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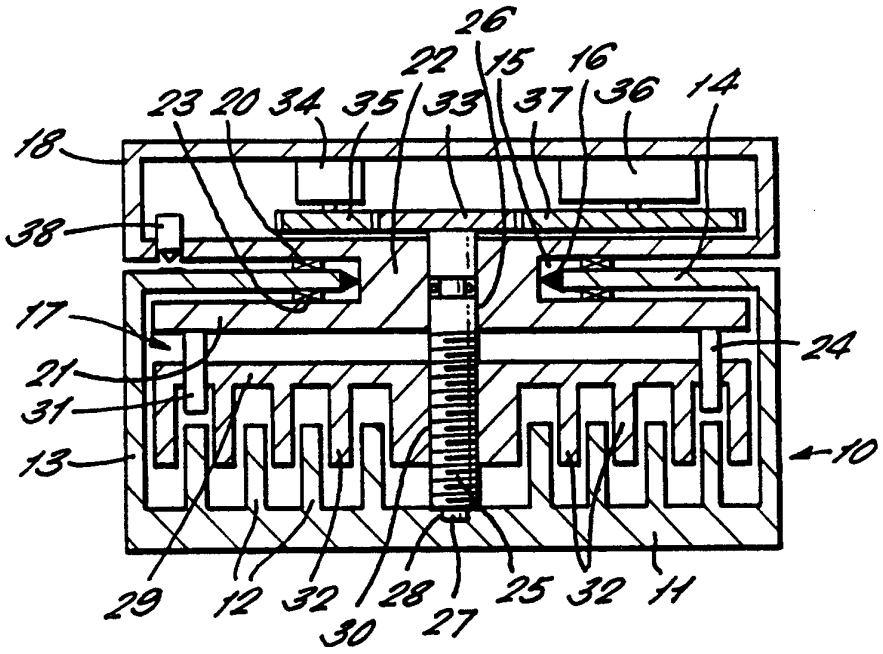
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With amended claims.

(54) Title: IMPROVEMENTS IN OR RELATING TO APPARATUS MOUNTINGS PROVIDING AT LEAST ONE AXIS OF MOVEMENT WITH DAMPING

(57) Abstract

The disclosure relates to a viscous damper of the labyrinth ring type for incorporation in a mounting for a TV or video camera for damping pan or tilt movement of the camera. The damper has a stator (10) having a multiplicity of upstanding concentric annular fins (12) and a rotor (17) having a corresponding multiplicity of concentric annular fins (32) projecting downwardly which interleave with clearance with the upstanding flanges of the stator, the space between the fins being filled with a viscous fluid to provide a resistance to relative movement between the rotor and stator. The rotor is adjusted with respect to the stator by a motor driven lead screw. A speed sensor measures speed of the rotor with respect to the stator and torque applied to the camera by the hand control to pan or tilt the camera is measured by a strain gauge associated with the hand control. A control system is provided for the motor embodying a microprocessor preprogrammed with one or more algorithms coordinating torque and speed. Thus the viscous damper may be controlled to provide a resistance torque to movement which rises generally linearly with speed as detected by the speed sensor to a certain level whereafter the resistance is maintained constant.



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IMPROVEMENTS IN OR RELATING TO APPARATUS MOUNTINGS PROVIDING AT LEAST ONE AXIS OF MOVEMENT WITH DAMPING

This invention relates to apparatus mountings having at least one axis of movement and more specifically to manually movable mountings incorporating variable resistance devices for damping movement of the apparatus. The invention is particularly although not exclusively applicable to mountings for film, T.V. or video cameras which, typically, are moveable in at least pan and tilt modes.

Various forms of dampers have been used in camera pan/tilt mountings, some, of the friction type, embodying inter-engaging sliding surfaces and others, of the viscous type, having relatively moveable surfaces with a viscous fluid therebetween sheared by the relative movement between the surfaces to provide resistance. Still other forms of damper have embodied both friction and viscous components. Examples of such arrangements can be found in our U.S. Patent No. 4,177,884 our International Patent Publication No. WO92/03683 and our International Patent Application No. PCT/GB93/00746.

The above arrangements are all essentially mechanical in nature and whilst it is normal to provide adjustment for varying maximum resistance offered, the torque/speed characteristics of such dampers are inherent in their design and construction and cannot readily be varied thereafter.

This invention provides an apparatus mounting providing movement for the apparatus in at least one axis and damping means bring provided for controlling

said movement, the damping means comprising a variable resistance device for opposing movement of the mounting, electrically operated control means for said variable resistance device for varying the resistance in accordance with one or more variable parameters relating to movement of the mounting and means to detect variation in said parameter or parameters to cause the control means to vary the resistance device to provide a requisite resistance in accordance with variation in said parameter or parameters.

