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(54) Pen plotter comprising a drawing instrument store allowing exchange of instruments and grouping of stored instruments, drawing instruments store and drawing instrument group definition process for same.

(57) The pen plotter comprises a plotting head displaceable relative to a print medium and a drawing instrument store from which an instrument can be exchanged automatically. The store has a number of individual instrument receptacles divided into groups of instruments of the same type. The system is managed by a control unit that receives the graphics data concerning the plots to be traced, so as to command the corresponding displacements of the plotting head and print medium, and also to order the selection of a particular type of instrument from the store, on the basis of information identifying the groups of receptacles allocated to each type of drawing instrument.

According to the invention, the instrument receptacles (Lk) that are assigned to a same group (GNi) are localised by identification devices (60) situated within the instrument store (24) and which cooperate with a detector, such as a electro-optical detector (70, 72) fixed to the plotter to supply the control unit with information defining the groups. Each identification device can indicate whether the two receptacles on either of its sides belong to the same group or not.

The invention also relates to a drawing instrument store for such a pen plotter and to a process for defining groups of drawing instruments using the above devices.

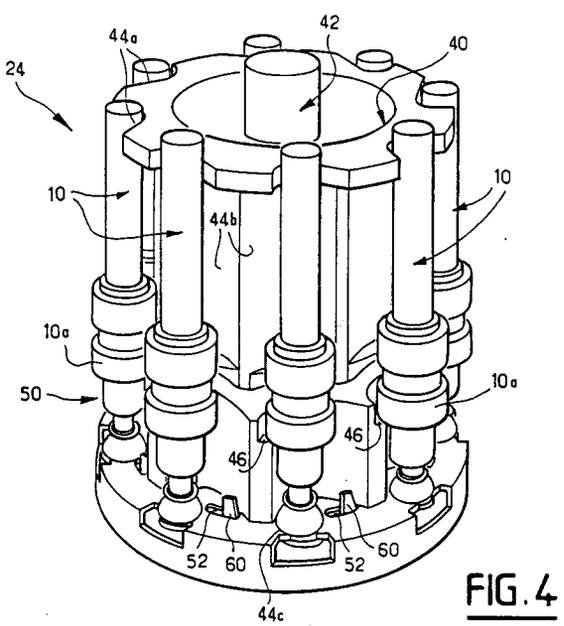

FIG.4

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The present invention relates to pen plotters in which a drawing instrument is carried by a plotting head that is moveable with respect to a chassis of the plotter so as to print traces on a print medium as a function of graphics data supplied to the plotter. More specifically, the present invention concerns pen plotters of the type equipped with a drawing instrument store having a number of individual receptacles and means for automatically exchanging selected drawing instruments between the plotting head and the receptacles.

The graphics data are sent to the plotter from an external source, such as a computer-aided design (CAD) workstation. The data contains information on the shape of the trace to be plotted, which is interpreted by the plotter's internal processing unit to control the relative displacements between the plotting head and the print medium to produce the required trace, which is generally in the form of successive vectors. The graphics data also include information specifying the type of drawing instrument to use, depending on the colour and thickness of the trace, and possibly on the dynamic characteristics of the tracing action, or the surface of the print medium too. There are two types of command through which the graphics data can be used to select a drawing instrument :

- either by direct selection of a specific drawing instrument in the store, using an index number specifying the receptacle of the store assigned to the instrument, or
- by selection of a particular type of drawing instrument belonging to a group of instruments having the same characteristics, the actual receptacles of the store assigned to instruments of a same group being specified at the level of the plotter's control unit.

The first type of command is the simplest to process, but has the drawback of relying on one and the same drawing intrument for all traces requiring that type of instrument, which leads to a certain rigidity in management of the drawing instrument store.

In contrast, the second type of command allows a more flexible management of the drawing instruments since the selection is based not on a specific instrument, but rather on a particular type of drawing instrument. The control unit can thus be pre-programmed to assign not just one, but several receptacles of the store for each type of drawing instrument, the choice of which actual receptacle to be employed at any one time for a given instrument group being made independently according to an arbitrary scheme at the level of the plotter.

This uncoupling between the external command specifying a particular group of drawing instruments on the one hand, and the selection of a corresponding instrument in one the store's receptacles assigned to that group on the other, grants a considerable improvement in the plotter's autonomy in operating cycles during which worn instruments have to be replaced. Indeed, the control unit can then command the use of a replacement instrument whenever a current instrument becomes worn, the wear being determined for each instrument by an internal management system on the basis of recorded cumulated traces.

Accordingly, when the writing instruments are initially installed in the instrument store, they are assigned into groups of instruments of the same type, with each group containing as many instruments as judged necessary to ensure a maximum of autonomy. If it is considered that the store only needs one drawing instrument of a certain type, then the latter is nevertheless considered as belonging to a group, of which it is the sole member.

A group is thus defined as a set of drawing instruments arranged in the store and considered as mutually interchangeable, being identical or of the same technology (ball, fibre, ...) and of the same diameter, colour, etc.. The make-up of a group must be entered into a memory of the control unit before an operating cycle. It may be redefined at any moment by an operator, for instance during an intrerruption in the plotting operation.

In prior art pen plotters, the operator can define the groups of drawing instruments in either of two ways.

The first is by means of a programming language which comprises sub-commands for assigning a set of receptacles in the writing instrument store to each selected group, the choice of particular active instrument receptacle within the group being determined at the level of plotter's control unit.

The second way consists in assigning drawing instrument receptacles directly through the plotter using a keyboard and display screen connected to the control unit. In this case, the user defines the groups by assigning each receptacle with a number designating a particular group.

This last option is however reserved for the more elaborate pen plotters. Simpler plotters normally have just a very basic control panel with a rather limited display capacity, if any, making such data input impossible.

In any case, there remains a problem in that the relationship between the table that assigns the drawing instruments' positions to the different groups and the actual physical locations of the drawing instruments in the store is little or not apparent. Accordingly, it is not easy for the operator to ensure that this relationship is correctly established, and there is thus a risk of error.

Moreover, the input of assignment data for the drawing instrument positions is a tedious task that

complicates the operator's work and adds to the amount of training required. Finally, this assignment requires a man-machine interface more complete than otherwise necessary with respect to the display, the control unit and the input/output circuits, causing extra manufacturing costs of the plotter.

It is an object of the present invention to overcome the above problems by providing means for defining groups of drawing instruments which are simple to use and which, in particular, allow the operator to see at a glance which actual receptacles are assigned to a same group during the process of defining groups of drawing instruments.

This object is achieved, according to the present invention, by a pen plotter comprising : a plotting head displaceable relative to a print medium,

a store for drawing instruments, comprising a plurality of individual drawing instrument receptacles, the receptacles being divided into a plurality of groups, each group comprising one or a plurality of receptacles and being assigned to a particular type of drawing instrument,

means for automatically exchanging drawing instruments between the plotting head and the instrument receptacles of the store, and

a control unit adapted to receive graphics data concerning traces to be plotted, for controlling relative movements between the plotting head and the print medium so as to produce a plot thereon corresponding to the information contained in the received graphics data, and to control a selection of a drawing instrument as a function both of information contained in the graphics data, which information identifies a particular type of instrument, and of information identifying the receptacles of the store that are assigned to a same type of instrument,

wherein the drawing instrument store contains identification means for identifying the instrument receptacles that belong to a same group of receptacles, and the plotter comprises detection means operatively cooperating with the identification means to supply the control unit with information defining the groups of instrument receptacles formed within the instrument store.

According to a particular embodiment of the invention, the identification means are associated to intervals between the receptacles, each identification means being able to adopt one or another of at least two states respectively indicating that the two receptacles on either side of the corresponding interval belong to a same group, or that the two receptacles belong to separate groups, the detection means being capable of detecting the states of the identification means.

The identification means may be in the form of moveable identification elements that can adopt at least two different positions and cooperate with detection means capable of detecting the position of each identification element by electro-optical means or by contact. The identification means may also be made in the form of magnetic substrates cooperating with detection means comprised of a magnetic read head.

The invention also relates to a drawing instrument store comprising receptacles for a pen plotter apparatus, wherein identification means are provided for identifying the instrument receptacles that belong to a same group of receptacles, in order to define a distribution of instrument receptacles into different groups.

The present invention also relates to a process for defining groups of drawing instruments for a drawing instrument store in a pen plotter, the store comprising a plurality of individual receptacles, the process comprising the steps of : distributing the instrument receptacles of the store into different receptacle groups, and sending data corresponding to the distribution to a control unit of the plotter apparatus,

wherein the process further includes the steps of : identifying the groups of drawing instrument receptacles using identification means arranged at the level of the instrument store, the identification means being capable of adopting at least two different states, and detecting the states of the identification means to supply the control unit with information defining the groups of instrument receptacles formed in the store.

The use of identification means according to the present invention calls for a certain amount of precision in the installation of the store provided with the identification means with respect to the detection means.

In particular, it is important to ensure that the data collected by the latter are not liable to be corrupted as a result of vibrations or other spurious movements transmitted to the store. This precaution applies especially in the case where the readout of data on the identification means requires a relative displacement between the latter and the detection means, the readout taking place e.g. when the store is driven into rotation about its axis, as in carrousel type drawing instrument stores.

Although the above prerogative can be satisfied by some known types of means for supporting, driving and guiding the drawing instrument store, it is nevertheless advantageous, according to another aspect of the invention, to provide a pen plotter having :

a drawing instrument store comprising a plurality of individual instrument receptacles distributed about an axis of the store, and a crown portion

forming a peripheral path,

means for supporting the store on a chassis of the plotter, and

means for driving and guiding the store into rotation about its axis, comprising a drive element for driving the store by engagement with said peripheral path,

wherein the store guiding means include at least two studs provided on the store support means for engagement with a guiding ramp formed by a frusto-conical surface which is provided on said crown portion and which is inclined with respect to the axis of the store, at least one of said studs engaging with the crown portion at a location angularly displaced by more than 90° with respect to the location of the engagement between the drive element and the crown portion.

