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

(11) Publication number: **0 330 407 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89301632.9**

(51) Int. Cl.4: **A63J 1/02**

(22) Date of filing: **20.02.89**

(30) Priority: **18.02.88 GB 8803839**

(43) Date of publication of application:
30.08.89 Bulletin 89/35

(84) Designated Contracting States:
AT CH DE ES FR GR IT LI SE

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(54) Scenery rigging apparatus.

(57) Items of scenery are moved by ropes operated by respective drums (14) on individual winches (2) each having its own driving motor (M). Synchronous operation of a plurality of ropes attached ton one or more items is ensured by a network of chain-and-sprocket transmissions (64,68;34) interconnecting all the winches in an array; each winch can be connected to a leg of the network by an electrically operated friction clutch (37) when required to operate or be held stationary by a brake, when declutched from the network. The motors (M), clutches (34) and brakes can be controlled by a computer which can also monitor correct operation of each winch by means of an angular position encoder (19) and a tachogenerator (20) for each winch.

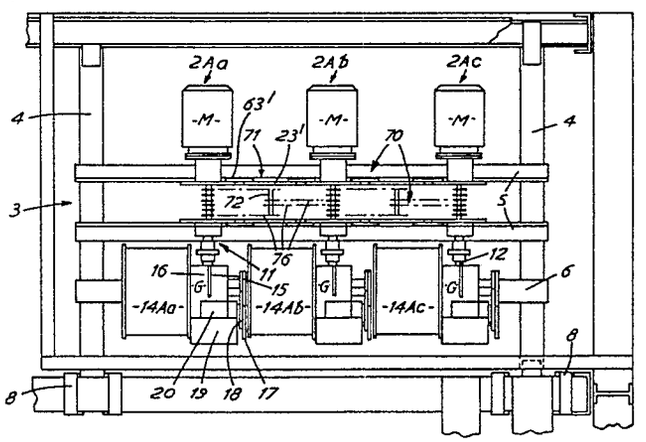

FIG.3

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SCENERY RIGGING APPARATUS

This invention relates to scenery rigging apparatus for supporting and moving items of scenery for example in theatres and opera houses and television and other auditoria.

In order to support and move large items of scenery, such as flats and drapes, several ropes are attached to each flat or drape at intervals along its length and pass over pulleys appropriately positioned over the stage and are thence led over further guide pulleys as necessary, to operating winches having variable speed motors. The winches are under the control of a computer which receives signals generated by angular position encoders and speed-sending tacho-generators and thereby synchronises the operation of the set of winches lifting of lowering the item or scenery. The shifting of several items of scenery may moreover by synchronised by the computer.

According to the invention there is provided scenery hoisting apparatus comprising an array of independently-operable motor driven winches and a network of slip-free synchronising transmissions interconnecting the positions occupied by the winches, each winch having a selectively-operable clutch for connecting the winch to a leg of the network and thereby to another winch of the array through the respective clutch thereof.

Conveniently, the legs of the transmission network are each formed by a roller chain passing round a sprocket wheel at each end of the leg, each said sprocket wheel being connectable to the respective winch by the said respective clutch.

Advantageously, the winches (or at least some of them) can be selectively clutched to more than one leg of the network.

Groups of winches within the array may be interconnected by one or more transfer legs of the network which are selectively engageable or disengageable.

An embodiment of the invention will now be described by was of example with reference to the accompanying drawings, in which:-

Figure 1 is an elevational view of an array of twelve winches forming part of a scenery rigging system in a theatre,

Figure 2 is a rear elevational view of the array of winches seen in the direction of the arrows II in Figure 1,

Figure 3 is a plan view on the lines III - III of Figures 1 and 2,

Figure 4 is an axial section view, on an enlarged scale of the input drive to one of the winches, for example on the line IV - IV of Figure 3, and

Figure 5 is a diagrammatic perspective view of the synchronising transmission network of the array of winches shown in Figures 1 to 4.

The array of winches shown in the drawings is located in any convenient position in the off-stage area, in this case just under the roof rafters 1 of the scenery tower of the theatre. The array comprises twelve identical winches 2 which are stacked four-high in three columns A, B, C, thus forming four super-imposed rows a,b, c,d each containing three winches.

