(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 243 686 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.09.2002 Bulletin 2002/39

(51) Int Cl.[7]: **D06F 37/22**, D06F 39/00

(21) Application number: **02004731.2**

(22) Date of filing: **01.03.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **05.03.2001 IT PN010021**

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(54) Control device for oscillations of tub-drum assembly for household washing machines

(57) Arrangement for controlling the oscillations of the suspended tub-drum assembly of clothes washing machines for both home and professional use, in which said clothes washing machines comprise lower vibration damping struts of said suspended tub-drum assembly (12, 13), which are comprised of a hollow casing (17) and a rod (18) arranged slidably within said hollow casing (17).

The arrangement comprises control means (21) associated with mechanical braking means (40, 47) co-operating with said rod (18) and said hollow casing (17) in such a manner as to selectively determine a controlled braking of the sliding motion of the rod (18) based either on the detection of the oscillations of the suspended tub-drum assembly (12, 13) by a sensor (20) or the measurement of the weight of the washload and washing liquor in the machine through the detection of the vertical displacements of the tub (12) by said sensor (20).

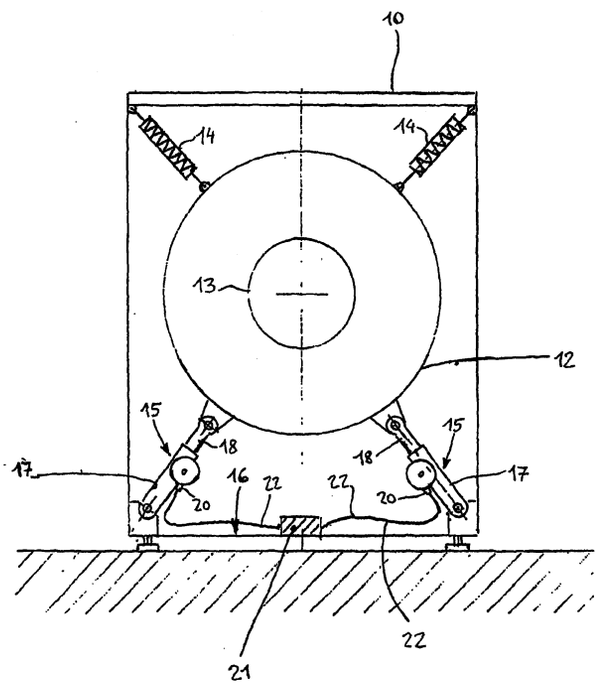

FIG.1

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Description

[0001] The present invention refers to an arrangement for controlling the oscillations of the suspended tub-drum assembly of clothes washing machines for both home and professional use, that is adapted to detect the oscillations of said suspended assembly in view of both effectively dampen said oscillations of said assembly, when the drum thereof is driven to rotate at high spin-extraction revolution speeds, and controlling the manner in which certain particular operational functions of the machine are carried out in accordance with the extent or amplitude of the detected oscillations.

[0002] Vibration-damping arrangements of various kinds are known in the art, which are currently used as damper means to deaden the oscillations of the suspended tub-drum assembly, which are typically induced in clothes washing machines when the washload-holding drum is driven to rotate at the high spin-extraction speeds thereof, in which said damper means are generally connected between the lower or bottom portion of each suspended tub-drum assembly and the bottom portion of the outer casing of the respective washing machine, and in which said damper means are generally constituted by an internally hollow cylinder and a cylindrical rod provided with friction surfaces of a suitable material and capable of alternately sliding within such inner cavity of said cylinder during the oscillatory displacements of said suspended assembly, as brought about by said drum rotating at its various washing and spin-extraction speeds, in such a manner as to give rise to braking actions aimed at dampening such oscillations.

[0003] Damper means of this kind are suitable for use in conjunction with clothes washing machines capable of spin-extracting at relatively high revolution speeds of the drum (i.e. up to approx. 900 rpm), but are rather critical if considered for use in conjunction with the washing machines that are currently manufactured with higher spin-extraction speed capabilities in view of improving the subsequent clothes drying process, owing to the fact that, under these conditions, it turns out as particularly difficult to be capable of effectively dampening the oscillations of the suspended tub-drum assembly through most intense braking actions.

[0004] It therefore is a main purpose of the present invention to provide an arrangement for controlling the oscillations of the suspended tub-drum assembly of clothes washing machines featuring such characteristics as to effectively do away with the drawbacks and the limitations of current-type shock-absorbers and oscillation-dampers, while ensuring an effective and reliable damping effect on the same oscillations at any rotating speed of the washload-holding drum and, in particular, at extremely high spin-extraction speeds of said drum, and at the same time controlling the manner in which certain operational functions of the machine are carried out in accordance with the extent or amplitude of the oscillations being detected.

