

E. SCHEYER.
AUTOMATICALLY CONTROLLED MECHANISM.
APPLICATION FILED DEC. 16, 1912.

1,172,058.

Patented Feb. 15, 1916.

10 SHEETS—SHEET II.

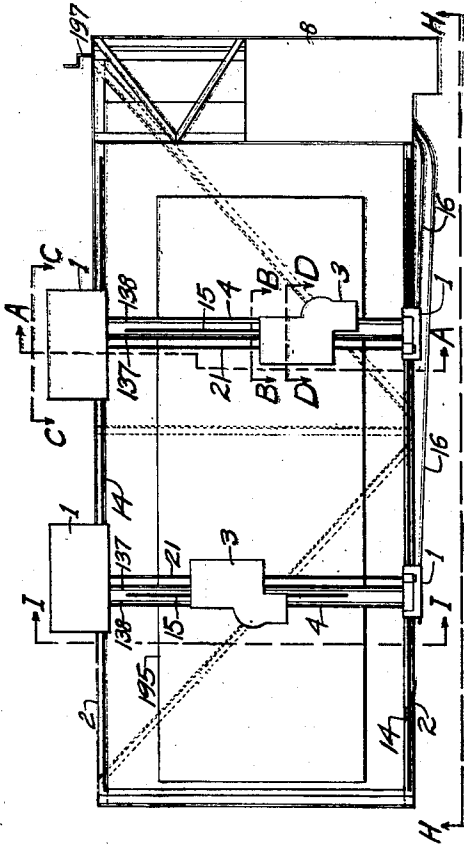


Fig. I

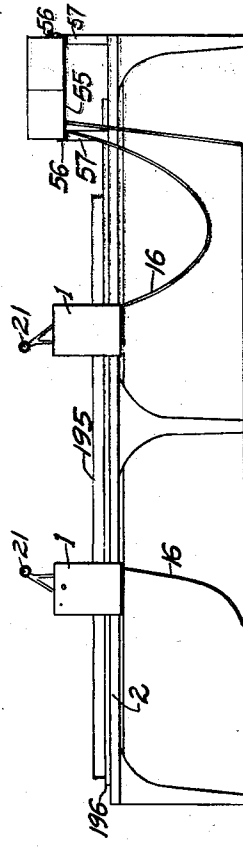


Fig. II

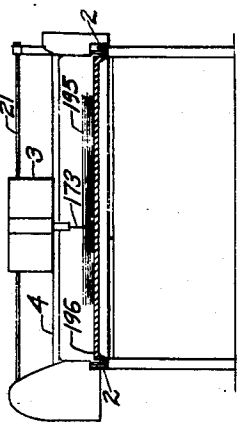


Fig. III

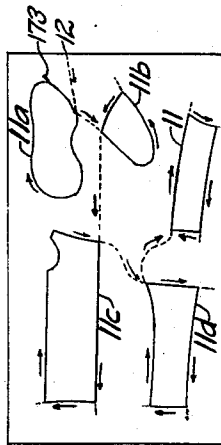


Fig. V

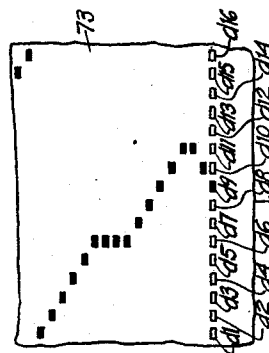


Fig. IV

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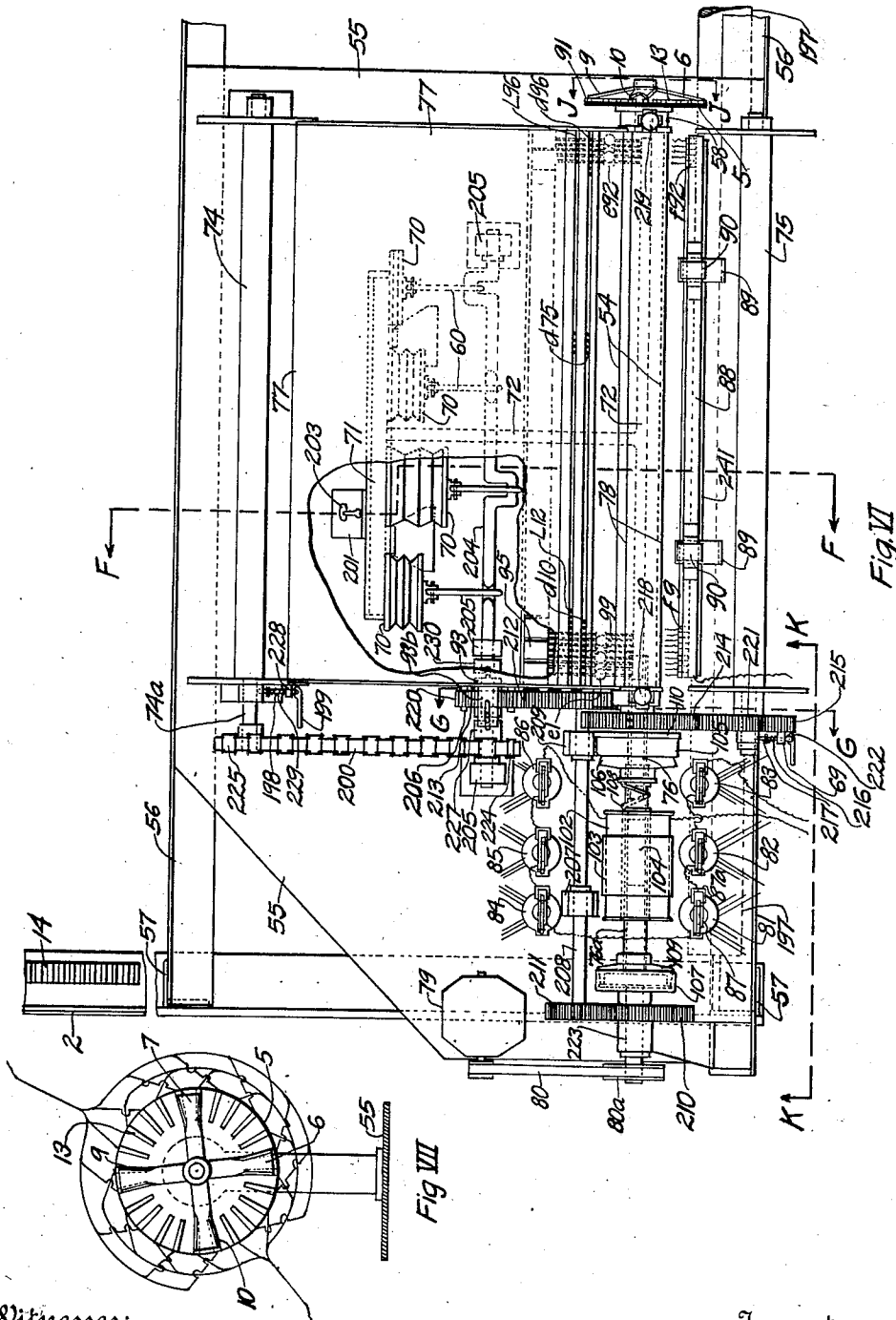
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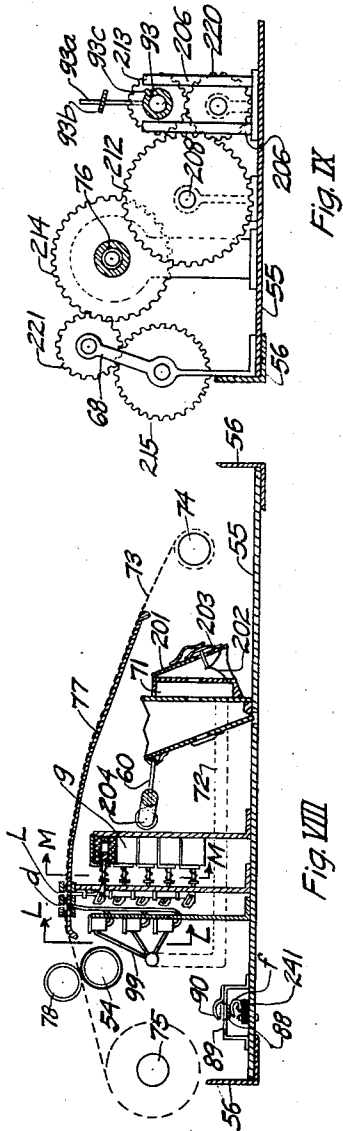


Fig. IX

Fig. VIII

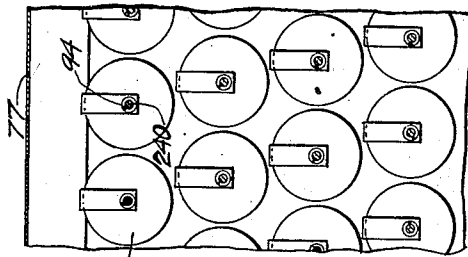


Fig. XII

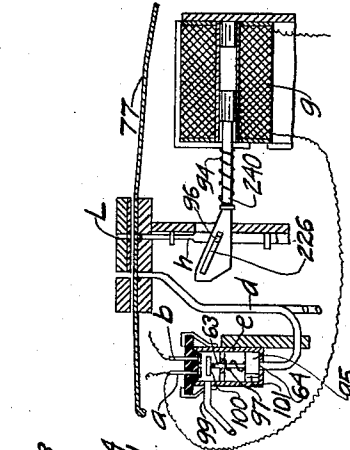


Fig. XI

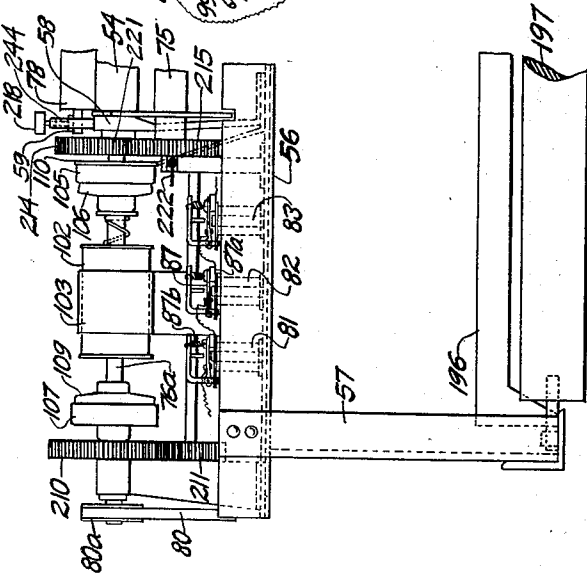


Fig. X

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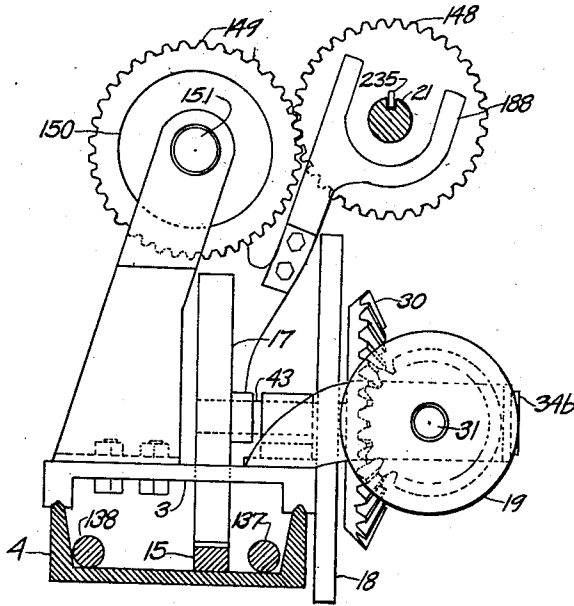


