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3,259,254

MOTION DEVICE

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3 Sheets-Sheet 1

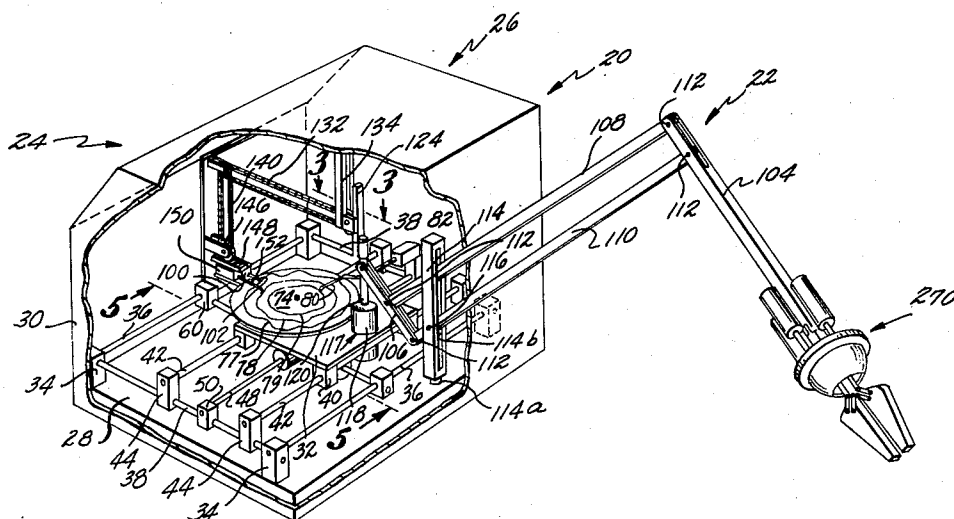


FIG. 1

FIG. 2

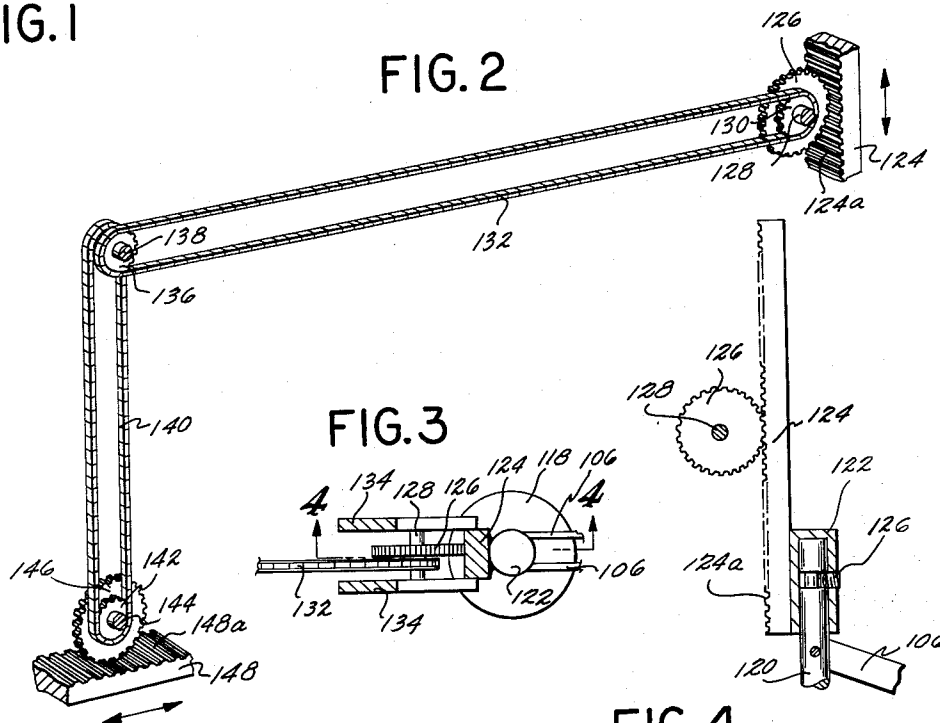


FIG. 3

FIG. 4

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FIG. 8

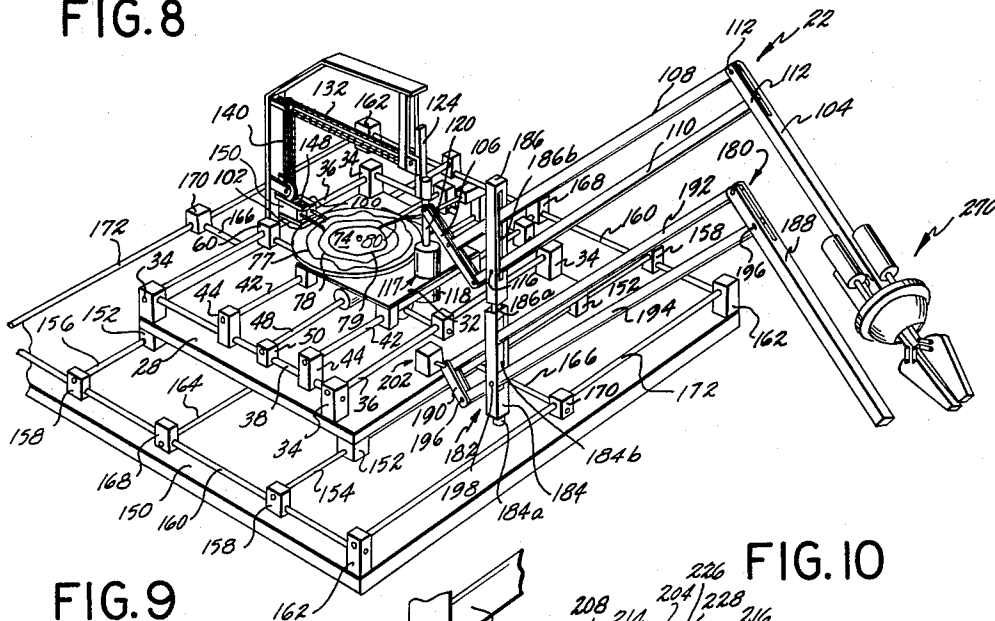


FIG. 9

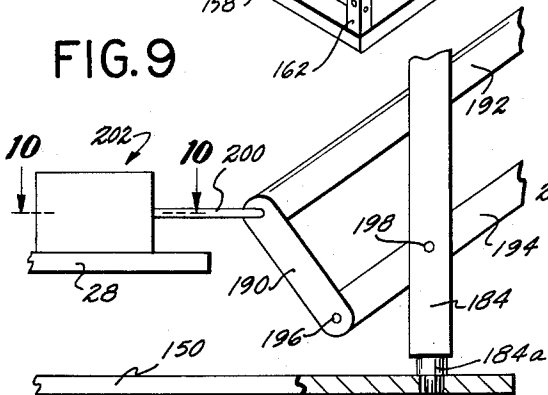


FIG. 10

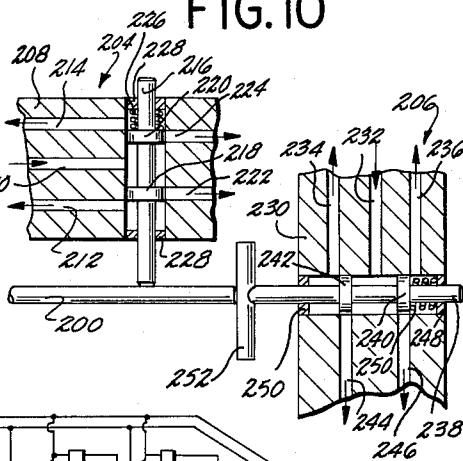
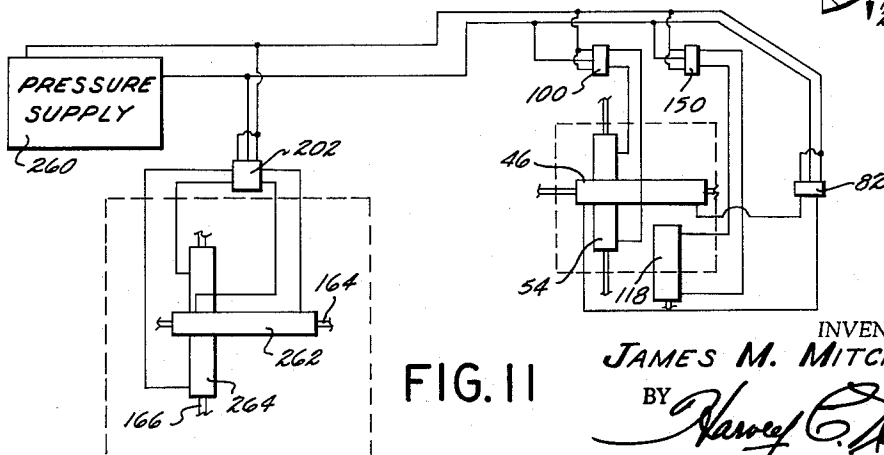


FIG. 11

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MOTION DEVICE

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18 Claims. (Cl. 214—1)

The present invention relates generally to motion devices, and more particularly to mechanisms and apparatuses for automatically performing certain work functions.

Scientific and technological advances have been so profound within the past several decades, that automation is a sought-after ingredient in virtually every phase of man's existence. This is, of course, particularly true in the United States where virtually all of the technological fields, such as manufacturing, communications, transportation and the like, have been developed to an extremely high standard. As a result, the importance of automatic work performing equipment of virtually any type and description has become extremely acute. That is, due to the fact that the economy of the United States is oriented toward the production of large quantities of goods within a short period of time, automatic equipment of virtually any kind finds immediate acceptance in the United States market place.

The economy of the United States, in fact, depends to a large measure on the ability to mass produce articles so as to reach a large number of consumers. These economic factors, of course, have resulted in the standard of living within the United States being considerably higher than that of virtually any other country in the world.

The many remarkable advances heretofore but recently made in the field of electronics has resulted in many different types of automatic work performing equipment. However, such electronic equipment is extremely expensive to manufacture and maintain due to the highly sophisticated nature of such equipment, and due to the fact that the average layman does not have sufficient knowledge and skill to perform the necessary repairs.

Such equipment utilizes many of the techniques now employed in electronic computers, such as magnetic information storage devices, such as magnetic tapes, magnetic drums and the like, and highly selective transducers for sensing different amounts of magnetic impulses. These and many other factors have contributed to the extremely high cost and to the extremely complicated nature of prior automatic work performing equipment.