The array of winches 2 is supported on a base framework 3 formed by an I-beam 4 at each end of the array, two spaced longitudinal angle irons 5 fixed to the top flanges of the I-beams 4, and a longitudinal I-beam 6 also fixed to the top flanges of the I-beams 4. Each end of each I-beam 4 is supported by means of an anti-vibration mounting 7 (Figures 1 and 2) on support members 8,9 secured to the structural framework S of the scenery tower.

Each winch 2 comprises a variable-speed DC or AC electric motor M (or fluid-powered motor) the output shaft 10 of which drives, by way of a drive shaft assembly 11, the input worm-carrying shaft 12 of a worm-and-wormwheel reduction gear box G, the output shaft 13 of which carries the wormwheel (not shown, within the gearbox G), and is extended outside the gearbox G to carry the winch drum 14. Gear wheels 15 and 16 on the opposite end of the output shaft 13 mesh with gears 17 and 18 on the input shafts of an angular position encoder 19 and a tachogenerator 20 which provide output signals respectively of the angular position and rotational speed of the winch drum 14. These signals are conveyed by suitable data cabling to a computer (not shown) controlling the operation of the winches.

Lift ropes extend from respective winch drums 14 over appropriately positioned pulleys to attachment points on the various items of scenery. Clearly, the movements of all ropes attached to a particular item must be accurately synchronised to avoid any visible inaccuracy of movement and also to ensure that no one winch becomes overloaded.

In current scenery shifting systems, the computer is required to ensure this synchronisation by reacting whenever the position and/or angular speed differs from the predetermined value, written into the computer's memory, by an amount greater than a prescribed error. If one of the winches should lag behind the others, this will be sensed by the computer which, in accordance with its programmed instructions, stops all of the winches in-

volved with that piece of scenery and then briefly reverses all these winches before instructing the winches to continue the required operation. This sequence of events can destroy an intended dramatic effect.

To avoid this problem, the motor shafts 10 of the winches 12 are interconnected by a network of selectively engageable synchronising chain-and-sprocket drives shown diagrammatically in Figure 5 and indicated in broken lines in Figures 2 and 3.

For this purpose, the construction of the input drive-shaft 11 between each motor M and gearbox G is as shown in Figure 4. This drive is constructed as a module comprising two spaced-apart rectangular steel plates 23 and 24 in which the intermediate drive shaft 25 of the cardan shaft 11 is mounted by ball bearings 26.

The casing of the motor M has a flange 27 which is bolted to a flange 28 on a tubular sleeve 29 bolted to the plate 23, thereby mounting the motor M on the plate 23. Within the sleeve is a flexible coupling 30 connecting the motor shaft 10 to the drive shaft 25 while avoiding vibrations due to possible misalignment. The coupling comprises three-armed spiders 31 and 32 keyed to, and secured by set bolts to the shafts 10 and 25, and a flexible ring 33 to which the arms of the two spiders are bolted alternately.

Between the plates 23 and 24 the drive shaft 25 carries a pair of sprocket wheels 34X and 34Y which are each independently rotatably supported on the shaft by a pair of ball bearings 35. Each of the sprocket wheels 34 is formed with a plurality of sets of sprocket teeth 36, in this case three sets 36^1, 36^2, and 36^3.

Each sprocket wheel 34X, 34Y can be selectively clutched to the shaft 25 (or both can be simultaneously clutched to the shaft 25) under the control of the computer by means of a respective electromagnetic clutch 37X, 37Y comprising an energising winding 38 mounted on the adjacent plate 23 or 24, a soft iron armature 39 which is slidably keyed or splined on the shaft 25 (here by a key 41), a ring of friction material 42 and a lubricant-shield disc 43. When a winding 38 is energised, it magnetises its armature 39 which is thus magnetically attracted towards the adjacent sprocket wheel 34 and thereby frictionally clamps the friction ring 42 and the disc 43 against the sprocket wheel, establish a frictional drive between the shaft 25 and the sprocket wheel 34.

The drive shaft 25 continues beyond the plate 24 to be connected at its free end to the input shaft of the gearbox G by means of a further flexible coupling 50 of construction similar to that of the coupling 30.

Keyed to the portion of the shaft 25 between the plate 24 and the coupling 50 is a brake disc 51 of a brake mechanism 52 which includes a ring of helical springs (not shown) parallel to the shaft. The springs normal clamp friction surfaces against the disc 51 to prevent any unintended rotation of the shaft 25. This brake can however be released by energising a winding within the brake under the control of the computer whenever the motor M is energised.

