of said main portion is less than that of said at least one end portion. Preferably the wall thickness of said main portion is in the range 1/8 to 1/15 of said outer diameter thereof.

The advantage of such a design is that the large diameter, thin walled, main portion of the shaft keeps weight to a minimum. As the or each end portion is of smaller outer diameter, it can engage with a universal joint member of small size keeping the cost and weight of this component to the minimum. The joint dimensions can be selected according to duty involved in the particular application. The required torsional strength of the or each end portion of the shaft is achieved by a great wall thickness, and by appropriate heat treatment.

The shaft may include two or more steps of outer diameter, the wall thickness of the parts with the greater diameter being smaller than the wall thickness of parts with the smaller diameter. Appropriate graduation of the shaft diameter can assist assembly or installation where space is limited.

The or each end portion may be provided with a plug, so that lubricant cannot enter the shaft interior thereby keeping to a minimum the quantity of lubricant required in the universal joint.

The invention will now be described by way of example with reference to the accompanying drawings, of which:—

FIGURE 1 is a section through part of a drive shaft according to the invention, with a universal joint,

FIGURE 2 is a section through a drive shaft alone, according to the invention,

FIGURE 3 is a section through a further embodiment of a drive shaft according to the invention.

Referring firstly to Figures 1 and 2, there is shown a tubular drive shaft with a main portion 2 and two end portions 9 which are splined at 10 to engage with the inner member of a constant velocity ratio universal joint.

The universal joint 1 comprises an outer member 3 having an internal wall with axially extending circumferentially spaced grooves 4 therein, and an inner member 6 whose outer wall has grooves 7 which face the grooves 4 in the outer member. A number of balls 5 are disposed one in each pair of grooves for torque transmission between the inner and outer joint members, and are guided in apertures in a cage 8 of annular form, disposed between the inner and outer joint members, the cage having an outer part spherical surface which engages the lands defined in the inner wall of the outer joint member between the grooves 4 therein. The universal joint is of the type in which the grooves in the inner and outer joint members are skewed relative to the axes of rotation of the joint members, and they cross one another so that the joint can accommodate relative axial movement or plunge between the inner and outer joint members, whilst the balls are always constrained to occupy the plane bisecting the angle between the axes of the members thereby to give the joint constant velocity ratio running characteristics. However, other forms of universal joint could be employed, such as a double offset joint, a Birfield type fixed joint, or a tripode joint. The inner joint member 6 has a splined bore 4 which receives the splines 10 of the end portion 9 of the drive shaft. The universal joint is sealed by a flexible boot 11 connected between the joint outer member and the drive shaft, and, on the opposite side, a rigid sealing cap 12 fixed to the joint outer member.

The drive shaft itself is shown in more detail in Figure 2. It is hollow throughout its length, and its main portion 2 is of greater outer diameter than its end portions 9. The wall thickness of its main portion is less than the wall thickness of its end portion 9, and in its main portion the wall thickness 13 is in the range 1/8 to 1/15 of the outer diameter 14 thereof. Between the main and end portions of the shaft there is a step or transition portion 15 in which the outer diameter of the shaft is decreasing and the wall thickness increasing. The splines 10 on the end portions 9 are produced by a non-chip forming process. The open ends of the shaft are closed by plugs 16 so that lubricant in the interior of the universal joint cannot escape into the inside of the shaft.

In Figure 3 there is shown a drive shaft which has two steps or transition portions 15 which, from the main portion 2 of the shaft to the end portions thereof are of decreasing diameter and increasing wall thickness. Again, the wall thickness in the main portion 2 of the shaft which is of greatest outer diameter is in the range 1/8 to 1/15 of such outer diameter.

A drive shaft as described above may be manufactured by a cold forming process involving the drawing down to a smaller diameter of the end portions of a straight tube, and the elongation of the main portion of the tube remaining at the original diameter to reduce the wall thickness thereof. A succession of mandrels would be used to control the inside diameters of the various parts of the tube at different stages of manufacture, and clearly the elongation of the main portion of the tube must be carried out before both ends thereof have been reduced in diameter to permit withdrawal of the largest diameter mandrel. The splines could be formed without metal removal using appropriately formed dies on the end portions of the tube.

CLAIMS

1. A drive shaft for a motor vehicle, of tubular form and including a main portion and at least one end portion splined for torque transmitting engagement with a universal joint member, wherein the outer diameter of said main portion is greater than that of said end portion and the wall thickness of said main portion is less than that of said at least one end portion.

2. A drive shaft according to Claim 1 wherein said wall thickness of said main portion is in the range 1/8 to 1/15 of the outer diameter thereof.

3. A drive shaft according to Claim 1 or Claim 2 including at least two steps in outer diameter, the wall thicknesses of the portions with greater diameter being smaller than those of the portions with the smaller diameter.

4. A drive shaft according to any of Claims 1 to 3 further comprising a plug closing the or each of said end portions.

5. A drive shaft substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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