For example, means may be provided for detecting applied force and speed of movement and said control means may adjust the variable resistance to provide a resistance to movement which varies with speed in accordance with a predetermined relationship.

One such control means may include a micro-processor programed with an algorithm to provide the required resistance/speed characteristic. In the latter case the micro-processor may be adapted to receive different algorithms for the force/speed relationship for selection by the operator.

Futhermore the micro-processor may contain a number of algorithms for different force/speed relationships and means are provided for the operator to select a requisite algorithm.

In any of the above arrangements the control means may have further means for detecting ambient conditions for adjusting the variable force device to suit the conditions.

For example the means for detecting said ambient conditions may include means for detecting temperature

and wind speed.

Also in any of the above arrangements the control means may include means for varying the variable resistance in accordance with adjustment of a camera parameter.

In one arrangement according to the invention the apparatus may comprise a camera having a zoom lens, and means may be provided for providing varying resistance to movement in response to change in focal length of the lens and thereby field of view of the lens.

Also in any of the above arrangements the mounting may provide pan and tilt movement of the camera and variable resistance devices for controlling movement of the camera in both pan and tilt are provided operated by said control means.

The following is a description of some specific embodiments of the invention, reference being made to the accompanying drawings in which;

Figure 1 is a diagrammatic illustration of a labyrinth type variable viscous damper for a camera mounting in accordance with the invention;

Figure 2 is also a diagrammatic illustration showing two such dampers utilised in controlling pan and tilt movements of a camera platform;

Figure 3 shows a graph of labyrinth engagement plotted against angular velocity for different drag characteristics without a torque sensor;

Figure 4 illustrates in block diagram form a control system for achieving the characteristics of Figure 3;

Figure 5 is a graph of drag torque plotted against angular velocity for a system with a torque sensor; and

Figure 6 is a block diagram of a control system for achieving the characteristics of Figure 5.

The drawings show a viscous damper of the labyrinth ring type for damping pan or tilt movement of a T.V./video camera in a camera mounting.

The damper comprises a stator 10 in the form of a hollow, circular cross-section housing having a base plate 11 formed with integral upstanding concentric annular fins 12, an annular outer wall 13 and an annular top wall 14 providing a central aperture 15 into the top of the housing. An annular seal 16 is mounted in the central aperture 15.

A rotor for the damper is indicated generally at 17 and comprises a hollow cylindrical hub 18 supported on the top wall of the stator on an annular thrust race 20. A circular drive plate 21 disposed within the stator housing has an upstanding boss 22 extending through the aperture 15 in the top plate in engagement with the seal 16 and is secured to the underside of the hub. A second annular thrust race 23 is disposed between the upper side of the drive plate and the underside of the hub. The drive plate has a pair of diametrically spaced downwardly projecting drive pins 24.

A lead screw 25 is rotatably mounted in a bore 26 at the centre of the drive plate 21 and extends downwardly thereof to the base plate 11 of the stator housing where the lead screw is formed with a short circular boss 27 which locates in a circular socket 28 in the base plate 11. The lead screw is thus supported for rotation in the stator housing.

A rotor plate 29 is located in the stator housing and has a central screw-threaded bore 30 in which the lead screw engages so that rotation of the lead screw raises and lowers the plate for a purpose described below.

The rotor plate is coupled to the drive plate to be rotatable therewith by the drive pins 24 which engage in bores 31 in the rotor plate. Raising and lowering the rotor plate by the lead screw raises and lowers the plate upward down the drive pins whilst maintaining the driving connection between the plates.

The rotor plate has a number of downwardly projecting concentric annular fins 32 which interleave with clearance with the upstanding flanges on the stator base plate and the space between the flanges of the rotor plate and stator is filled with a viscous fluid to provide resistance to relative movement between the rotor and stator. The seal 16 prevents loss of fluid between the boss 22 and aperture 15 in the top wall 14. Raising and lowering the rotor plate by the lead screw varies the overlap between the fins of the stator and rotor to vary the "coupling" or viscous drag between the rotor and stator.

The upper end of the lead screw 25 projects into the hub 18 and carries a gear 33. A reversible

electric drive motor 34 is mounted on the hub to one side of the gear and has an output drive carrying a drive pinion 35 which meshes with the gear 33 to rotate the lead screw. Control of the lead screw is effected through a rotary potentiometer 36 mounted in the hub on the other side of the gear 33 and carrying a pinion 37 meshing with the gear 33. A speed sensor 38 is mounted on the hub 18 facing a surface of the stator for measuring speed of the rotor with respect to the stator. Torque applied to the camera by the hand control to pan or tilt the camera is measured by a strain gauge associated with the hand control.