As can be seen from Figures 2 and 3, the lower edges of the plates 23 and 24a of the lowermost row a of winches are bolted directly to the upstanding flanges of the angle-irons 5. The gearboxes G of this lowermost row are supported on the I-beam 6 through pairs of packing members 61 formed by short lengths of channel.

The plates 23b and 24b of the next row b of winches are supported on spacer plates 62 which in turn rest on the plates 23a and 24a of the bottom row. This arrangement is repeated up to the top row. The junctions between the spacer plates 62 and of the respective plates 23 and 24 are secured by fishplates 63 bolted to them.

Similarly, the gearboxes G of the superimposed winches b, c, d are supported on the next lower gearbox through a packing or spacer member 64 formed by portions of I-beam of appropriate height having their webs cut away to accommodate the tachogenerators 18.

The upper edges of the plates 23 and 24 of the top row d of winches are bolted to horizontal angle irons 65 which in turn are bolted to the underside of an I-beam 66 the top of which carries a further anti-vibration mounting 67 secured to the structural framework F. The I-beam 66 is also secured to the top gearbox Gd.

As indicated in broken lines in Fig. 2 and as shown diagrammatically in Fig. 5, the sets of sprocket teeth 36^2X of the winches 2a and 2b are interconnected by a roller chain 64Xab. Similarly the sprocket teeth 36^2Y of the winches 2a and 2b of each column are interconnected by a chain 64Yab. Similar chains 64Xcd and 64Yd interconnect the respective sprocket teeth 36^2 of the top two winches of a column of winches. Further similar chains 64Xbc and 64Ybc interconnect the winches b and c of a column but in this case cannot of course pass round the teeth 36^2 and so engage the teeth 36^1.

In operation, a simple item of scenery may be connected for example, to the ropes of the winches b and c in one column. To synchronise the operation of these winches, thereby ensuring that the item remains level, whenever these winches have their motors energised by the computer, the latter will in addition to energising and freeing the brakes 52b and 52c, energises the clutches 37Xb and 37Xc, thereby establishing a synchronising drive between the shafts 25, and thus the motors M of

the winches, by way of chain 68Xbc.

The torque capacity of the clutches 37 is chosen to be relatively small compared with the output torque available from its motor M, but sufficient to synchronise its motor with the next motor to which it is connected by the clutches and chain, provided that both such winches are operating correctly. In the event of a malfunction of any winch, in a group, no operational signal is received from the defective winch by the computer which immediately stops the whole group.

It will be noted that the sprocket wheels 34X of the other winches in the column will be driven by the synchronising chains while the winches, 12b and 12c are operating but these other winches will not be affected as the friction clutches 37aX and 37dX are not engaged and the sprocket wheels can thus idle on the shafts 25a and 25d. In fact, the winches 12a and 12d may be used to operate another item of scenery, independentely, by engagement of their clutches 37Y, their drive shafts be synchronised by the chains 68Yab, 68Ybc and 68Ycd (without affecting the operation of the winches 12b and 12c.

As indicated in Figures 3 and 5, winches in adjacent columns may be selectively synchronised by transfer legs 70 of the network. To increase the flexibility of use of the array, these transfer legs 70 include intermediate clutch modules 71 formed by a pair of spaced rectangular plates 23′ and 24′ secured to the plates 23′ and 24′ of adjacent winch modules by fishplates 63′.

A clutch shaft 72 is journalled in ball bearings in the plates 23′ and 24′ and can be connected to sprocket wheels 74X and 74Y, mounted on the shaft, by electromagnetic clutches 75X and 75Y of similar construction to the clutches 37 and under the control of the computer. Chains 76 connect the sprocket wheels 74 to the appropriate rings of sprocket teeth in the adjacent columns of winch modules to be interconnected.

Larger and heavier items of scenery are handled by increasing the number of winches having their ropes attached to it as necessary, all of these winches being synchronised by the chain and sprocket drives by appropriate engagement of the friction clutches. It will be appreciated that a very wide range of network designs is possible as required by particular theatres and other stages.

The synchronising drives of separate arrays of winches may be interconnected by other forms of transmission such as shafting with bevel gearing if a change of direction is necessary.

Claims

1. Scenery hoisting apparatus comprising an array of independently-operable motor driven winches and a network of slip-free synchronising transmissions interconnecting the positions occupied by the winches, each winch having a selectively-operable clutch for connecting the winch to a leg of the network and thereby to another winch of the array through the respective mechanisms thereof.