Virtually any and every technological segment of our present day life has need for an uncomplicated and inexpensive mechanism for performing predetermined work functions. Prior to the present invention it was thought that such equipment should be primarily mechanical in nature so as to be capable of being repaired or modified by the great majority of workmen who presently make up our national work force. That is, whereas prior automatic work performing equipment has required persons who are highly educated and possessed of exceptional skills merely to repair such equipment, it has been realized that it would be extremely advantageous to have such automatic equipment which utilizes merely the average predominant skills for effecting repairs.

To this end, it is an object of the present invention to provide work performing equipment which is primarily mechanical in nature and hence utilizes merely average technological skills for purposes of repair.

Another object of the present invention is to provide work performing equipment as characterized above which can perform any desired, predetermined function.

A further object of the present invention is to provide work performing equipment as characterized above which

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utilizes mechanical recording means and electrical or hydraulic actuating devices, all of which are well understood by today's average technicians.

Another object of the present invention is to provide automatic work performing equipment which is capable of performing predetermined work motions relative to a given moving object.

Another object of the present invention is to provide work performing equipment as characterized above which is capable of following such object regardless of the path of movement thereof, and without the need to know such path of movement in advance.

A further object of the present invention is to provide automatic work performing equipment as characterized above which utilizes mechanical record discs having pre-formed grooves therein which constitute the pre-recorded intelligence for defining the desired motion.

Another object of the present invention is to provide automatic work performing equipment as characterized above which is extremely accurate and sensitive in performing the prescribed motions as set forth on the recordings.

A still further object of the present invention is to provide automatic work performing equipment as characterized above wherein any one of several different types of mechanisms may be utilized for transposing the pre-recorded motion intelligence into actual physical motion.

Another further object of the present invention is to provide automatic work performing equipment as characterized above which utilizes a pantographic work performing element.

Another object of the present invention is to provide automatic work performing equipment as characterized above which can be quickly and completely repaired by maintenance technicians who are possessed of relatively ordinary and predominant skills and abilities.