The invention also relates to a drawing instrument store adapted for such a guiding system.

The present invention shall be more clearly understood upon reading the description of the preferred embodiments, given below as a non-limiting example with reference to the appended drawings in which :

- figure 1 is a highly schematic general view of a pen plotter;
- figure 2 is a functional diagram of the control unit for the pen plotter of figure 1;
- figure 3 is a schematic diagram showing an example of the relationship established between groups each corresponding to a type of drawing instrument and specific receptacles of the plotter's instrument store, according to a step of definition of groups of instrument receptacles;
- figure 4 is a three-quarter view of a drawing instrument store according to one embodiment of the present invention;
- figure 5 is a simplified side view of the base of the drawing instrument store shown in figure 4;
- figure 6 shows the drawing instrument store of figure 4, seen along the cross-section A-A' of figure 7;
- figure 7 is a plan view illustrating very schematically the arrangement of the means for driving and guiding the instrument store in rotational movement relative to the chassis of the pen plotter;
- figure 8 is a detailed view showing an identification element mounted on the base of the store shown in figure 4;
- figure 9 is a schematic illustration of the drawing instrument store showing the positioning of the identification elements for defining the groups of drawing instrument receptacles according to the example of figure 3;
- figure 10 is a timing chart for a signal obtained by detection of the identification elements positioned as shown in figure 9;
- figure 11 is a flow chart indicating the steps for recording into a memory the group definition data contained in the signals obtained by detection of the identification elements; and
- figure 12 illustrates group identification elements according to another embodiment of the invention.

Figure 1 gives a highly' schematic illustration of the general aspect of a pen plotter.

Pen plotters operate by relative displacements between a print medium and a drawing instrument along two mutually perpendicular directions X, Y. Typically, the print medium is displaceable to-and-fro along one of these directions (X), while the drawing instrument is displaceable to-and-fro along the other direction (Y).

In the example, which is based on a particular type of plotter known as a "drum type plotter", the print medium 2 is in the form of a continuous sheet that passes over a drum 4 driven into rotation by a motor 6 whose drive shaft may be coupled directly to the drum 4. The drum 4 has its axis parallel to the Y direction and rotates so as to displace the sheet along the X direction.

The drawing instrument 10 in active use is held fast by a clamp 12 forming part of a plotting head 14 supported on a carriage 16. The carriage is displaceable along a sliding rail 18 extending along the Y direction. The carriage 16 is moved along the sliding rail by means of a motor 20 driving a belt attached to the carriage. The tip of the drawing instrument can be selectively placed in contact with the sheet 2 by means of an electromagnetic actuator carried by the plotting head, which can displace the writing instrument along a direction Z between a raised position and a lowered position.

A drawing instrument store 24, shown here in the form of a carrousel, is provided for storing a number of instruments in respective receptacles. The drawing instruments can be exchanged automatically by bringing the plotting head 12 to a transfer position adjacent the carrousel 24 and corresponding to an end of the travel of the plotting head. The carrousel 24 is rotatably driven by a motor 26 so as to present a selected receptacle against the plotting head 12 in the transfer position. The receptacle may be empty for receiving the instrument carried by the plotting head, or it may contain the instrument to be transferred onto the plotting head.

The process for automatically exchanging drawing instruments is already well established in the art; more details on that aspect can be found in patent document FR-A-2 624 794.

The various commands required for controlling the plotter's active devices, and in particular the different drive motors 6, 20, 26 and the electromagnetic actuator, are supplied by an internal control unit which shall now be described with reference to figure 2.

The control unit is organised around a standard type of microprocessor-based central processing unit (CPU) 30 that sends commands selectively to the different active devices as a function of the graphics data DG inputted from an external source. The graphics data DG may originate from graphics processing equipment, such as a computer aided design (CAD) workstation, and be entered into the CPU 30 via an input interface 32. They include data specifying the traces to be plotted and the type of drawing instrument to be used for each trace.

The traces to be plotted are usually defined by a succession of two-dimensional vectors whose respective components determine the displacements of the sheet in the X direction and of the drawing instrument in the Y direction.

The graphics data relating to the traces to be plotted and the drawing instruments to be used are interpreted in the CPU 30 to produce commands transmitted from an output interface 34 to a bus 36 connected to controllers that provide the electromechanical interface for each of the plotter's active devices. For simplification, the figure only shows the controllers 38a, 38b, 38c corresponding respectively to the motor 6 for driving the drum 4, the motor 20 for driving the carriage 16 carrying the plotting head 14, and the motor 26 for driving the drawing instrument store 24. (It will be noted that in this simplified example, a change of drawing instrument only involves the last two active devices.)

The selection of a specific drawing instrument from among those in the store's receptacles is determined from the graphics data identifying a type of instrument to be used, in conjunction with the following two parameters : the data defining the groups of receptacles, such data being stored in a group memory unit 35 that can be accessed by the plotter's CPU 30, and the state of wear of the drawing instruments, this parameter being determined by the CPU 30 on the basis of data stored in an intrument trace logging memory 37, as shall be explained further along.

The relationship between groups of receptacles in the instrument store and the types of instruments shall now be explained with reference to the example shown in figure 3.

The graphics data relative to a type of drawing instrument are coded in terms of groups GNi, where i is an integer specifying a particular group. When the plotter is programmed in an initial phase, each group GNi is made to correspond with one or several receptacles Lk of the drawing instrument store, where k is an integer specifying a particular receptacle. It will be noted that each receptacle of the store can be individually placed at a transfer position by means of indexing devices allowing each receptacle to be identified by its own reference number k.

In the present example, it shall be assumed that the graphics data employ four groups GN1, GN2, GN3 and GN4, thus allowing four types of drawing instruments to be specified, respectively OC1, OC2, OC3 and OC4, and which differ from each other e.g. by their ink colour, linewidth, type of inking system (ball point, fibre tip, ...), etc..

The operator takes into account the characteristics of the drawing instruments OCi when programming the plotter in the group definition phase.

As an example, the corresponding information may be in the form of a specification such as :

Group GN1 : red ink, fibre tip drawing instrument (OC1),

Group GN2 : red ink, ball point drawing instrument (OC2),

Group GN3 : blue ink, fibre tip drawing instrument (OC3),

Group GN4 : blue ink, ball point drawing instrument (OC4).

The operator chooses which receptacles are to go with which type of drawing instrument OCi, and how many drawing instruments of the same type are to be kept in the store. This last choice is made in view of maximising the autonomy of the plotter when the latter is used in conjunction with an internal wear management program that monitors each drawing instrument and, whenever one of them reaches the end of its useful life, commands its replacement by an automatic exchange with another instrument of the same type. Accordingly, for each type of drawing instrument, the number of instruments to use is chosen as a function of that instrument's lifetime and an estimation of the total distance to be traced by that type of instrument.

In the example, the number of drawing instruments OC1 to OC4 for groups GN1 to GN4 are respectively two, one, three and two. The total number of instruments is made equal to the number of receptacles in the store, to exploit its full potential.

The drawing instruments of a same group are physically located in adjacent receptacles of the store, and the group memory block 35 records a table of correspondance between these groups and the receptacles to which they are assigned. In the present example, the receptacle identified by L1 is assigned to the first OC1-type instrument of group GN1, then receptacle L2 is assigned to the second OC1-type instrument of that group, and so on. The data recorded in the memory thus contain the

following information :

Group GN1 : L1 or L2 (receptacles for OC1-type instruments)

Group GN2: L3 (receptacle for the OC2-type instrument)

Group GN3 : L4 or L5 or L6 (receptacles for OC3-type instruments)

Group GN4 : L7 or L8 (receptacles for OC4-type instruments).

The definition of groups thus consists in loading the group memory 35 with the above table of correspondance between receptacles Lk of the store and the identification numbers of the groups of instruments GNi.

The information contained in the group memory 35 enables the CPU 30 to select a specific receptacle of the store in response to the graphics data received. Where a group gives a choice between several receptacles, as is the case with groups GN1, GN2 and GN3, the choice will depend on the state of wear of the drawing instruments in those receptacles, and follows a predetermined order, such as a progression starting from the receptacle Lk having the lowest k value. The state of wear of the instruments is recorded in an instrument trace logging memory 37, which totalises the total length traced by the instruments associated with each of the receptacles Lk. When the totalised value for an instrument associated with a receptacle Lk exceeds a wear limit that is programmed at the level of the CPU 30 according to the specific wear characteristics of the tool, the CPU 30 replaces that instrument by another of the same type contained in the next receptacle.

There shall now be explained how the groups of drawing instrument receptacles in the store can be defined according to different embodiments of the invention, starting with figure 4 which is a general three-quarter view of an instrument store equipped with group definition means.

The store 24 is in the form of a carrousel having a peripheral body 40 depending from a central sleeve 42 at the level of a base portion 50. The individual receptacles for the drawing instruments 10 are uniformly distributed around the periphery of the body 40 and are defined by recesses 44 opening radially towards the outside. Each instrument is positioned vertically in its respective receptacle by means of a rest 46. The latter is in the form of a horizontal stepping surface formed in the wall 44b of the receptacle and cooperating with a ring 10a on the writing instrument 10. The instrument is held in place within its receptacle by means of a tab (not shown) projecting vertically upwards from the outside edge of the rest 46 and engaging a groove formed in the base of the ring 10a. In an instrument exchange operation, as described in patent document FR-A-2 624 794, the plotting head withdraws a selected instrument by effecting a horizontal displacement such that the clamp 12 engages the instrument's body by resilient deformation of the two clamp branches, followed by an upward vertical displacement to free the ring 10a from the tab engaged therewith. An instrument is stowed in its receptacle by carrying out the same movements in reverse.

The upper end of each drawing instrument 10 (i.e. the end opposite the tip) rests laterally at the bottom of a recess 44a formed in an upper crown section 48 of the carrousel. The lower end of each instrument also rests on conical recess 44c formed in the base 50.