2. Apparatus according to claim 1, wherein the legs of the transmission network are each formed by a roller chain passing round a sprocket wheel at each end of the leg, each said sprocket wheel being connectable to the respective winch by the said respective clutch.

3. Apparatus according to claim 1 or 2, wherein the winches (or at least some of them) can be selectively clutched to more than one leg of the network.

4. Apparatus according to any of the preceding claims wherein groups of winches within the array may be interconnected by one or more transfer legs of the network which are selectively engageable and disengageable.

5. Apparatus according to any of the preceding claims, wherein the winches are under the control of a computer araanged to monitor the performance of each winch in such a manner, as to stop all winches, in the event of malfunction of any winch, inn a group thereof interconnected by their clutches and synchronising transmissions.

6. A winch module for scenery hoisting, comprising a modular housing, a drive motor a winch drum driving shaft driven by the motor and journalled in the housing, and at least one sprocket wheel rotatably mounted on the shaft and a clutch for the or each sprocket wheel for selectively connecting the respective sprocket wheel to the shaft.

7. A winch module according to claim 6 wherein the or each clutch is remotely controlled.

8. A winch module according to claim 6 or 7 wherein the or each sprocket wheel has a plurality of axially spaced sets of sprocket teeth.

9. A winch module according to any of claims 6-8 wherein the housing carries a releasable brake for the shaft.

10. A winch module according to any of the claims 6 to 9 wherein the said shaft is connected by a flexible coupling to the input of a worm-reduction gearbox, the output shaft of which carries the winch drum and an angular position encoder.

