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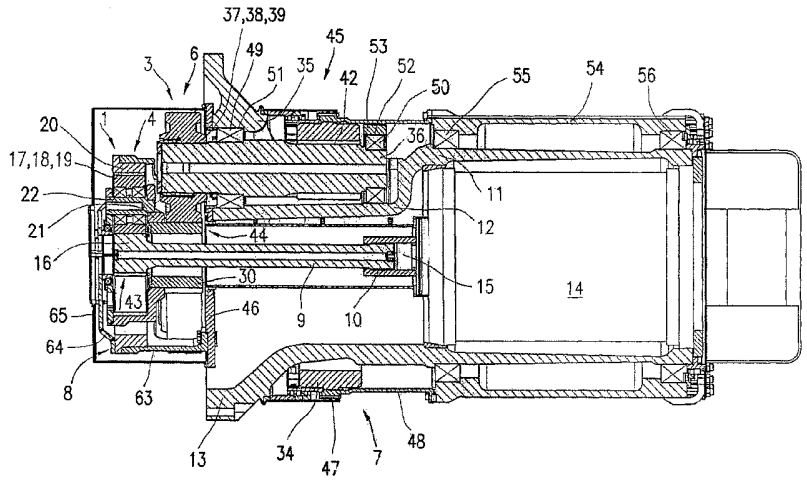
(54) **Title:** BUILT-IN PLANETARY DRIVE



(57) **Abstract:** Built-in planetary drive, joined as planetary gearings (1,3), aligned one behind the other, is solved into drums spces, each of which is formed of one two gear reductions (4,6,7). These are joined by the satellite carrier (21) or the ring gear (20) and joined to sun gear (30) of following planetary gearing. Sun gear (16) on driving shaft (9) is led by satellites (17,18,19), sun gear (30) is freely seated amoung double satellites (37,38,39). Together with led ring gear (34) of last gear reduction (7), differential mechanism (43,44,45) is formed for power distribution to individual satellites (17,18,19,37,38,39). Basic immobile supporting frame for the planetary drive is formed of hollow body (11) with built-in motor (14) and contracted section (12) and joining flange (13). To body (11), gear box (8) is joined frontally with overhung location of greater gears of satellites (37,38,39) of last planetary gearing (3) and with reached planetary gearing (1). Last gear reduction (7) is built into the space between outer circumference of contracted section (12) of body (11) and inside circumference of hub sleeve (48) which is driven by the ring gear (34) by coupling teeth (47).

WO 2005/057047 A1

BUILT-IN PLANETARY DRIVE

Technical Field

The invention relates to built-in planetary drive assembled of joined planetary gearings aligned one behind the other, with gears with differential mechanism that are joined to the motor shaft, said planetary gearings being solved as gearings built into limited spaces of drums, hubs, electro-drums etc. of various machinery equipments.

Background of the Invention

Until now, the transmission gearings, assembled of spur or planetary gearings or of the combination thereof, are being used for traction drives of industrial machines.

Taking into consideration the need of constructional building the gearing into the drum hub space, these transmission devices are being solved generally only for the small number of gear reductions, arranged one behind the other, only with simple satellites if necessary. The disadvantage of such realizations is based in achieving the lower gear ratio only due to which more robust driving motors must be used.

Some structures of planetary gearings, aligned one behind the other, do not use differential mechanism at all or less effective realization only due to which the transmitted power to individual satellites is not distributed uniformly.

With this the question of the number of satellites is connected. The number of three satellites can be justified which is omitted the arrangements in some cases.

The general conceptions of transmission gear space arrangement as well as supporting frame structure of some built-in drives enable only low power transmission and to achieve only lower gear ratio values.

Summary of the Invention

The above mentioned disadvantages are eliminated by the built-in planetary drive, formed exemplarily of three planetary gearings, aligned one behind the other, with the differential mechanism assembled of four gear reductions in order to achieve higher gear ratio where following planetary gearing is arranged of the same number of gear reductions or of one higher number thereof.

The satellite carrier or the ring gear of the first planetary gearing is joined to the sun gear of the next planetary gearing. The sun gear of the first planetary gearing with the driving shaft, fitted with the gear coupling, is led by satellites and the sun gears of the following planetary

gearings are freely seated and ring gear of last planetary gearing is led by means of coupling teeth. In this way the differential mechanisms are formed for uniform distribution of the supplied power to individual satellites.

