March 29, 1938. J. M. TYLER 2,112,797

FLEXIBLE PROPELLER SPIDER

Filed July 17, 1937 2 Sheets-Sheet 1

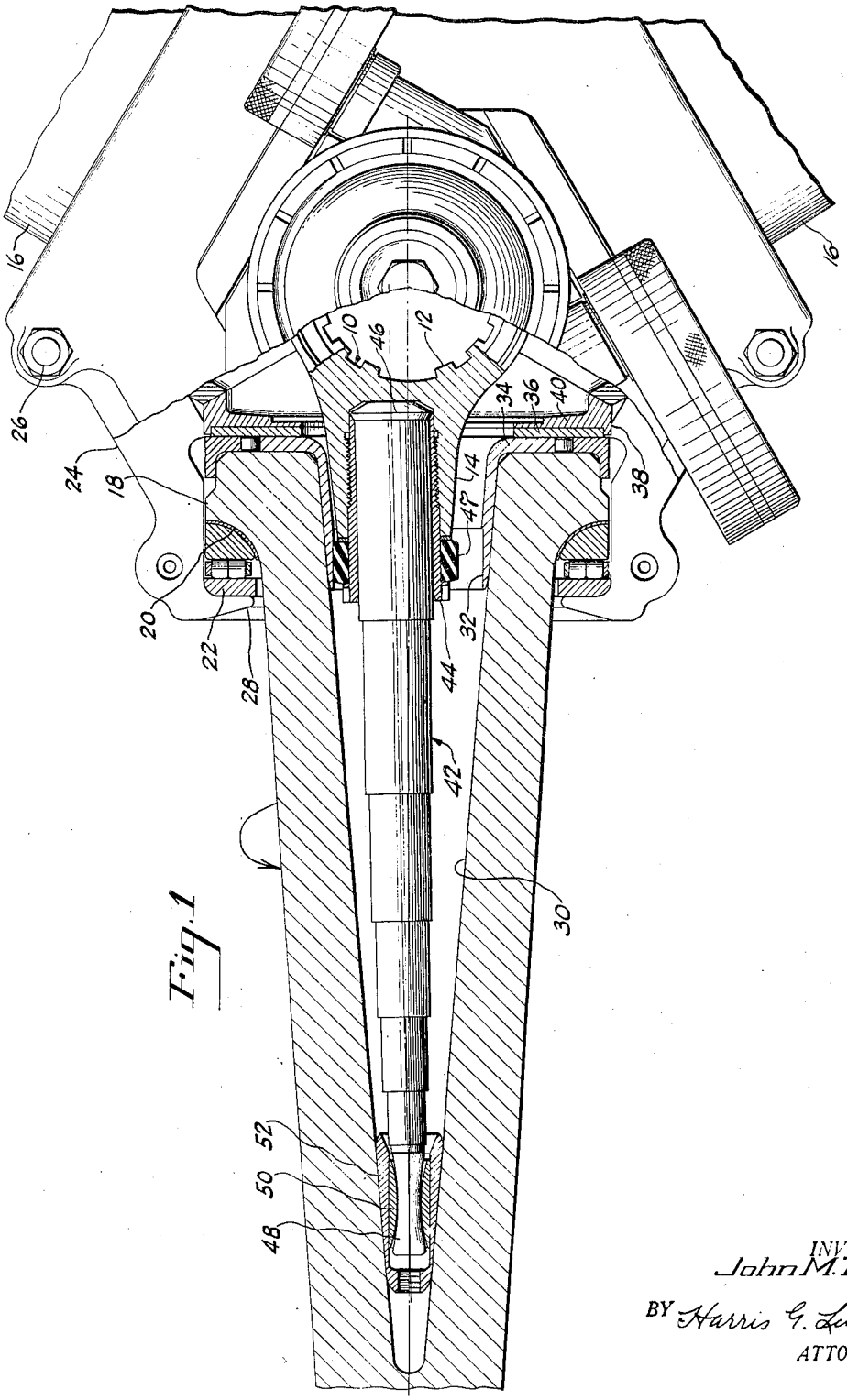


Fig. 1

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March 29, 1938. J. M. TYLER 2,112,797