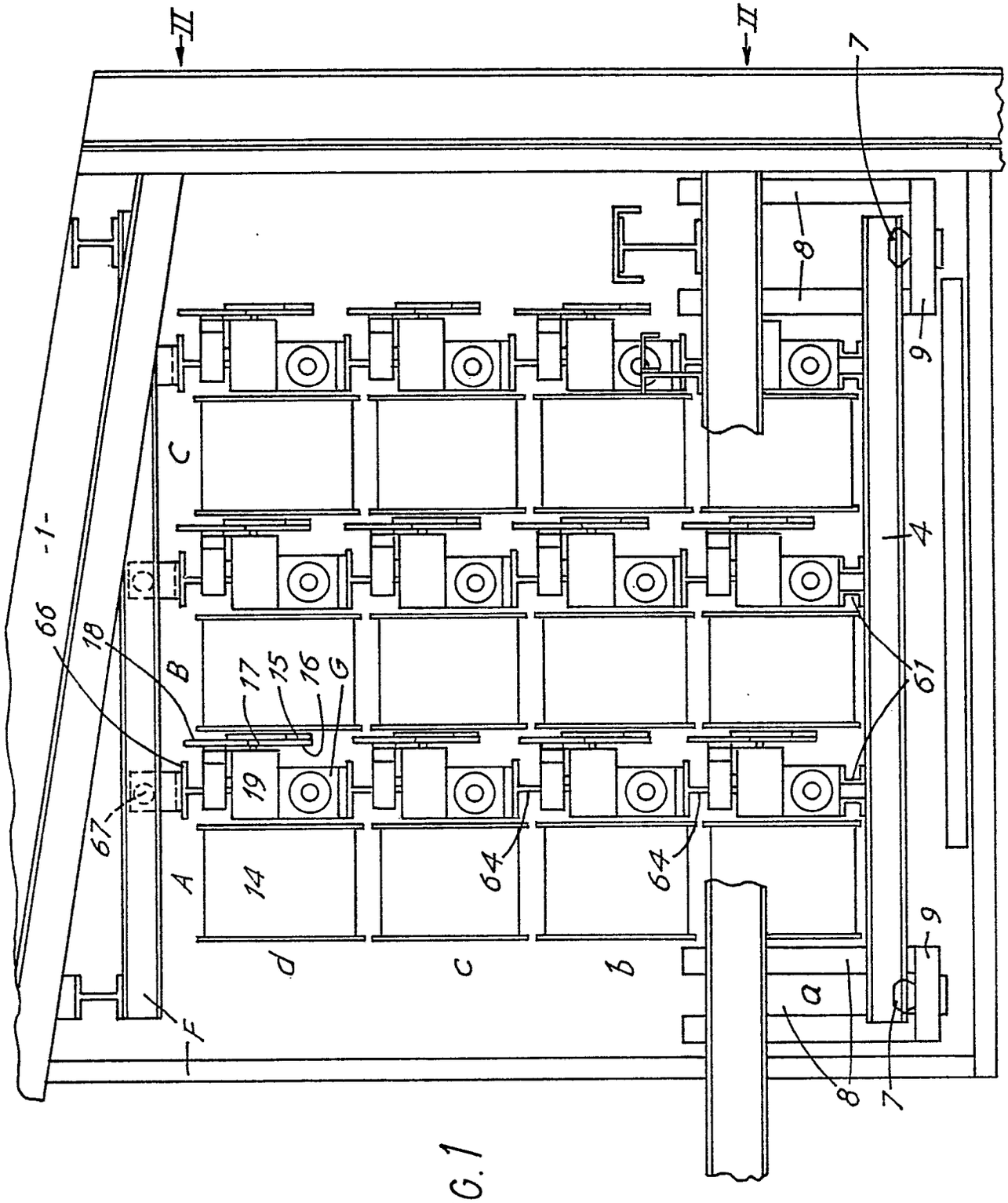
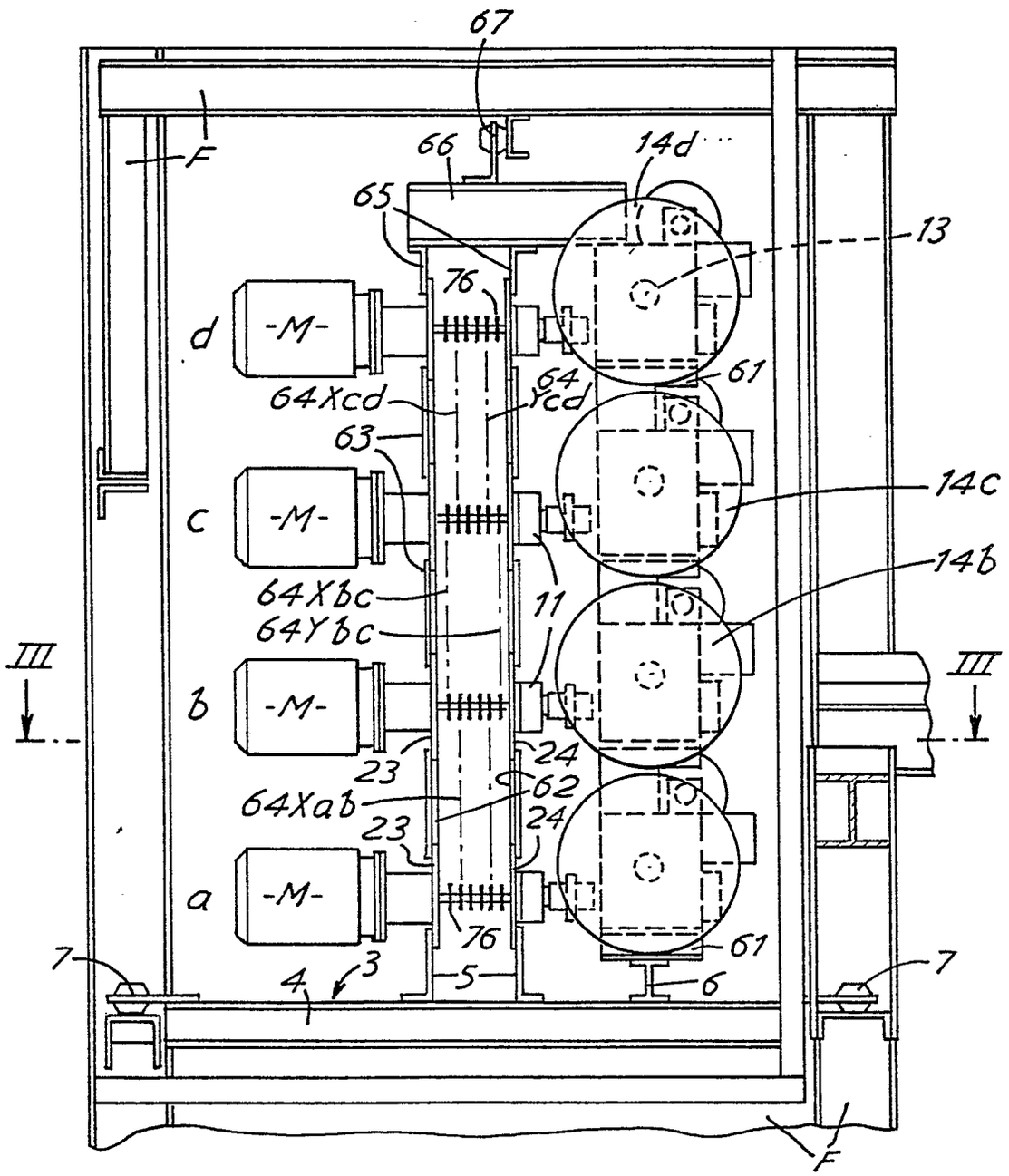