Figure 2 of the drawings shows two such dampers controlling the pan and tilt movement of a camera platform 40. The platform is mounted for tilt movement about a horizontal axis 41 with an upright side wall 42 of the platform coupled to the rotor of one damper indicated at 43 which controls rotation about the horizontal axis 41. The stator of the damper is mounted on the rotor of a second damper 44 rotatable about a vertical axis 45 to control pan movement of the platform.

A control system for the variable viscous dampers which resist pan and tilt movements of the mounting is provided embodying a microprocessor pre-programmed with one or more algorithms coordinating torque and speed to provide a required relationship therebetween. In addition means can be provided for measuring ambient conditions which may effect the control of the camera such as temperature which could affect the viscosity of the damper fluid, wind speed could affect the control which the operator has over the camera, the adjustment of features of the camera such as a zoom lens to provide varying resistance with change in

focal length and therefore field of view. In addition, the microprocessor may be programmed to suit the particular operating characteristics which are the personal preferences of the user. By way of example, the mounting may have an input device to receive pre-recorded information on a magnetic card for controlling the damper in accordance with the operators' preference.

Finally, a manual control may be provided for adjusting the resistance, that is the amplitude of the characteristics of the damper.

Movement of the camera on its mounting in either the tilt or pan axes results in the damper providing a resistance torque to movement which rises generally linearly with speed of movement as detected by the speed sensor 19 to a certain level whereafter the resistance is maintained constant. That is but one torque speed characteristic and it would be appreciated that many other such characteristics may be pre-programmed for selection by the user as required.

As indicated above, the viscous damper provides varying resistance by adjustment of the spacing of the rotor and stator. Other means are available for varying the damping provided by a viscous damper including the use of electro-rheological fluids which change viscosity in accordance with electric fields. It is also envisaged that piezo electro devices may be used for providing motive force for varying the level of damping in relation to an electrical signal in putting the invention into effect.

The motor drive for adjusting the viscous

coupling is preferably of the stepper motor type or a DC servo motor in a controlled loop.

Figure 3 of the drawings is a graph showing labyrinth engagement plotted against angular velocity for different drag characteristics and Figure 4 is a block diagram of a corresponding control system.

Figure 5 is a graph of drag torque plotted against angular velocity and Figure 6 is a block diagram of a corresponding control system.

CLAIMS

1. An apparatus mounting providing movement for the apparatus in at least one axis with damping means for controlling said movement, the damping means comprising a variable resistance device for opposing movement of the mounting, electrically operated control means for said variable resistance device for varying the resistance in accordance with one or more variable parameters relating to movement of the mounting and means to detect variation in said parameter or parameters to cause the control means to vary the resistance device to provide a requisite resistance in accordance with variation in said parameter or parameters.

2. A mounting as claimed in Claim 1, wherein means are provided for detecting applied force and speed of movement of said mounting and said control means adjusts the variable resistance to provide a resistance to movement which varies with speed in accordance with a predetermined relationship.

3. A mounting as claimed in Claim 2, wherein the control means include a microprocessor programmed with an algorithm to provide the required resistance/speed characteristic.

4. A mounting as claimed in Claim 3, wherein the microprocessor is adapted to receive different algorithms for the force/speed relationship for selection by the operator.

5. A mounting as claimed in Claim 4, wherein the microprocessor contains a number of algorithms for

different force/speed relationships and means are provided for the operator to select a requisite algorithm.

6. A mounting as claimed in any of the preceding claims, wherein the control means has further means for detecting ambient conditions for adjusting the variable force device to suit the conditions.

7. A mounting as claimed in Claim 6, wherein the means for detecting said ambient conditions include means for detecting temperature and wind speed.

8. A mounting as claimed in any of Claims 1 to 7, wherein a manual control for the variable resistance is provided for use by the operator to enable a nominal level of resistance to movement offered by said device to be adjusted.

9. A mounting as claimed in any of the preceding claims, wherein the or at least one of the movements provided by the mounting is in rotation and the variable resistance device is a rotary viscous damper having means for varying the drag therein.

10. A mounting as claimed in Claim 9, wherein the damper comprises a stator having multiple annular plates and a rotor having multiple annular plates interleaved with and spaced from the plates of the stator and a viscous fluid filling the spaces between the plates, means being provided for adjusting the separation of the rotor/stator to vary the overlap between the plates thereof and thereby vary the resistance of the damper.