An even further object of the present invention is to provide automatic work performing equipment as characterized above which is simple and inexpensive to manufacture, and which is rugged and dependable in operation.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The device itself, however, both as to its organization and mode of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGURE 1 is a fragmentary perspective view of one form or embodiment of the present invention;

FIGURE 2 is a fragmentary perspective view of mechanical feedback means employed in the embodiment of FIGURE 1;

FIGURE 3 is a fragmentary sectional view taken substantially along line 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary sectional view taken substantially along line 4—4 of FIGURE 3;

FIGURE 5 is a fragmentary sectional view through one of the servo mechanisms used in the present invention, such view being substantially along line 5—5 of FIGURE 1;

FIGURE 6 is a fragmentary sectional view similar to FIGURE 5, but showing the certain parts thereof in different operating position;

FIGURE 7 is a bottom plan view of the movable platform of the embodiment of FIGURE 1;

FIGURE 8 is a perspective view of a second embodiment of the present invention;

FIGURE 9 is a fragmentary sectional view of a portion of the sensing means of the embodiment of FIGURE 8;

FIGURE 10 is one form of switch means which may be used in the sensing means of FIGURE 9; and

FIGURE 11 is a diagrammatic showing of a fluid pressure system for use in the second embodiment of FIGURE 8.

Like reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIGURE 1 of the drawings, there is shown therein a motion or work performing mechanism 20 which comprises work performing means 22 and control means 24 therefor.

Control means 24 may take any one of a variety of different forms, as will hereinafter become apparent from a complete understanding of the present invention.

The first embodiment of FIGURE 1 comprises an enclosure 26 which includes a base member 28 and a cover member 30. Within such enclosure 26 there is provided the control means for operating the work performing means 22. Such control means comprises a movable platform or table 32 which, as will hereinafter be explained, is afforded motion in at least two directions with respect to base member 28.

To provide such motion for platform 32, there is provided, as shown most clearly in FIGURE 7, guide members or rods which enable the platform to move in opposite directions along two axes at right angles to each other within a given plane parallel to base 28. Four stanchions or posts 34 are secured to base 28 at or near the marginal edges thereof. Such stanchions are formed with suitable openings for receiving guide members 36 which extend along the front and the rear of the control unit 26, and guide members 38 which extend along the opposite sides thereof. As shown most clearly in FIGURE 1 of the drawings, to accommodate various of the components to be hereinafter described, the guide members 36 are disposed at a higher elevation than the guide members 38.

Secured to the underside of platform 32 at or near the marginal edges or corners thereof are bearing members 40. Such bearing members are formed with through openings for slidably receiving guide rods 42, one of which extends through both of the bearing members 40 at the rear of platform 32, while the other guide rod 42 extends through both of the bearing members 40 at the forward edge of such platform.

The guide rods 42 are movably secured to the side guide members 38, the opposite ends of each such rod being connected relative to a separate one of such guide members by suitable bearing means 44. Thus, platform 32 by virtue of the bearing members 40 and guide rods 42 is permitted to move along such guide rods in opposite directions parallel with guide members 36. That is, such arrangement enables platform 32 to move sideways in opposite directions within the enclosure 26.

The bearing members 44 which connect the opposite ends of guide rods 42 to the members 38 are each formed with a through opening for slidably receiving such guide members. As such, the platform 32 is permitted to move parallel to the guide members 38 or in opposite directions from front to back with respect to the enclosure 26.

To move such platform 32 in the various directions, there is provided a servo mechanism for each such axis along which motion in opposite directions is to be afforded. That is, since the guide members 36 and 38 are disposed, as shown in FIGURE 7, to form a square or rectangle, the motion of platform 32 as afforded by the aforescribed mounting and guide means is along two axes at right angles to each other.

Such servo mechanisms may take substantially any desired form, many of such mechanisms being well known in the art today. For illustration of one form of hydraulic servo mechanism for use in controlling the movement of platform 32, reference will now be made to FIGURES 5, 6 and 7 of the drawings.

As shown in FIGURE 7, a hydraulic servo mechanism 45 for moving the platform from side to side within

enclosure 26 may comprise a hydraulic cylinder 46 secured to the undersurface of platform 32. An actuating or piston rod 48 extends through such cylinder and is connected to a movable piston within the latter. The opposite ends of piston rod 48 carry suitable bearing members as shown at 50 and 52 which slidably receive the guide members 38 so as to permit platform 32 to move in the forward and rearward directions within the enclosure 26.

In like manner, another hydraulic servo mechanism 55 is provided for moving the platform 32 in such forward and rearward directions. Such mechanism comprises a hydraulic cylinder 54 which is secured relative to platform 32, but which is disposed beneath hydraulic cylinder 46 or at a lower elevation with respect thereto as shown in FIGURES 5, 6 and 7. A suitable actuating or piston rod 56 extends through cylinder 54 and carries a piston which is slidable within the latter. The opposite ends of piston rod 56 carry bearing members 58 and 60 for permitting platform 32 to have sidewise motion relative to base 28.

Referring to FIGURES 5 and 6, it is seen that the hydraulic cylinder 46 is provided with closed opposite ends as shown at 46a and 46b, each of which is formed with a through opening for receiving the piston rod 48. As will be readily apparent to those persons skilled in the art, such openings may be provided with suitable packing or other fluid sealing means for preventing the hydraulic fluid (liquid or air) from escaping from cylinder 46. The piston carried by piston rod 48 is shown at 62 and is movable with respect to cylinder 46.

The piston 62 divides cylinder 46 into a pair of pressure or actuating chambers 46c and 46d. When the pressure within chamber 46c is increased and the pressure within chamber 46d decreased, the increased pressure against end wall 46a of cylinder 46 causes such cylinder to move to the left as viewed in FIGURE 5. In like manner, when the pressure within chamber 46d is highest, the fluid pressure against end wall 46b because cylinder 46 and the platform 32 attached thereto to be moved to the right as viewed in this figure. It is thus seen that the piston 62 and piston rod 48 remain stationary while the cylinder 46 and the various components carried thereby are caused to move in a sidewise direction in accordance with variations in fluid pressure.

Servo mechanism 55 for moving the platform 32 in the forward and rearward directions operates in the same manner as above described with respect to servo mechanism 45.

Mounted on platform 32 for movement therewith is record means 64 which may take substantially any desired form as will hereinafter become apparent. The means chosen for the first embodiment for illustration of the present invention comprises a turntable 66 which is secured to a pivot pin or spindle 68, the latter of which extends through the platform 32. Such pivot pin, of course, is freely rotatable relative to platform 32 by motive power means such as electric motor 70 which is secured to the underside of platform 32. Energization of motor 70 through lead wires 72 effects rotation of spindle 68 and hence rotation of turntable 66.