The sun gear with the driving shaft of the first planetary gearing is placed in the contracted section of the hollow body constructing the basic immobile supporting frame of the planetary drive with the built-in motor.

The gearbox with overhung larger gears of double satellites and with reached one gear reduction at least is joined to the body face.

The double satellites pinion gears and the ring gear of the last gear reduction are built into the space between the outer circumference of the contracted section of the body and the inside diameter of the sleeve hub which is driven by coupling teeth of the ring gear.

Satellite pins are located by means of satellite bearings in bearing bores of the joining flange face into which the body is extended and in bearing bores of the radially shaped body which are provided with closing clips of the satellite bearings.

The hub sleeve is strongly joined to the hub which is located by means of the hub bearings on the outer body circumference.

In one of further realizations the first planetary gearing with simple satellites is placed into the contracted section of the hollow body between the second and third gear reductions of the last planetary gearing or behind the last gear reduction which is nearer to the motor.

Survey of Figures on Drawings

Realization of the built-in planetary gearing according to the technical solution is presented as non-limiting examples at the attached Figs 1 to 5 in the axial section.

In the Fig. 1 the project realization is given with two planetary gearings.

The Fig. 2 presents the kinematical scheme of the assembly of the Fig. 1 where the "replacement of mechanism" is applied.

In the Fig. 3 the realization with two planetary gearings with double satellites is displayed in the kinematical scheme.

In the Fig. 4 the kinematical realization with three planetary gearings i.e. with four gear reductions is presented.

The Fig. 5 presents the project scheme from the Fig. 1 where the first planetary gearing is placed into the contracted section of the hollow body.

Examples on the Realization of the Invention

In the Fig. 1 the built-in planetary drive with two planetary gearings 1, 3 is elaborated as the project, i.e. in three gear reductions 4, 6, 7.

In the first planetary gearing 1, simple satellites 17, 18, 19 have been used. The second planetary gearing 3 is formed by two gear reductions 6, 7 with double satellites 37, 38, 39, i.e. in epicycloid and hypocycloid realization of gears which is briefly named as epi- hypo. This means that the gear reduction 6 is realized in permanent meshing of the sun gear 30 and the larger of the gears of the double satellites 37, 38, 39 with external teeth and in the gear reduction 7 there is the pinion gear 42 with smaller external teeth of the double satellites 37, 38, 39 in permanent mesh with the ring gear 34 having internal teeth.

The first planetary gearing 1 is realized with the rotating satellite carrier 21 and with the fixed ring gear 20, the second planetary gearing 3 is realized as the pseudoplanetary one with fixed satellite carrier 35 and the rotating ring gear 34. The first planetary gearing 1 is formed by the sun gear 16 with the longer, torsional elastic driving shaft 9 located at the side of the motor 14 in the gear coupling 10 passing over the hollow body 11 where the sun gear 16 is in permanent mesh with simple satellites 17, 18, 19 and these ones with the ring gear 20.

The satellites 17, 18, 19 can be used only in the number of three as based on theoretical analysis of force conditions.

The differential mechanism 43, 44, 45 serves to achieve uniform distribution and dividing of transmitted power to the individual satellites 17, 18, 19 and 37, 38, 39 of the planetary gearings 1 and 3. In the first gear reduction 4 the led sun gear 16 by the satellites 17, 18, 19 on the satellite pins 22, i.e. at connecting this sun gear 16 with the driving shaft 9 fitted with the gear coupling 10 in doubled realization for joining to the motor shaft 15.

The satellite carrier 21 of the first gear reduction 4 is joined to the sun gear 30 freely seated among the satellites 37, 38, 39 of the second planetary gearing 3.

Later, the ring gear 34, led by the smaller gears of the double satellites 37, 38, 39 of the last gear reduction 7, is joined to the hub sleeve 48 by means of the coupling teeth 47.

In this way the differential mechanism 43, 44 and 45 of this built-in planetary drive realization is formed.

The hollow body 11 forms the basic immobile supporting frame for the whole built-in planetary drive with the built-in motor 14 and said hollow body is shaped to the contracted section 12 which is extended in the joining flange 13. At the front face of this body 11 and its joining flange 13 the gear box 8 is joined.

