NASA CASE NO. LEW-12,445-1

PRINT FIG. The Figure

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(NASA-Case-LEW-12445-1) MULTIPLE PLATE HYDROSTATIC VISCOUS DAMPER Patent Application (NASA) 7 p HC A02/MF A01 CSCL 13I

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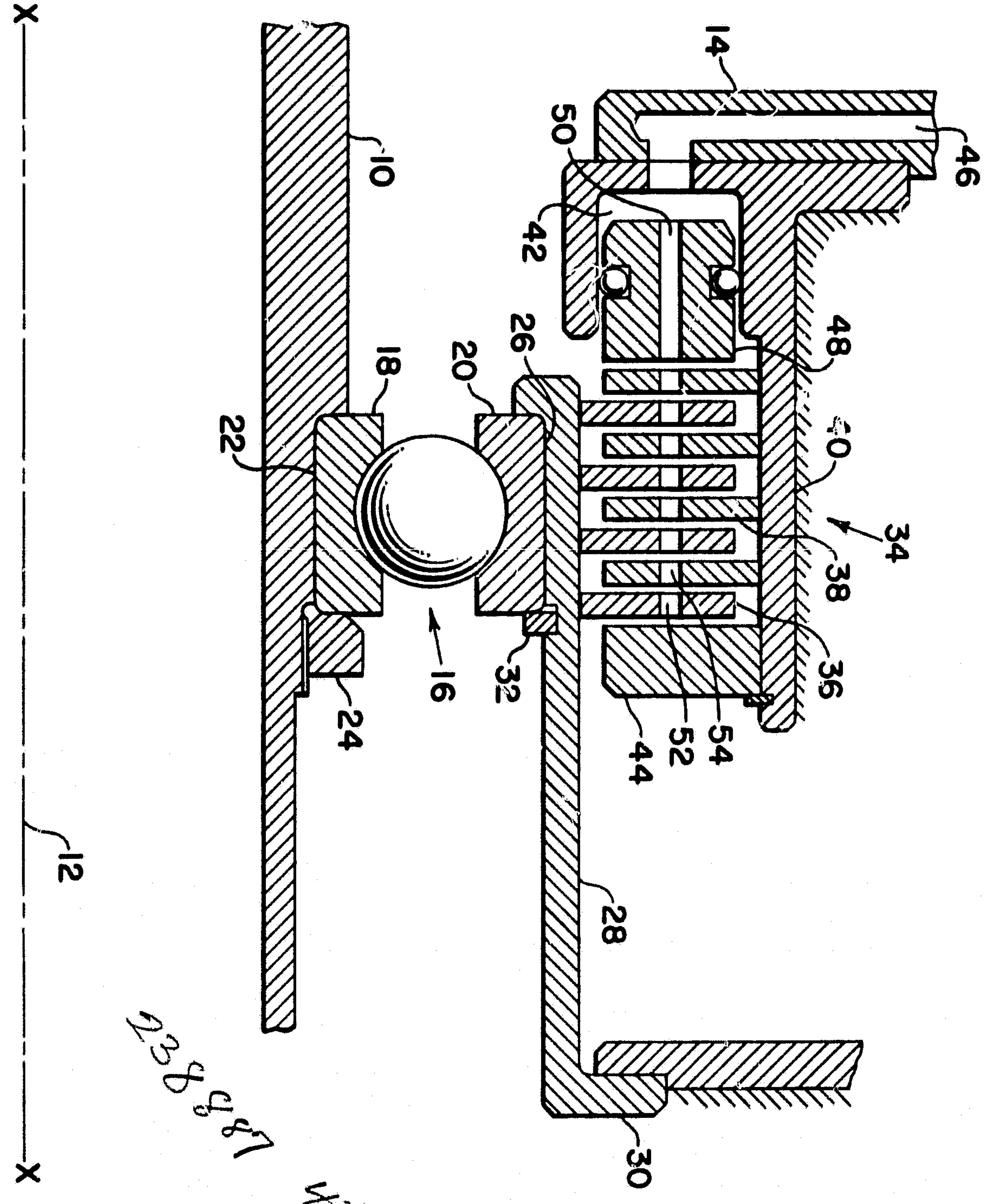

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Description

Multiple Plate Hydrostatic Viscous Damper

Origin of the Invention

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

Technical Field

This invention is concerned with providing a high degree of damping in a rotor/case system of gas turbines. The invention is further concerned with improving the rotor dynamics of turbomachinery in general.

In the prior art damping is supplied by the squeeze film action of a squeeze film damper. Such a damper has the disadvantage of being highly non-linear, and this characteristic often exacerbates the rotor dynamics problem under conditions of high imbalance loads such as when a blade breaks free from a turbine.

Damping is also supplied by rubbing friction type dampers of various designs. Rubbing friction type dampers are subject to wear problems and uncontrollable variations in friction coefficient.

The present invention does not have these disadvantages of the prior art. More particularly, the hydrostatic viscous damper accommodates large radial motion resulting from high imbalance loads, without a highly non-linear characteristic. Also, wear is avoided inasmuch as the damper plates are not in rubbing contact, and the viscous damping magnitude is controllable within acceptable design limits.

Background Art

Shotwell patent No. 3,823,619 is directed to a multi-plate vibration damper contained in a housing. This housing is at least partially filled with a damping fluid which enters the clearances between the plates during damper operation. This fluid is not under pressure.

Gryglas patent No. 3,865,216 is concerned with a continuous rotary damper having a stator that is engaged in an annular stationary housing. A radial vane on the rotor projects into the stator. A viscous fluid in the housing retards rotation of the rotor.

Forkel patent No. 4,172,510 is concerned with a torsional vibration damper utilizing intermeshing discs. The interstertial spaces are filled with a highly viscous liquid which is sealed off with resilient material. This fluid is not under pressure.