[0005] According to the present invention, this aim is reached in an oscillation control arrangement having substantially the characteristics as recited in the appended claims.

[0006] Anyway, features and advantages of the present invention will be more readily understood from the description that is given below by way of nonlimiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematic front view of a clothes washing machine provided with a pair of vibration-damping struts associated to the control arrangement according to the present invention;
- Figure 2 is a front cross-sectional view of one of the vibration-damping struts shown in Figure 1;
- Figure 3 is a plan cross-sectional view of the vibration-damping strut shown in Figure 2;
- Figure 4 is a front view of a component part of the vibration-damping strut according to the present invention, as sectioned along the A-A line of Figure 3 and displaced into a first operating position thereof;
- Figure 5 is a front view of the same component part shown in Figure 4, as displaced into a second operating position thereof;
- Figure 6 is a side view of the component part shown in Figures 4 and 5, as sectioned along the B-B line.

[0007] Figure 1 is shown to schematically illustrate a clothes washing machine 10, which may be of the type for both home and professional use, comprising an outer cabinet 11 resting with its bottom portion on the floor, in which there is suspended assembly formed by an outer washing tub 12 and a washload-holding drum 13 housed inside said tub, wherein said assembly is suspended in the machine by means of upper suspension springs 14 attached between the upper portion of the casing 11 and the tub 12, and lower vibration-damping or shock-absorber struts 15 provided between said tub and the bottom portion 16 of the outer casing of the machine, in which each one of said vibration-damping strut is formed by an internally hollow casing 17 and a rod 18 capable of alternately sliding within the internal cavity 19 of said hollow casing, wherein the two free ends of said hollow casing and said rod are pivotally joined with the bottom portion 16 of the outer casing of the machine and the bottom portion of the tub 12, respectively.

[0008] The clothes washing machine further comprises a control arrangement according to the present invention, which is intended for dampening, in conjunction with the vibration-damping struts 15, the oscillations of the suspended tub-drum assembly that are generated

during the rotation of the washload-holding drum at the different washing and spin-extraction speeds, in which said control arrangement is substantially constituted by the vibration-damping struts themselves, as conformed in the manner that shall be described in greater detail further on, and at least a sensor 20 adapted to detect the out-of-balance conditions of the suspended tub-drum assembly, and associated to at least one of said vibration-damping struts, as well as an electronic control unit 21 applied preferably against the base or bottom 16 of the outer casing of the machine, in which said sensor and said electronic control unit are connected with each other via electric conductor leads 22 and are arranged so as to be capable of interacting with each other in the manner that shall be more closely described further on.

[0009] Figures 2 and 3 are at this point shown to illustrate one of said vibration-damping struts 15 (two such struts, in this case), the internally hollow casing 17 of which is shaped so as to feature a rectilinear and elongated box-like portion 23, delimiting the internal cavity 19 in which said rod 18 is capable of sliding alternately, and a circular box-like portion 24 joined laterally to said elongated box-like portion 23, and featuring smaller dimensions than the latter, which delimits a corresponding internal cavity 25 intended to accommodate the component parts that will be described below.

[0010] Such an elongated box-like portion 23 is provided with an open end portion 26, enabling the sliding rod 18 to be inserted in the internal cavity 19, and a closed end portion 27 showing a tapered shape and provided with a transversal through-hole 28 for admitting the passage of a corresponding pivotally hinging pin 29 (see Figure 1) for the attachment of said casing 17 on to corresponding support plates 30 secured to the bottom portion 16 of the outer casing of the machine.

[0011] The sliding rod 18 is made out of a single piece 31 of a rectilinear, elongated box-like form, slidably adaptable to the internal cavity 19 of said elongated box-like portion 23 of the strut, in which said rod is further provided with side recesses 32 extending along almost the entire longitudinal extension thereof, as well as a front plane surface 33 and an opposite rear surface 34 provided with a rack portion 35, in which said plane surface 33 is arranged to co-operate with a friction shoe 36 of a suitable anti-friction material, secured against the opposite inner surface of the elongated box-like portion 23 and acting as an element adapted to prevent the surfaces of this elongated box-like portion and the rod from wearing down during the alternate siding motion of the rod.

[0012] The rack portion 35 extends in turn almost over the whole length of the rod 18 and is provided in order to determine the transmission of the movement, with the component parts that will be described further on, during the longitudinal alternating sliding motion of the same rod within said elongated box-like portion 23.

[0013] In particular, the toothing 37 of said rack portion 35 is advantageously made to a bi-helical type of conformation, i.e. with two longitudinal half-serrations 38 and 39 inclined in symmetrically opposed directions with respect to each other, so as to determine in this way a low-noise motion transmission under conditions of an enhanced mechanical strength.