Into the gearbox 8, the overhung location is placed of the greater gears of the double satellites 37, 38, 39 located on the satellite pins 36, on pinion gears 42 if need be, in the satellite bearings 49 of the planetary gearing 3, i.e. in the bearing bores 51 of the front joining flange 13 and in the bearing bores 52 of the radially formed body 11, said bores being fitted with closing clips 53 of the satellite bearings 50. Further, into the gear box 8, the planetary gearing 1 is placed which is joined, by means of the satellite carrier 21, to the freely located sun gear 30 of the second planetary gearing 3 and here the sun gear 30 is in permanent meshing with three satellites 37, 38, 39.

Itself the gear box 8 is formed of the disk flange 46 to which the cylindrical detail 63 is screwed which is closed by the shaped face 64. This gear box 8 is covered as the whole by the cover 65 of the lubricating space.

The pinion gears 42 with smaller gears of the double satellites 37, 38, 39 with the meshing gear 34 of the last gear reduction 7 are built into the space between the outer circumference of the contracted section 12 of the body 11 and the inside diameter of the sleeve hub 48. By means of the coupling teeth 47 of the ring gear 34, this hub sleeve 48 is driven together with the strongly joined hub 54 which is located at the outer circumference of the body 11 by means of the hub bearings 55 and 56.

The planetary drive, formed in this way built into the drum space of the hub 54, can be solved in other variants as will be seen partially on other figures.

The Fig. 2 displays the kinematical scheme of the conception given in the Fig. 1.

The difference of the conception of the Fig. 1 is based on that for the new form of the built-in planetary drive the so called "replacement of mechanism" in the first planetary gearing 1 has been used. The satellite carrier 21 has been transformed into the immobile member which became the fixed member now, at the rotating sun gear 16, the rotating member is the ring gear 20 now.

In such a way, in the first gear reduction 4 the so called pseudoplanetary gearing with the fixed satellite carrier 21 with the power flow being distributed to individual satellites 17, 18,

19. Further, the ring gear 20 of the first gear reduction is joined to the free sun gear 30 of the second planetary gearing 3 with double satellites 37, 38, 39 of the gear reductions 6, 7.

In the Fig. 2 the application of the exploitation of the invention is demonstrated for traction drive built in drum hubs 57, 58 with rims 59, 60, 61, 62. The rotary motion passes from the driven ring gear 34 over the coupling teeth 47 to the hub sleeve 48 joined to the hub 54 and to the drum hubs 57, 58, pressed thereon, with the driven rims 59, 60, 61, 62 with rubber tires.

In the Fig. 3 the kinematical scheme of the connection of two second planetary gearings 1, 3 to the double satellites 31, 32, 33 and 37, 38, 39 is shown which form four gear reductions 4, 5, 6, 7.

The first planetary gearing 1 consists of the sun gear 16 and the ring gear 27 which are in permanent mesh with the satellites 31, 32, 33 leading the sun gear 16 joined to the driving shaft 9. The satellite carrier 21 is joined to the freed sun gear 30 of the second planetary gearing 3. The ring gear 34 of the last gear reduction 7 is led and coupled to the hub sleeve 48 by means of the coupling teeth 47.

By this the differential mechanism 43 of the first planetary gearing 1 and the differential mechanisms 44, 45 of the second planetary gearing 3 have been formed for uniform power distribution to individual satellites 31, 32, 33 and 37, 38, 39 in all gear reductions 4, 5, 6, 7.

The satellite pins 29 and 36 can be made together with gears of smaller diameters of double satellites 31, 32, 33 and 37, 38, 39 of one piece of material as the pinion gears 40 and 42.

Analogically as in the Figs 1 and 2, the supporting hollow body 11 and further details can be formed. In front of the hollow body 11, i.e. the planetary drive frame, three gear reductions 4, 5, 6 are built which occupy some greater width.

In the Fig. 4, there is the kinematical scheme for the conception of three planetary gearings 1, 2, 3 aligned one behind the other by means of which four gear reductions 4, 5, 6, 7 have been formed.

In the first and second planetary gearings 1, 2 simple satellites 17, 18, 19 and 24, 25, 26 are used and in the third planetary gearing 3 of the double satellites 37, 38, 39 are applied in epi-hypo realization as well.

The assembly of the first planetary gearing 1 with rotating sun gear 16 and the satellite carrier 21 at the fixed ring gear 20 is identical with the Fig. 1. The first planetary gearing 1 is joined by the satellite carrier 21 to the free sun gear 23 of the second planetary gearing 2 at fixed satellite carrier 28.