11. A mounting as claimed in Claim 10, wherein an

electric motor is provided for adjusting the spacing of the rotor/stator of the damper, said motor being operated by said control means to vary the resistance offered by the damper as required.

12. A mounting as claimed in Claim 11, wherein the motor is a stepper or D.C. servo motor for providing precise control of the spacing of the rotor/stator.

13. A mounting as claimed in Claim 9, wherein the viscous damper contains an electro-rheological fluid and means are provided for generating a variable electric field in the fluid for changing the viscosity in the fluid.

14. A mounting as claimed in any of Claims 1 to 8, wherein the variable resistance device includes a piezo-electro device for varying the resistance in accordance with the voltage supply from the control means.

15. A mounting as claimed in any of the preceding claims, wherein the control means includes means for varying the variable resistance in accordance with adjustment of an apparatus parameter.

16. A mounting as claimed in Claim 15, wherein the mounting is adapted to receive a film, T.V. or video camera and the control means includes means for adjusting resistance of the damper with adjustment of a camera parameter.

17. A camera mounting as claimed in Claim 16 and where the camera has a zoom lens, wherein means are provided for changing resistance to movement of the damper in response to variation in focal length of the

lens and thereby the field of view of the lens.

18. A mounting as claimed in any of the preceding claims, wherein the mounting is adapted to receive a film, T.V. or video camera and provides pan and tilt movement for the camera and said variable resistance devices having electrically operated control means are provided for controlling movement of the camera in both pan and tilt directions.

19. A mounting as claimed in any of the preceding claims, wherein the mounting is adapted to receive a film, T.V. or video camera and includes a variable height column having a variable resistance damping device with electrically operated control means.

20. A mounting as claimed in any of the preceding claims, wherein the mounting is supported on a wheeled pedestal and the pedestal wheels have variable resistance damping devices with electrically operated control means.

21. A mounting as claimed in any of the preceding claims, wherein the mount includes a movable crane arm having a variable resistance damping device and electrically operated control means.

AMENDED CLAIMS

[received by the International Bureau on 13 March 1995 (13.03.95); original claims 1-22 replaced by amended claims 1-22 (4 pages)]

1. An apparatus for an apparatus mounting suitable for a camera or like equipment having movement in at least one axis with damping means for controlling the movement, the damping means comprising a variable resistance device for opposing movement of the mounting, electrically operated control means for said variable resistance device for varying the resistance in accordance with one or more variable parameters relating to the movement of the mounting and means to detect variation in said parameter or parameters to cause the control means to vary the resistance device to provide a requisite resistance in accordance with variation in said parameter or parameters, wherein means are provided which are responsive to one or more parameters, the or one of which is speed of movement of the mounting in said axis to vary, through said electrically operated control means, the torque provided by said variable resistance device.

2. A mounting as claimed in claim 1, wherein means are provided for detecting speed of movement of said mounting and said control means adjusts the variable resistance to provide a resistance to movement which varies with speed in accordance with a predetermined relationship.

3. A mounting as claimed in claim 2, wherein means are provided for detecting applied force and speed of movement of the mounting and said control means adjusts the variable resistance to provide a resistance to movement which varies with applied force and speed in accordance with a predetermined relationship.

4. A mounting as claimed in claim 2 or claim 3,

wherein the control means include a microprocessor programmed with an algorithm to provide the required resistance/speed characteristic.

5. A mounting as claimed in claim 4, wherein the microprocessor is adapted to receive different algorithms for the force/speed relationship for selection by the operator.

6. A mounting as claimed in claim 5, wherein the microprocessor contains a number of algorithms for different force-speed relationships and means are provided for the operator to select a requisite algorithm.

7. A mounting as claimed in any of the preceding claims, wherein the control means has further means for detecting ambient conditions for adjusting the variable force device to suit the conditions.

8. A mounting as claimed in claim 7, wherein the means for detecting said ambient conditions include means for detecting temperature and wind speed.

9. A mounting as claimed in any of the preceding claims, wherein the or at least one of the movements provided by the mounting is in rotation and the variable resistance device is a rotary viscous damper having means for varying the draft therein.

11. A mounting as claimed in claim 10, wherein the damper comprises a stator having multiple annular plates and a rotor having multiple annular plates interleaved with and spaced from the plates of the stator and a viscous fluid filling the spaces between the plates, means being provided for adjusting the separation of the rotor/stator to vary the overlap between the plates

thereof and thereby vary the resistance of the damper.

12. A mounting as claimed in claim 11, wherein an electric motor is provided for adjusting the spacing of the rotor-stator of the damper, said motor being operated by said control means to vary the resistance offered by the damper as required.