Fig. XVI

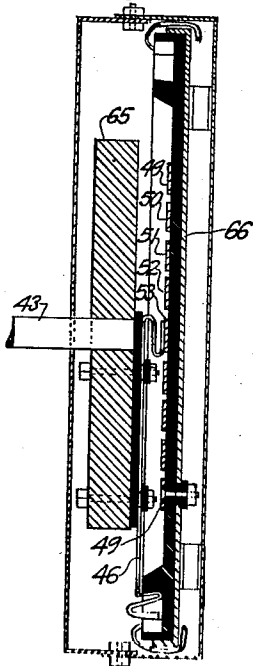


Fig. XV

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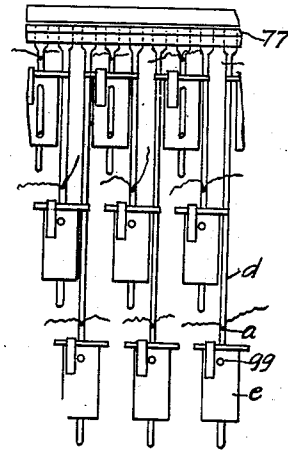


Fig. XIII

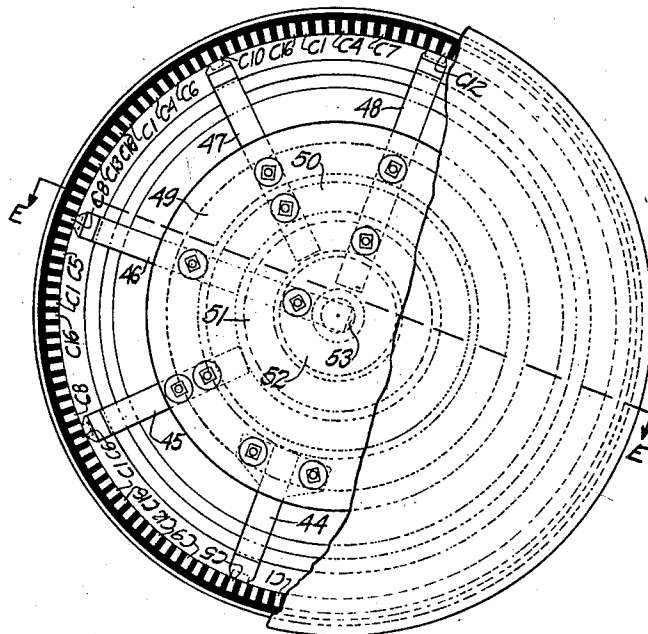


Fig. XIV

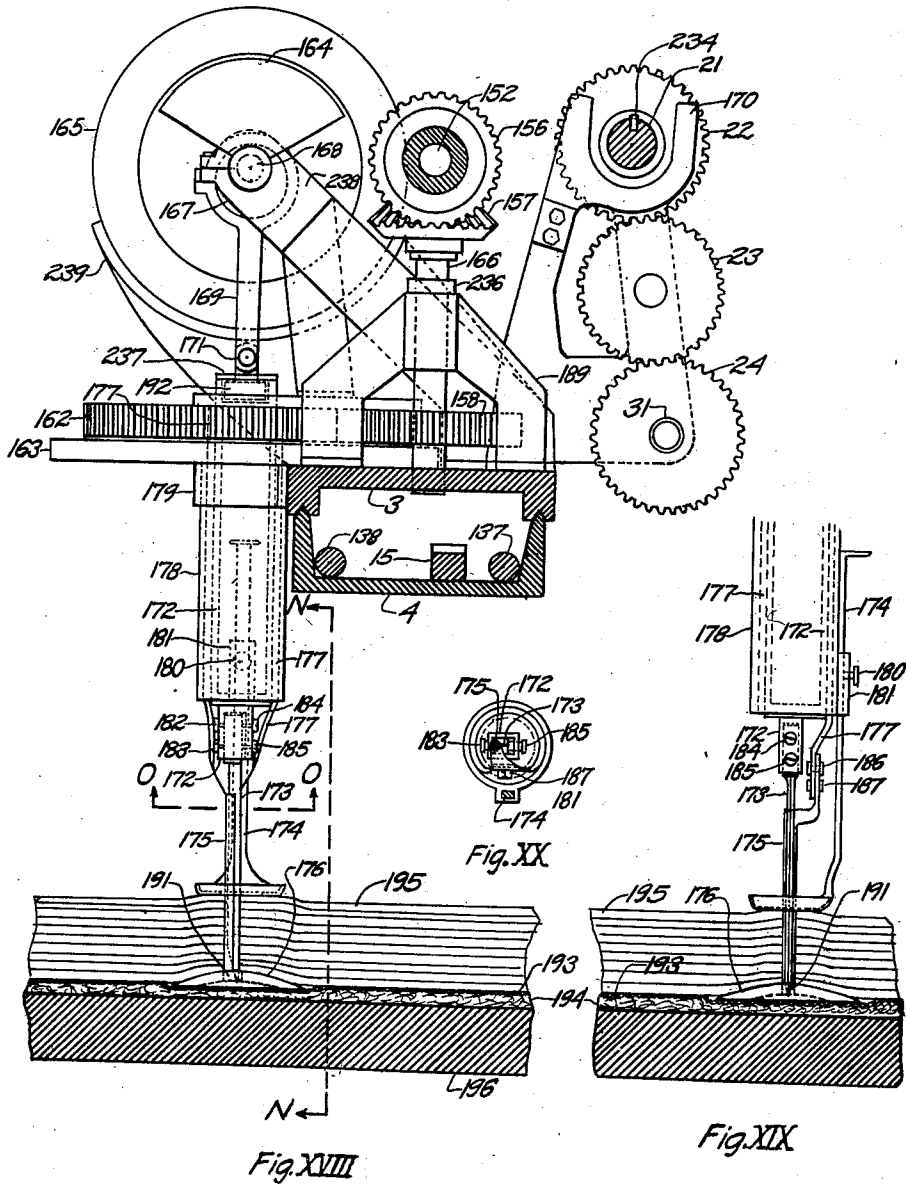
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10 SHEETS—SHEET 6.



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10 SHEETS—SHEET 8.