The carrousel is mounted onto the plotter by engagement of its sleeve 42 on a supporting axle.

The group definition means are integrated to the carrousel 40 at the level of the base 50 and comprise programming elements in the form of toggles 60. Each interval between two adjacent instrument receptacles is provided with a toggle 60 that can slide along an opening 52 formed in the base 50. The toggle has an upper portion forming a tip that projects through the base so as to be externally visible.

Depending on whether it is positioned at one side of the opening 52 or the other, the toggle 60 indicates if the adjacent instrument receptacles belong to the same group or not, with the tips giving the operator a visual indication of the receptacle groups defined in the carrousel 24, even when the latter is its working position. The positions of the toggles are detected by electro-optical means.

As shown in figures 5 and 6, the base 50 has an upper annular horizontal face 50a in which the openings 52 are formed, and which is prolonged by an outer vertical rim 51 turned towards the bottom. A crown-shaped vertical inner annular wall 54 is also formed beneath the upper face 50a, in the region of the openings 52.

The internal face of the outer rim 51 contains a peripheral geared portion 53 that engages with a pinion 55 coupled to the shaft of the carrousel's drive motor 26. The latter is a stepper motor for which each step corresponds to a pulse controlled by the CPU 30.

The inner annular wall 54 has respective cut-outs 56 each corresponding to a respective opening 52. An additional cut-out 57 is formed in the inner annular wall 54 to define an angular reference position, which may e.g. correspond to that of receptacle L1. This cut-out 57 distinguishes from the other cut-outs 56 by its larger width.

Each toggle 60 (figures 6 and 8) is connected with a clip-shaped element 62 comprising two parallel wing members 62a, 62b joined together at their lower ends by a base 64. One of the wing members 62a is taller than the other 62b, so that

its top end projects through the opening 52 to form the aforementioned visible tip. The top end of the other wing member 62b has a finger or catch 68 turned towards the inside.

The clip 62 is fitted on the inner annular wall 54 by passing the two wing members 62a, 62b on either side from its lower edge. The wing members 62a, 62b spread apart from each other by resilient deformation until the catch 68 comes to press against the upper edge of the inner annular wall 54, inside the opening 52, as shown in figure 6 (only one clip 62 is shown for the sake of clarity).

As shown in figure 8, the base 64 of the clip 62 is prolonged on either side of the wing members 62a, 62b -to form a manoeuvering tab that is accessible for sliding the toggle 60 from one end of the opening 52 to the other. The upper surface 64a, 64b of the base is designed to slide against the lower edge of the inner annular wall 54. Each end of the manoeuvering tab comprises a boss 65a, 65b for blocking the clip 62 in each of its two sliding positions by engagement in one or the other of two pairs of notches 55a, 55b and 55'a, 55'b respectively, formed in the lower edge of the inner annular wall 54. The clip 62 is manoeuvered by the central part of its base, beneath the wing members 62a, 62b. The maintenance of the toggle in one or the other of its positions is further ensured by the resilient clamping force exerted by the wing members 62a, 62b on the inner annular wall 54.

The wing members 62a, 62b contain respective aligned windows 66a, 66b that are substantially the same size as the cut-outs 56. The mutual dispositions of the openings 52, cut-outs 56, toggles 60 and windows 66a, 66b are such that when a toggle 60 is at a first end of its travel in its corresponding opening 52, the windows 66a, 66b are aligned with the cut-out 56, while when the toggle is at the second end of its travel in the opening 52, the cut-out 56 is shut off by solid portions of the wing members 62a, 62b at one side of the windows 66a, 66b.

An electro-optical detector is fixedly mounted on the plotter and comprised of a transmitter 70 and detector 72 located at respective sides of the inner annular wall 54 and the clips 62. In a read mode, the carrousel 24 is driven into rotation, whereupon each time a clip 62 passes before the detector, the latter delivers a first or second signal depending on whether the clip is in its first or second position, namely whether the windows 66a, 66b are aligned with the cut-out 56 and allow the light beam to pass from the transmitter 70 to the receiver 72, or whether the windows are not aligned with the cut-out 56 so that the light beam is interrupted by the clip.

The electro-optical detector also detects the passage of cut-out 57, the signal in this case being longer than that produced in response to passage of cut-out 56 as seen through the windows 66a, 66b.

Advantageously, the location of each opening 52 relative to the two drawing instruments on either side thereof is chosen such that when the toggle 60 is at the first position P1, indicating that the two instruments belong to the same group, its projecting tip is at least partially hidden behind one of the instruments. Conversely, the projecting tip is chosen to be clearly visible when the toggle 60 is at the position P2 indicating a separation of groups between the two instruments. This allows an operator to quickly determine the distribution of drawing instruments in the carrousel by locating the visible projecting tips of the toggles. Such an arrangement for the openings 52 and drawing instruments 10 can be seen in figure 9, which shows an example of how groups of receptacles are set by the toggles 60 in the carrousel 24.

Figure 9 is a schematic illustration of the toggles 60a to 60h placed in either the first position (P1) or second position (P2) at intervals between the receptacles L1 to L8 of the carrousel, so as to define define the groups GN1 to GN4 according to the example of figure 3.

Toggle 60a, which is located between receptacles L1 and L2, is at position P1 so as to establish that these two receptacles belong to the same group GN1. This group comprises only two OC1-type instruments. Accordingly, a separation is established between receptacles L2 and L3 by placing the toggle 60b between the receptacles L2 and L3 at position P2.

Receptacle L3 is the sole member of the second group GN2. A separation will therefore be established with respect to its neighbour L4, by placing toggle 60c between receptacles L3 and L4 at position P2.

The same procedure is used to define group GN3, which is composed of three OC3-type instruments at receptacles L4, L5 and L6, and group GN4, which is composed of two OC4-type instruments at receptacles L7 and L8.

The data thus encoded by the toggles 60a to 60h are read out by setting the carrousel into rotation in an arbitrary direction (arrow F), so that each clip passes across the electro-optical detector 70, 72.

It can be appreciated that a reliable readout of the data encoded by the toggles 60 will depend, among other things, on the stability of the carrousel as it is driven into rotation. Indeed, the signals obtained by the electro-optical detector 70, 72 must correspond precisely with carrousel's displacement steps determined by motor 26, as explained in more detail with reference to figures 10 and 11.

Accordingly, it is important to make sure that the instrument carrousel 24 is correctly guided and supported during the rotational movements, which often involve high accelerations and decelerations, as well as when it experiences radially-directed forces during changes of instruments. The latter forces are produced by the mechanical contact between the store and the plotting head 14, via the instrument being exchanged. When an instrument is returned to or withdrawn from its receptacle, it exerts on the rest 46 a lowering force or lifting force respectively, as well as a transversal movement. Furthermore, the rotational axis of the carrousel 24 must be correctly maintained in spite of any mass imbalance resulting from an incomplete loading of drawing instruments.

There shall now be described a means for guiding the store 24 that satisfies the above-mentioned requirements while remaining mechanically simple and economic to manufacture.

As shown in figure 6, the carrousel 24 is received on a central axle 58 attached to the chassis 53 and rotatably mounted around the axle by means of a bearing 59 that is unitary with the central sleeve 42. The carrousel is guided by two fixed studs 49 attached to the chassis of the plotter and designed to abut against a portion of the under surface 51a of the base 50 that forms a frusto-conical ramp close to the geared portion 53. The contact point of a stud 49 is on a dome-shaped end surface. The ramp 51a is concentric with the store's axle.

As can be seen from figure 7, which shows very schematically a plan view of the elements forming the carrousel's drive and guiding system, each of the two studs 49 is angularly separated from the point where the pinion 55 meshes with the geared portion 53 by at least 90° around the axle 58. Consequently, the contact point of each of the studs presses against the ramp 51a with a thrust Rp having a horizontal component Rh tending to compensate the force exerted by the pinion along the radial direction n at the point where it contacts the geared portion 53.

The above horizontal force component Rh is a function of the angle of inclination α of the ramp 51a (figure 6, half-angle at the apex of the cone containing the surface of the ramp), the coefficient of friction at the contact points between the studs 49 and the ramp 51a , and the weight of the carrousel 24. As a general indication, the optimum angle α is in a range of 30° to 60° for the example considered. Advantageously, the above parameters can be determined as a whole so as to produce a self-alignment of the carrousel when the latter is slightly offset in the axial direction. This can be the case when the carrousel 24 is being received by the axle 58, to allow easy engagement of the geared portion 53 with the pinion 55. The studs 49 then abut against the ramp 51a before the carrousel settles into place. The sliding movement of the ramp 51a against the studs under the weight of the carrousel 24 can thus take up any play in the pinion-to-gear interface and ensures proper alignment of the carrousel with respect to its rotational axis, by a balance of forces exerted by the studs and the pinion.

Such a guiding system can also rapidly damp the vibrations induced by jittering movements from the plotting head 14 and sheet displacement drum 4. The vibrations will be all the more limited as the horizontal plane connecting the thrust points of the studs 49 and the plane passing through the centre of the pinion 55 are made close to each other.

The studs 49 and the pinion 55 together thus form stable equilibrium points for supporting the store around the central axle 58. Naturally, it can be envisaged to provide more than two studs to abut against the ramp 51a. Moreover, it is clear that the balance of thrust forces exerted by the studs 49 and the pinion 55 can be achieved with just one stud situated at more than 90° from the pinion 55 around the axle 58.

The guiding system can be implemented not only with a pinion-and-gear drive, as in the present example, but more generally with any drive means involving a contact between a peripheral path on the store and a rotating element, such as a pressure roller driven by a motor fixed on the plotter's chassis.

There shall now be explained with reference to figures 10 and 11 how the group programming data are loaded into the group memory 35 of the control unit from the signals collected by the detector 70, 72.