Positioned on turntable 66 is a record 74 which carried pre-recorded intelligence in the form of mechanical grooves 77, 78 and 79, as shown in FIGURE 1. It is intended to be within the scope of the present invention as defined by the appended claims, that three separate turntables and record discs may be mounted on spindle 68 (if desired) with each such record disc carrying a separate one of the grooves 77, 78 and 79. Also, it is appreciated that the form of the record or recording would not have to be a rotatable disc having grooves, but rather it could take the form of other record means wherein the intelligence carried thereby is in the form of a cam surface such that predetermined motion of the record effects mechanical movement of a cam follower or stylus as will hereinafter be described.

To effect movement of platform 32 in accordance with pre-recorded intelligence on record disc 74, additional means is required to associate each cylinder 46 and 54 with the record 74 such that the above-mentioned servo mechanisms 45 and 55 are provided. Thus, to complete the servo mechanism or system 45, a stylus or cam follower element 80 and suitable hydraulic valve means 82 for operation thereby are provided. Such hydraulic valve means comprises a valve housing 84 having a fluid pressure inlet port 86 and a pair of exhaust ports 88 and 90. Also associated with valve body 84 is a length of flexible tubing 92 which affords connection between an opening 84a in valve body 84 and the fluid pressure chamber 46d of cylinder 46. In like manner, another flexible tube 94 is provided between another opening 84b formed in valve body 84 and the fluid pressure chamber 46c of cylinder 46.

Mounted on stylus 80 for operation thereby is a pair of valve members 96 and 98 which cooperate, as will hereinafter be described, with the exhaust ports 88 and 90 and with inlet port 86 to provide certain fluid paths to and from the openings 84a and 84b in valve body 84. As shown most clearly in FIGURES 5 and 6, valve mechanism 82 is carried by or may be formed integrally with bearing member 52 which slides on guide member 38 so as to be movable with the cylinder 46 as platform 32 is moved forward or rearward relative to base member 28.

Thus the servo mechanism 45 for moving platform 32 and all of the components mounted thereon in a sidewise direction comprises the hydraulic cylinder 46, the record means 64 carried by such cylinder, the stylus 80 and the valve means 82, as well as the various components such as tubing 92 and 94, and the piston rod 48. As will hereinafter be explained, such servo mechanism causes platform 32 to be moved a predetermined distance in accordance with the pre-recorded intelligence on record disc 74.

In like manner, there is provided on bearing member 60, valve means 100 which is controlled by a stylus 102 for completing servo mechanism 55 which includes hydraulic cylinder 54. That is, such stylus 102 and valve means 100 are substantially identical in construction to stylus 80 and valve means 82, and cooperate to control the movement of platform 32 in the rearward and forward directions as will hereinafter be explained.

The work performing means 22, shown in FIGURE 1 of the drawings, is a pantographic element having a work performing member 104 and a control member 106 joined together by a pair of intermediate members 108 and 110. Such intermediate members are substantially identical in size and shape, and are arranged in spaced parallel relation to provide the desired pantographic arrangement. Pivot pins 112 are employed as shown to complete the desired pantographic arrangement and to permit pivotal movement between the various members of work performing means 22 as will hereinafter become apparent.

A pivotal support member 114 is provided to establish a reference point for operation of the pantographic means 22. Such mounting member is formed with a cylindrical lower end portion 114a which slidably engages a suitable opening formed in base 28. Thus, the mounting member 114 is afforded about a vertical axis. The pantographic means 22 is inserted within a slot 114b formed in mounting member 114 and a pivot pin 116 is inserted in suitable openings to pivotally secure the lower intermediate member 110 of the pantographic means to such mounting member.

A hydraulic actuator 117 comprising a cylinder 118 having a movable piston therein and a piston rod 120 connected with the latter is rigidly secured to platform 32. The piston rod 120 is firmly secured to the piston within the cylinder 118. Such hydraulic actuator operates in a usual manner, namely by the application of fluid pressure to one side or the other of the piston in order to effect movement of piston rod 120. Control member 106 of pantographic means 22 is pivotally secured to rod

120 to be movable therewith along any one or all of the three axes at right angles to each other. That is, such control member is movable with rod 120 as effected by the servo mechanisms 45 and 55 within the horizontal plane or by the hydraulic cylinder along the vertical axis.

As shown most clearly in FIGURES 3 and 4, the upper end portion of piston rod 120 is provided with an adaptor 122 which carries a flat gear member or rack 124. The adaptor is adjustably secured to the top of piston rod 120 by a set screw 126 which is threaded within a suitable opening in adaptor 122 for engagement with an annular groove in the piston rod. The rack 124 may be secured to adaptor 122 as by welding, brazing, soldering, or the like, and is formed with a series of gear teeth 124a.

As shown most clearly in FIGURE 2 of the drawings, rack 124 cooperates with a circular gear member 126 mounted on a drive shaft 128. Also mounted on such shaft is a gear member 130 which drives an endless chain 132. As shown most clearly in FIGURE 1 of the drawings, drive shaft 128 may be rotatably supported by suitable bracket means 134 mounted relative to movable platform 32.

The endless chain 132 cooperates with a gear member 136 which is rigidly secured to a drive shaft 138. Such shaft also carries another gear member which, in turn, drives an endless chain 140. This chain is drivingly connected to a gear member 142 which, by means of a drive shaft 144, is fixed relative to another gear member 146. The gear member 146 drives a gear rack 148 having gear teeth 148a.

As shown most clearly in FIGURE 1 of the drawings, the gear rack 148 is associated with a valve device 150 which is actuated by a stylus 152 in cooperation with the groove 78 of record 74.

As will hereinafter become readily apparent, stylus 152 and valve mechanism 150 are similar in many respects to the styluses and valve mechanisms for controlling the aforescribed servo mechanisms 45 and 55. However, the embodiment shown in FIGURE 1 utilizes a substantially coplanar record medium, namely record disc 74, and hence the platform 32 is movable oppositely only in two directions within a given plane. Thus, in order to provide the third or vertical coordinate direction of movement for the work performing means, it is necessary for the sensing element, here the stylus 152, to be actuatable in a direction 90 degrees to the direction of movement of the hydraulic cylinder 118. As a result, the feedback of the servo mechanism for effecting the vertical movement of the work performing means must be provided by additional mechanical means which is capable of transposing the vertical movement of piston rod 120 into a horizontal movement of the valve housing of valve means 150.