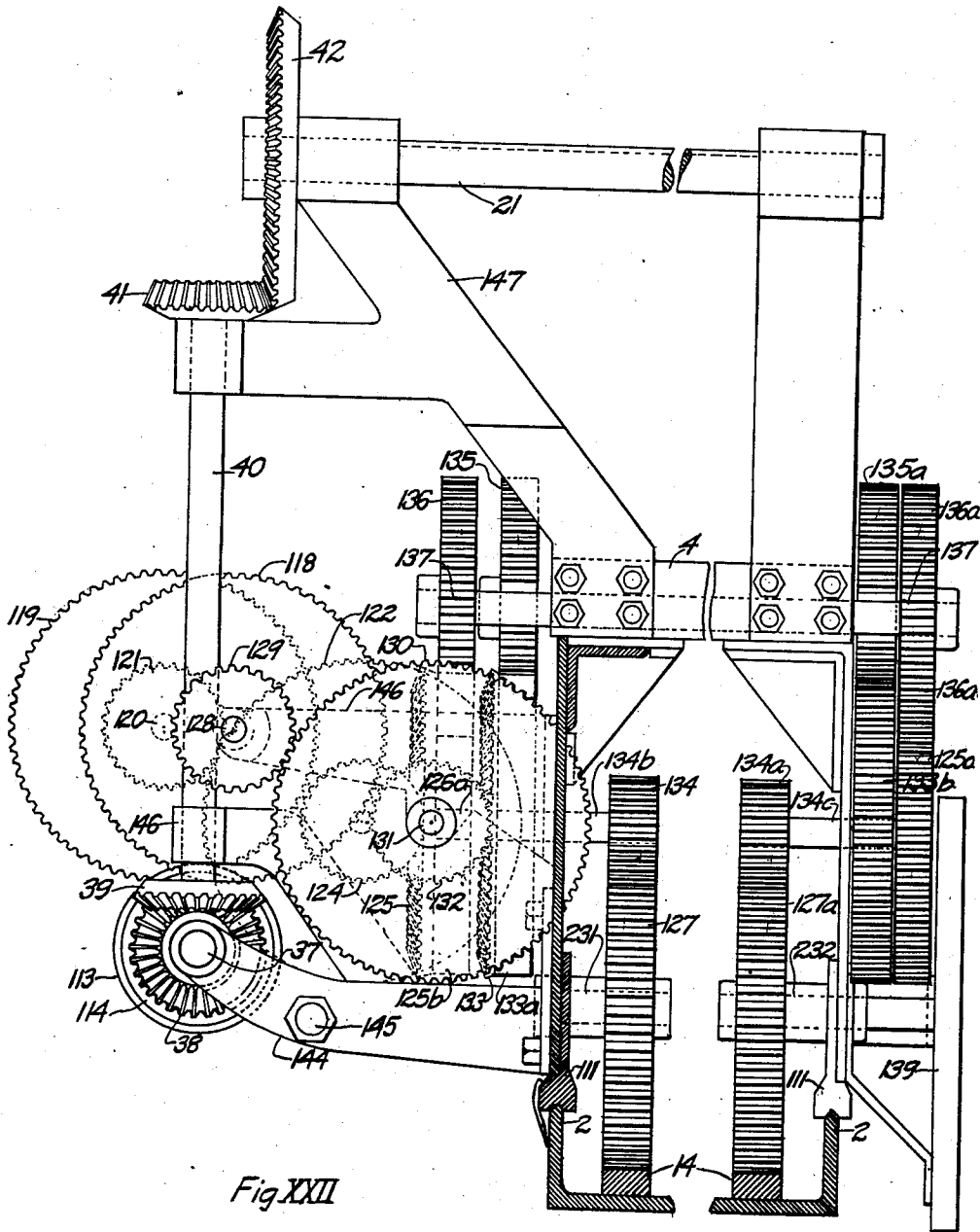


Fig. XXII

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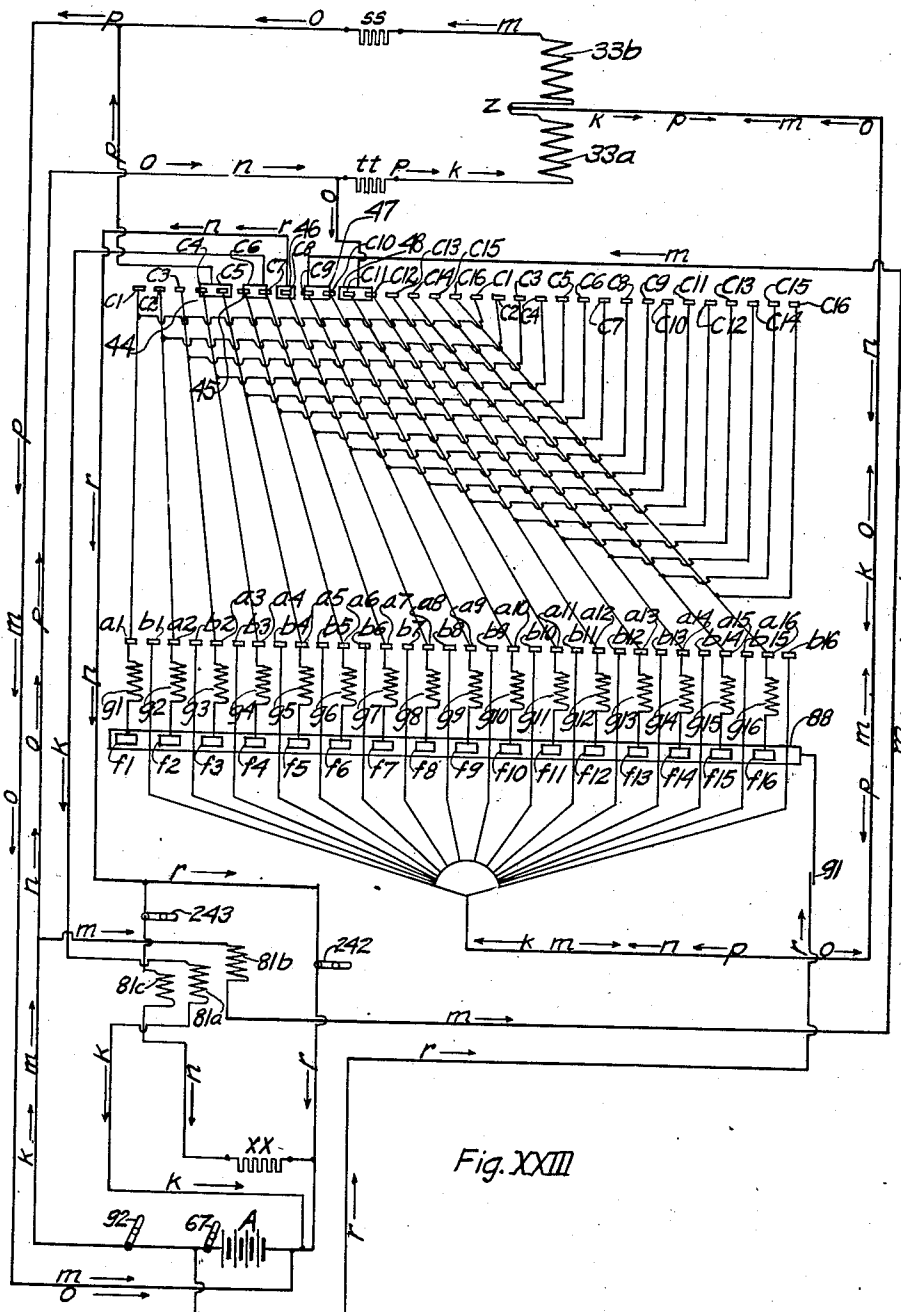


Fig. XXIII

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10 SHEETS—SHEET 10.

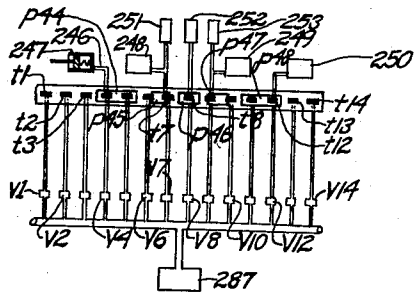


Fig. XXIV

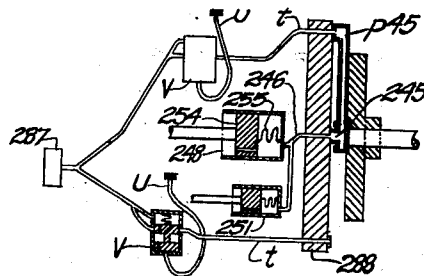


Fig. XXV

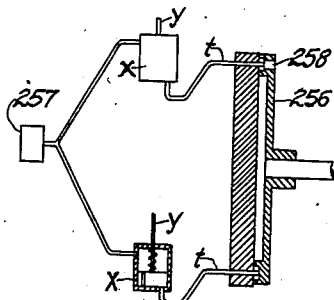


Fig. XXVI

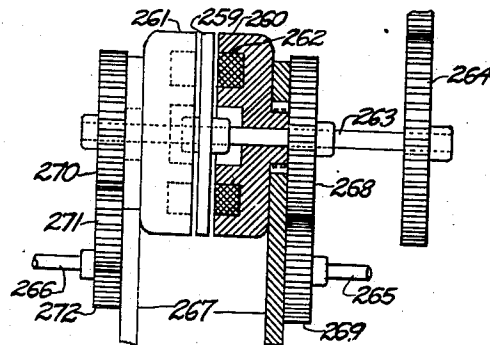


Fig. XXVII

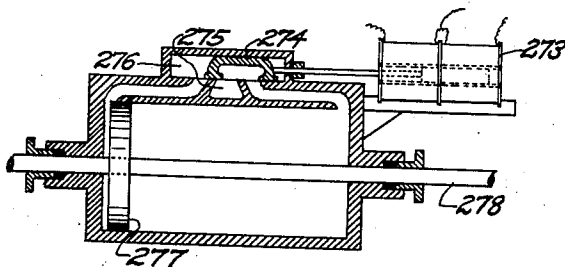


Fig. XXVIII

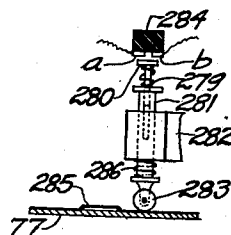


Fig. XXIX

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UNITED STATES PATENT OFFICE.

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AUTOMATICALLY-CONTROLLED MECHANISM.

1,172,058.

Specification of Letters Patent.

Patented Feb. 15, 1916.

Application filed December 16, 1912. Serial No. 737,072.

To all whom it may concern:

Be it known that I, EMANUEL SCHEYER, a citizen of the United States, residing at New York, county of New York, State of New York, have invented a new and useful Automatically-Controlled Mechanism, to be known as the Kinautograph, and a particular application of its many uses to the operation of a cutting-machine for cloth and other materials.

The object of my invention is to provide a means for controlling motion in any direction in space, either in one plane or several, or angular motion, by means of a previously prepared record, such as a perforated sheet of paper or other material, an embossed sheet or a cylindrical or flat record, of the general form of such as are used in phonographs. In fact, any form of record may be used, where the recorder in whatever form it is used, can be made to retravel its original path.

In order to demonstrate the practical application of my control mechanism, I employ it in the control of a cutting machine for cloth or other materials, but it may be employed in controlling the motions of many other machines.

The device which I employ and which is described in detail here, is a pneumo-electrically controlled machine; however, I do not limit myself to this, for, employing the same fundamental principles here disclosed, an entirely electrical control, or an entirely pneumatic-control can be devised.