Figure 10 is a time chart showing the signal S obtained from the detector after a signal shaping stage. Logic levels 1 and 0 respectively correspond to a detection and a non-detection of the beam by the receiver 72. In a complete rotation of the carrousel, the signal S comprises a reference pulse Iref corresponding to the passage of the reference cut-out 57 before the detector 70, 72, and pulses I corresponding to the passage of those clips 62 whose ergots are in a position P1 or in the inverse P2, before the detector.

The steps for the recordal of group definition data are carried out by a computer program as described below with reference to the flow chart of figure 11.

First, the reference cut-out 57 is searched for by rotating the carrousel 24 using control pulses sent to the stepper motor 26. The carrousel is rotated until detection of a pulse having a pulsewidth exceeding a predetermined threshold in the signal S. The widths of the pulses in signal S

are measured by counting the number of clock pulses in the control unit from the detection of a logic level transition from 0 to 1, to the following opposite transition. Upon detecting that the pulsewidth threshold is exceeded, the carrousel is stopped at the following transition from level 1 to level 0, i.e. the falling slope of the Iref pulse. This position corresponds to an angular reference position of the carrousel with respect to the plotter. In this case, the reference cut-out 57 is aligned with receptacle L1, i.e. the vertical centre-line of the latter coincides with the rear edge of the cut-out 57 in the carrousel's rotation direction. The carrousel's angular reference position is therefore the one where the optical axis of the detector is substantially in the median plane of receptacle L1.

Assuming that the angular separation between the position of photoelectric detector and the instrument transfer position at the end-travel point of the plotting head are known, as is also the angular position of each drawing instrument receptacle in the carrousel, it is clear that any receptacle can be brought to the transfer position by sending a calculated number of control pulses to the drive motor 26.

The recordal of the group definition proper thus begins with the carrousel at its reference position and the parameters i and k (representing the group and receptacle numbers respectively) both set to 1 (step 100). There is then recorded into the memory 35 data establishing that receptacle Lk belongs to group Gi (step 101).

Next, it is checked (test 102) whether i is less than the total number NL of receptacles in the carrousel (in the present example, NL = 8).

Then, the carrousel drive motor 26 is started (step 103) and the control pulses sent thereto are counted (step 104).

At each motor control pulse, a sub-routine 105 is performed to detect the state of signal S. If a logic level 1 is detected, a register S is set to 1.

When the content IM of a motor control pulse counter reaches a value N corresponding to an angular displacement equal to the pitch between two receptacles (test 106), the above counter is reset to zero (step 107) and the content of register S is examined (test 108).

If S is equal to 1, register S is reset to 0 (step 109) and values i and k are incremented by one unit (step 110), signifiying a passage to the next group and to the next receptacle, respectively. If S is equal to 0 at test 108, only the k value is incremented by one unit (step 111).

The process then returns to step 101 for recording the information specifying that receptacle Lk belongs group Gi.

The automatic data recording process is terminated when the condition i = NL is detected at test 102.

It will be noted that the above scheme rests on the assumption that receptacle L1 defines the beginning of a group, and that there is necessarily a group separation between receptacles L1 and L8. Accordingly, no notice is taken of the information carried on toggle 60h. However, the program parameters can easily be modified to accommodate for an additional degree of freedom in the partitioning between receptacles L1 and L8, by taking into account the position of toggle 60h.

The material aspects of the invention allow for many variants that are within the reach of the skilled person.

For instance, the aforementioned arrangement based on the use of a electro-optical detector 70, 72 cooperating with cut-outs associated to intervals between instrument receptacles can also be implemented with shutters other than slidable clips 62, such as vertically retractable shutters, or even removable shutters.

This latter variant is illustrated in figure 12, which shows very schematically a plan view through the upper horizontal face 50a of the carrousel's base 50. The identification elements are in the form of removeable masks 90 that can be clipped onto the inner vertical annular wall 54 at the level of an opening 52, so as allow selective closing off of the cut-outs 56.

Each mask 90 is fitted with grippable tab 92 for handling and also to provide a visual indication of the mask on the carrousel.

In another variant of the present invention, the electro-optical detector 70, 72 are replaced with a feeler type sensor. In this ease, the identification means take the form of contact elements associated with intervals between the receptacles.

The contact elements can be removable devices having a contact surface with slight protruberances in relation to the outer surface of the vertical annular wall 54. The corresponding detector comprises a feeler arranged to follow the outer surface while the carrousel is made to rotate. The detection of the contact surfaces is then effected by analysing the transitions in the pressure exerted on the feeler.

Alternatively, the identifying means can be in the form of magnetic substrates on which are recorded a first item of data indicating that the receptacles on either side of interval in which it is situated belong the same group, or a second item of data indicating that these receptacles belong to distinct groups. In such a variant, the detection means comprise a magnetic reading head fixed to the plotter chassis and arranged to detect the above first and second items of information on the magnetic substrates.

It can be noted that all the above variants are also amenable for the detection of the reference receptacle L1 using similar means.

In the examples described, each identifying element can only adopt two different states, indicating whether or not the receptacles adjacent thereto belong to the same group. However, the invention is not restricted to such binary devices. Indeed, it is relatively simple to design identification elements that carry not just binary data, but more complex information for sending to the control unit 30 by any known means. In particular, such elements could be associated with respective receptacles rather than the interval between the receptacles, in which case they could identify which specific group the corresponding receptacle belongs to, as well such information as the order in which the instruments of a particular group are to be used.

Other means can be envisaged for encoding this more complex information, such as bar code labels associated with each receptacle and readable by a bar code reader connected to the CPU 30. The bar codes can also be replaced by colour codes or embossed coded surfaces readable by a feeler sensor.

Claims

1. A pen plotter apparatus comprising:
- a plotting head (14) displaceable relative to a print medium (2),
- a store (24) for drawing instruments (10) comprising a plurality of individual drawing instrument receptacles (L1-L8), the receptacles being divided into a plurality of groups, each group comprising one or a plurality of receptacles and being assigned to a particular type of drawing instrument,
- means for automatically exchanging drawing instruments between the plotting head (14) and the instrument receptacles of the store (24), and
- a control unit (30) adapted to receive graphics data (DG) concerning traces to be plotted, for controlling relative movements between the plotting head and the print medium so as to produce a plot thereon corresponding to the information contained in the received graphics data (DG), and for controlling a selection of a drawing instrument as a function both of information contained in the graphics data (DG), which information identifies a particular type of instrument, and of information identifying the receptacles of the store that are assigned to a same type of instrument,

characterized in that the drawing instrument store (24) contains means (60; 90) for identifying the instrument receptacles (Lk) that belong to a same group (GNi) of receptacles, and in that the plotter comprises detection means (70, 72) operatively cooperating with the identification means to supply the control unit (30) with information defining the groups (GNi) of instrument receptacles formed within the instrument store.

2. Pen plotter apparatus according to claim 1, wherein the identification means (60; 90) are associated with intervals between the receptacles (L1-L8), and wherein each identification means can adopt one or the other of at least two states respectively indicating whether two receptacles on either side of the corresponding interval belong to a same group or whether the two receptacles belong to distinct groups, the detection means (70, 72) being capable of detecting the states of the identification means.

3. Pen plotter apparatus according to claim 2, wherein the identification means are moveable elements (60) that can adopt at least two different positions and which cooperate with detection means (70, 72) capable of detecting the position of each identification element.

4. Pen plotter apparatus according to claim 3, wherein the detection means (70, 72) are of the electro-optical type.

5. Pen plotter apparatus according to claim 4, wherein a cut-out (56) is formed in a part (54) of the drawing instrument store (24) in correspondance with each instrument receptacle (L1-L8), and wherein the identification elements comprise shutter elements (62; 90) for selectively occluding the cut-outs (56).

6. Pen plotter apparatus according to claim 1, wherein the detection means comprise a feeler sensor for detecting the positions of the identification elements by contact therewith.

7. Pen plotter apparatus according to claim 1, wherein the identification means comprise data support media located on the drawing instrument store, and the detection means comprise means for reading out information carried by the identification means.

8. Drawing instrument store (24) for a pen plotter comprising a plurality of instrument recepta-

cles (L1-L8), characterized in that it comprises means (60; 90) for identifying the instrument receptacles (Lk) that belong to a same group (GNi) of receptacles, in order to define a distribution of instrument receptacles into different groups.

9. Drawing instrument store according to claim 8, wherein the identfication means (60; 90) are associated with intervals between the receptacles (L1-L8), and wherein each identification means can adopt one or the other of at least two states respectively indicating whether the two receptacles on either side of the corresponding interval belong to a same group or whether the two receptacles belong to distinct groups.

10. Process for defining groups (GNi) of drawing instruments in an instrument store (24) for a pen plotter apparatus, the store having individual receptacles, comprising the steps of:

- assigning the instrument receptacles of the store (24) into different receptacle groups, and
- sending data corresponding to the assignment to a control unit (30) of the plotter apparatus,

characterized in that it further includes the steps of:

- identifying the groups (GNi) of drawing instrument receptacles using identification means (60; 90) arranged at the level of the instrument store, the identification means being capable of adopting at least two different states, and
- detecting the states of the identification means to supply the control unit with information defining the groups of instrument receptacles formed in the store.

11. Process according to claim 10, further comprising the steps of:

- providing each identification means (60; 90) at an interval between two adjacent instrument receptacles (L1-L8) for indicating whether or not the two adjacent receptacles belong to a same group (GNi), and
- detecting the states of the identification means (60; 90) by displacing the instrument store (24) relatively to the detection means (70, 72) fixed to the pen plotter apparatus.