In this way the pseudoplanetary gearing 2 has been originated the rotating ring gear 27 of which is joined to the freed sun gear 30 of the third planetary gearing 3.

Further, as in other conceptions in the figures, the pseudoplanetary realization of the planetary gearing 3 is applied at satellite carrier 35 being fixed.

The ring gear 34 of the last gear redution 7 is led by means of the coupling teeth 47 and coupled with the hub sleeve 48.

In such way, the differential mechanism 43, 44, 45 is formed for uniform power distribution to individual satellites 17, 18, 19, 24, 25, 26 and 37, 38, 39 in all gear reductions 4, 5, 6, 7.

In this Fig. 4 the hollow body 11 is solved analogically as well which forms the basic rigid frame as it was given in the Figs 1 to 3. In front of the hollow body 11 three gear reductions 4, 5, 6 are reached.

The Fig. 5 presents the project scheme resulting from the Fig. 1.

The first planetary gearing 1 with simple satellites 17, 18, 19 is placed in the contracted section 12 of the hollow body 11 between the second and the third gear reductions 6, 7 of the last planetary gearing 3 wit double satellites 37, 38, 39. The first planetary gearing 3 remains the first aligned gear reduction 4 on the driving shaft 9 of the motor 14.

By this the width of reach for one gear reduction 6, for the gear box 8 becomes shorter and so is the driving shaft 9 length as well.

Other analogical realizations enable to situate the planetary gearing 1 in the contracted section 12 of the hollow body 11 as far as behind the last gear reduction 7 nearby the motor 14.

In such a way the width of the reach gets shorter only at one gear reduction 6 again and the width of the gear box 8 as well as the length of the driving shaft 9 decrease.

Industrial Applicability

The built-in planetary drives assembled of planetary gearings aligned one behind the other with gears and differential mechanism can be used as gearings built in spaces of drums, hubs etc. with limited dimensions for engineering devices, e.g. electro-drums with requested higher gear ratio.

The invention can be exploited in the branch with traction and mobile drives i.e. for heavy duty machines for transportation of loose materials, earth, minerals, and solid fuels etc.

PATENT CLAIMS

1. Built-in planetary drive, assembled of joined planetary gearings, aligned one behind the other with permanent meshing gears with the differential mechanism, with joining to the motor shaft and being built into the limited space, c o m p r i s i n g the built-in planetary drive contains at least three gear reductions (4, 5, 6, 7), where each planetary gearing (1, 2, 3) is formed by one or two gear reductions (4, 5, 6, 7), whereby each following planetary gearing (2, 3) is arranged of the same or one higher number of gear reductions (5, 6, 7) and one of members formed of the satellite carrier (21, 28) and of the ring gear (20, 27) of the preceding planetary gearing (1, 2) is joined to the sun gear (23, 30) of the following planetary gearing (2, 3) which is freely seated among the satellites (24, 25, 26, 37, 38, 39), the led sun gear (16) of the satellites (17, 18, 19, 31, 32, 33) with the driving shaft (9) being fitted with the gear coupling (10) of the first planetary gearing (1) joined to the motor shaft (15) and the led ring gear (34) of the last gear reduction (7) is joined to the hub sleeve (48) by means of the coupling teeth (47), due to which the differential mechanism (44, 43, 45) power distribution is formed, meanwhile the driving shaft (9) of the sun gear (16) or the first planetary gearing (1) is placed in the contracted section (12) of the hollow body (11) forming said basic immobile supporting frame of said planetary drive with inside built-in motor (14) and extended into the joining flange (13) with the frontally joined gear box (8), with said overhung located larger gears of double satellites (37, 38, 39) of the last planetary gearing (3) and with reached at least one gear reduction (6), where said smaller gears, the pinion gears (42) of double satellites (37, 38, 39) and ring gear (34) of the last planetary gearing (3) are built in space between the said outer circumference of the contracted section (12) of the body (11) and said inside diameter of the hub sleeve (48), driven by means of the coupling teeth (47) of the ring gear (34), whilst the satellite pins (36) are located in the satellite bearings (49) in the bearing bores (51) of the frontal joining flange (13) and in satellite bearings (50) in bearing bores (52) of the radial shaped body (11), provided closing clips (53) and where the hub sleeve (48) is strongly joined to the hub (54) which is located by means of the hub bearings (55, 56) on said outside circumference body (11).