[0014] Furthermore, the circular box-like portion 24 is provided with a corresponding circular cap, or bell 40, which has a slightly smaller size than the circular portion 24 itself and is housed inside the latter, wherein said circular bell is conformed with a plane rear wall 41 and a frontally open peripheral wall 42 joining with said rear wall 41, and is rotatably supported by a pin 43 firmly joined therewith and inserted with its end portions in corresponding seats or receptacles 44 and 45 provided in the hollow casing 17, in which a pinion gear 46 is furthermore shrink-fitted on to said pin in a position lying between the end portions thereof, wherein said pinion gear is provided with a toothing that is similar to the one of the rack portion 35, i.e. a bi-helical toothing in this case, to be in this way capable of meshing with the toothing of said rack portion 35.

[0015] In this manner, thanks to the corresponding toothings of the rack portion 35 and the pinion gear 46 meshing with each other, the alternating sliding displacement of the rod 18 determines the rotation of the circular bell 40 in either one or the other of the directions of rotation thereof.

[0016] Again, within said bell there are housed two crescent-shaped braking shoes 47 (see Figures 4 to 6) identical to each other and arranged in a symmetrical position with respect to each other, in which said braking shoes are provided with respective end portions 48 that are pivotally hinged on to said circular box-like portion 24 by means of corresponding pins 49, as well as respective other free end portions 50 arranged opposite to and spaced from each other, between which there are interposed two mutually independent movable cores, i. e. slugs 51 of an electromagnet 52. Each such movable core 51 is provided with a head 53, which is facing the opposite end portion 50 of the related braking shoe, and is permanently biased by at least a central spring 54, which is housed in corresponding cavities 55 of said movable cores 51, to compress the related head against the opposite end portion of braking shoe. These braking shoes, furthermore, are held in position by means of at least a spring 56, the end portions of which are linked up in proximity of the corresponding pivotally hinged end portions 48 of the same braking shoes, wherein such a spring keeps said braking shoes biased towards each other with a less intensive action than that of said central spring 54.

[0017] Finally, the braking shoes are shaped so as to feature a corresponding circular outer surface 57 facing the opposite circular inner surface 58 of the bell 40, slightly spaced from the latter, wherein in said surface there is provided a respective seat 50 for housing a friction shoe 60 made of a suitable anti-friction material, and adapted to come into contact with the related inner sur-

face 58, thereby determining a braking action adapted to dampen or even stopping the rotation of the bell 40.

[0018] The electromagnet 52 is in turn connected via appropriate electric leads (not shown) to both the power supply and the electronic control unit 21, and this electromagnet is energized by said electronic control unit 21 so as to switch over from one to the other of its energized and de-energized conditions, with an on-off type of command, i.e. by abruptly switching the power supply of the electromagnet on and off, or a gradual type of command, i.e. by gradually varying the intensity of the current flowing across said electromagnet.

[0019] Furthermore, this electromagnet 52 acts on the movable cores 51 in such a manner that, when it is de-energized, said movable cores remain free and are therefore compressed by the central spring 54 with the heads 53 thereof against the related free end portion 50 of the corresponding braking shoe (see operating position illustrated in Figure 4), under resulting compression of the friction shoes 60 against the inner surface 58 of the bell 40, which is in this way braked, and when said electromagnet is on the contrary energized (see operating position illustrated in Figure 5), said movable cores are attracted towards each other, against the action of said central spring 54, while the braking shoe are no longer compressed by said movable cores and therefore, owing to them not being pushed by said internal spring 54 any longer, are biased by the action of the other spring 56 into displacing towards each other, into a position in which the friction shoes 60 are moved apart from the inner surface 58 of the bell 40, with the result that the latter is capable of rotating freely.

[0020] In this way, the vibration-damping strut made in the above-described manner is capable of bringing about a braking action (due to the compression of the friction shoes 60 against the bell 40) that enables the oscillations of the suspended tub-drum assembly of the machine to be effectively and quickly dampened even in the presence of the quite high mechanical loads that are produced when the drum is driven to rotate at extremely high spin-extraction revolution speeds or in the critical intermediate phases thereof.

[0021] In addition, this braking action is brought about in a most reliable, certain manner even in the case of possible accidental failures of the power supply to the washing machine, thanks to the circumstance that the electromagnet remains actually de-energized in this operating condition.

[0022] Finally, the fact should to be duly mentioned that the sensor 20 is used to detect the intensity, i.e. extent of the mechanical oscillations and the out-of-balance condition of the suspended tub-drum assembly of the machine, and is adapted to generate corresponding electric signal in response thereto, which are sent to the electronic control unit 21 that is in turn adapted to process these electric signals and convert them into electric voltages of a correspondingly variable intensity, which are ultimately applied to the electromagnet 52 that is in this way enabled to bring about corresponding braking actions performed on the vibration-damping strut according to the same operating principles as described above.