FIG. 1

FIG. 2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III
b
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7
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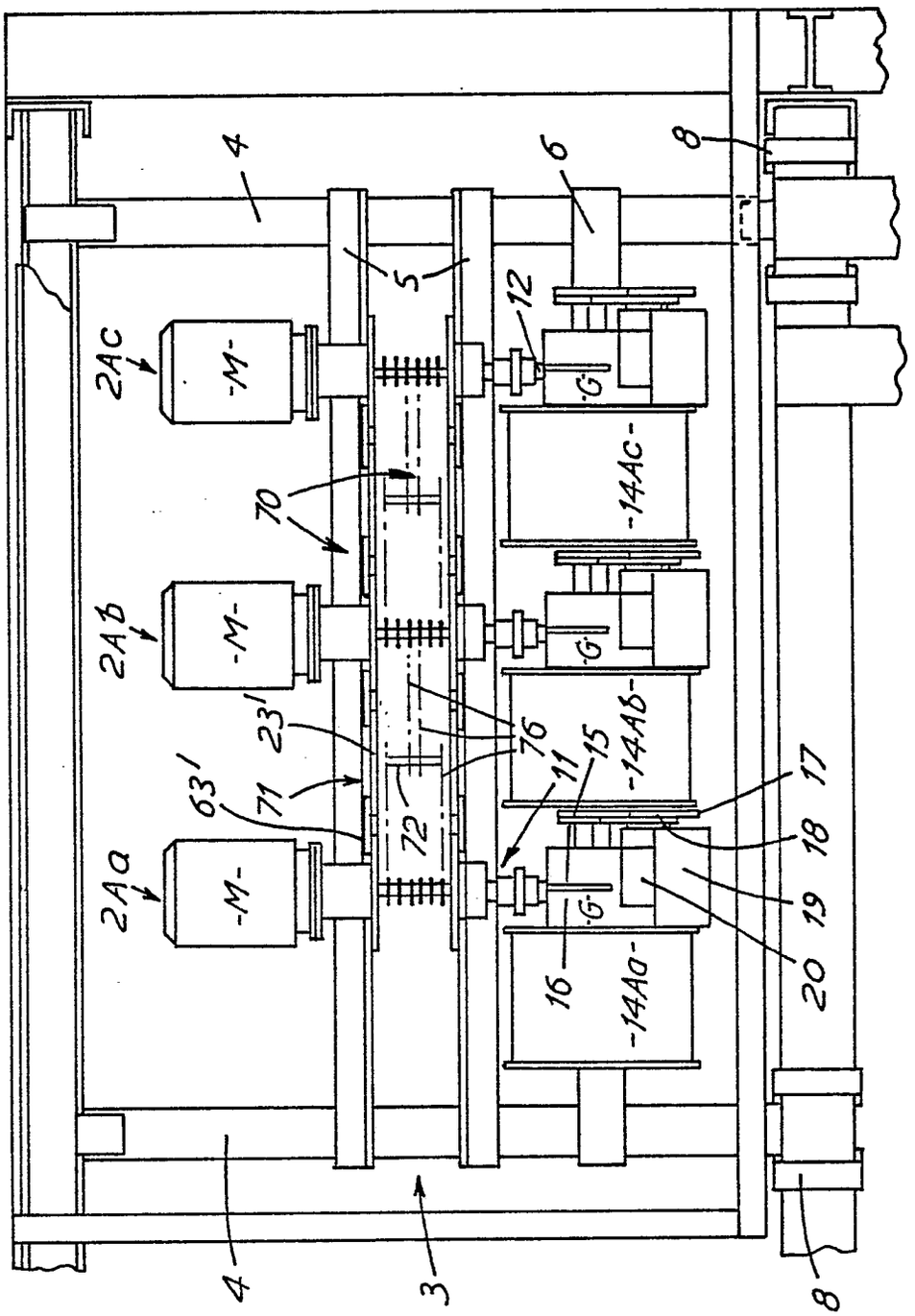
F