The record I employ is a perforated sheet in a roll, somewhat similar in form to that employed in automatic piano players. I obtain my object by having this perforated sheet pass over a series of tracker ducts. As the various perforations pass over the openings of the tracker ducts, certain electrical connections are made, and certain circuits are controlled. The same end may be obtained by using a grooved cylinder, in which a pointer is made to follow the grooved path on the cylinder and the said pointer thereby is caused to make certain electric contacts, or control the opening or closing of tracker ducts and thus control certain electric or pneumatic circuits. The motion of the tool or any other part of a machine can be split up into component velocities as it travels along its path. In the kinautograph, a record is made of these velocities; then by using this record to control certain circuits which

in turn control means of transmitting motion, the original path of the tool or other part is obtained. In the particular application of the kinautograph to a cutting machine for cloth or other material, the path of the tool is in one plane, but it will be evident from the subsequent description that if the path is in more than one plane, *i. e.*, in space, all that would be necessary to accomplish this, is to add a unit element for motion at an angle to the plane containing the motions of the other unit elements. The mechanism of recording, of controlling and of transmitting the motion of a component, will be called a unit element. The direction in which a component velocity is to act having been determined, a unit element is arranged to take care of motion along this direction forward and backward. In cases of pure rotation, a unit element of angular velocity is provided. In the general case, any system of components can be chosen. In the particular application herein disclosed, rectangular components are used. They are the longitudinal velocity and the transverse velocity of the cutting tool as it travels along its path. A third velocity is used which causes the tool to be presented at the proper angle to the work as it travels along its path. This is the angular or slope velocity. The unit element of longitudinal velocity will be called the longitudinal motion, that of the transverse velocity, the transverse motion, and the unit element of angular velocity, the slope motion. The record of a unit element is the record of the velocity of the tool or other part in the direction or about the axis chosen for the unit. The word direction is used here in the sense to include both forward (plus) motion and backward (minus) motion parallel to a given line. Velocity as it is known, is a vector quantity having both magnitude and direction. This record as stated before controls certain circuits and these circuits are made to control the motion of the unit element so that it is plus or minus, and of the proper speed. There are many means by which a series of circuits can be made to control the motion (plus and minus and in speed) of a unit element. The particular method chosen consists essentially of a gear or train of gears causing motion forward and another gear or train of gears causing motion backward. These gears take their motion from a power shaft revolving con-

stantly. The control circuits, by operating a clutch or other device for transmitting power, cause one gear or train of gears, or the other gear or train of gears, to drive, or
 5 neither, and to take off from the power shaft just the right amount of motion. The resulting movement is one which can change gradually from one speed to another as called for by the sequence of the perfora-
 10 tions past the different tracker ducts, as the record is continuously fed by. There are many kinds of clutches or other devices for transmitting motion which can be used; also the electrical or pneumatic devices which
 15 can be used to operate the clutches are many. I use a solenoid to operate friction clutches. The winding of the solenoid is so arranged that the control circuits determine the position of its plunger. When the plunger is in
 20 one position it causes one friction clutch to engage, driving one train of gears and causing forward motion; in another position the plunger releases the clutch just mentioned and throws in another, which causes the
 25 other train of gears to drive in the backward direction; and in still another position, the neutral position, both clutches are disengaged.

My device consists of a carriage mounted
 30 on a table of required length upon which the cloth to be cut is spread in a layer or a number of layers. The carriage is capable of moving along the table in a longitudinal direction upon fixed ways. A second carriage, mounted on the first, is arranged to
 35 move in a transverse direction upon the first carriage, and is carried along with it in a longitudinal direction. The cutting blade is attached to mechanism in the transverse carriage. The mechanism holding the blade
 40 is of such construction that the knife can be turned in an angular direction about its vertical axis, and can have reciprocating motion at the same time.

45 It is evident that the tool may perform any other function instead of cutting. The tool may be a pointer to mark out any suitable design, or figures, or it may engrave or scratch certain marks on metal or other material. The pointer may mark or write
 50 certain letters or figures. The tool may be in the form of a reciprocating needle of a sewing machine, and thereby stitch certain patterns. It would be particularly useful in a
 55 quilting machine, or in an embroidering machine.

It is not necessary that the tool alone should move; certain unit elements can control the movement of the tool and others the
 60 movement of the work, both acting together giving the desired result. In some forms of embroidering machines, this would be useful.

To cause certain paths to be followed is not the only use to which the kinautograph
 65 can be put. It can be used to operate the

various control levers of a machine according to a previously made record, each lever being controlled by a unit element, as in the multiple punch or simple punch for putting
 70 rivet holes in structural steel, particularly where a large number of pieces are to have the same punching.

The order of the description is as follows: First, the device that automatically controls the movements of the plunger in its sole-
 75 noid, by means of the previously prepared record will be explained. In describing that mechanism reference will be made to other parts of the unit element only, when it is necessary to show their relation to the control mechanism. Then it will be shown how
 80 the solenoid controls the driving mechanism of the unit element. After that it will be shown how the three unit elements used in this machine are controlled and caused to
 85 act in unison. The complete working of the machine will then be shown. Finally, the method of making the record will be described.

Reference is to be had to the following
 90 drawings forming a part of this specification, in which—

Figure I is a general plan of the table showing two machines mounted on same. Fig. II is a longitudinal elevation of the
 95 table taken along the line H—H. Fig. III is a section taken along the line I—I. Fig. IV is a piece of the perforated record. Fig. V is a diagram of the path of the tool over a given piece of work. Fig. VI is a plan of
 100 the control and recording mechanisms. Fig. VII is a detail of the interrupter used in connection with the making of the record, taken along the line J—J of Fig. VI. Fig. VIII is a section of the control mechanism
 105 taken along the line F—F of Fig. VI. Fig. IX is a section of the control mechanism taken along the line G—G of Fig. VI. Fig. X is a partial elevation of the control mechanism taken along the line K—K of Fig. VI.
 110 Fig. XI is an enlarged detail of the pneumatic electric contact arrangement, also showing the recording punches as shown in smaller scale on Fig. VIII. Fig. XII is an enlarged
 115 section along the line M—M of Fig. VIII, showing the solenoids controlling the recording punches. Fig. XIII is an enlarged section taken along the line L—L of Fig. VIII, showing the arrangement of the air cylinders.
 120 Fig. XIV is a plan of an electrical selector. Fig. XV is a section of the selector taken on line E—E of Fig. XIV. Fig. XVI is an end view of the transverse carriage taken along the line B—B of Figs. I and XVII.
 125 Fig. XVII is a plan of the transverse carriage. Fig. XVIII is a sectional elevation of the transverse carriage taken on the line D—D of Figs. I and XVII, showing the cutting tool. Fig. XIX is a view along the line N—N of Fig. XVIII. Fig. XX is a section 130

along the line O—O Fig. XVIII. Fig. XXI is an end view of the longitudinal carriage taken along the line C—C Fig. I. Fig. XXII is a sectional elevation of the longitudinal carriage taken on line A—A Figs. I and XXI. Fig. XXIII is a diagram showing control circuits for one unit element. Fig. XXIV is a diagram of the arrangement of the pneumatic tubes in an entirely pneumatically controlled machine. Fig. XXV is a diagrammatic section showing the cylinders and pneumatic selectors. Fig. XXVI shows diagrammatically the method used in making the record in an entirely pneumatic method. Fig. XXVII shows a form of magnetic clutch which may be used instead of a friction clutch. Fig. XXVIII shows a pneumatic cylinder whose slide valve is actuated by a control solenoid for actuating clutches, where great power is required. Fig. XXIX shows the method used for closing circuits by means of an embossed record in the all electric method.

Similar numerals refer to similar parts throughout the several views.

Referring to Fig. I the recording and controlling mechanism 8, inclosed in a suitable casing is located at the end of the table 196. The two cables 16, contain all the wires connecting the mechanism 8, with the longitudinal carriages 1. The cables connecting the transverse carriages 3 with the mechanism 8, will be carried above the machine by means of trolleys or wires strung above the machine.

Referring to Figs. VI, VIII, X, XI, XII and XIII, the motor 79, by means of the belt 80, rotates the rollers 74, 75, 54 and 78, which causes the perforated sheet 73 to unwind from roller 74 and wind around roller 75, passing over the plate 77 and the tracker ducts d^1 , d^2 , d^3 , etc. The train of connections causing the above motions will be explained hereinafter. The same source of power 79 also causes the rotation of the shaft 204, and by means of crank shafts 60, the exhaust bellows 70 are made to operate. The train of connections from the motor 79 to the shaft 204 will also be explained later. The exhaust bellows are connected with an air chamber 71, which in turn is connected to air cylinders e^1 , e^2 , e^3 , etc., by means of the pipe 72 and connecting pipes 99. The exhaust bellows keep the air chamber below atmospheric pressure. 201 is a device known as the pressure regulator. By means well known to the art, the spring 202 forces open the valve 203 when the reduction of pressure becomes too great, i. e., greater than a predetermined reduction. This permits air at atmospheric pressure to enter, which brings the pressure up to the proper point, when the valve 203 closes again.

Referring to Fig. XI where a cross sec-

tion through one of the air cylinders e^1 , e^2 , e^3 , etc., is shown, a and b are two electric terminals attached to the top 61. A piston 95 is kept at the bottom of the cylinder by means of the spring 97 placed on the rod 63 attached to the piston 95. The spring 97 reacts against the piece 62 which has large openings in it to permit the free passage of air. To the top of the rod the conducting contact disk 100 is attached and insulated from it. The piston 95 is provided with a very small port 101. When the tracker duct opening is closed, the air in the cylinder is exhausted by means of the bellows, through the pipe 99. The pressure in the cylinder and in the tracker duct d is brought below atmospheric pressure by means of ports 101 and 64. When a perforation passes over a tracker duct d , air at atmospheric pressure enters the duct and forces the piston in the corresponding cylinder up against the spring 97 until the disk 100 comes in contact with the terminals a and the terminals b , forming an electrical connection between them. The port 101 is so small in comparison with the port 64 that the leakage through it will have very little effect against the forcing of the piston 95 upward by the inrush of air at atmospheric pressure. When the perforation passes from the top of the tracker duct, and it is closed, the air below the piston 95 is soon exhausted through the port 101, to such an extent, that the spring 97 forces the piston 95 down, breaking the connection between the terminals a and the terminals b . Whereas the means of operating the air cylinders just described is a reduced pressure system, the plenum system could be used just as well. As is well known to the art, by using the bellows as pressure bellows above atmospheric pressure and the air chamber 71 as a high pressure chamber, by a simple rearrangement of the ports of the air cylinders, the plenum system could be used.

In Figs. XIV and XV are shown a plan and section of one of three electrical selectors used in this machine. The contact arms 44, 45, 46, 47 and 48 are fastened to a disk 65, which is fixed to shaft 43, in the case of the transverse motion and are insulated from each other. The disk 66 has a layer of insulation as shown in section Fig. XV, and is concentric with the shaft 43. The contact rings 49, 50, 51, 52 and 53 connect by means of brushes the arms 44, 45, 47, 48 and 46 respectively, with their proper circuits as explained in the description of Fig. XVIII. The contact pieces c^1 , c^2 , c^3 , c^4 , etc., separated by insulation from each other are connected electrically to corresponding terminals a^1 , a^2 , a^3 , etc., in the air cylinders a^1 , a^2 , a^3 , etc., which are designated in the typical one shown in Fig. XI

as a . In Fig. XXIII the contacts are shown diagrammatically; 44, 45, 46, 47 and 48 are the correspondingly marked contact arms of Fig. XIV. The areas c^1, c^2, c^3, c^4 , etc., correspond to the contact pieces similarly marked in Fig. XIV, also a^1, a^2, a^3 , etc., correspond to the terminal a in the cylinder in Fig. XI and b^1, b^2, b^3 , etc., correspond to b . The number of contact pieces c^1, c^2, c^3 , etc., are taken in multiples of 16 as shown from c^1 to c^{16} , and then repeated in cycles. The pieces marked c^1 are all electrically connected, all marked c^2 are connected to each other, and so on, so that there are sixteen circuits with several multiples of contact pieces around the disk. There are two cycles shown on Fig. XXIII. The number sixteen was chosen here for convenience. Another number could have been used provided the number of strips included between the extreme of arms 44 and 48 is the minimum.