[0023] In this connection, the electronic sensor 20, which may be of a traditional kind (eg. an optical reader), is inserted through the circular box-like portion 24 in such a manner that its sensitive portion 61 is facing the opposite surface of the peripheral wall 42 of the circular bell 40, from which it is slightly spaced, wherein various dents or reference marks 62 applied in an indelible manner and distributed in a circular pattern all along the same surface, in such positions as to enable them to selectively come to coincide with the sensor 20 during the rotation of the bell 40. These dents or reference marks 62 are applied on to the rotating bell 40 spaced at appropriate intervals from each other and in such a number as to enable any rotation of the bell 40, however slight it may also be, and therefore the corresponding displacement of the rod 18, as determined by the vibrations and oscillations of the suspended tub-drum assembly during washing and spin-extraction phases, to be detected with the utmost accuracy.

[0024] This sensor also allows for the measurement of the vertical displacement of the suspended tub-drum assembly from its raised position, in the condition in which the drum is empty and the tub has not been filled with washing liquor, to its lowered position, in the condition in which the clothes to be washed have been loaded into the drum and the tub has been duly filled with washing liquor, thereby measuring the actual amount of clothes and washing liquor introduced in the dram and the tub, respectively. In this case, in order to perform such a measurement, the electronic control unit 21 is properly set to energize the electromagnet 62 at the beginning of a washing cycle, both before and after the introduction of the clothes in the drum and the washing liquor in the tub, thereby creating the condition in which there is no braking action exerted by7 the braking shoes 47 on the bell 40, so that said bell is capable of rotating freely thanks to the pushing action exerted by the rod 18 within the hollow casing 17 owing to the progressive lowering of the tub under the weight of the clothes and the washing liquor, thereby enabling the sensor 20 to read off the dents or reference marks 62 before and after such a loading of the machine, and the electronic control unit 21 to detect the actual amount of washload introduced in the tub.

[0025] Then, as soon as such a detection is completed, the electronic control unit 21 causes the electromagnet 52 to be de-energized, so that the vibration-damping strut is able to perform its breaking, i.e. oscillation deadening action throughout the remaining part of the washing cycle.

In this manner, the electric signals generated by the sensor 20, which are proportional to the amplitude of the rotation of the bell 40, and therefore to the vertical displacements, vibrations and oscillations of the tub-

drum assembly, or to the vertical displacements of the tub, are received by the electronic control unit 21 which checks up the levels of these signals and compares them with the levels of reference signals that will have been previously stored in a coded form in the same electronic control unit and correspond to the various parameters relating to the desired or allowed pattern of oscillations and vibratory displacements of the suspended tub-drum assembly, or the vertical displacements of the tub, so as to be able to trigger, in accordance with the outcome of such a comparison, the desired braking action for damping such oscillations and displacements, by activating the braking operation of the vibration-damping struts in the afore described manner, or the measurement of the amount of washload introduced in the tub.

[0026] In the latter case, it is possible for following operational functions to be in this way controlled:

- weighing of the amount of clothes introduced for washing;
- weighing of the amount of washing liquor filled;
- control of the amount of washing liquor being let out each time, with the resulting possibility for additional amounts of washing liquor to be filled in correspondingly,
- control of the degree of drynem of the clothes after spin-extraction;
- control of possible leaks and losses of washing liquor (anti-flooding safety provision).

Claims

1. Arrangement for controlling the oscillations of the suspended tub-drum assembly of clothes washing machines, of both home and professional type, with a drum driven to rotate at high spinning speeds, comprising an outer cabinet sustaining said suspended tub-drum assembly by means of upper suspension springs and lower vibration-damping struts, which are arranged between said tub and the bottom portion of said outer cabinet and are constituted by at least a respective internally hollow casing and at least a respective rod capable of sliding alternately within said hollow casing, and further comprising sensor means of a per se known kind and control means associated with said sensor means for detecting the oscillations of said suspended tub-drum assembly when said drum is driven to rotate at the various washing and spin-extraction revolution speeds thereof, as well as the vertical displacements of said tub as caused by the clothes loaded into the drum and the washing liquor filled into the tub, **characterized in that** said control means (21) are associated with mechanical braking means (40, 47) cooperating with said rod (18) and said hollow casing (17), and adapted to determine a controlled braking action on the sliding motion of said rod (18) within said hollow casing (17), in which said control means (21) are adapted to selectively determine such a controlled braking action, or the measurement of the amount of clothes introduced in the drum and washing liquor filled into the tub, through the detection by said sensor means (20) of the intensity of the oscillations of said suspended tub-drum assembly or said vertical displacements of the tub, respectively.