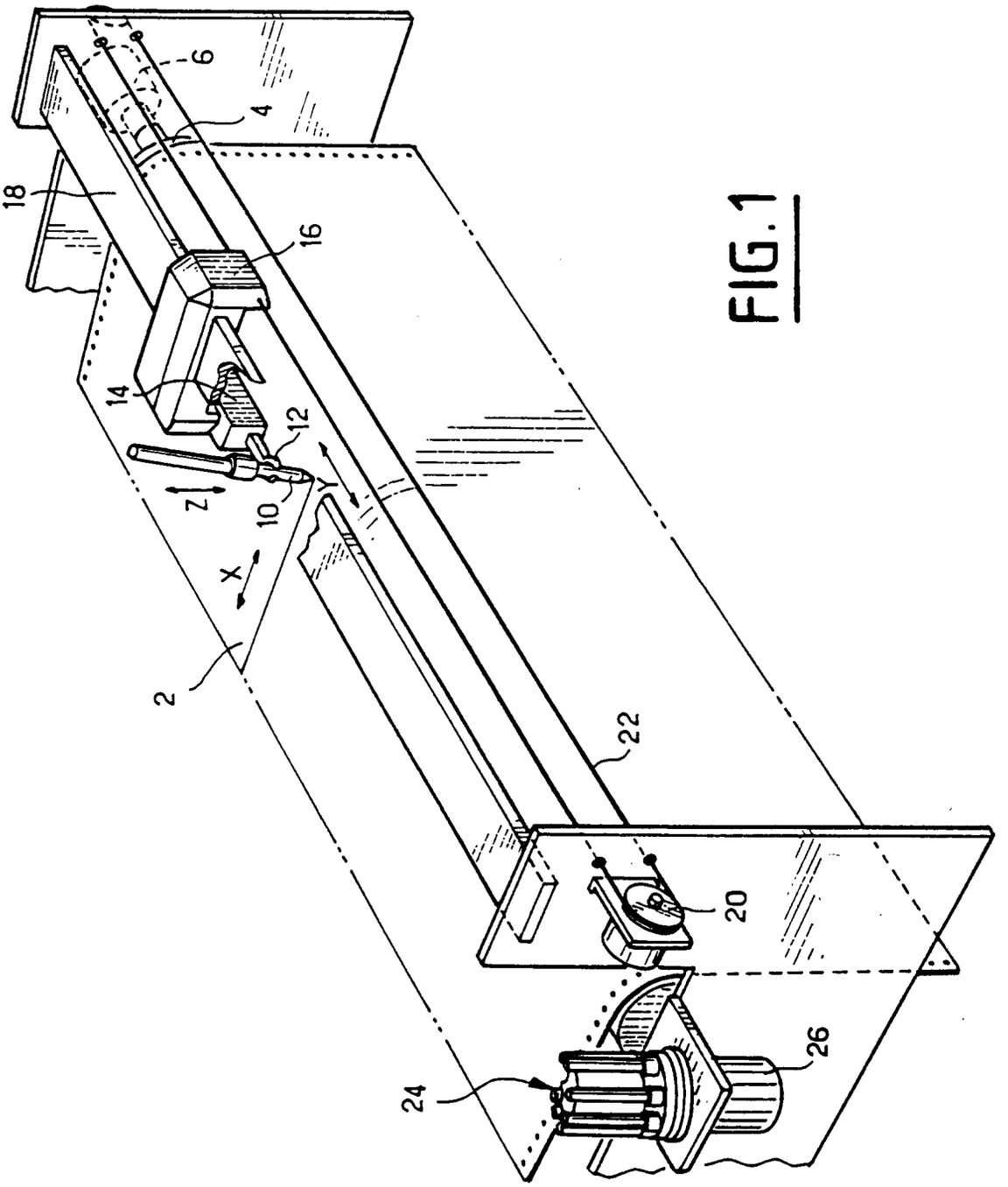


FIG.1

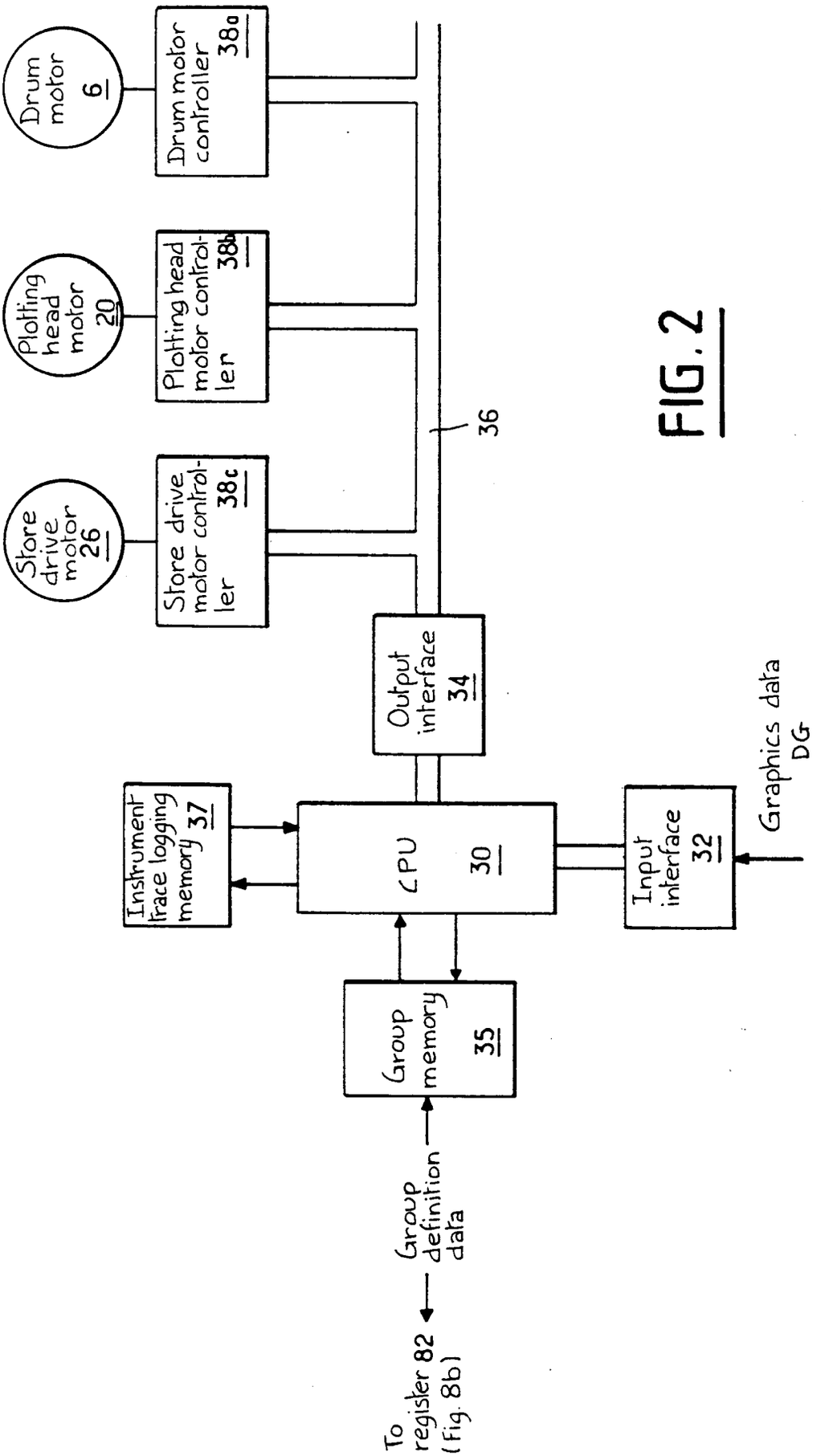

Drum motor 6
Drum motor controller 38a
Plotting head motor 20
Plotting head motor controller 38b
Store drive motor 26
Store drive motor controller 38c
36
Output interface 34
Instrument trace logging memory 37
CPU 30
Input interface 32
Graphics data DG
Group memory 35
Group definition data
To register 82 (Fig. 8b)

FIG. 2

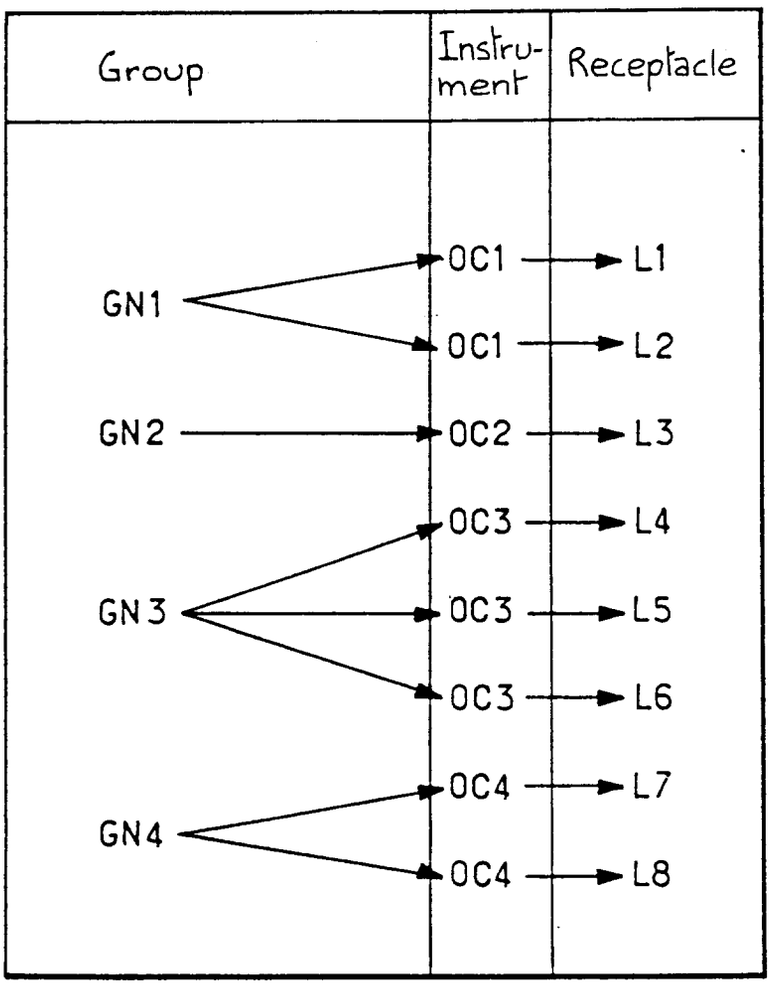

Group
Instru-ment
Receptacle
GN1
GN2
GN3
GN4
OC1
OC1
OC2
OC3
OC3
OC3
OC4
OC4
L1
L2
L3
L4
L5
L6
L7
L8