FIG.3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-M-
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-14AC-
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2AB
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63'
71
72
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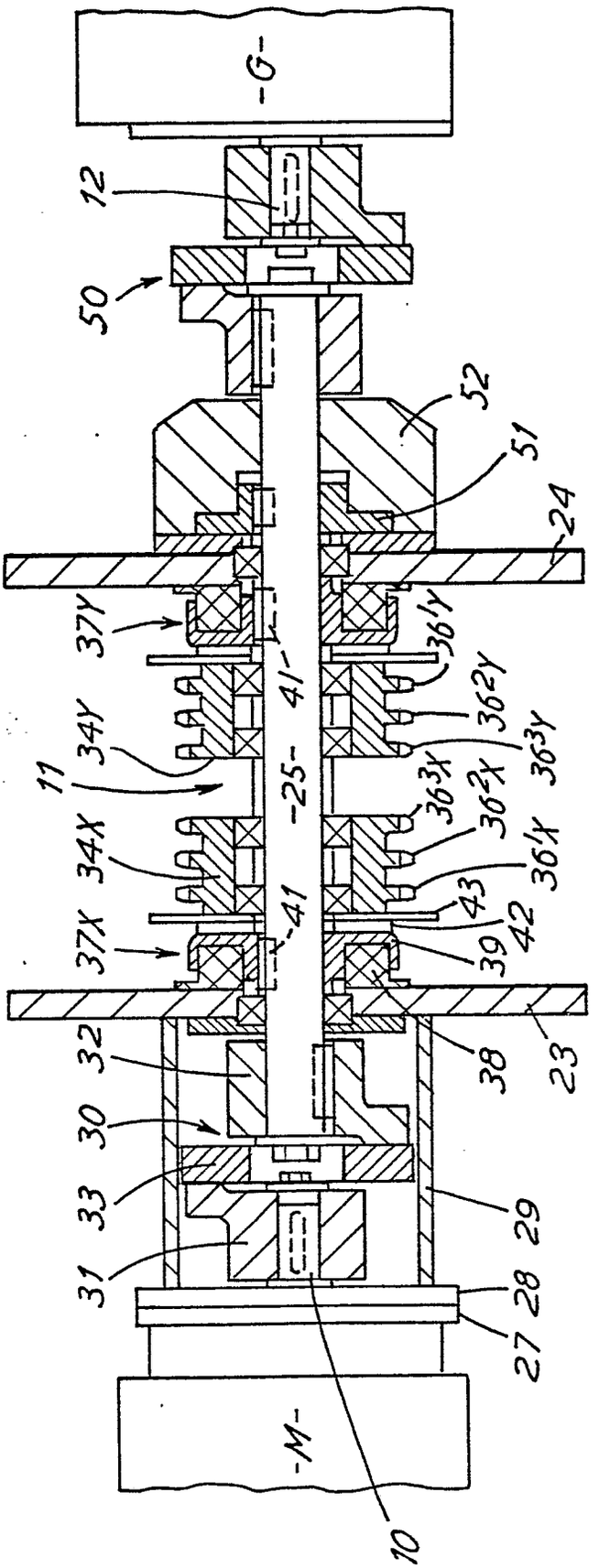
-G-
16
-14AO-
4
3
8