It is realized, however, that a three dimensional record medium could be provided whereby all three of the servo systems would be directly connected back to the record medium, thereby eliminating the need for elaborate mechanical feedback means. Such further modifications are contemplated within the scope of this invention.

The embodiment of the present invention shown in FIGURE 1 of the drawings, operates generally as follows:

The record 74, of course, is to be pre-formed, the grooves 77, 78 and 79 thereon being pre-recorded in accordance with the particular motion desired for the work performing member 104 of the pantographic work performing means 22. In this regard, the subject work or motion performing device can be used to cut or form such records if desired. By manually moving the work performing member 104 through all of the desired work performing physical movements, the various styluses 80, 102 and 152 can be caused to follow the proper paths on record 74 while the latter is rotating, which paths then become the paths for the grooves 77, 78 and 79 to cause the member 104 to repeat such motions.

The record 74, of course, is placed on turntable 66 and

the motor 70 is caused to be energized so as to rotate such record.

As the grooves 77, 78 and 79 vary in their distances from the axis of rotation of spindle 68, the respective styluses are caused to be repositioned. The styluses 80 and 102 are disposed at right angles to each other and operate servo mechanisms 45 and 55 respectively which are also at right angles to each other and which operate to effect horizontal movement of platform 32. The third stylus, namely stylus 152, although not being disposed for movement in a vertical plane is nonetheless operable to actuate vertical cylinder 118, the piston rod 120 of which is movable at right angles to the movement of platform 32 as effected by either of the other styluses 80 and 102. As such, since control member 106 of pantographic means 22 is pivotally secured to piston rod 120 and since such rod is movable in the horizontal directions with platform 32, the three styluses cooperate to control the position of control member 106 with respect to all three coordinate axes.

The movement of such member 106 in the horizontal plane is effected substantially as follows:

If the stylus 80 (FIGURE 5) is caused by the groove 79 of record 74 to be moved to the right (FIGURE 6), fluid pressure is caused to be applied to the chamber 46c of hydraulic cylinder 46. That is, such movement of stylus 80 causes the valve members 96 and 98 to assume the positions shown in FIGURE 6. This enables the fluid under pressure to come into the valve body 84 through inlet port 86 and to be applied to the chamber 46c through flexible tubing 94. At the same time, the pressure within chamber 46b is exhausted through flexible tubing 92 and exhaust port 88 as most clearly shown in FIGURE 6.

The increase in pressure within chamber 46c and the decrease in pressure within chamber 46d permits the higher pressure against end wall 46a to move the entire cylinder 46 and platform 32 thereon to the left. Such movement continues until the valve member 96 and 98 are returned to their flow preventing positions in cooperation with ports or openings 84a and 84b respectively as shown in FIGURE 5. The stylus 80 thus assumes a new position on record disc 74, provided further changes have not been required because of further variations in the path of groove 79.

Since control member 106 of pantographic work performing means 22 is connected relative to platform 32, such movement of platform 32 to return the valve members 96 and 98 to their flow preventing positions causes corresponding movement of member 106. As a result, the pantographic means 22 is pivoted about the pivotal mounting member 114.

However, since the motion of platform 32 is rectilinear, the pantographic means 22 not only pivots about the vertical axis afforded by member 114 but also is caused to expand or contract in accordance with the pantographic operation. That is, simultaneous with such pivotal movement is the contracting or expanding of the pantographic means thereby causing the work performing member 104 to follow a rectilinear path.

In the event the stylus 80 is moved inwardly by the groove 79 (toward the spindle 68), the valve members 96 and 98 are moved to the left of their flow preventing positions shown in FIGURE 5. When this happens, fluid pressure is applied to chamber 46d from pressure inlet port 86 through flexible tubing 92. At the same time, chamber 46c is exhausted through flexible tubing 94 and exhaust port 90. This results in the platform 32 being moved to the right as viewed in FIGURES 5 and 6 until the valve members 96 and 98 are again returned to their flow preventing positions.

Such movement of platform 32 as caused by servo mechanism 45 causes the bearing members 58 and 60 to freely slide on their respective guide members 36.

The servo system 55 operates in the same manner as above described with respect to system 45. However,

operation of servo system 55 causes the pantographic means 22 to be expanded or contracted in accordance with the direction of movement of platform 32. Also such rectilinear movement of platform 32 may effect pivotal movement of the entire pantographic element 22 about the pivot axis of mounting member 114, depending on the position of piston rod 120 with respect to the pivotal mounting means 114.

The vertical movement of work performing member 104 is accomplished in response to movement of the stylus 152. When this stylus is moved by groove 78, the valve means 150 is actuated such as to apply fluid pressure to the proper side of the piston within cylinder 118. Suitable flexible conduits (not shown) are provided for this purpose. In the event the piston moves upwardly, the piston rod 120 and hence member 106 are moved upwardly. The work performing member 104, of course, is then moved downwardly a distance corresponding to the amount of movement of stylus 152 as caused by the shape or contour of groove 78.

In order to return valve means 150 to its off or flow preventing position, suitable mechanical feedback means is provided. That is, as the piston rod 120 moves upwardly, the gear rack 124 is moved therewith. This causes the chain 132 to be driven a certain distance through the gear members 126 and 130. In like manner, the chain 140 also moves a corresponding amount due to operation of the intermediate gear members including the member 136. Such movement of chain 140 causes the gear rack 148 to move the valve body or housing of valve means 150 until the valve members therewithin are in their flow preventing positions.

Thus the work performing member 104 of the pantographic means 22 is caused to move in any one of the three coordinate directions as determined by the record disc 74. It should also be realized that any combination of such motions also can be provided so that the work performing member 104 is caused to follow any predetermined path desired.

Referring to FIGURE 8 of the drawings, a second embodiment of the present invention is shown therein. This embodiment comprises the same base member 28 and platform 32 movably mounted thereon, in addition to the other parts and components shown in FIGURE 1 and hereinbefore described. The main difference between the embodiments of FIGURES 1 and 8 is that in FIGURE 1 the base member 28 is stationary, while in FIGURE 8 such base member is movable as will herein-after be described. Such movement is desirable to enable the various work performing motions of the pantograph 22 to be related to a moving object.