2. Control arrangement according to claim 1, **characterized in that** said mechanical braking means comprise at least a rotating circular bell (40) housed in and pivotally hinged on to a corresponding circular box-like portion (24) of said hollow casing (17), at the side of an elongated rectilinear box-like portion (23) that is also formed in said hollow casing (17), in which said rod (18) is capable of sliding, said rotating bell (40) being rotatably actuated in wither one or the other of the directions of rotation thereof during the alternate sliding motion of said rod (18) via motion transmission means (35, 46), and **in that** said mechanical braking means further comprise braking shoes (47) housed in and pivotally hinged on to said hollow casing (17), and cooperating with said bell (40) and actuation means (51, 52) that are operatively linked with said control means (21) and actuatable in such a manner as to displace said braking shoes (47) from a working position thereof, in which they are pressed against said bell (40), thereby determining said braking action, to the resting position thereof, in which they are moved apart from said bell (40) and do not determine any braking action any longer.

3. Control arrangement according to claim 2, **characterized in that** said motion transmission means comprise a rack portion (35) provided on said rod (18) and extending almost along the full length thereof, and a pinion gear (46) shrink-fitted within said bell (40) and firmly joined thereto, as well as adapted to mesh with said rack portion (35).

4. Control arrangement according to claim 3, **characterized in that** said rack portion (35) is provided with a toothing (37) of a bi-helical type, i.e. with two longitudinal half serrations (38, 39) inclined in symmetrically opposed directions with respect to each other.

5. Control arrangement according to claim 2, **characterized in that** said braking shoes (47) are made each to a crescent-shaped configuration, are iden-

tical to each other and arranged in a symmetrical position with respect to each other, so that their respective outer circular surface (57) faces the opposite inner circular surface (58) of the bell (40) and features a respective seat (50) for housing at least a friction shoe (60) made of a suitable anti-friction material and adapted to be pressed against said inner circular surface (58), in which said braldng shoes (47) are pivotally hinged on to said hollow casing (17) with respective first end portions (48) thereof, connected with each other via at least a first spring (56), and are further provided with other free end portions (60), opposing and spaced from each other, co-operating with said actuation means (51, 52).

6. Control arrangement according to claim 5, **characterized in that** said actuation means comprise a pair of mutually independent movable cores (51) and at least an electrically powered electromagnet (52) actuating said movable cores (51) and connected with said control means (21), in which said movable cores (51) are provided each with a head (53) of its own facing the opposite free end portion (50) of the related braking shoe (47) and brought into contact against the same free end portion by the pushing action exerted by at least a further spring (54) that is housed in corresponding cavities (55) in said movable cores (51) and adapted to produce a more intense action than said first spring (56), and in which said electromagnet (52) is driven by said control means (51) to either abruptly or progressively switch over from a de-energized state position, in which said movable cores (51) are in a free state and can therefore be pressed by said further spring (54) against said braking shoes (47), thereby pushing them into the working position thereof, to an energized-state position, in which said movable cores (51) are on the contrary attracted towards each other, against the action of said further spring (54), thereby causing said braking shoes (47) to regain the resting position thereof, and vice-versa.

7. Control arrangement according to claim 6, **characterized in that** said sensor means (20) comprise at least a sensor of a traditional type, such as for instance an optical reader, inserted through said circular box-like portion (24) in such a manner that its sensitive portion (61) is facing the opposite surface of the peripheral wall (42) of said circular bell (40), from which it is slightly spaced, in which surface there are provided various dents or reference marks (62) distributed in a circular pattern externally on said bell (40), and corresponding to the oscillations or the vertical displacements of said suspended tub-drum assembly (12, 13), in such a manner as to enable them to selectively come to coincide with said sensor (20) and electric response signals to be in this way generated that are proportional to the intensity of said oscillations or vertical displacements.

8. Control arrangement according to claim 7, **characterized in that** said control means comprise an electronic control unit (21) adapted to convert said electric response signals generated by said sensor (20) into electric voltage signals of a correspondingly varying intensity, that are then applied to said electromagnet (52), and to compare the levels of such signals with the levels of reference signals previously stored in a coded form in the same electronic control unit, and corresponding to pie-determined oscillations or vertical displacements, so as to drive, in accordance with the outcome of such a comparison, said electromagnet (62) into the de-energized state position thereof, in view of bringing about said braking action, or into the energized-state position thereof at the beginning of each washing cycle, both before and after the introduction of the clothes to be washed and the washing liquor in the machine, so as to perform said measurement of the amount of clothes loaded into the drum and washing liquor filled into the tub.