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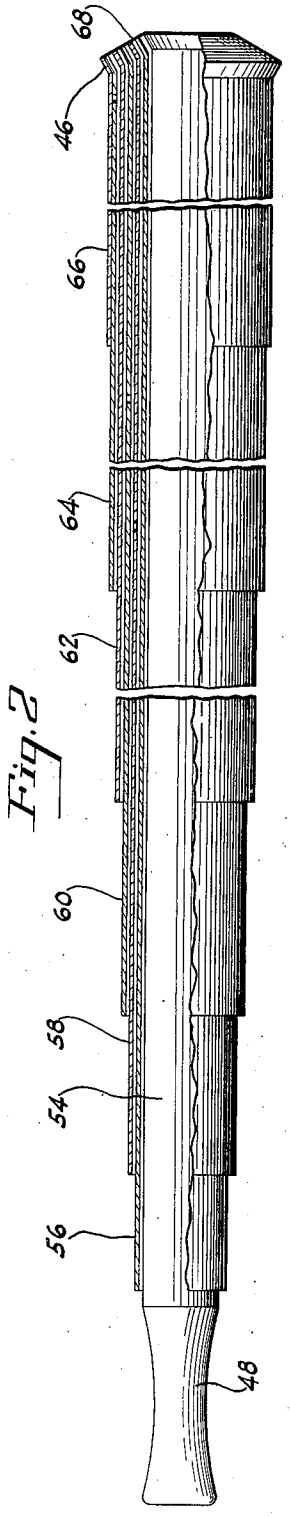


Fig. 2

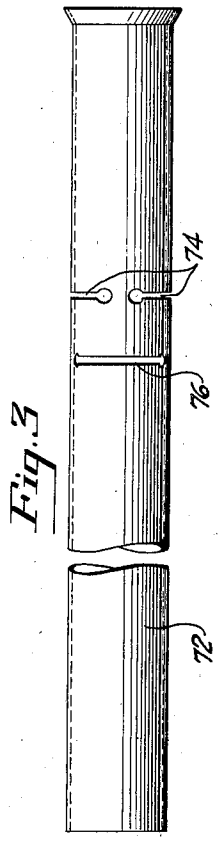


Fig. 3

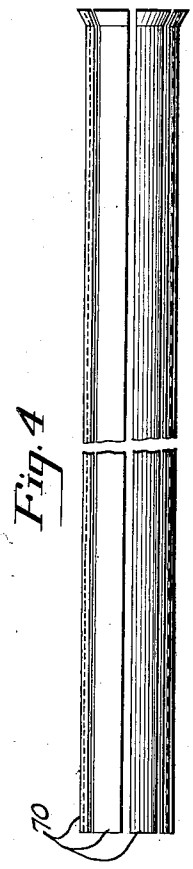


Fig. 4

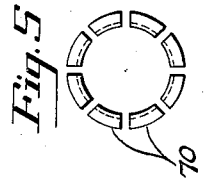


Fig. 5

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2,112,797

FLEXIBLE PROPELLER SPIDER

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Application July 17, 1937, Serial No. 154,187

10 Claims. (Cl. 170—162)

This invention relates to improvements in aeronautical propellers and has particular reference to an aeronautical propeller constructed and arranged to control the vibration of the propeller and the propeller driving engine during operation.

An object of the invention resides in the provision of an improved aeronautical propeller embodying resilient cushioning means and damping means for cushioning and damping out a large portion of the vibrational forces existing in the engine and propeller when the propeller is being driven by the engine.