Before continuing further with the description of the operation of the control mechanism, it will be necessary to explain a few of the mechanical parts.

Referring to Fig. XVII, 18 is the electrical selector for the transverse motion, which is shown in detail in Figs. XIV and XV. There are similar ones for the longitudinal motion and for the slope motion. In the case where the selector is not located at the end of the shaft of the driving gear, as is the case in the transverse motion in connection with shaft 43, the contact rings 49, 50, 51, 52 and 53 are enlarged to allow an opening at the center for the shaft to pass through. The selector 18 is fixed to the carriage so that the disk 66 cannot rotate. The arms 44, 45, 46, 47 and 48 are fixed to shaft 43, and rotate with it. It will be shown later that when the carriage moves in one direction, the shaft 43, and hence the arms, rotate in one direction, while if the carriage moves in the opposite direction, the shaft and the arms then rotate in the opposite direction. 33 is a solenoid composed of two solenoids 33^a and 33^b wound in series with each other with a shunt running off between them. The location of this shunt is at z , as shown in the diagrams Fig. XXIII. The plunger 32 is drawn toward solenoid 33^a , solenoid 33^b , or held between them as the currents are shunted or sent through them in series. It will be shown later that when plunger 32 moves toward solenoid 33^a , the carriage travels in one direction, when it moves to solenoid 33^b , the carriage travels in the opposite direction, and when it is held between, there is no power driving the carriage in either direction, except its own inertia.

Fig. IV shows a partial view of the perforations in the record passing over a set of tracker ducts for one unit element. For

illustration, it will be assumed that at a certain instant, the carriage is in such a position that the arms of the selector are in the position shown in Fig. XXIII, viz. 45 at c^6 and c^7 , 46 at c^8 , etc., and the record in such a position that a perforation is at tracker duct d^9 . This will close the circuit between the terminals a^9 and b^9 by means of the air at atmospheric pressure, forcing up the piston 95, as shown in Fig. XI. The circuit shown by arrows m is then closed, viz., from source A through switches 67 and 92, then through electro-magnet 81^b, the function of which will be explained later. It then follows through the arm 47 to the contact strip c^9 , thence from the terminals a^9 to b^9 as explained above, thence through the common point of intersection to z and through solenoid 33^b , thence through resistance ss back to source. As the solenoid 33^b is energized, the plunger 32 is drawn into it, and the carriage is sent forward. The circuit just described contains the dominating current. There is however, another current passing through the solenoids 33^a and 33^b in series. That current is considerably less than the shunted one, owing to the additional resistance tt and the resistance of the solenoids 33^a , in its circuit, and therefore leaves the center of magnetism in the solenoid 33^b . As the sheet 73 continues to move, the second perforation comes over the next tracker duct, and in the same manner as before contact is made between the terminals a^{10} and b^{10} . As the carriage moved forward due to the connection between the terminals a^9 and b^9 the arms of the selector also moved forward and the contact arm 47 now covers the pieces c^{10} and c^{11} so that the circuit is completed, and the current m is flowing again, and as before the carriage is sent forward, and the arm 47 covers the pieces c^{11} and c^{12} . The third perforation now passes over the duct d^{11} , making connection between the terminals a^{11} and b^{11} , causing motion in the forward direction again and bringing arm 47 in contact with the pieces c^{12} and c^{13} . At the same time, the other arms 44, 45, 46 and 48 travel along in the same relative positions to 47. The fourth perforation also passes over the duct d^{11} , connecting the terminals a^{11} and b^{11} . The arm 46 is now on contact piece c^{11} , the one connecting with the terminals a^{11} and b^{11} . This causes a current to be sent through the circuit marked n , viz, from source through switches 67 and 92, the resistance tt through solenoid 33^a , then shunted at z to terminal b^{11} , from terminal b^{11} to terminal a^{11} to piece c^{11} , through arm 46 to switch 243, through electromagnet 81^a and resistance XX to source, the switch 242 being open and the bar 88 disconnected. The resistance XX is made so much greater than that of ss , tt , 33^a and 33^b , that the current passing through n is small, 130

and therefore the dominating current flows through the switch 92, through tt , and through the solenoids 33^a and 33^b in series, and then through resistance ss to source. The two solenoids 33^a and 33^b are energized practically equally bringing the plunger 32 very near the center of the triple solenoid 33, and the carriage remains stationary neglecting its inertia for the purpose of illustration. The arm 45 is now at contact pieces c^9 and c^{10} . As the record continues to move, the fifth perforation now passes over the duct d^{10} . This makes connection between the terminal a^{10} and b^{10} , and the circuit is completed, with arm 45. A current k is now flowing from source through the switches 67, 92 and resistance tt , thence through solenoid 33^a , is then shunted at z , thence through the terminals a^{10} and b^{10} , through arm 45, thence through electromagnet 81^a and back to source. The center of magnetism is now in solenoid 33^a , and the carriage is sent backward in opposite direction. The arm 45 is now brought over contact pieces c^8 and c^9 . The sixth perforation sends the current through the terminals a^9 and b^9 , and the arm 45, and the carriage is sent still farther back. The motion back and forth is continued according to the position of the perforations.

In Fig. IV, the perforations are shown spaced with an interval between them in the direction of the feed of the record as well as across the sheet. Any positive spacing can be used the larger the spacing center to center of perforations, the larger the sheet for any given path. In this particular application of the kinautograph, I shall space the perforations with an overlap in the direction of travel of the record, although the drawing shows the contrary, for the sake of clearness in showing the individual perforations. The effect of overlap is that there is always an air cylinder with its contacts connected.

The explanation of the perforations and their effect so far have been for one unit element; in order that the three unit elements should be controlled simultaneously, the perforations corresponding to the several unit elements are placed abreast of each other. In the case of two machines working at the same time over different paths, the perforations of six unit elements are abreast. Then, as the record is fed, the several unit elements act together, each bringing about its component motion, the combination is the resultant motion desired.

The relations between perforations, tracker ducts, air cylinders and selectors are similar for the several unit elements. The contact pieces are shown in cycles and arranged around the periphery of the selector, with the several arms 44, 45, etc., revolving

within. This method is useful where the travel of the unit elements is long. If there were short travel, the contact pieces could be arranged in one or more cycles in a line along the direction of motion of the unit element, and the arms 44, 45, etc., attached to the body of the unit element, so that as it moved along, the arms could pass over the pieces. The arrangement of pieces and arms shown in Fig. XXIII illustrates this. Each contact piece, in the case where only one cycle is used and the pieces laid out in a line along the path of the unit element, represents a point on the line of travel of the unit element, and has a corresponding tracker duct and air cylinder. If the pieces are laid along the path of the unit element but are in cycles, each piece represents a point on the line of travel or path of the unit element and similar pieces of each cycle are electrically connected to each other and each group of similar pieces has a tracker duct and air cylinder. If, instead of the selector having its contact pieces laid along the line of travel of the unit element, they are arranged around the periphery of a selector with rotating arms, each piece still represents a point or points on the path of the unit element. Where the contact arms 44, 45, etc., are directly connected to the shaft of the driving gear of the unit element, as they are when connected to the shaft 43, each complete revolution of the driving gear causes the contact arms to make a complete revolution around the selector. Then in a distance traveled by the unit element equal to the pitch circle of the driving gear, there are a number of contact pieces equal to the number of pieces around the periphery of the selector. Then as the driving gear continues to develop itself, the contact pieces develop themselves along the line of travel of the unit element in number, giving the same result as though the contact pieces were laid out in a line. Increased accuracy of control is obtained by increasing the diameter of the selector, and by having the arms 44, 45, etc., on a shaft geared so as to revolve faster than the shaft of the driving gear. On Fig. XXIII the arms 44, 45, etc., are shown, covering adjacent contact pieces; in Fig. XIV, they are shown on contact pieces of different cycles but adjacent groups. These two arrangements are identical in respect to the control of circuits. In the circular selector, this is done because the size of the arms is too great to place them on adjacent contact pieces unless the depth of the contact pieces were made great enough to place the arms overlapping each other one above the other. The accuracy of control can be regulated also by the number of contact pieces each one of the arms 44, 45, etc., is made to extend over. They

are of such a width and so spaced that no contact piece is left unconnected to an arm, between the several arms. Means well known to the art will be used to eliminate eddy currents and other forms of inductance from the several circuits. The limit of error within which the unit element can be made to move, can be made as small as desired by the several methods just described. By limit of error, I mean the deviation of the motion of the unit element, from the original motion of the unit element, as recorded on the perforated sheet or embossed sheet, or whatever other form of record is used.

The two other arms 44 and 48 come into use only when the driving mechanism fails to act in unison with the controlling mechanism. Before explaining the function of these arms, and their relation to the main controlling circuits, it will be necessary to explain part of the mechanism controlling the feeding of the perforated record.

Refer now to Figs. VI, VIII and X. The record 73 is fed by being gripped between the two rollers 54 and 78, and is wound on spool 75. Roller 54 drives and 78 is an idler pressing against it. The shaft 76, which is a continuation of roller 54, extends through 105, which is the female portion of a friction clutch. 105 in turn is attached to 110, a part of the frame, which fixes it against rotation. The male portion of the clutch 106 is fixed to a hollow shaft 76^a.