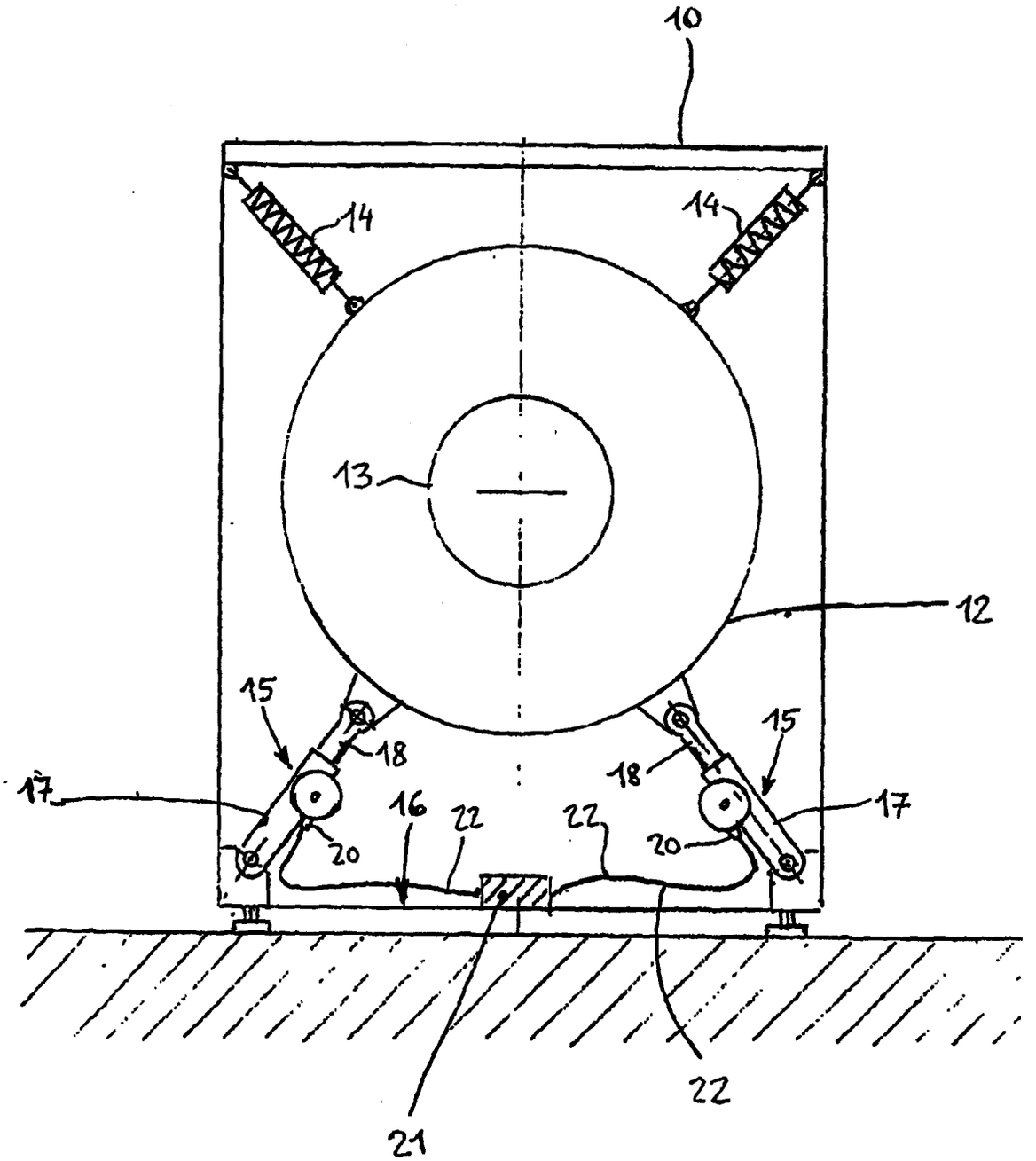

FIG.1

FIG. 3

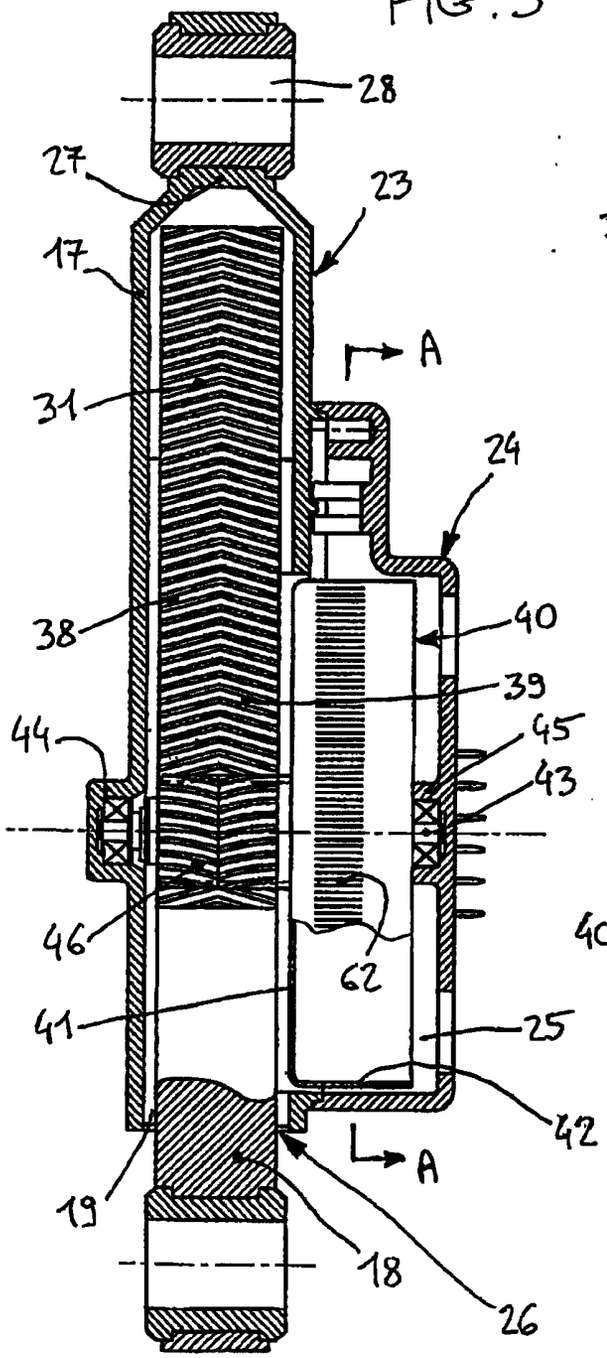
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