A further object resides in the provision of an improved aeronautical propeller having vibration damping features, which do not add to the weight or complication of the propeller and which do not decrease the strength or efficiency thereof.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawings in which like reference numerals are used to designate similar parts throughout, there is illustrated a suitable mechanical embodiment of what is now considered to be the preferred form of the idea of the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the drawings, Fig. 1 is an elevational view of the hub portion of an improved aeronautical propeller constructed according to the idea of this invention, a portion thereof being broken away and shown in section to better illustrate the construction thereof.

Fig. 2 is a sectional view of a resilient drive arm through which power is transmitted from the propeller hub to a propeller blade.

Fig. 3 is an elevational view of a resilient tubular member forming a part of the resilient drive arm.

Fig. 4 is an elevational view of another tubular member divided into a series of sections and also forming a portion of the resilient drive arm, and

Fig. 5 is an end view of the tubular member shown in Fig. 4.

Referring to the drawings in detail, the numeral **10** generally indicated the hub spider of the propeller. This spider is adapted to be rigidly mounted upon the propeller carrying and driving shaft of the engine and restrained against rotation with respect to the shaft by means of suitable interengaging splines, as indicated at **12**. The spider **10** is also provided with a plurality of radially extending hollow arms, as indicated at **14**, there being one arm for each of the several blades of the propeller.

The propeller blades are generally indicated by the numeral **16** and there may be two, three or more blades depending upon the particular propeller installation. As the construction of all of the blades and their connections to the hub portion of the propeller is the same, a description of only one blade and its associated retaining and driving connections is considered sufficient for the purposes of this disclosure.

In the form of the invention illustrated the propeller blade is formed of metal and is provided with a substantially cylindrical base or root end rotatably mounted in the propeller hub and retained therein by means of a flange **18**, the periphery of which is joined to the adjacent surface of the base end of the blade by a fillet **20** of large radius which bears against an anti-friction thrust bearing **22** retained in the portion of the split propeller hub barrel **24**, surrounding the base end of the blade. The hub barrel **24** is split transversely to the axis of rotation of the propeller and the two parts thereof are rigidly secured together by suitable means such as the clamp bolt **26**. The outer race of the bearing **22** is retained in the barrel member by a suitable overhanging flange portion **28** surrounding but out of contact with the cylindrical base end of the propeller blade. By this means the propeller blade is rotatably mounted in the barrel member and is held therein against the action of centrifugal force. As such blade mounting means are well-known to the art, it is believed that a further description is unnecessary for the purpose of this disclosure.

Each of the blades is provided in its base or root end with an elongated substantially conical shaped hollow or aperture, as indicated at **30**, and within the open end of the hollow **30**, there is inserted a sleeve member **32**, which has a flange portion **34** overlying the flattened base end of the propeller blade. The surface of the flange portion **34** of the sleeve **32** opposite the surface in contact with the end of the propeller blade, bears upon a suitable bearing washer **36** of hardened material, which in turn, rests upon a support member **38**. In a three bladed propeller, such as the one illustrated in Fig. 1, each support member is in the form of a triangular section of a cylinder, the angle between the inclined faces thereof being 120 degrees so that when the three support members are assembled together, they entirely sur-

round the center portion of the spider member and bear upon one another. The apex of each support member is cut away so that the support members fit about the cylindrical portion of the spider member surrounding the propeller drive shaft, without however, contacting the spider member at any point. The circular end of each support member is provided with an inwardly projecting flange **40** which surrounds but does not touch the respective spider arm **14**. With this construction it will be observed that the blades are firmly secured in the barrel member **24** and are solidly supported upon each other but do not contact or derive any support from the propeller drive shaft or the hub spider **14** mounted upon the shaft.

An elongated resilient arm, generally indicated at **42**, is rigidly secured in the spider arm **14** by means of an internal screw-threaded nut **44**, which bears at its inner end against an outwardly flared enlarged portion **46** at the base end of the resilient arm, thus rigidly securing the resilient arm **42** in the hollow spider arm **14**. A ring of suitable resilient material such as rubber, indicated at **47**, is clamped between the outwardly flanged head end of the nut **44** and the opposed end of the spider arm **14** and lies between the outer end of the nut **44** and the outer end of the sleeve **32** to provide a resilient bumper between the driving arm and the sleeve in case the arm is moved sufficiently with respect to the blade to bring it into contact with the surface of the hollow **30**.