FIG. 3

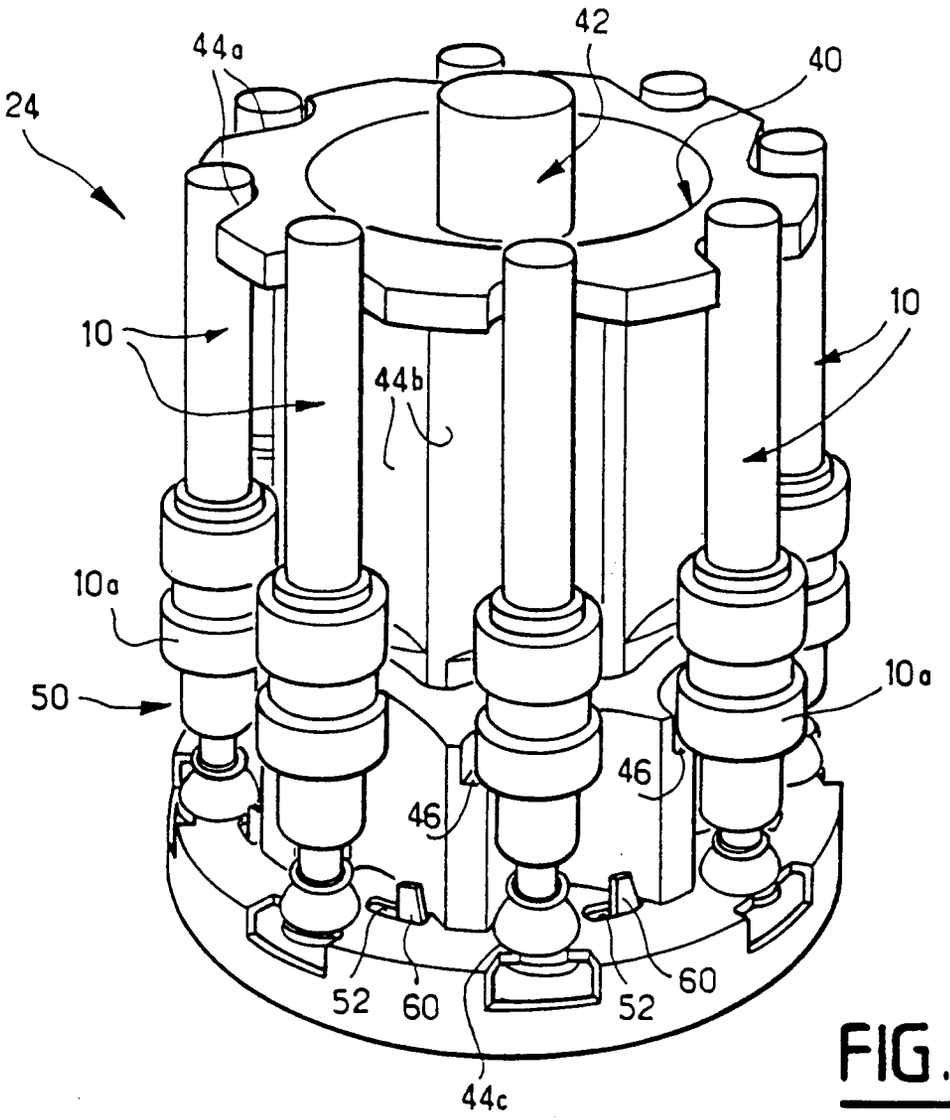

42
44a
40
24
10
10
44b
10a
10a
50
46
46
52
60
52
60
44c

FIG. 4

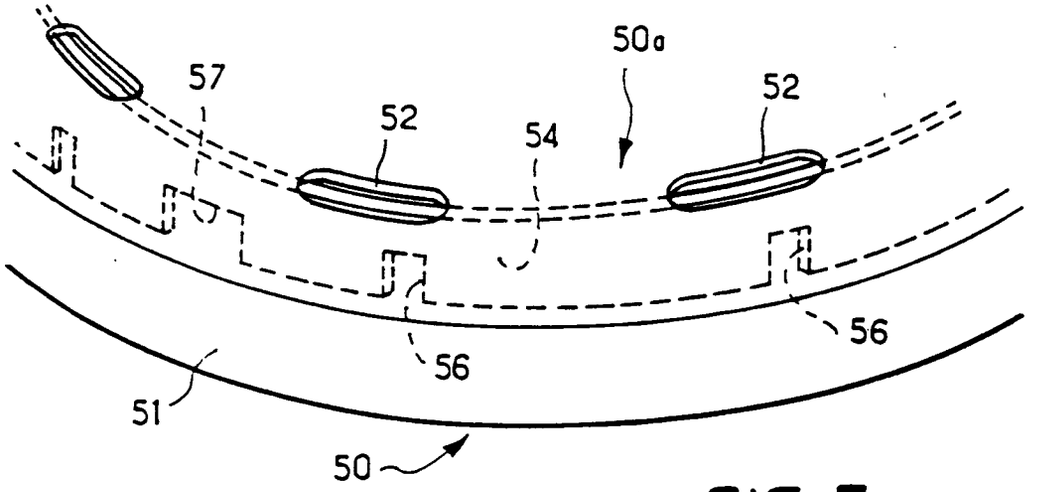

50a
57
52
52
54
56
56
51
50

FIG. 5

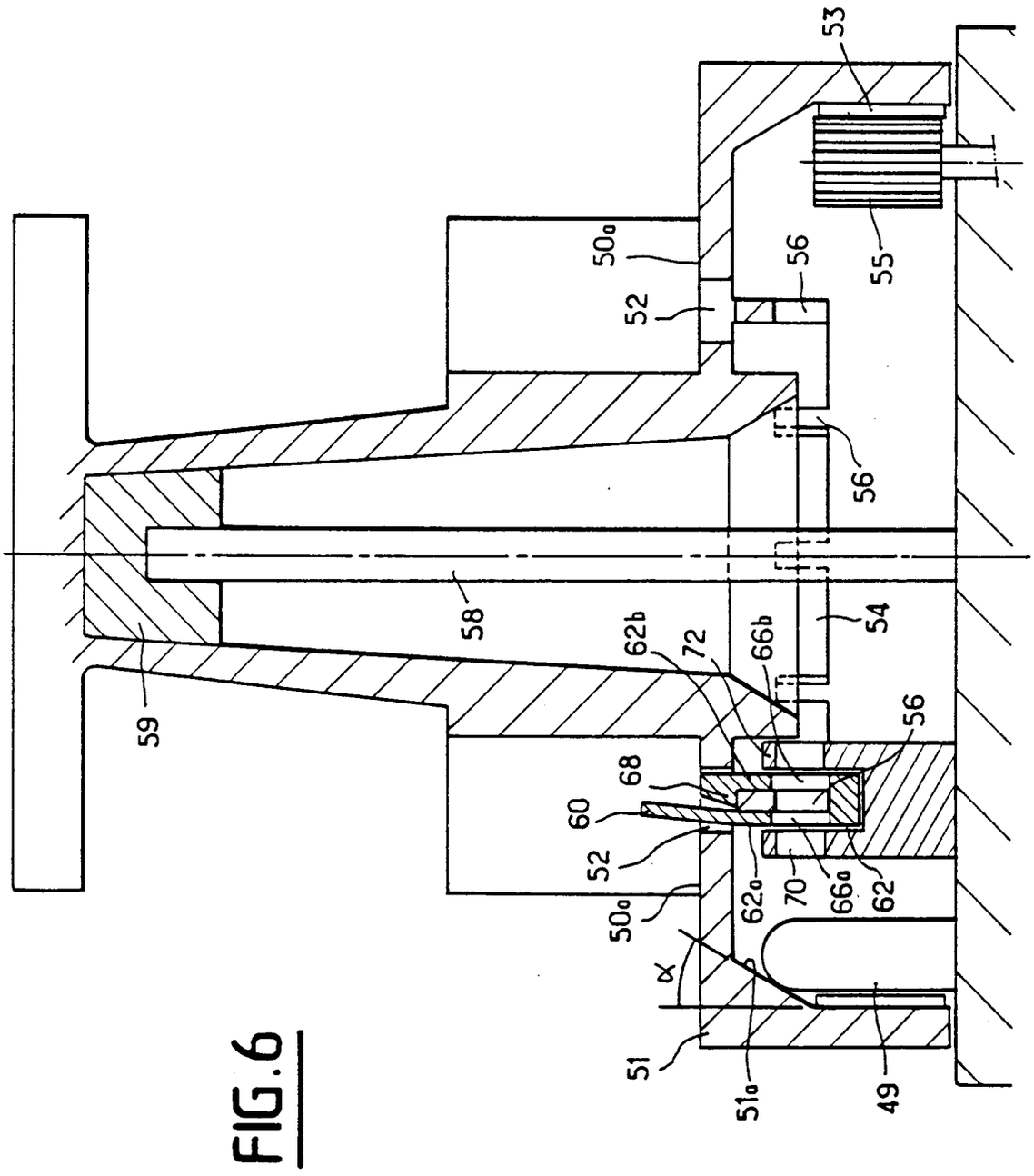

53
55
50a
56
52
56
58
54
62b
72
66b
56
59
68
60
52
62a
70
66a
62
50a
α
51
51a
49

FIG.6