13. A mounting as claimed in claim 12, wherein the motor is a stepper or D.C. servo motor for providing precise control of the spacing of the rotor/stator.

14. A mounting as claimed in claim 10, wherein the viscous damper contains an electro-rheological fluid and means are provided for generating a variable electric field in the fluid for changing the viscosity in the fluid.

15. A mounting as claimed in any of claims 1 to 9, wherein the variable resistance device includes a piezo-electro device for varying the resistance in accordance with the voltage supply from the control means.

16. A mounting as claimed in any of the preceding claims, wherein the control means includes means for varying the variable resistance in accordance with adjustment of an apparatus parameter.

17. A mounting as claimed in claim 16, wherein the mounting is adapted to receive a film, T.V. or video camera and the control means includes means for adjusting resistance of the damper with adjustment of a camera parameter.

18. A camera mounting as claimed in claim 17, and where the camera has a zoom lens, wherein means are provided for changing resistance to movement of the

damper in response to variation in focal length of the lens and thereby the field of view of the lens.

19. A mounting as claimed in any of the preceding claims, wherein the mounting is adapted to receive a film, T.V. or video camera and provides pan and tilt movement for the camera and said variable resistance devices having electrically operated control means are provided for controlling movement of the camera in both pan and tilt directions.

20. A mounting as claimed in any of the preceding claims, wherein the mounting is adapted to receive a film, T.V. or video camera and includes a variable height column having a variable resistance damping device with electrically operated control means.

21. A mounting as claimed in any of the preceding claims, wherein the mounting is supported on a wheeled pedestal and the pedestal wheels have variable resistance damping devices with electrically operated control means.

22. A mounting as claimed in any of the preceding claims, wherein the mount includes a movable crane arm having a variable resistance damping device and electrically operated control means.

FIG. 1.