At its outer end the resilient arm **42** is provided with a concave portion **48** about which is disposed a split bearing sleeve **50**, slidably received in a cup-shaped bearing member **52**, secured in the outer end of the hollow **30**. Through this bearing is transmitted the power which rotates the propeller and also the force of the thrust which the propeller blade exerts when rotated.

From an inspection of Fig. 1 it will be observed that the driving arm is much closer to one side of the blade hollow **30** than to the other. This point of adjacency is located at the forward side of the blade within the angle intercepted by the plane of thrust and the plane of rotation of the blade so that as the blade is turned and exerts a thrust force upon the driving arm, the interior of the base end of the blade tends to move away from the adjacent surface of the driving arm, and, under operating conditions, the arm becomes substantially concentric with the longitudinal axis of the blade.

The construction of the driving arm **42** is particularly illustrated in Figs. 2, 3 and 4. From an inspection of these figures it will be observed that the arm has a solid metal core in the form of an elongated rod member having a relatively short outwardly flared enlargement at the base end and a concave reduction at the outer end to receive the bearing **50**. The core element **54** is surrounded by concentric pairs of telescopically associated tubes, as indicated at **56**, **58**, **60**, **62**, **64** and tube **66**. Of these various pairs of tubes the pair immediately surrounding the core **54** is the longest and the other pairs decrease in length as they are located progressively outward from the core, the outermost tube **66** being the shortest and surrounding the base end of the core, **54**. Each pair of tubes is flared outwardly at its base end, as indicated at **68**, to receive the outwardly flared enlargement on the core and on the successive pairs of tubes and to provide the outwardly flared enlargement **46** at the base end of the arm to provide on the arm a retaining bearing against which the nut **44** presses to retain the resilient arm in the hollow spider arm **14**.

Each pair of tubes, as indicated from **56** to **64** inclusive, comprises an outer tube, as illustrated in Fig. 3, and an inner tube, as illustrated in Fig. 4. As all of the inner tubes and all of the outer tubes with the exception of the outer tube **66**, are exactly similar except for length, it is considered that a detailed description of only one of each is sufficient for the purpose of this disclosure.

The outer tube **72** of any pair, except the outermost pair **66**, as illustrated in Fig. 3 is a relatively thin resilient metal tube but in this case the tube has been slotted transversely at spaced distances along its length, as indicated at **74** and **76**. Each of the slots extends almost half way through the tube, leaving only a small amount of metal between the opposed ends of each pair of transverse slots, and alternate slots along the length of the tube are disposed at a circumferential angle at 90 degrees to each other. The outer tube **66** is not slotted.

The inner tube **70** of any pair, as illustrated in Fig. 4, is also a relatively thin resilient metal tube that has been split longitudinally from end to end on a plurality of angularly spaced radial planes to provide a group of longitudinal resilient staves. In the form of the invention illustrated each of the staves constituting one of the tubes as, for example the tube **70**, has a circumferential extent somewhat less than one-eighth of a circle and the sections or staves of all of the tubes are substantially equal in width or circumferential extent. This splitting of the inner tubes decreases their resistance to bending while increasing the total sliding movement between the inner tube and the associated outer tube when the resilient arm is bent.

The core element **54** and the various concentric tubes are all fitted together with a slight pressure fit so that, although the various elements will slide relative to each other whenever the arm **42** is distorted by bending forces, they will at the same time offer a large amount of frictional resistance to distortion or bending of the arm.