The hollow shaft fits over the shaft 76. Shaft 76 is provided with a feather and shaft 76^a is provided with a slot so that 76^a slides over 76 longitudinally, but the two are made to rotate together. The shaft 76^a extends through the solenoid 102 which is attached to the frame 103. The plunger 104 fits inside of shaft 76^a. The male portion of the friction clutch 109 is rigidly attached to the shaft 76^a. The female portion of the clutch 107 is rigidly attached to shaft 223. The spring 108, by pressing against the clutch part 106 forces it into its mate 105, and releases the clutch part 109 from the clutch part 107. In that position, while the motor 79 imparts motion to the shaft 223 and to the clutch part 107, by means of belt 80 and pulley 80^a, the shaft 76 is stationary. If the solenoid 102 is now energized the plunger 104 is drawn in against the spring 108, the clutch part 106 is released from its mate 105, and the clutch part 109 locks with its mate 107. Since the clutch part 107 is rotating, its motion is now transmitted to the shaft 76, and the record is fed. It is therefore evident that in order to feed the record, the solenoid 102 must be energized. The current used in energizing the solenoid 102 must pass through the circuit shown in Figs. VI and X, through the armatures 87 and the plates 87^a of the six electro-magnets, 81, 82, 83, 84, 85 and 86. This circuit will be known as the auxiliary circuit. There is one magnet for each component motion to be controlled by the record. In this case there are two machines, each having three unit elements, as shown in Fig. I. In order to close the circuit, every one of the magnets 81, 82, 83, etc., must be energized, then the armatures 87 are brought in contact with the plates 87^a. If the current through any one of the magnets is stopped, the armature 87 is released, the spring 87^b pulling it up, and the auxiliary circuit is broken. Since they are all connected in series, the armatures 87 on all six magnets must be kept down, in order to energize the solenoid 102. Each one of these electro-magnets is in reality a magnet composed of a single core wound with three separate insulated helices which for 81, are shown as 81^a, 81^b and 81^c in Fig. XXIII. A current through any one of these helices keeps the magnets energized and the circuit through the solenoid 102 is closed. It will be recalled that in tracing the circuits *k*, *m* and *n* causing the motion of the carriage in either direction, they were made to pass through either helix 81^a, 81^b or 81^c, and in such event the record continues to feed. If now a circuit be made such that no current will flow through either helix 81^a, 81^b or 81^c, the auxiliary circuit will be broken, the solenoid 102 will be deenergized and the record will stop. Let it be assumed now that something has happened to retard the motion of the carriage while the record continues to feed. Assuming the record in the position shown in Fig. IV, and the arms of the selector in the position shown in Fig. XXIII, and the first perforation has just passed over the tracker duct *d*⁹, now if the driving mechanism fails to respond, the arm 47 remains on the contact piece *c*⁹ when the second perforation comes over the duct *d*¹⁰. If there is still no response when the third perforation comes over the duct *d*¹¹, the circuit through the arm 48, the contact piece *c*¹¹ and the terminals *a*¹¹ and *b*¹¹, *i. e.*, the circuit *O*, is closed, viz:—from source through switches 67 and 92, arm 48, thence through contact pieces *c*¹¹ to terminals *a*¹¹ and *b*¹¹, thence through *z*, through solenoid 33^b, through resistance *ss* to source. It will be noted that no current flows through either helix 81^a, 81^b or 81^c. This releases the armature 87, breaking the auxiliary circuit, and the record is stopped. The dominating current passes through the solenoid 33^b, causing the carriage to travel in the forward direction while the record is stationary. This allows the driving mechanism to catch up with the record. As the travel of the carriage continues, it brings the arm 47, up to contact piece *c*¹¹ once

more, causing the current to flow through the circuit m , as the perforation is over the duct d^{11} . This sends the current through the coil 81^b , closing the auxiliary circuit, and starting the record again. That the record is stopped every time the record and body get out of synchronism by more than the allowed limit of error is true only in the theoretical sense. Most of the time, owing to inertia and the slippage of the clutches feeding the record, the feeding motion is only retarded and when the body and record come into unison, the retarding action of the clutches is changed to one of driving. Now, consider again the position of the arms as shown in Fig. XXIII and the first perforation in Fig. IV, just over the tracker duct d . If the driving mechanism should run away from the record, and pass through the neutral position, and beyond, the arm 45 coming into contact with contact piece c^9 , closes the circuit K. This causes the plunger 32 to be thrown to the solenoid 33^a and the result is a reverse driving motion in the back direction, bringing the arm 46 over contact piece c^9 . The neutral circuit n is thereby closed. Then as the second perforation comes into line, the machine takes up its normal travel. If the drive should lag behind or run away from the record entirely, no arm would be in circuit with the contacts of that tracker duct energized by the perforation passing over it. In this condition, no current passes through the magnets 81 , and the current passes through the solenoids 33^a and 33^b in series. This causes both the machine and record to stop. In order to start the machine now, the parts must be brought into proper position by hand. In order to locate the position of the machine for the corresponding position of the record, the position of the various unit elements will be marked on the record at stated intervals to correspond with the marking on the machine.

The use of the arm 44 and the circuit p is similar to the arm 48 and the circuit o , except it is for motion in the opposite direction.

I do not limit myself to the system of circuits herein described. There are many systems which can be used to accomplish the same control.

In the description of the controlling mechanism, several motions were assumed. The train of mechanical connections causing these various motions will now be followed through. The record mechanism is supported on plate 55, which is in turn bolted to the horizontal angle irons 56, and these are supported by the angles 57. The motor 79 is attached to the plate 55. The motor transmits motion to shaft 223, by means of belt 80 and pulley 80^a . The manner in

which the shaft 223 transmits motion to the shaft 76 has been previously explained. The roller 54 revolves in bearings in frames 58 at both ends. The upper part of frame 58 is provided with a slot, in which the end pins of the idler roller 78 fit. Rounded bearing pieces 59 are placed in the slot, and are adapted to bear on the pins at the ends of the roller 78. The screws 218 and 219 press springs 244 against the pieces 59, and thus the roller 78 is made to bear against the roller 54. The pressure can be increased or diminished by screwing 218 and 219 down or up. The perforated sheet is passed between the rollers 54 and 78 and is pulled forward by the rotation of the roller 54 against the roller 78. The gear 214, is fixed to the shaft 76, and drives the gear 221 attached to a spindle revolving in bearings in frames 68. The gear 215 driven by the gear 221, grips the shaft to which the spool 75 is attached by means of friction, but is not rigidly attached to same. The lug 69 on the gear 215 is provided with a hole into which the pin 217 is placed. 217 also fits into a hole in the hub of the gear 215, and by means of the spring 216 is brought to bear against the shaft 75. The pin can be raised by means of the eccentric lift or cam 222. The spool 75 is used to wind up the perforated sheet as it is fed between the rollers 54 and 78. If the gear 215 rotates faster than the record is fed, it will just slide over the shaft 75. The gear 210 is fixed to the shaft 223, and drives gear 211 fixed to shaft 208. The shaft 208 revolves in bearings 207 and 209 and drives the gear 212 fixed to it. The gear 220 driven by gear 212 in turn transmits motion to the gear 213, which slides over the sliding part of the clutch 93 and is made to turn with it by the feather 93^c. 93 fits loosely over the shaft 204. The bearing frames 205 support the shaft 204. The gear 213 is held laterally by the four up-rights 206. 230, the mating part of the clutch 93 on the right is fixed to the shaft 204 and its mating part 227 on the left is attached to the sprocket wheel 224. 227 and 224 fit loosely over the shaft 204 which is extended through the bearing frame 205. When the clutch 93 is thrown to the right, the shaft 204 is rotated, and consequently the bellows 70 operate. When 93 is kept in the center, the gear 213 rotates idly. If the clutch 93 is thrown to the left, it engages the clutch 227 and the sprocket 224 is rotated. The rotation of 224 is transmitted to sprocket 225 by means of chain 200. The sprocket 225 is fixed to shaft 74^a. The record spool 74 has a friction grip over shaft 74^a and gets its motion from it by means of pin 198, passing through lug 228, and being pressed down by spring 229. The pressure is released by raising the eccentric lifter or cam 199. When the clutch

93 is thrown into its mating part 227, the record will wind up on the spool 74. When the machine is in operation, the clutch 93 is thrown into its mating part 230 and the cam 199 is raised so that the spool 74 will revolve freely on shaft 74^a, and the record will unwind, and be wound on the spool 75. Means not shown but well known to the art will be provided for attaching a record to the spool 74. The cam 222 is kept down when it is working thus. In rewinding the record, the cam 222 is lifted and the cam 199 is put down. In order to conveniently throw the clutch 93, it is provided with a groove, over which a loose collar is fitted. The pin 93^a is screwed into that collar, and is held in place by the plate 93^b, provided with a slot. To throw the clutch, the pin 93^a is pulled to either side. The curved plate 77 is used as a guide and support for the record sheet. It is held in place by uprights, and at ends not shown in figures.

In the description above, it was shown how a previously prepared record controlled the movements of a plunger in a solenoid. In this description, it was assumed that if the position of the plunger in the controlling solenoid were on one side, the unit element would move in one direction, if it were at the other end, the unit element would move in the opposite direction, and if it were at the center, the unit element would not be driven in either direction except by its own inertia. That there is a corresponding change of motion of the unit element for each change of position of the plunger is true only in a theoretical sense and is a useful assumption for the purpose of illustration. Owing to inertia and other factors inherent in the mechanism, the changes of motion of the unit element lag behind the changes of position of the plunger. This has the advantage of steadying the motion of the unit element, resulting in a smoothly running motion, permitting gradual changes in speed and direction.

The details of the longitudinal carriage will now be described, to show how the above mentioned results are obtained.

Referring to Figs. I, XXI and XXII. the table 196 is provided with V ways 2, on each side of the table and running its length. The longitudinal carriage 1, is provided with two shoes 111 at the bottom, which slide over the V ways 2. The gears 127 and 127^a, attached to the carriage 1, engage with the two racks 14, running the length of the table. It is evident that if the gears 127 and 127^a rotate in one direction, the carriage will move say, in a forward direction, and if the gears rotate in the opposite direction, the carriage will move in a backward direction. It will now be necessary to trace the relation between the movement of the plunger

in the controlling solenoid, and the gears 127 and 127^a.