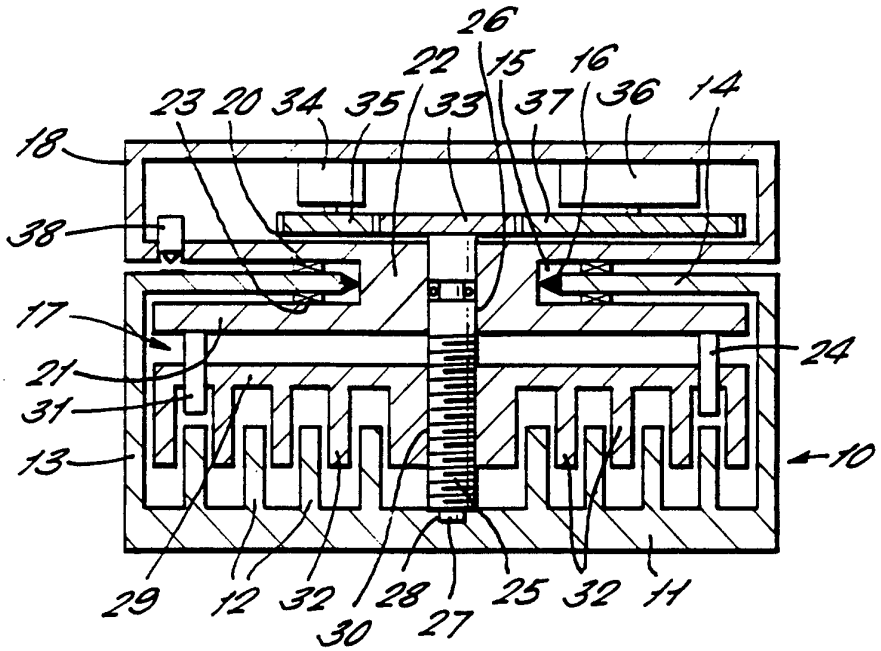
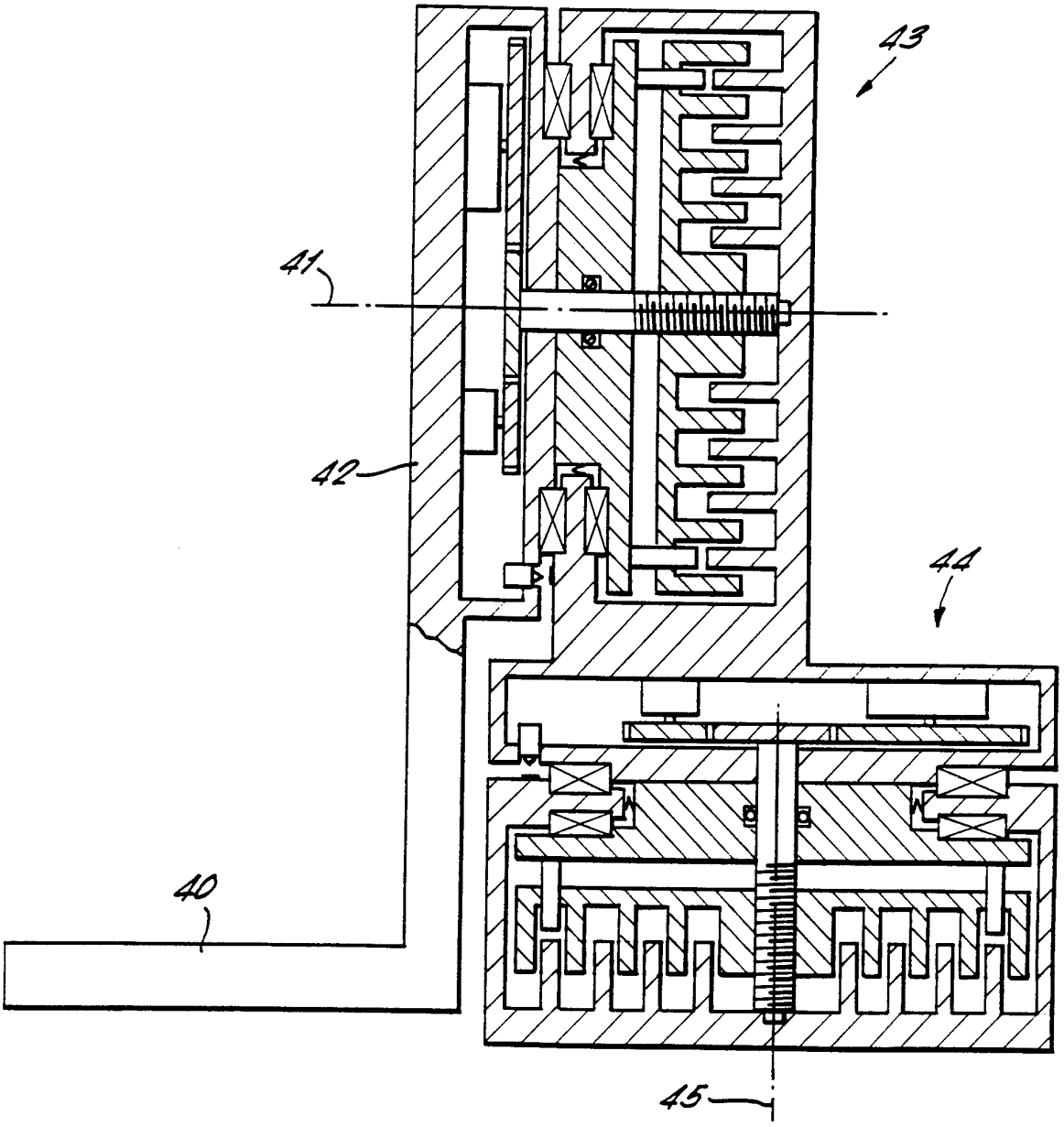

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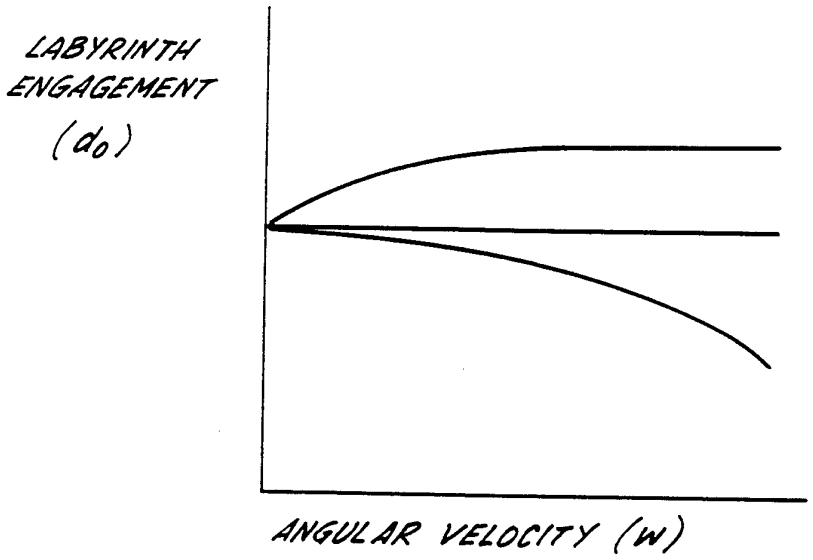
FIG. 2.