In addition to the various parts and components hereinabove described with respect to the embodiment of FIGURE 1, the embodiment of FIGURE 8 further comprises a stationary foundation 150.

The opposite ends of mounting rods 154 and 156 are provided with bearing members 158 having through openings for receiving oppositely disposed guide members 160. The latter are members secured relative to foundation 150 by mounting posts 162 at each corner of the foundation. This arrangement enables base plate 28 to be moved from side to side on rods 154 and 156, and at right angles thereto on guide members 160.

Mounted on the underside of base plate 28 is a pair of hydraulic cylinders (not shown) forming individual servo systems disposed at substantially right angles to each other. Such cylinders are similar to the cylinders 46 and 54, as above described with respect to the first embodiment, and comprise piston rods 164 and 166 shown in FIGURE 8. The piston rod 164 carries bearing members 168 at its opposite ends while the rod 166 carries bearing members 170 at its opposite ends. The bearing members 168 are formed with through openings for receiving the guide members 160, and the bearing members 170 are formed with similar through openings for receiving

ing guide members 172 at the front and rear of the foundation.

Such hydraulic cylinders for moving base plate 28 are formed with hydraulic pressure chambers as above described with respect to cylinder 46, so that varying the high pressure from one chamber to another causes base member 28 to be moved accordingly.

In the embodiment shown in FIGURE 8, the pantographic work performing means 22 is mounted immediately above a pantographic sensing element 180. To accomplish this, a dual mounting device 182 having a lower pivotal mounting member 184 and an upper pivotal mounting member 186 is provided.

The lower mounting member 184 is formed with a cylindrical lower end portion 184a for insertion within an appropriately formed opening in foundation 150. Such cylindrical lower end portion 184a loosely fits within such opening so that the mounting member 184 is freely pivotal about a vertical axis. A longitudinal slot 184b is formed in mounting member 184 for receiving the pantographic sensing element 180 as will be hereinafter described.

The upper mounting member 186 is also provided with a cylindrically shaped lower end portion 186a. Such lower end portion rotatably fits within an opening in the upper end portion of mounting member 184 whereby the several mounting members 184 and 186 are caused to be independently pivotable about a common vertical axis. Mounting member 186 is formed with a longitudinal slot 186b which receives the pantographic work performing means 22.

As above described with respect to the first embodiment disclosed herein, work performing means 22 comprises a work performing member 104, a control member 106 and a pair of intermediate members 108 and 110. A pivot pin 116 is employed to pivotally secure the intermediate member 110 to the mounting member 186 while the work performing means 22 is positioned within the slot 186b as shown in FIGURE 8.

In like manner the pantographic sensing element 180 is formed with a sensing member 188, a control member 190 and a pair of spaced intermediate members 192 and 194. All such elements are arranged in the form of a parallelogram as shown in FIGURE 8, the various members being connected together by pivot pins 196. A pivot pin 198 is employed to pivotally secure the intermediate member 194 to the mounting member 184 when the sensing element 180 is positioned within the slot 184b formed therein as shown in FIGURE 8.

As shown most clearly in FIGURES 9 and 10 of the drawings, an actuating member 200 is connected to control member 190 of sensing element 180. Such actuating member is associated with fluid pressure control means 202 mounted on movable base plate 28.

As shown most clearly in FIGURE 10 of the drawings, control means 202 comprises suitable control elements such as valves 204 and 206 for controlling the hydraulic actuators or cylinders which move base plate 28 with respect to the foundation 150.

The valve means 204 comprises a valve body 208 having a fluid inlet port 210 and a pair of exhaust ports 212 and 214. A valve stem 216 carrying valve members 218 and 220 is mounted for movement within valve body 208 by actuating rod 200. Ports 222 and 224 are also formed in valve body 208 for cooperation with valve members 218 and 220 respectively and for controlling the pressure within the several pressure chambers of the hydraulic cylinder associated with piston rod 164. Such hydraulic cylinder, as above explained, is for use in controlling the sidewise movement of base plate 28. A compression spring 226 may be employed for urging valve stem 216 against actuating member 200, and suitable sealing means as shown at 228 may be employed if desired.

The control device 206 comprises a valve body 230 having an inlet port 232 and a pair of outlet or exhaust

ports 234 and 236. A valve stem 238 carrying valve members 240 and 242 is movably positioned within valve body 230 as shown. Ports 244 and 246 are formed in valve body 230, and are connected with the hydraulic cylinder associated with piston rod 166. This cylinder, of course, controls the forward and rearward movement of base plate 28. A compression spring 248 may be employed to urge valve stem 238 toward actuating member 200, and sealing means as shown at 258 may be employed if desired.

To permit actuating member 200 to move in a sidewise direction without becoming incapable of actuating valve stem 238, a transverse member 252 is secured to valve stem 238 as by welding, brazing, soldering or the like. With this arrangement, actuating member 200 is permitted to move from side to side while still being operable to actuate the valve members 240 and 244 by virtue of engagement of such member with the transverse member 252.

In like manner, actuating member 200 is not secured to valve stem 216 of valve means 204, but rather merely abuts the same so as to be capable of actuating valve members 218 and 220, regardless of its rearward or forward movement.

FIGURE 11 of the drawings schematically shows a hydraulic or pneumatic supply system for actuating the embodiment shown in FIGURE 8.

The source of fluid pressure 260 is connected to the valve mechanisms 82, 100 and 150 for controlling the various movements of work performing means 22 as above described. Each such valve mechanism has an intake port and a pair of exhaust ports, all of which communicate with the source 260 to provide a closed system. As above described, valve mechanism 82 controls the operation of cylinder 46 while valve mechanism 100 controls cylinder 54 and valve mechanism 58 controls cylinder 118.

As also shown in FIGURE 11, valve means 202 is connected with the source 260 of fluid pressure and with a cylinder 262 which controls the sidewise movements of base plate 28. Such cylinder is associated with piston rod 164. Another hydraulic cylinder 264 is provided for controlling the forward and rearward movement of the base plate and is under control of valve 206 of valve means 202.

The embodiment of the present invention shown in FIGURE 8 of the drawings operates generally as follows:

Sensing member 188 of the sensing means 180 is caused to be connected to the object (not shown) to be followed by the subject motion device. For instance, if it is intended that the work performing element 22 should perform certain functions on an automobile in an assembly line of automobiles, the sensing member 188 might be caused to engage or "feel" the bumper or wheel of such automobile. Then as such automobile progresses along the assembly line the work performing means 22 effects the desired work functions with automobile as called for by the intelligence of the record 74. In this manner, the desired work is performed on the automobile without requiring the assembly line to be stopped. All such functions are performed automatically without the need for human intervention or assistance.