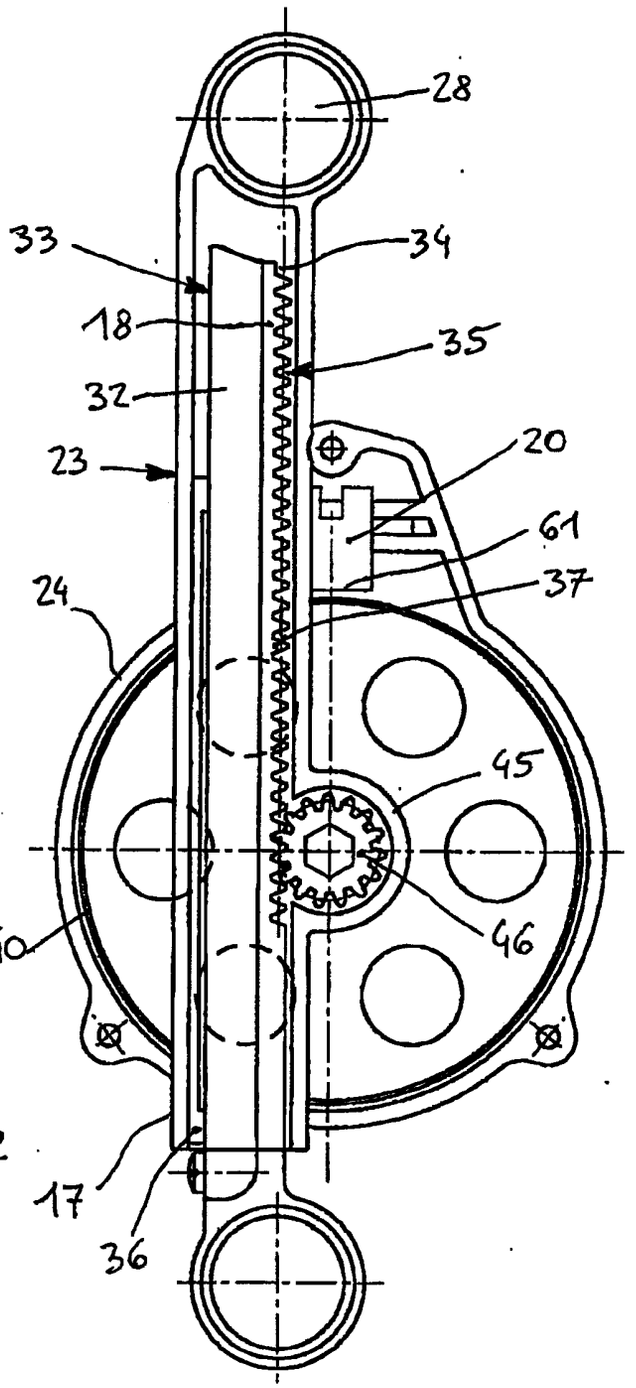
FIG. 2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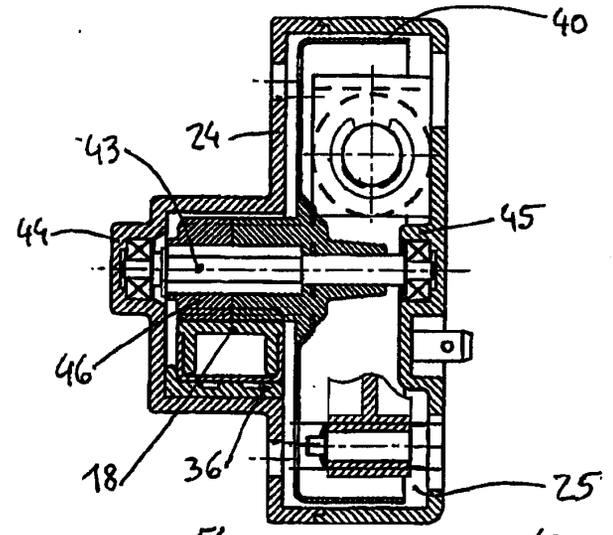