As is clearly illustrated in Fig. 2, the core member **54** is in the form of an elongated rod. This member is made of some strong resilient material, such as tempered steel, so that it acts as a spring when varying forces are applied to it near its opposite ends. Thus vibrational forces transmitted from the engine to the propeller are cushioned by the spring action of the core portion of the rod while the driving forces are transmitted to the propeller blades and the thrust forces are transmitted from the blades back to the propeller hub and to the engine. The resilient action of the core member, however, is damped by the frictional resistance of the surrounding pairs of tubes or sleeves so that, while the vibrational shocks are cushioned by the spring action of the cores and their force is thereby greatly reduced, their amplitude is also reduced by the damping action of the friction sleeves or tubes and the excess energy thus removed from the vibration shocks is dissipated harmlessly in the form of heat occasioned by the friction of the tubes. By this arrangement the frequency of a harmonic vibration existing in the propeller and engine crankshaft combination may be so greatly reduced that the vibration will occur at an engine speed that is far below the normal operating speed and at which the power delivered by the engine

is sufficiently low so that the vibration will have no serious detrimental effect.

While there has been illustrated and described a suitable mechanical embodiment of what is now considered to be the preferred form of the idea of the invention, it is to be understood that the invention is not limited to the particular construction so illustrated and described but that such changes in the size, shape and arrangement of parts may be resorted to as come within the scope of the subjoined claims.

Having now described the invention so that others skilled in the art may clearly understand the same what it is desired to secure by Letters Patent is as follows:

1. A drive arm for an aeronautical propeller comprising, a resilient core member, and a plurality of frictionally engaged telescoped tubes surrounding said core member.

2. A drive arm for an aeronautical propeller comprising, a resilient core member, and a plurality of pairs of frictionally associated concentric tubes surrounding said core member, said pairs being substantially flush at one end with the end of said core member and decreasing in length as they are located progressively outwardly from said core member.

3. A drive arm for an aeronautical propeller comprising, a resilient core member, and a plurality of concentric pairs of friction sleeves surrounding said core member, the inner sleeve of each pair being split longitudinally to provide a plurality of separate staves around said core member.

4. A drive arm for an aeronautical propeller comprising, a resilient core member, and a plurality of pairs of friction sleeves surrounding said core member, the outer sleeve of each pair being transversely slotted at spaced intervals along its length.

5. A drive arm for an aeronautical propeller comprising, a resilient core member, and a plurality of concentric pairs of friction sleeves surrounding said core member, the outer sleeve of each pair being transversely slotted at spaced intervals along its length by opposed slots each extending slightly less than half the circumference of said tube, alternate slots being disposed at approximately ninety degrees to each other on the circumference of said tube.

6. A drive arm for a propeller blade comprising, a resilient core member surrounded by groups of friction elements each group including a plurality of longitudinal staves surrounded by a plurality of circumferential tubular sections.

7. A hub spider for a propeller comprising, a central member apertured to receive a drive shaft and provided with a plurality of radially extending hollow arms, and a drive arm fixed at one end in each of said hollow arms, each drive arm comprising a resilient core surrounded by frictional damping elements.

8. A hub spider for a propeller comprising, a central member apertured to receive a drive shaft and provided with a plurality of radially extending hollow internally screw-threaded arms, and a resilient drive arm secured in each of said hollow arms by means of a nut surrounding said resilient arm, bearing against an enlargement on the end of said resilient arm and screw-threaded into said hollow arm.

9. A hub spider for a propeller comprising, a central member apertured to receive a drive shaft and provided with a plurality of radially extending hollow integral arms adapted to extend into respective hollow propeller blades, and drive arms rigidly secured each by one end in a respective one of said hollow spider arms and provided at its opposite end with a bearing for engaging the wall of the hollow interior of the respective propeller blade, each drive arm comprising a resilient core member and a plurality of frictional damping elements surrounding said core member.

10. A hub spider for a propeller comprising, a central member apertured to receive a drive shaft and provided with a plurality of radially extending hollow arms, and a drive arm secured in each of said hollow arms, each drive arm comprising a resilient core member surrounded by groups of frictional elements, each group including a plurality of longitudinal staves surrounded by a plurality of circumferential tubular sections.

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