Referring to Fig. XXI, the motor 27, supplying the power for this machine, is directly connected to shaft 27^a, and is properly supported on the frame work of the carriage. The gear 35 is fixed to shaft 27^a, the armature shaft, and engages with gear 36. The gear 36 transmits its motion to shaft 37, to which it is fixed. The hollow shaft 37^a has an inside diameter large enough to fit over the shaft 37. A feather on the shaft 37 engages with a slot in shaft 37^a, so that they both rotate together, but the hollow shaft 37^a is capable of sliding over the shaft 37, consisting of two female parts of a friction clutch, is fixed to 37^a. 114, the male portion of this clutch is fixed to gear 116, but both fit loosely over the shaft 37^a. They are held laterally by the piece of frame work 142. The male portion of the friction clutch on the other side, 115, is similarly fixed to gear 117, they also fit loosely over the shaft 37^a, and are held laterally by the frame 143. I do not limit myself to the type of clutch here described. Many forms of clutches capable of reversing the motion transmitted, and transmitting no motion if desired, controlled by the position of the plunger, could be used for the unit elements. The solenoid 141 is placed so that its plunger 140 is attached to the end of the shaft 37^a. 37^a is made of non-magnetic material for a sufficient distance, so that it will not interfere with the action of the plunger 140. When the plunger 140 is at the end of the solenoid, as shown in Fig. XXI, the clutch 113 will engage with its mate 114, and drive the gear 116, as the shaft 37 is rotated. If the plunger 140 is at the other end, the clutch 113 engages with its mate 115, and consequently drives gear 117. If 140 is at the center of the solenoid, the clutch 113 does not engage with either 114 or 115, and therefore neither gear is driven by it. 141 is one of the control solenoids noted before in describing the controlling mechanism. 141^a and 141^b correspond to the solenoids 33^a and 33^b described hereinbefore, and shown in Fig. XXIII. The position of the plunger 140 is controlled by the record. When the clutch 114 is thrown in, the gear 116 drives the gear 118 which is fixed to the shaft 128, which in turn revolves in bearings in frame 146. The gear 129 is rigidly attached to end of shaft 128 and in turn drives gear 130 and the shaft 131 to which 130 is fixed. The shaft 131 revolves in suitable bearings in the frame, and drives the bevel gear 132 which is fixed to it. The bevel gear 133 mates with 132. 133 is fixed to gear 133^a, or both are made of one piece and are fixed to shaft 134^b to which the gear 134 is fixed. The gear 134 drives gear 127, which revolves on shaft 231, which is attached to the frame.

The gear 127 engages with the rack 14, and thus drives the longitudinal carriage. The gear 133^a drives the gear 135 being in turn fixed to shaft 138 which extends for the width of the carriage. The gear 135^a is fixed to the other end of the shaft 138, and in turn drives gear 133^b and the shaft 134^c, to which it is fixed. The gear 134^a fixed to shaft 134^c, drives gear 127^a which in turn engages with rack 14, and drives the longitudinal carriage. It will be noted, that the gears 127 and 127^a rotate in the same direction at the same time and at the same speed, and therefore the carriage is driven forward at both sides of the table simultaneously. When the clutch 115 is thrown in, the gear 117 drives the gear 119, which is fixed to shaft 120. The gear 121 attached to the shaft 120, in turn drives gear 122. The shaft 123 to which 122 is fixed, drives the bevel gear 124, which is attached to same. The bevel gear 125 mates with the bevel gear 124. The gear 125^b is fixed to 125, or both are made of one piece, and both are fixed to shaft 126^a. The gear 126 is fixed to the shaft 126^a, and in turn drives gear 127 which engages with rack 14, and therefore the longitudinal carriage is driven in the opposite direction to that when the clutch 114 was engaged with its mate 113. The gear 125^b drives gear 136, which is fixed to shaft 137. 137 runs for the width of the table parallel to the shaft 138. At the other end of 137, the gear 136^a is attached, and in turn drives gear 125^a. Gear 125^a is fixed to the same shaft as gear 126^b (not shown because it is behind 134^a) and in turn, it drives the gear 127^a, which engages with rack 14, and transmits motion to the carriage opposite to that when the clutch 114 is thrown in. As noted before, 127 and 127^a bear the same relation in driving the carriage.

139 is the electrical selector for the longitudinal carriage, and is similar in construction to the one described in Figs. XIV and XV. It is fixed to the frame of the carriage, while its five contact arms are fixed to shaft 232, and hence rotate in the same direction as this shaft. It is therefore evident that when the carriage moves in one direction, the arms will rotate one way. When the carriage moves in the opposite direction, the arms will rotate in the opposite direction and when the carriage is stationary, the arms will be stationary. These were assumptions made in describing the controlling mechanism. In the drawing and description, the arms of the electrical selector, are shown connected directly to the shaft to which the driving gear 127^a is attached. It was shown that way for simplicity of drawings and explanation. In the preferred form, the arms will be attached to a train of gears, so that for any motion of the shaft 232, the arms will travel

more rapidly. There were a few objects kept in view in laying out the gearing for this and the other component motions; one was the elimination of back-lash, and the others were the accuracy of control, and the keeping of the solenoid within practical size. When the clutches act on a shaft of relatively high speed of rotation to the driving gear, the thrust on the clutches can be made much less than on a shaft of slow speed, in order to transmit the same amount of power. This accounts partly for the number and complicated arrangement of the gearing. Back-lash is eliminated by having in connection with the friction on their bearings and between their teeth, two trains of driving gears instead of one, although it could be eliminated largely by having one train of gears and the racks, the teeth of which would be helical or herringbone shape. However the double train of gears are believed to be best, as no amount of wear will permit any increase of back-lash to enter into the action of the machine, particularly in sudden reversal of direction.

In driving the gears 127 and 127^a, two trains of gears are used, one train beginning with the gear 117 and ending with the gears 126 and 125^a, the other train beginning with the gear 116 and ending with the gears 134 and 134^a. At any time for motion in a given direction one train of these two trains of gears is driving while the other train is being driven by the gears 127 and 127^a, so that when reversal in the direction of motion takes place, the driven gears, having their teeth already in contact, do the driving without any lost motion. In order to carry the elimination of back-lash to a greater degree of accuracy and perfection, the machine can be constructed so that instead of having one gear 127 and one gear 127^a do the driving, as shown, there will be two gears 127 and two gears 127^a, traveling on the racks 14. One gear 127 and one gear 127^a, can take care of the train of gears which cause motion in one direction, as for example, the train driving the gears 126 and 126^a, while the other pair of gears 127 and 127^a, can take care of the motion in the opposite direction caused by the train of gears driving the gears 124 and 134^a. This eliminates the back-lash between one driving gear and a rack in reversal of driving. When the plunger of the solenoid is pulled from one of its end positions to the neutral position, as is well known instead of stopping, when it gets to the neutral position, it will travel beyond (there is a tendency to oscillation) and throw in the reversing clutch momentarily, which in connection with the elimination of lost motion acts as a brake immediately.

144, 145, 146 and 147 are parts of the frame, containing the bearing for shafts, 130

and are used for bracing the machine. The forms shown are not necessarily the ones used in the machine as built, but are merely shown to illustrate the parts logically held in place.

In order to transmit the motion from the motor 27 to the transverse carriage, which is mounted on the channel 4 of the longitudinal carriage, its flanges being planed to form, V shaped guides similar to the ways 2 for the longitudinal carriage, the bevel gear 38 is fixed to shaft 37, which is in constant motion when the motor 27 is running. The mating gear 39 is attached to shaft 40, revolving in bearings in frames 146 and 147. The shaft 40 drives the bevel gear 41 fixed to it, and in turn 41 drives its mate 42 which is fixed to horizontal shaft 21 and drives it. The shaft 21 furnishes the power for the transverse carriage motion and for the slope motion, and extends for the width of the longitudinal carriage and is provided with a slot 233.

Referring to Figs. XVI, XVII, XVIII, XIX and XX, the gear 22 fits loosely over shaft 21 and is held by a key 234, so that the gear 22 can slide over the shaft 21, but is made to rotate with it. 22 is held in place by the forked guide frame 170, which in turn is attached to the body of the transverse carriage. As the carriage travels over the ways of channel 4, the gear 22 slides along the shaft 21, and is caused to revolve by same. Gear 23 is driven by the gear 22, and is also attached to frame 170. Gear 24 is driven by the gear 23, and fits over shaft 31, thereby causing shaft 31 to rotate. The shaft 31 revolves in bearings of frame 34, and at one end of same, the plunger 32 of the solenoid 33, is attached. The end of the shaft adjoining 32, is made of non-magnetic material for a sufficient distance not to interfere with the magnetic action of 32. The female part of a friction clutch 25, is fixed to the shaft 31, as is also the female part of another friction clutch 19. The male part of the friction clutch 26, mating with the clutch 25 is fastened to the bevel gear 29. The bore of both is such that they will fit loosely over shaft 31. The gear 29 and the clutch 26 are held in place by the frame 34. The male portion of the friction clutch 20, the mate of 19, is fastened to the bevel gear 28, and both fit loosely over shaft 31. They are held in place by the frame 34^a. 34 and 34^a are braced by the plate 34^b. The bevel gear 30 fixed to shaft 43 mates with both gears 28 and 29. When the plunger 32 is in the position shown, the clutches 25 and 26 are engaged, and shaft 31 drives gear 29, which in turn drives gear 30. The gear 28 is driven by the gear 30. If the plunger 32 is moved to the other end of the solenoid, the shaft 31 is moved laterally, the clutches 25 and 26 are disengaged, and the

clutches 19 and 20 are engaged, driving the gear 28 which in turn drives the gear 30 in the opposite direction. 20 is now the driven gear. Since the gears 28, 29 and 30 are always in contact, when the direction of motion is reversed, backlash is eliminated. When the plunger 32 remains in the center of the solenoid 33, both clutches are disengaged and the gears 28, 29 and 30 are not driven by 31. The solenoid 33 is the triple solenoid 33^a, 33^b and 33 described in the typical control solenoid, and shown in the circuit diagram Fig. XXIII.

The gear 17 is fixed to shaft 43 and is driven by same. 17 engages with rack 15 which is attached to channel 4, and runs the width of the longitudinal carriage as shown in Fig. I. As gear 30 is driven in either direction, gear 17 is driven in the same direction, and consequently the frame 3 to which the shaft 43 and the frame 34 are attached moves back and forth over the ways of channel 4. The electrical selector 18 constructed as shown in Figs. XIV and XV, is attached to frame 3. The five selector arms are all attached to shaft 43, and rotate with it.