FIG. 6

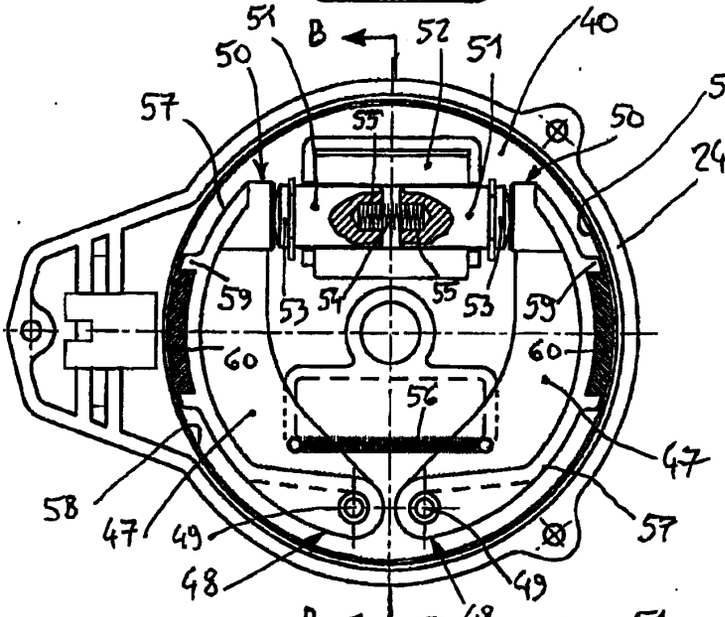

FIG. 4

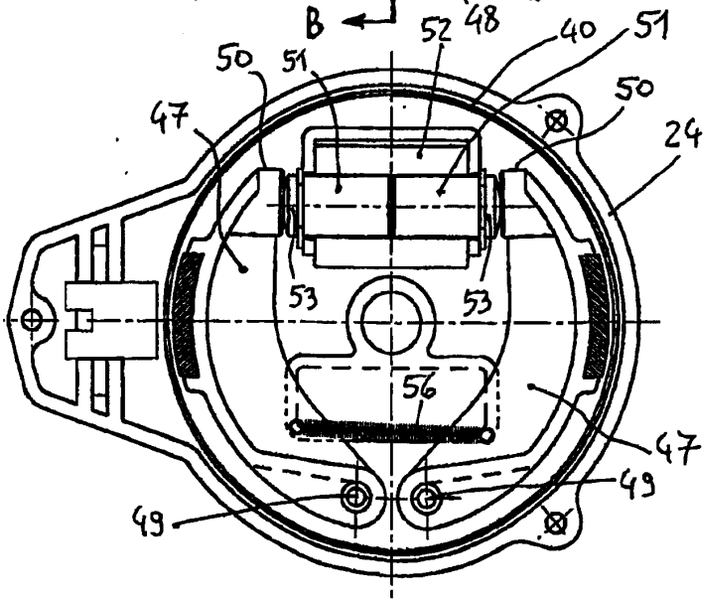

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 00 4731

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	EP 0 965 675 A (R & D S SRL) 22 December 1999 (1999-12-22) * column 3, line 31 - column 4, line 7 * * column 7, line 27 - column 8, line 24 * * figures 1-13 *	1 2-4	D06F37/22 D06F39/00
Y	EP 0 984 092 A (MIELE & CIE) 8 March 2000 (2000-03-08) * column 2, line 17 - line 57; figure 1 *	2-4	
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

D06F
F16F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	24 July 2002	Weinberg, E

CATEGORY OF CITED DOCUMENTS

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