The manner in which the foregoing is accomplished is substantially as follows:

With the sensing member 188 against the moving object, the pantographic sensing element 180 permits such member 188 to follow the object wherever it goes within certain predetermined limits. As such object moves in a sidewise direction with respect to mounting member 184, the control member 190 of sensing means 180 causes actuating member 200 to be moved in a sidewise direction. Such movement of member 200 causes the valve members 218 and 220 to be actuated such as to vary the pressure in the several chambers of the hydraulic cylinder 266 so as to cause the base plate 28 to follow the

movement of member 200. In this manner, the valve means 204 also is caused to follow member 200 until the valve members 218 and 220 are returned to their flow preventing positions.

Since platform 32 is carried by base plate 28, the movement of the latter causes the platform and hence the control member 106 of work performing means 22 to be moved accordingly. Therefore, the work performing element 104 of pantographic means 22 is caused to follow the precise path of movement of sensing element 188 as it "feels" the moving object.

In the event the object moves away from foundation 150, the pantographic sensing element 180 is expanded thereby causing actuating member 200 to move valve stem 238 inwardly thereby moving the valve members 240 and 242 to flow permitting positions. This causes fluid pressure to be applied to the chambers of hydraulic cylinder 264 such that the base member 28 is moved rearwardly until the valve members 240 and 242 are returned to their flow preventing positions. When this occurs, base plate 28 has been moved a distance corresponding to the distance of movement of the object away from the foundation.

Again, since control element 106 of pantographic means 22 is mounted relative to platform 32, and such platform is carried by base plate 28, such rearward movement of base plate 28 causes the work performing pantograph 22 to be expanded. As a result, the work performing member 104 is caused to follow the movement of the object to which the member 188 is attached.

It is thus seen that the work performing member 104 is always maintained in fixed position relative to the moving object. The actual work performing functions as called for by record 74 are then superimposed on such motion of the work performing element 104 with the object. That is, once having insured that member 104 will move with the object whenever it goes, whatever additional work performing motions as called for by record 74 are utilized to perform work on the object.

As shown generally at 270 in FIGURES 1 and 8, the end of work performing member 104 may be provided with substantially any desired type of mechanism. For instance, the mechanism 270 may comprise one or more hydraulic cylinders for opening, closing and turning a set of jaws or fingers for gripping and retaining various objects. In the alternative, such mechanism may be a torque wrench, a power operated screwdriver, drill, a saw or any similar device for performing the desired function. The selection of particular devices is believed to be within the skill of persons skilled in the present art.

It is also contemplated within the scope of the present invention that the mechanisms employed on the end of work performing member 104 may be controlled by suitable record means such as the record 74 shown on the drawings, or by magnetic tapes and the like.

It is thus seen that the present invention provides automatic motion or work performing means for use in performing any desired function on a stationary object or on an object which is in motion.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim:

1. A pre-recorded motion producing device comprising in combination, a relatively stationary base, a record mounted for movement in at least one direction relative to said base, feedback actuating means operatively interposed between said record and said base, control means for said actuating means responsive to said record to cause said actuating means to effect corresponding movement of said record, and an elongated movable member having a work performing end portion, an actu-

able end portion connected to said record, and an intermediate portion pivotally connected to said base; whereby the work performing end portion of said movable member is caused to follow the movement of said record relative to said base.

2. A pre-recorded motion producing device comprising in combination, a relatively stationary base, a record having pre-recorded intelligence thereon mounted for movement in at least one rectilinear direction relative to said base, a hydraulic servo system for moving said record in said one direction operatively interposed between said record and said base, control means for said hydraulic servo system responsive to said intelligence on said record to effect corresponding movement of said record, and work performing means having connection with said base and said record to be actuated thereby and comprising means for causing a portion of said work performing means to follow a straight line in accordance with the rectilinear movement of said record.

3. A pre-recorded motion producing device comprising in combination, a relatively stationary base, a record mounted for movement in at least one direction relative to said base, feedback actuating means operatively interposed between said record and said base, control means for said actuating means responsive to said record to cause said actuating means to effect corresponding movement of said record, and a pantographic work performing element having a work performing end portion, an actuable end portion connected to said record and an intermediate portion pivotally mounted relative to said base, whereby said work performing end portion reproduces proportionally every movement of said record by said actuating means.

4. A pre-recorded motion producing device according to claim 3 wherein said work performing element comprises a pair of substantially parallel opposite end members interconnected by a pair of spaced parallel intermediate members, one of which is pivotally mounted relative to said base.

5. A pre-recorded motion producing device comprising in combination, a relatively stationary base, a rotatable record mounted for movement in at least one rectilinear direction relative to said base and formed with at least one groove representing the desired motion, means for rotating said record relative to said base, feedback actuating means operatively interposed between said record and said base, control means for said actuating means responsive to said groove when said record is rotating to effect corresponding movement of said record, and work performing means having connection with said base and said record to be actuated thereby, and comprising means for causing a portion of said work performing means to follow a straight line in accordance with the rectilinear movement of said record.

6. A universal motion producing device comprising in combination, a relatively stationary base, a platform movably mounted on said base to have motion along at least two axes at right angles to each other, a separate feedback actuating device for each of said motions operatively interposed between said platform and said base, each of said actuating devices comprising a control element having a control movement aligned with the respective motion axes, work performing means having connection with said platform to be moved in accordance therewith, and a mechanical record operatively mounted on said platform having intelligence for effecting movement of each of said control elements according to the motion desired for said work performing means, whereby said work performing means is caused to be moved by said platform in accordance with the pre-recorded intelligence on said record.

7. A universal motion producing device according to claim 6 wherein each of said control elements comprises a stylus operatively associated with said mechanical record to be moved thereby and a control device asso-

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ciated with said stylus to be operated thereby so as to cause the corresponding actuating device to effect movement of said platform corresponding to the intelligence on said mechanical record.