2. Built-in planetary drive in the claim1, c o m p r i s i n g the sun gears (16, 23, 30) and the ring gear (20, 27, 34) are in permanent mesh with the satellites (17, 18, 19, 24, 25, 26, 31, 32, 33, 37, 38, 39) which are arranged in all planetary gearings (1, 2, 3) always in the number of three, whereby the individual gearings (1, 2, 3) are formed with the rotating

sun gear (16, 23, 30) and the satellite carrier (21, 28, 35) at the fixed ring gear (20, 27, 34) or as pseudoplanetary gearings with the rotating sun gear (16, 23, 30) and the ring gear (20, 27, 34) at the fixed satellite carrier (21, 28, 35) in realization as epi-hypo gears.

3. Built-in planetary drive in the claims 1 and 2, c o m p r i s i n g the first planetary gearing (1) with the individual satellites (17, 18, 19) forms the first gear reduction (4), the second planetary gearing (3) with the double satellites (37, 38, 39) forms the second gear reduction (6) and the third, last gear reduction (7).

4. Built-in planetary drive in the claims 1 and 2, c o m p r i s i n g the first planetary gearing (1) with the double satellites (31, 32, 33) forms the first gear reduction (4) and the second gear reduction (5), the second planetary gearing (2) with the double satellites (37, 38, 39) forms the third gear reduction (6) and the fourth, last gear reduction (7).

5. Built-in planetary drive in the claims 1 and 2, c o m p r i s i n g the first planetary gearing (1) with the simple satellites (17, 18, 19) forms the first gear reduction (4), the second planetary gearing (2) with the simple satellites (24, 25, 26) forms the second gear reduction (5) and the third planetary gearing (3) with the double satellites (37, 38, 39) forms the third gear reduction (6) and the fourth, last gear reduction (7).

6. Built-in planetary drive in the claims 1 to 3, c o m p r i s i n g the first planetary gearing (1) is formed with the differential mechanism (43) with the rotating satellite carrier (21), joined to said sun gear (30) of the second planetary gearing (3) in the pseudoplanetary realization with the fixed satellite carrier (35) with the differential mechanism (44, 45) and at the reachen gear reductions (4, 6) into the gear box (8).

7. Built-in planetary drive in the claims 1 to 3, c o m p r i s i n g the first planetary gearing (1) with the single satellites (17, 18, 19) is placed into the contracted section (12) of the hollow body (11) between the second and third gear reductions (6) and (7) of the last planetary gearing (3) or behind the last gear reduction (7) to the motor (14).

8. Built-in planetary drive in the claims 1 to 7, c o m p r i s i n g the frontally joined gear box (8) is joined to the body (11) for at least one gear reduction (6) which is formed by the disk flange (46) with screwed-on cylindrical detail (63) and which is closed with shaped face (64) where the gear box (8) is covered with the cover (65) of the lubricating space.

9. Built-in planetary drive in the claims 1 to 8, c o m p r i s i n g the sun gear (16) of the planetary gearing (1) is together with the driving shaft (9) made of one piece of material

and that said gears of smaller diameter double satellites (31, 32, 33, 37, 38, 39) of the planetary gearings (1, 3) are together with the satellite pins (29, 36) made of one piece of material as the pinion gears (40, 42).

10. Built-in planetary drive in the claims 1 to 9, c o m p r i s i n g the radial and radial-axial hub bearings (55, 56) carrying the hub (54) with drum hubs (57, 58) and driven rims (59, 60, 61, 62) with rubber tires are fitted to the outer circumference of the body (11).