Disclosure of Invention

The damper of the present invention utilizes a series of spaced plates which extend radially outward from the axis of shaft rotation. A hydrostatic fluid is supplied to the space between the plates, and a hydraulic piston applies a load to the plates.

Each radial plate is provided with a suitable hydrostatic bearing geometry. This geometry may be on one or both faces of the plate.

This structure provides a high degree of dampening in a rotor/case system of turbomachinery in general. The damper is particularly useful in gas turbine engines.

Brief Description of the Drawing

The objects, advantages and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawing which is an axial section view of a rotating shaft utilizing a hydrostatic viscous damper constructed in accordance with the invention.

Best Mode for Carrying Out the Invention

Referring now to the drawing there is shown a shaft 10 which rotates about its longitudinal axis 12 in a stationary housing 14. The shaft 10 may carry the spindle of a gas turbine engine of the type shown in U.S. patent No. 3,581,492.

The shaft 10 extends through a suitable bearing 16 which is preferably of the anti-friction type. A ball bearing may be used which has an inner race 18 and an outer race 20.

The inner race 18 engages a suitably machined portion 22 on the shaft 10. A retainer 24 forces the bearing 16 against an opposed shoulder on the machine portion 22 so that the inner race 18 is rigidly mounted on a shaft 10 for rotation about the axis 12.

The outer race 20 engages a suitably machined portion 26 of a bearing support in the form of a sleeve or cylinder 28 having a predetermined radial stiffness. The end 30 of the sleeve 28 opposite from the bearing 10 is rigidly secured to the stationary housing 14. A retainer 32 forces the bearing 16 against an opposed shoulder on the machined portion 26 so that the outer race 20 is rigidly mounted in the sleeve 28 and is stationary relative to the shaft 10.

Hydrostatic damping means 34 is rigidly mounted in the housing 14 for operable engagement with the bearing 16 through the sleeve 28. This damping structure includes a plurality of intermeshed annular plates 36 and 38 which extend around the shaft 10 normal to the axis 12. These intermeshed plates extend radially outward from the bearing 16 and are spaced from one another along the axis 12.

Alternate plates 36 are piloted on the outer surface of the sleeve 28 adjacent to the outer race 20 of the bearing 16. Thus, any radial motion of the shaft 10 resulting from an imbalance load thereon is transmitted through the bearing 16 to the damper plates 36.

The alternate plates 38 are positioned inside a sleeve 40 that is rigidly mounted on the housing 14. An annular chamber 42 is provided in the sleeve 40 adjacent to the housing 14. A retaining ring 44 is mounted in the sleeve 40 opposite the chamber 42 to properly position the circular plates 36 and 38 so that they engage the inner surface of the sleeve.

A passage 46 in the housing 14 is connected to a fluid source which is not shown. A suitable fluid which is preferably a liquid under pressure passes through the passage 46 to the annular chamber 42 through a suitable opening at the base thereof.

An annular piston 48 in the form of a ring is mounted for reciprocating movement in the chamber 42. An increase in the hydrostatic pressure in the chamber 42 forces the annular piston 48 to move toward the plates 36 and 38 thereby increasing the load thereon. This pressure is increased when high imbalance situations are encountered as explained below.

A small passage 50 enables a portion of the liquid from the passage 46 to flow through the piston 48 to the plates 36 and 38. Small aligned apertures 52 and 54 through the plates 36 and

38, respectively, enable this liquid from the chamber 42 to pass to the spaces between the intermeshing plates.

The pressurized liquid in the passage 46 maintains a predetermined pressure in the chamber 42, and liquid leaks out of the aligned apertures 52 and 54. With radial displacement of the plates 36 the apertures 52 and 54 are moved out of alignment and are partially covered. This increases the pressure in the chamber 42 because the leakage through the apertures 52 and 54 decreases. The resulting increase in pressure moves the piston 48 toward the plates 36 and 38 to increase the loading.

An important feature of the invention is that each annular plate 36 and 38 has a suitable hydrostatic bearing geometry formed on at least one of its faces. This hydrostatic bearing geometry can be of several conventional types. A preferable geometry for the faces of the damper plates 36 and 38 is one of the hydrostatic recess types. Such geometrics are discussed in NACA publications TN D-4936 and TN-D-4934.

The pressurization for the hydrostatic bearings formed by the plates 36 and 38 is from the hydraulic pressure on the loading piston 48. The size of this loading piston with respect to the hydrostatic bearing size of the plates 36 and 38 is a parameter in the determination of the hydrostatic bearing film thickness between each plate. It is apparent that the plates 36 and 38 do not contact, but are separated by a hydrostatic lubricating film which is less than 0.0005 inch in thickness.

As shown in the drawing, larger diameter plates 38 engage the surface of the sleeve 40 while the smaller diameter plates 36 engage the sleeve 28 adjacent to the outer race of the bearing 16. Therefore, under rotor vibration conditions any relative motion between the outer race 20 of the bearing 16 and the turbomachinery case 14 is damped out by the action of the hydrostatic viscous damper structure 34.

While a preferred embodiment of the novel structure has been described, it will be appreciated that various modifications may be made to the invention without departing from the spirit thereof or the scope of the subjoined claims.

LEW-13,445-1

-Abstract-

Multiple Plate Hydrostatic Viscous Damper

This invention is directed to damping radial motion of a rotating shaft.

The damper (34) comprises a series of spaced plates (36,38) extending in a radial direction. A hydraulic piston (48) is utilized to place a load in these plates. Each annular plate is provided with a suitable hydrostatic bearing geometry on at least one of its faces.

This structure provides a high degree of dampening in a rotor case system of turbomachinery in general. The damper is particularly useful in gas turbine engines.

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