ACTIVE DRAG

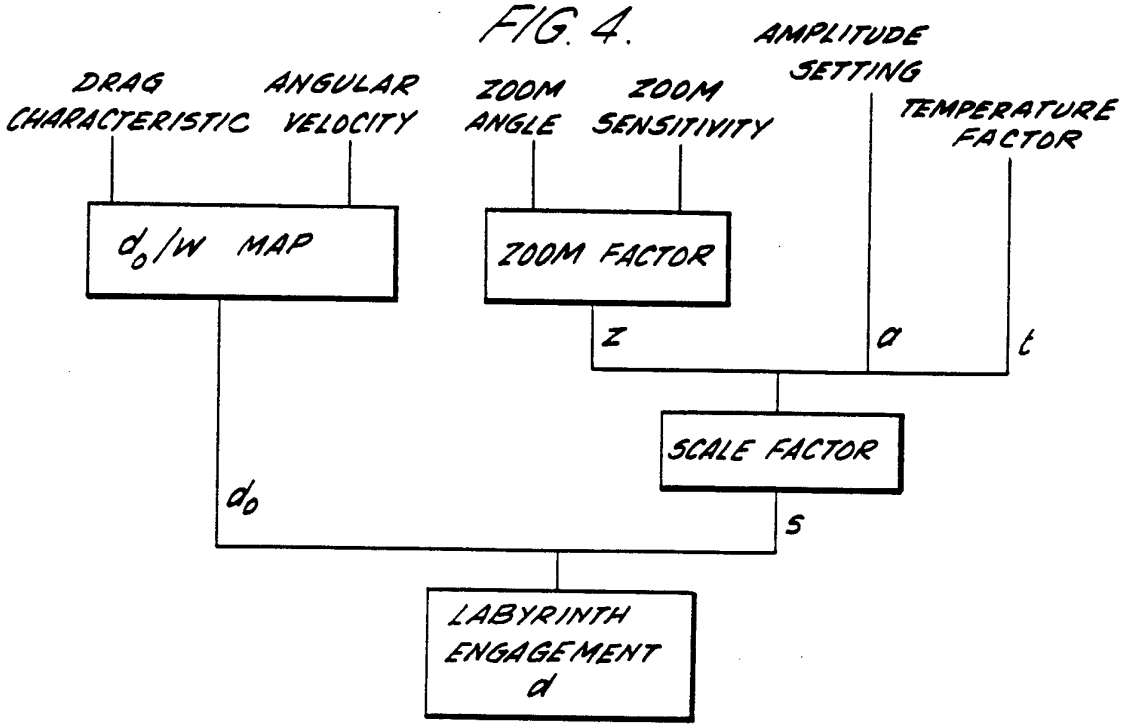
a/ WITHOUT TORQUE SENSOR

FIG. 3.



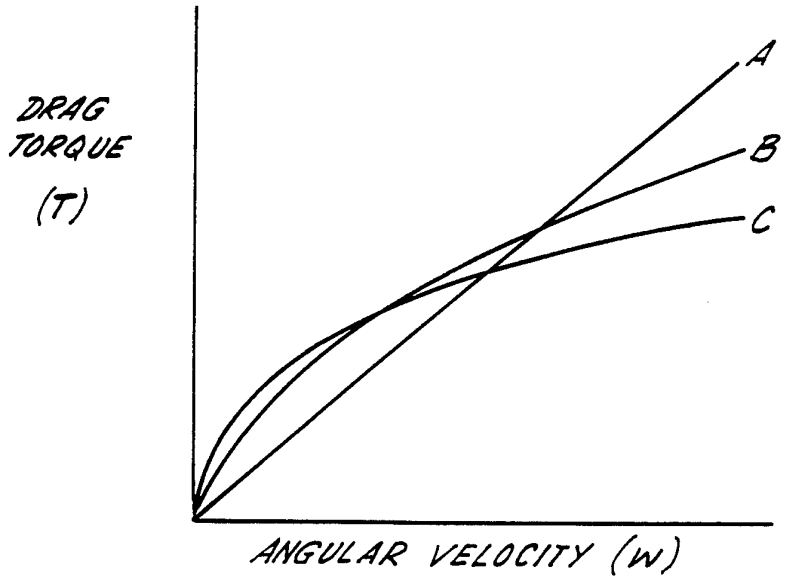
NOMINAL LABYRINTH ENGAGEMENT FOR ALTERNATIVE DRAG CHARACTERISTICS (CORRECTED FOR TORQUE/ENGAGEMENT RELATIONSHIP)

FIG. 4.