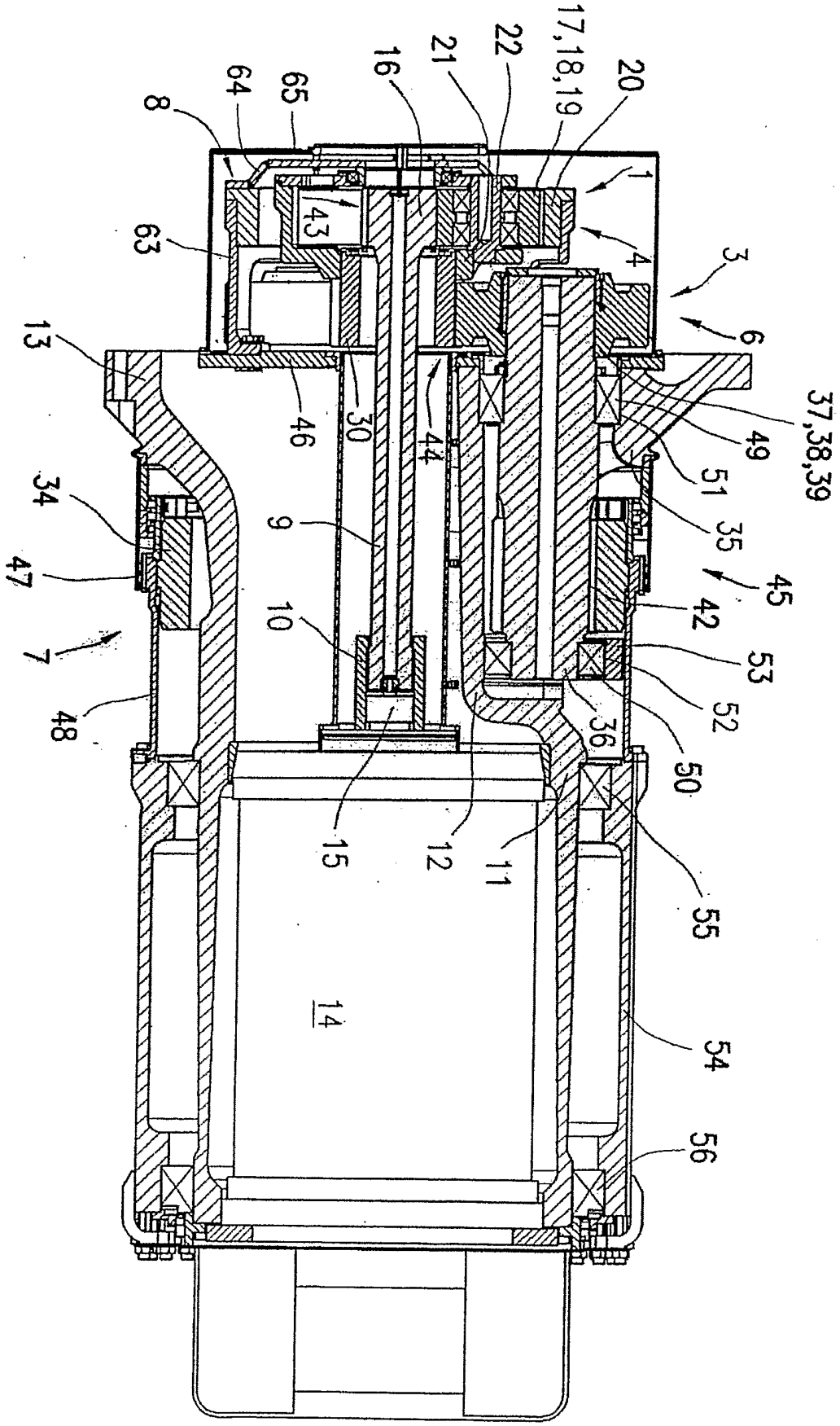

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Fig. 1

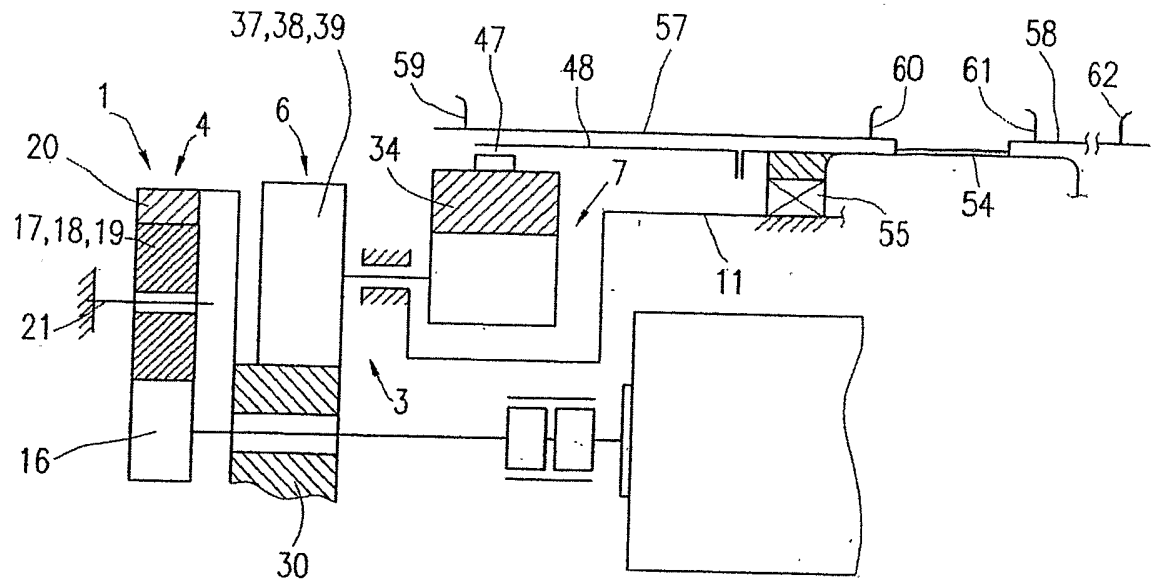
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Fig. 2