8. A universal motion producing device comprising in combination, a relatively stationary base, a platform movably mounted on said base to have motion along at least two coordinate axes, a separate servo system for each such motion operatively interposed between said platform and said base and comprising a control element having a control movement parallel to the motion afforded by the respective servo systems, work performing means having connection with said platform to be moved in accordance therewith, and a mechanical record having pre-recorded intelligence thereon operatively mounted on said platform and associated with each of said control elements, whereby each of said control elements is afforded control movement by said pre-recorded intelligence on said record to cause the corresponding one of said servo systems to move accordingly said platform so as to effect movement of said work performing means until the platform has been moved sufficiently to return each control element to its initial relative position.

9. A universal motion producing device according to claim 8 wherein each of said servo systems is operated by fluid pressure so that movement of any one of said control elements causes fluid pressure to effect movement of said platform and said mechanical record thereon to thereby cause said control element to render said fluid pressure incapable of operating said servo system.

10. A universal motion producing device according to claim 9 wherein said mechanical record is a rotatable disc and the pre-recorded intelligence thereon is one or more grooves formed in such record.

11. A universal motion producing device for performing pre-recorded movements in predetermined relation to a moving object comprising in combination, a stationary foundation, a base plate movably mounted on said foundation for movement along predetermined axes at substantially right angles to each other, separate feedback actuating means for each of said axes, individual control means for said actuating means mounted on said base plate and operable along the respective axes to cause the respective actuating means to correspondingly move said base plate relative to said foundation, a sensing element pivotally mounted on said foundation and having a sensing portion for engagement with said moving object and an actuating portion operatively associated with said control means, whereby said base plate is caused to be moved along said axes in accordance with the movement of said object, a platform movably mounted on said base for movement along predetermined axes at substantially right angles to each other, a separate feedback actuating device for moving said platform along each of said axes relative to said base plate, a record on said platform operatively connected to said actuating devices to cause said platform to be moved in accordance with predetermined recordings on said record, and a work performing element pivotally mounted on said foundation and having a work performing portion and a portion connected to said platform, whereby said work performing portion is caused to be moved in accordance with both the movement of said object and the recordings on said record.

12. A universal motion producing device for performing pre-recorded movements in predetermined relation to a moving object comprising in combination, a stationary foundation, base plate movably mounted on said foundation for the movement thereon along predetermined axes at substantially right angles to each other, separate feedback actuating means for moving said base plate along each of said axes, individual control means for said actuating means mounted on said base plate for operation along the respective axes to cause the respective actuating means to correspondingly move said base plate on said foundation, a pantographic sensing element having a

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sensing member in engagement with said moving object, an actuating member operatively associated with said control means and a pair of substantially identical intermediate members, one of said intermediate members being pivotally mounted relative to said foundation whereby said base plate is caused to be moved along said axes in accordance with the movement of said object, a platform movably mounted on said base plate for movement along predetermined axes at substantially right angles to each other, a separate feedback actuating device for moving said platform along each of its axes of movement on said base plate, a record on said platform operatively connected to said actuating devices for said platform to cause said platform to be moved in accordance with predetermined recordings on said record, and a pantographic work performing element having a work performing member, an actuating member connected to said platform and a pair of substantially identical parallel intermediate members, one of said latter intermediate members being pivotally mounted relative to said foundation, whereby said work performing member is caused to be moved in accordance with the movement of said object and the predetermined recordings on said record.

13. A universal motion producing device for performing pre-recorded movements in predetermined relation to a moving object according to claim 12 wherein means is provided for mounting both said pantographic sensing element and said pantographic work performing element for pivotal movement about a single vertical axis.

14. A universal motion producing device for performing pre-recorded movements in predetermined relation to a moving object comprising in combination, a stationary foundation, a base plate movably mounted on said foundation for movement along predetermined axes, a separate servo system for movement of said base plate along each of said axes, individual control means for said servo systems mounted on said base plate, a sensing element pivotally mounted on said foundation and having a sensing portion for engagement with a moving object and an actuating portion operatively associated with said control means whereby said base plate is caused to be moved along said axes in accordance with the movement of said object, a platform mounted for movement on said base plate along predetermined axes, a separate servo system for moving said platform along each of the last mentioned axes, a record on said platform operatively connected to the servo systems for said platform to cause said platform to be moved in accordance with predetermined recordings on said record, and a work performing element pivotally mounted on said foundation and having a work performing portion and a portion connected to said platform, whereby said work performing portion is caused to be moved in accordance with the movement of said object and the predetermined recordings on said record.

15. A universal motion producing device for performing pre-recorded movements in predetermined relation to a moving object according to claim 14 wherein the servo systems for moving said base plate and said platform are operated by fluid pressure.

16. A universal motion producing device comprising in combination, a relatively stationary base, a record movably mounted on said base to have motion along at least two axes at right angles to each other, and a separate feedback actuating device for each of said motions operatively interposed between said platform and said base, each of said actuating devices comprising a control element having a control movement aligned with the respective motion axis, said record having intelligence for effecting movement of each of said control elements according to the motion desired for said record, whereby said record is caused to be moved in accordance with the pre-recorded intelligence thereon.

17. A motion producing device comprising in combination, a relatively stationary base, a platform movably

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mounted on said base to have motion along at least one axis, a feedback actuating device for operation along said axis operatively interposed between said platform and said base, said actuating device comprising a control element having a control movement aligned with said axis, work performing means having connection with said platform to be moved in accordance therewith, and a mechanical record operatively mounted on said platform having intelligence for effecting movement of said control element according to the motion desired for said work performing means, whereby said work performing means is caused to be moved by said platform in accordance with the pre-recorded intelligence on said record.

18. A universal motion producing device comprising in combination, a relatively stationary base, a platform movably mounted on said base to have motion along at least two axes, a separate feedback actuating device for each of said motions operatively interposed between said platform and said base, each of said actuating devices comprising a control element having a control movement aligned with the respective motion axis, work performing

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means having connection with said platform to be moved in accordance therewith, and a record operatively mounted on said platform having intelligence for effecting movement of each of said control elements according to the motion desired for said work performing means, whereby said work performing means is caused to be moved by said platform in accordance with the pre-recorded intelligence on said record.

References Cited by the Examiner

UNITED STATES PATENTS

1,037,460	9/1912	Ettl.	
1,959,512	5/1934	Wall.	
2,380,357	7/1945	Ziebolz.	
2,466,241	4/1949	Johnson.	
2,679,620	5/1954	Berry.	
2,696,804	12/1954	Kendall	91—37 X
2,882,475	4/1959	Neergaard	91—37 X
3,024,535	3/1962	Von Rabenau.	

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