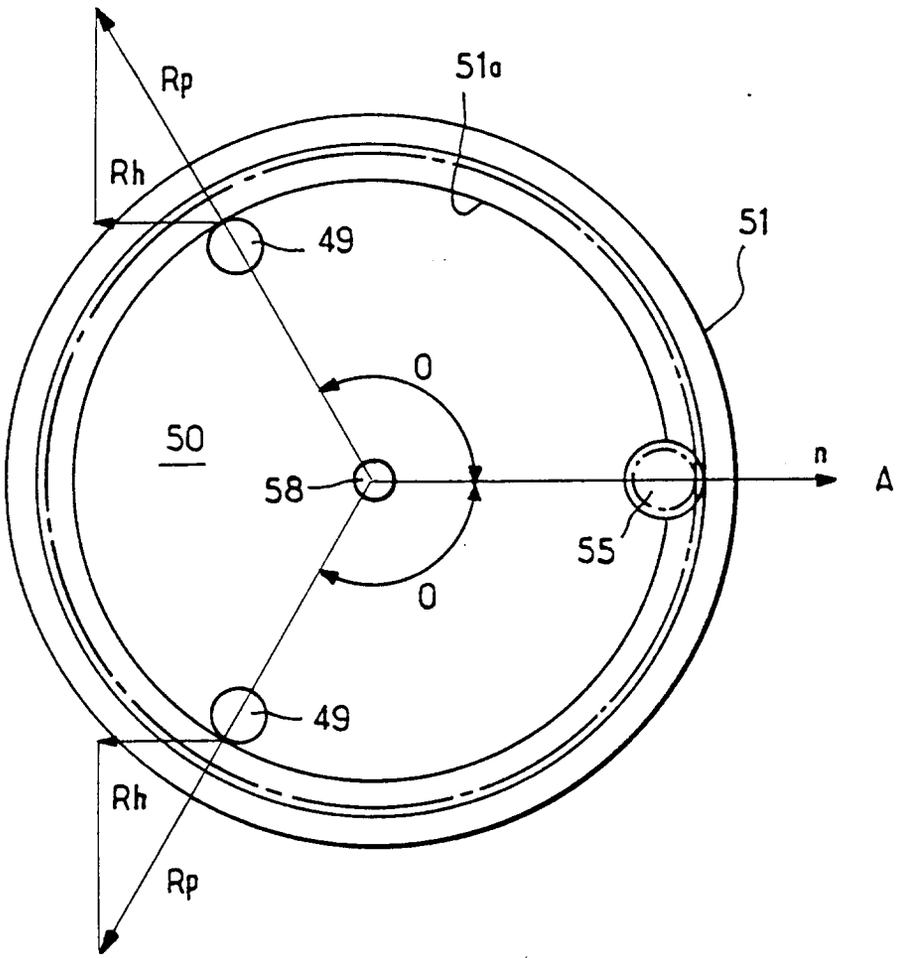


FIG. 7

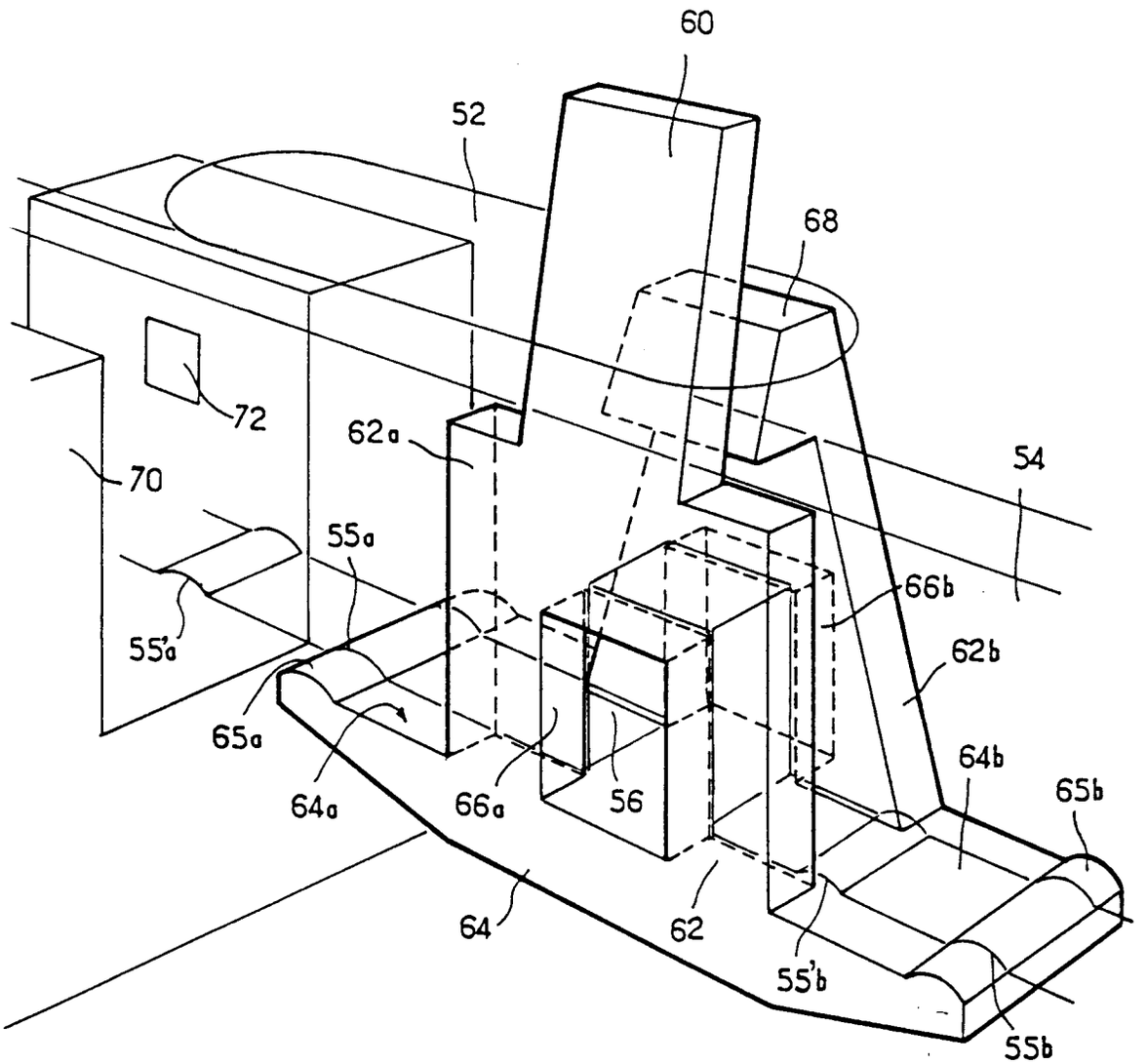
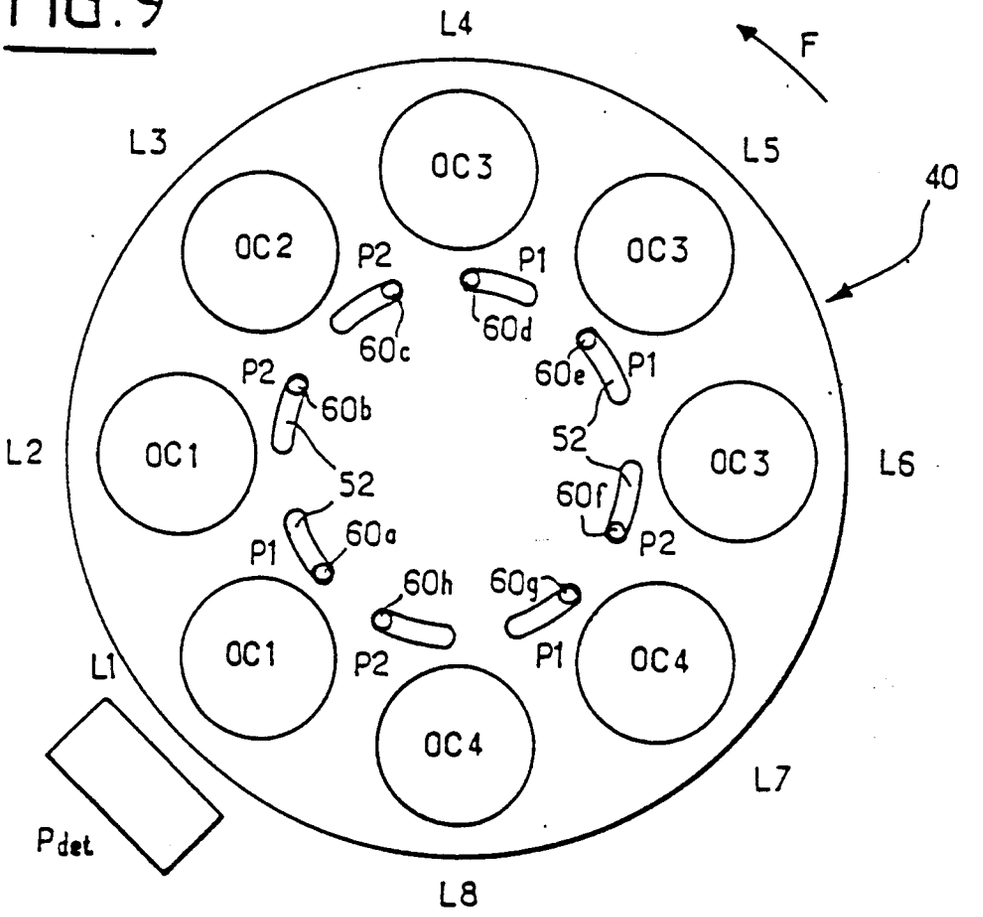

60
52
68
72
70
62a
54
55a
55'a
66b
62b
65a
64a
66a
56
64b
65b
64
62
55'b
55b

FIG.8

FIG.9


L4
F
L3
L5
40
OC3
OC2
P2
P1
OC3
60c
60d
P2
60e
P1
60b
L2
OC1
52
OC3
L6
52
60f
60a
P2
P1
60h
60g
OC1
P2
P1
OC4
L1
OC4
L7
Pdet
L8