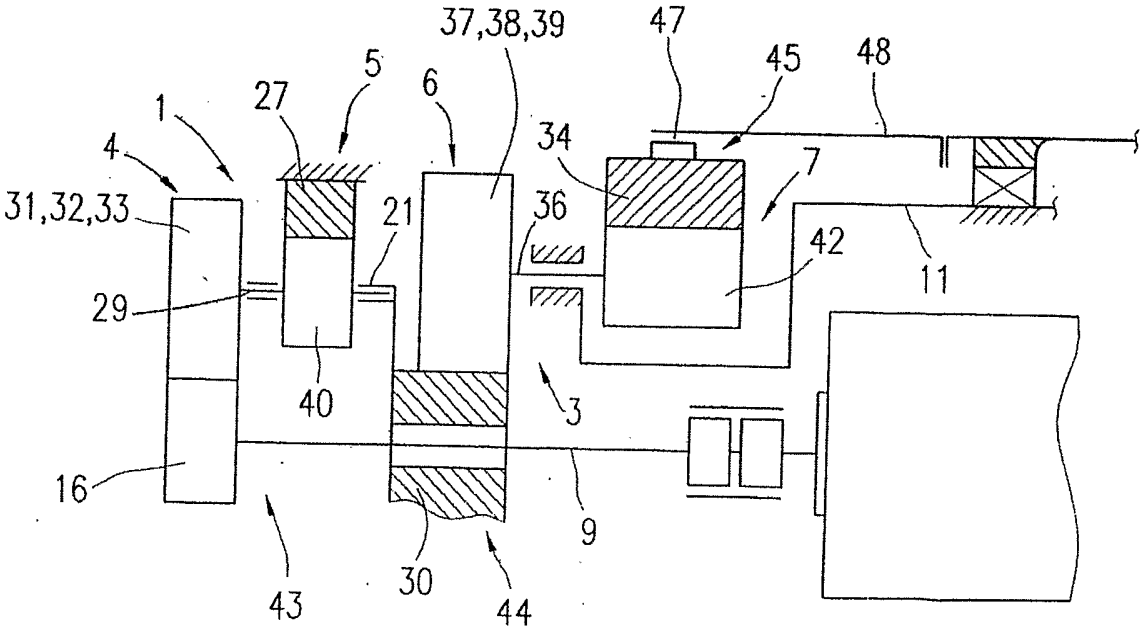
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Fig. 3