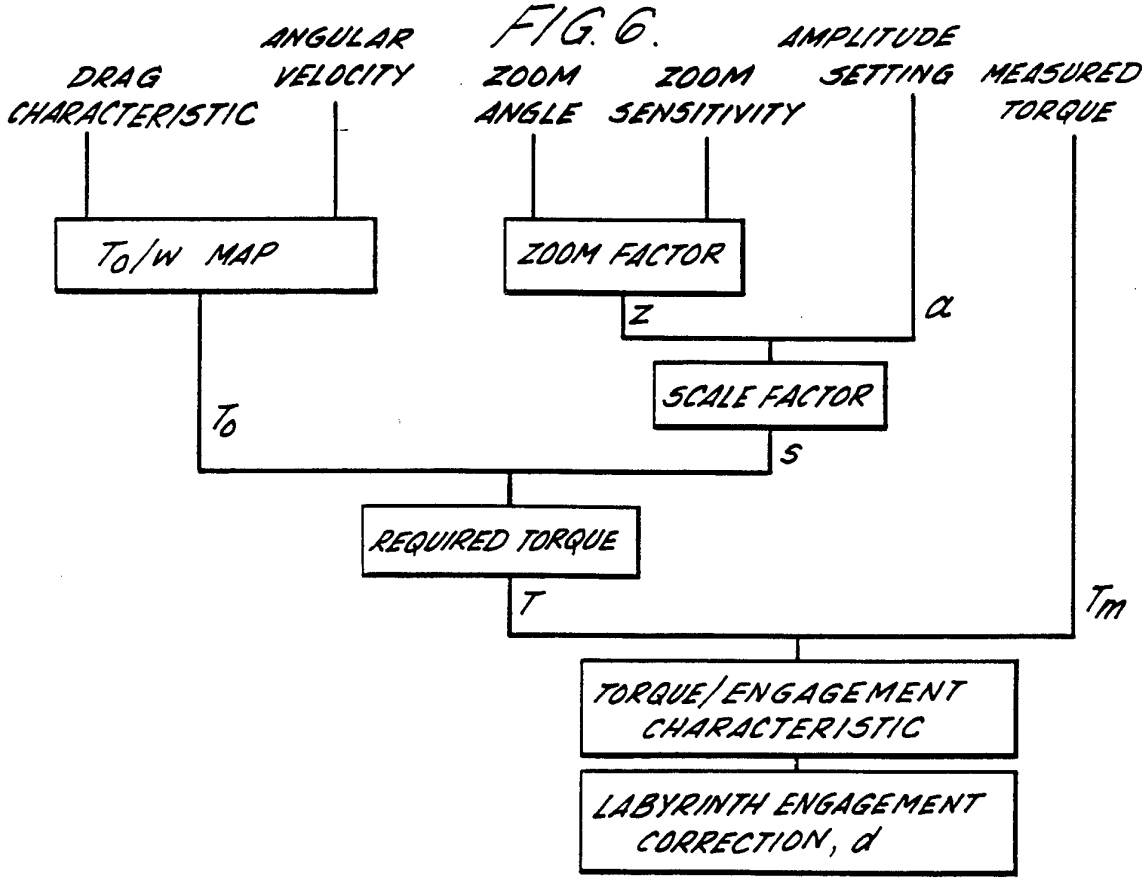


LABYRINTH ENGAGEMENT, $d = d_0, s$ WHERE $s = f(z,a,t)$

b/ WITH TORQUE SENSOR FIG. 5.



ALTERNATIVE NOMINAL DRAG CHARACTERISTICS FIG. 6.



INTERNATIONAL SEARCH REPORT

Interna Application No PCT/GB 94/02251

A. CLASSIFICATION OF SUBJECT MATTER

F 16 M 11/12,F 16 F 15/10

According to International Patent Classification (IPC) or to both national classification and IPC 6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F 16 M,F 16 F,G 03 B,H 04 N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, A, 1 937 011 (RONFORD LTD.) 29 January 1970 (29.01.70), the whole document. --	1
A	US, A, 4 955 568 (O'CONNOR et al.) 11 September 1990 (11.09.90), the whole document. --	1
A	DE, A, 3 629 866 (FILMTECHNISCHE GERÄTE OSKAR HEILER) 10 March 1988 (10.03.88), fig. 1,2; abstract. ----	1

☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 December 1994	

Name and mailing address of the ISA	Authorized officer
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ANHANG

zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.

ANNEX

to the International Search Report to the International Patent Application No.

ANNEXE

au rapport de recherche international relatif à la demande de brevet international n°

PCT/GB 94/02251 SAE 97748

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben. Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

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