FIG.4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12
50
52
51
24
37Y
361Y
41
362Y
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363Y
11
25
363X
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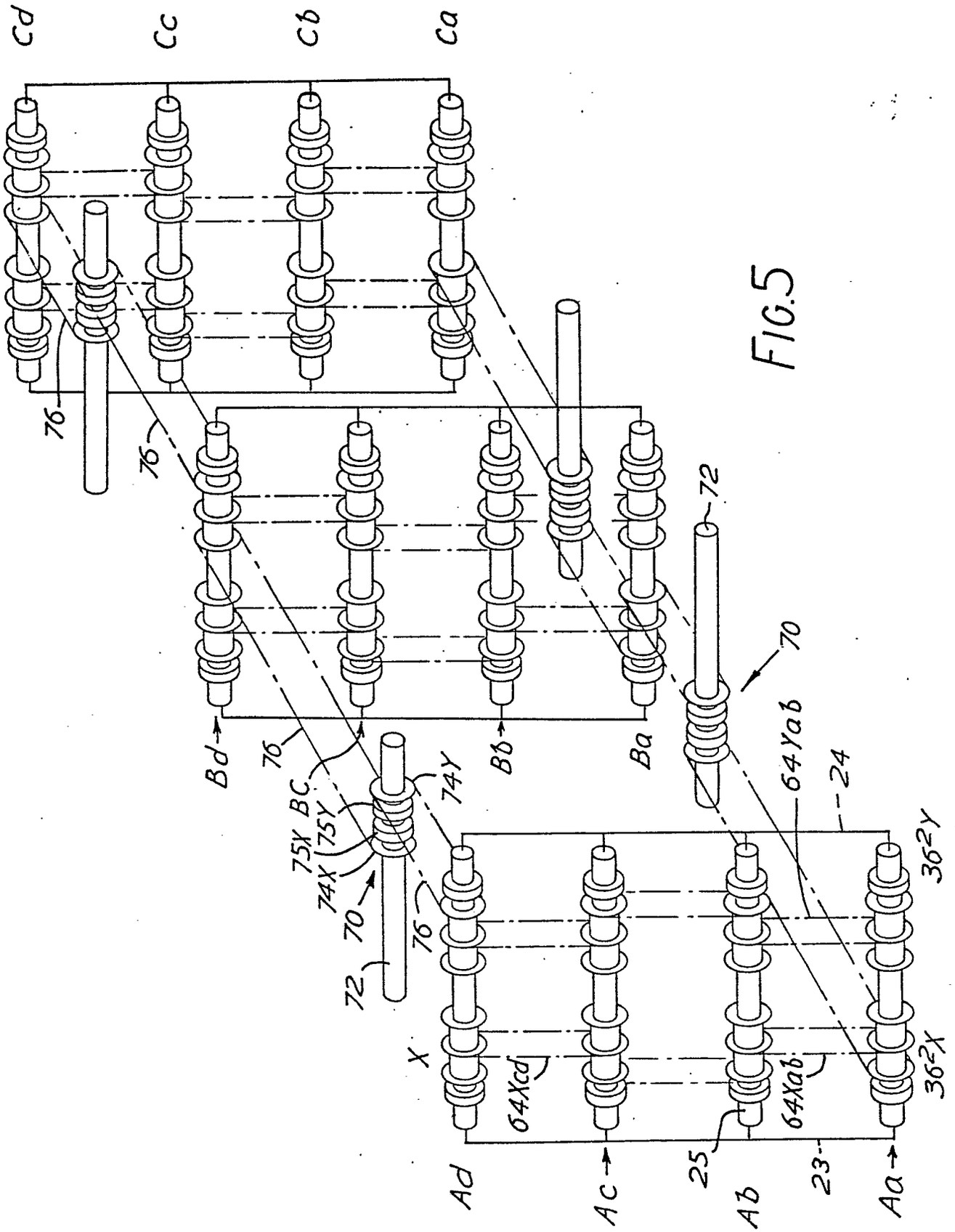
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64Xab
36²X
Ad
Ac
Ab
Aa
25
23

FIG.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 1632

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.4)
A	US-A-2 942 879 (IZENOUR) * Column 2, lines 26-28,40-42; column 3, lines 24-31; column 6, lines 70-72; column 7, lines 50-54; column 7, line 73 - column 8, line 7; column 12, lines 29-38; figures 6,7 *	1-10	A 63 J 1/02
A	US-A-4 303 237 (HOFFEND Jr. et al.) * Abstract; figure 3 *	1	
A	FR-A-2 162 261 (SORES S.A.) * Page 2, lines 13-42; page 11, lines 9-26; claim 1; figure 1 *	1	
A	DE-A-2 400 848 (ZILLER) * Page 1, lines 3-10; page 2, lines 1-20; page 3, lines 1-33; claims; figures 2,6 *	1-10	
A	US-A-3 986 703 (BRETT et al.) * Column 1, lines 23-36; column 2, lines 53-61; figures *	1-10	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

A 63 J
B 66 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06-06-1989	ZEINSTRA H.S.J.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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