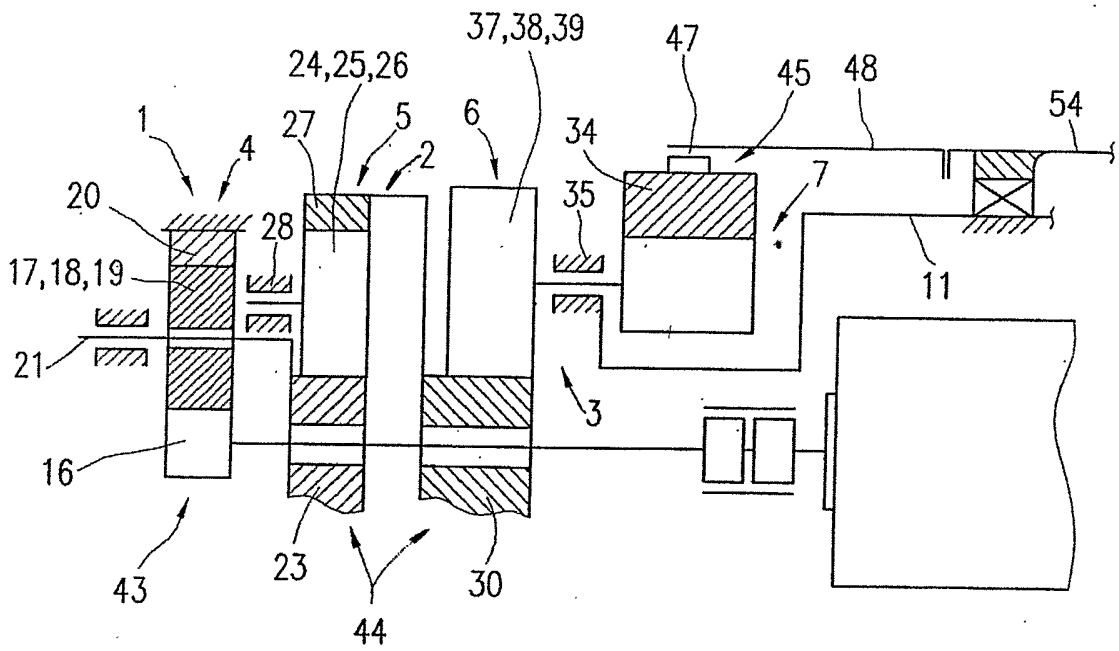
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Fig. 4

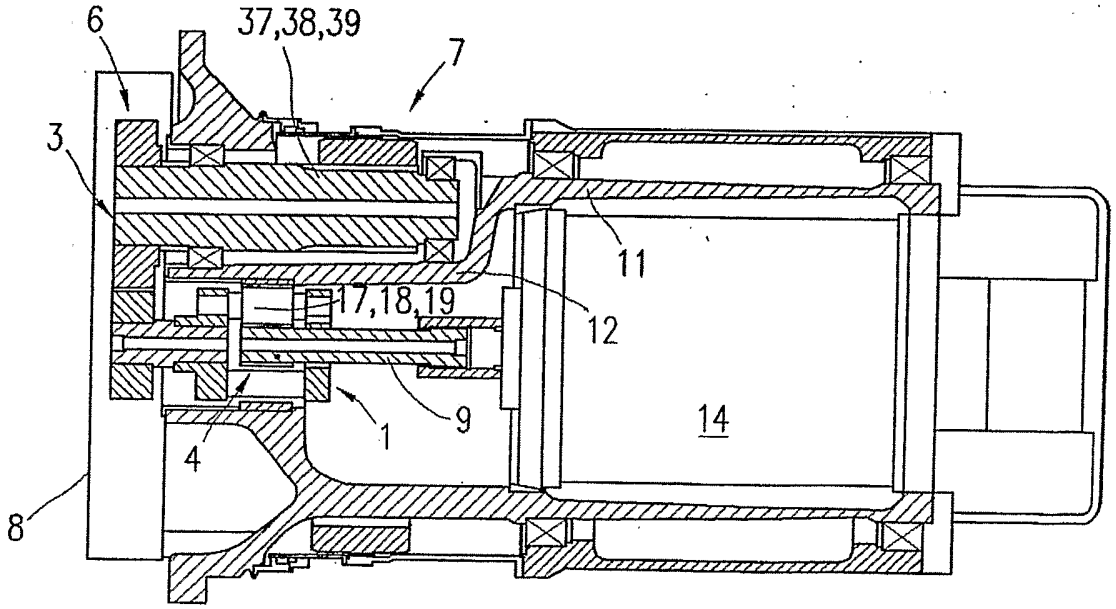
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Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No
/CZ2004/000084

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H1/46

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16H H02K

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)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 91/19916 A (HICKS TRANSMISSIONS LIMITED) 26 December 1991 (1991-12-26) abstract page 2, line 26 - page 3, line 11 figure 1	1-10
A	WO 01/13007 A (ALPHA GETRIEBEBAU GMBH; BAYER, THOMAS) 22 February 2001 (2001-02-22) abstract	1-10
A	GB 850 613 A (JOHN WILLIAM FELIX) 5 October 1960 (1960-10-05) the whole document	1-10
A	GB 926 920 A (HEINRICH DESCH G.M.B.H) 22 May 1963 (1963-05-22) the whole document	1-10

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Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2005	31/03/2005

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Information on patent family members

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