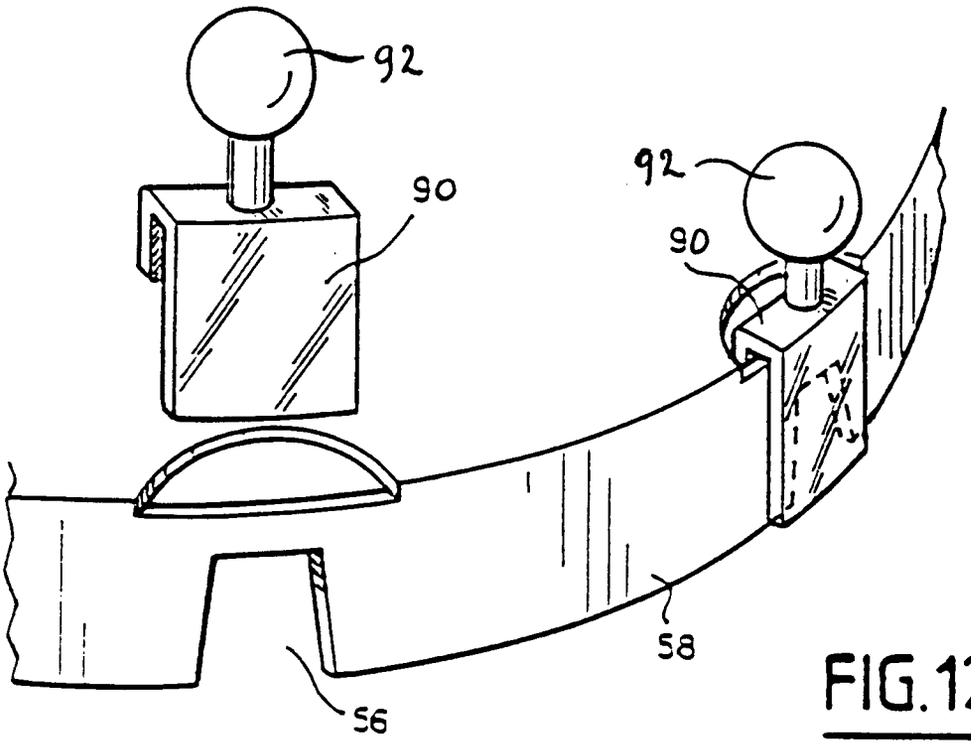

92
90
92
90
58
56

FIG.12

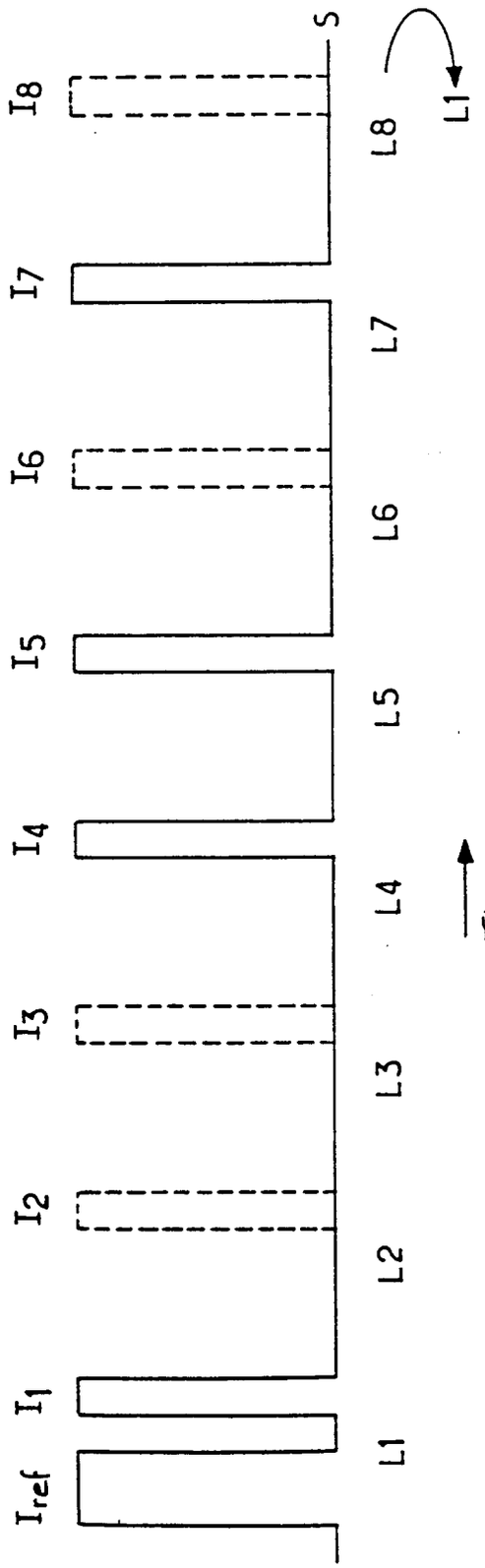
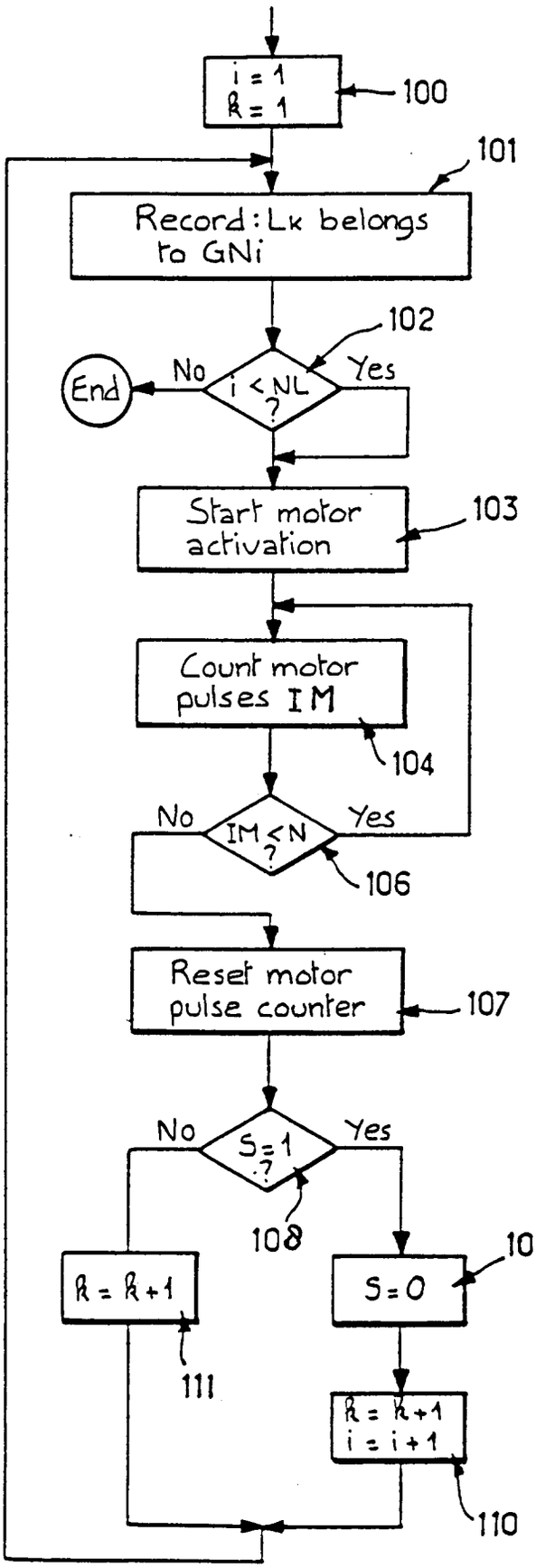


FIG.10


i = 1
k = 1
100
101
Record: Lk belongs to GNi
102
No
i < NL ?
Yes
End
Start motor activation
103
Count motor pulses IM
104
No
IM < N ?
Yes
106
Reset motor pulse counter
107
No
S = 1 ?
Yes
108
109
k = k+1
S = 0
111
k = k+1
i = i+1
110

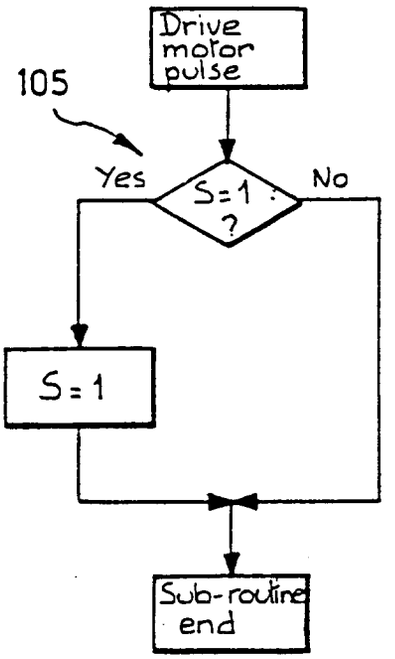

Drive motor pulse
105
Yes
S = 1 ?
No
S = 1
Sub-routine end

FIG.11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 20 0078

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.5)
X Y	US-A-4 677 572 (GUNDERSON ET AL.) * column 6, line 52 - column 7, line 43 * * abstract; figures 1,2,9-14 *	1,4,8,10 2,3,5,7,11	B43L13/02
Y	US-A-4 754 288 (LAWRENCE) * column 3, line 66 - column 4, line 63; figures 3-6 *	2,3,5,7,11	
X	IBM TECHNICAL DISCLOSURE BULLETIN vol. 32, no. 3B, August 1989, pages 265 - 269 , XP29856 IBM * the whole document *	1,4,8,10	
A A,D	EP-A-0 322 307 (SCHLUMBERGER INDUSTRIES) * abstract; figures 1-3 * & FR-A-2 624 794	1	
A	US-A-4 920 357 (JOHNSON) * abstract; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B43L B43M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 APRIL 1993	PERNEY Y.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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