To transmit motion from shaft 21 to the axial or slope component, the gear 148 is feathered to shaft 21, and is made to rotate with same by means of key 235, in the same manner as gear 22. The gear 148 is held in place by the forked frame 188. 148 drives gear 149 which in turn transmits its motion to shaft 152. The shaft 152, revolving in suitable bearings and being made of non-magnetic material for a sufficient distance, is attached to the plunger 151 of the solenoid 150. The female part of a friction clutch 161 is attached to the end of shaft 152, and the female part of another friction clutch 153 is attached to the shaft 152 near the gear 149, as shown. The mating male parts of these clutches 160 and 154 are fastened to the bevel gears 159 and 156 respectively. 159 and 160 fit loosely over shaft 152, and are held in place by frame 190. The clutch 154 and the gear 156 also fit loosely over 152, and are held in place by frame 155. The bevel gear 157, attached to the vertical shaft 166, mates with both the bevel gears 156 and 159 and is driven by either one. When the plunger 151 is actuated by the solenoid 150, so that it assumes the position shown in Fig. XVII, the clutch 153 engages with its mate 154, and the bevel gear 156 will then drive the bevel gear 157, while the bevel gear 159 will be driven by the bevel gear 157. If the plunger 151 assumes a position at the other end of the solenoid, the clutches 153 and 154 will become disengaged, while the clutch 160 will become engaged with its mate 161, since the rotation of the shaft 152 is always in the same direction. The bevel gear 159 will

now drive the bevel gear 157 in the opposite direction to that which it was driven before, and the bevel gear 156 will be driven. Since the teeth of the gears 156, 159 and 157 are always in contact, there is no backlash when the direction of motion is reversed. When the plunger 151 assumes a central position in the solenoid 150, both clutches become disengaged, and the shaft 152 will rotate without driving the bevel gear 157 in either direction. The solenoid 150 is the control solenoid for the slope, or axial component and is composed of a triple solenoid 150, 150^a and 150^b, as explained and shown on Fig. XXIII as 33, 33^a and 33^b. It is controlled by the perforations in the record. The shaft 166 revolves in bearings in frame 189, and in frame 3. It is held in proper position by collar 236. The gear 158 is fixed to the shaft 166, and transmits its motion to gear 162, which is attached to cylinder 177, and rotates it. The cylinder 177 revolves in the supporting shell 178, which is fastened to frame 3, by means of collar 179, and is moved along with it.

The reciprocating piece 172, to which the cutting tool is attached below, slides inside of the cylindrical piece 177, but is made to rotate with it by means of a feather in 177, thus permitting the piece 172 to have a reciprocating motion. The electrical selector 163, similar to the one used for the other component motions, is attached to frame 3. Its five contact arms are attached to cylinder 177 and revolve with it. The cutting tool 173 is attached to the reciprocating piece 172 by means of the adjusting screws 182, 183, 184 and 185. The cutting edge of the tool 173 is made to coincide with the vertical axis of the piece 177 by adjusting the blade laterally until it does. A guide line is marked on the piece 172, to indicate the correct position. A guide piece 175 is attached to the arm extending from 177, and is attached to it by means of screws and nuts 186 and 187. 175 is so placed that the back or dull edge of the knife 173, and part of its sides reciprocate in it. The rotation of the gear 162 brings the edge of the knife at the proper angle required for cutting. In order to eliminate backlash, there would have to be two such wheels as 158, instead of one as shown, to turn 162, and two gears 157 and two axes 166. This is not shown in order to simplify the drawing. The top of the piece 172 is provided with a cylindrical cavity into which is fitted a cylindrical piece 192 and is held in place by the plate 237. The crank shaft 169 is removably attached to the cylindrical piece 192 by means of the removable pin 171. It is provided with a spring catch not shown, which permits removal, and when it is pushed into place, the catch snaps and locks the pin 171 in place. The above provision is made, in case it is

desired to pull the knife up, and above the layer of fabric 195. The crank shaft 169 is operated by the eccentric 167, attached to shaft 168. The shaft 168 revolves in bearings in frame 238, and is directly connected to motor 165, which is suitably supported on framework 239. The counterweight 164 is attached to shaft 168 to lessen vibration. When the motor 165 is operated, the piece 172 is given a reciprocal motion, while the gear 162 imparts to it an axial motion. The cylindrical piece 192 and the pin 171 provide a universal joint which allows the two motions.

The foot plate 176 is attached to the guide piece 175 and is adjusted to proper height by means of slotted holes in the guide piece 175, and is fastened by bolts 186 and 187. The slot 191, in plate 176, is provided to receive the blade 173.

174 is an adjustable presser finger used to keep the fabric from becoming disarranged as the blade reciprocates. It is fixed in any position, by being clamped by screw 180 in guide 181.

The material to be cut 195, is spread on the table 196, the top of which is preferably made of wood. On top of that is placed a layer of yielding material 194, such as cotton batting. This is covered with a layer of tougher material 193, such as felt or the like, such that it will offer a frictional resistance to the sliding of material 195, as the plate 176 passes under it. The advantage of a soft yielding material is, that when the plate 176 bears into the material, there is a ripple formed around it which holds up the fabric 195, and thus permits the edge of 176 to get in under it.

The sequence of operation of the machine is as follows:—Let the shapes 11 Fig. V be the desired forms into which the material 195 is to be cut. The machine is set at the starting point. The record which has been previously prepared for the desired shapes by a method which will be described hereinafter, is placed on the roller 74, and its end is attached to the spool 75, by means of any ordinary catch, and is passed between rollers 54 and 78. The record is so made that it will control the three component motions simultaneously. The switches are then turned on and the motors started. As the record is fed along, the three controlling solenoids are actuated and the longitudinal carriage begins to travel in the path desired and as prepared on the record. The transverse carriage being placed on the longitudinal carriage, is carried back and forth with it, and simultaneously has a transverse motion on the runways of channel 4, due to its controlling solenoid. The resultant direction of motion of the cutting blade, which is attached to the transverse carriage, is the resultant of the paths of the longitudinal and

transverse carriages. The control of the axial motion meanwhile, keeps the blade 173, at the proper slope. As the cutting tool enters at 12, it travels along the dotted line 5 until it reaches the position indicated for piece 11^a. The tool then follows the direction indicated by the arrows around 11^a, it being controlled by the simultaneous action of the three component motions and their 10 actuating solenoids. After passing completely around 11^a, the blade reaches the position shown at 11^b, and follows the direction of the arrows, until it cuts out the piece 11^b, and then follows the direction shown, 15 until 11^c is cut out and so on. It is evident that the path of the blade can be so laid out that it will cut out the various shapes with the least waste of material.

It will be evident to any one familiar with 20 the art, that by a very simple rearrangement of parts, a continuously moving blade may be used instead of a reciprocating one. If desired, a circular blade may be used, by a simple change in the mechanism.

25 In order to conveniently slide the material to be cut upon the table, the roller 197 is provided at one end of the table. Wound on the roller is a continuous piece of some smooth material long enough to reach 30 the length of the table. The material previously arranged in a pile, if more than one layer is to be cut, is clamped at one end and slide on the table. Before sliding the pile of material to be cut upon the table, the 35 smooth layer is unwound from the roller and placed over the rough layer of material covering the surface of the table. After the pile has been slid into place, the clamped end is fastened by some ordinary means to the 40 table. The roller is now revolved by means of its handle, winding up the smooth material from under the pile.

By adding unit elements to those already 45 described as mentioned in the earlier part of this specification, motion can be had in all directions in space, and the axis of rotation can be tilted at various angles. For example, let it be desired to carry a tool about through space and have it rotate 50 about an axis of varying inclination, and let the tool be carried about on the transverse carriage 3. Referring to Fig. XVII, it is obvious that by adding a unit element for motion in a vertical direction to the 55 transverse carriage 3, providing vertical ways for the tool to travel up and down between, a tool traveling along with the carriage, and able to move in a vertical direction can be made to traverse a given path in 60 space. The tool can be fitted between the vertical ways to allow rotation about a horizontal axis, and this horizontal axis can be so supported that it can be made to revolve about a vertical axis. Corresponding perfo-

65 rations, tracker ducts, selectors, etc., must be provided, a set for each axis of rotation.

The mechanism herein described embodies my preferred form. There are, however, several modified forms of it which may be advantageously used. 70

If it be desired to use an all electrically controlled machine, an embossed record may be used instead of a perforated one. Referring to Fig. XXIX, the embossed record 285 is made to pass over plate 77, the 75 same as the perforated one. The series of terminals *a* and *b* are fastened to the non-conducting piece 284. The sliding conducting piece 280 closes the circuit between them. As an embossed marking on the record 80 passes under the wheel 283, it lifts the piece 281 which forces the conducting piece 280 against *a* and *b*. 281 acts against 280 through the spring 279. 282 is part of the frame holding the pieces 281 in line. As the 85 embossed mark passes out from under the wheel 283, the spring 286 and its own weight force down the piece 281, breaking the circuit between *a* and *b*. The terminals *a* and *b* correspond to the similarly marked terminals in the cylinder *c* shown in Fig. XI. In making the record, the recording punches emboss the sheet by being stopped short of cutting through the sheet. Another method, as a substitute for feeding the record only, 95 can be used when desirable, by causing a relative movement between the record and the tracker ducts in the case of the perforated record. Both the record and the tracker ducts may move or the record be 100 still and the tracker ducts move. Of course this method applies as well to any other form of record and its corresponding actuated parts.

The friction clutch described can be replaced by a magnetic clutch, a type of which 105 is shown in Fig. XXVII. By arranging this clutch, for example, on the transverse motion, it can be made to transmit the power from shaft 31 to driving gear 17, Fig. XVI. 110 In general, all the unit elements can be similarly adapted. In Fig. XXVII, the gear 264 fixed to shaft 263, receives its motion from a driving shaft, similar to 31 in Fig. XVI, and drives shaft 263. The soft iron 115 disk 259, is fixed to shaft 263. The magnets 260 and 261 are rigidly fixed to gears 268 and 270 respectively, but fit loosely over shaft 263. 262 is the winding of the magnets. If the magnet 260 is energized, the 120 disk 259 is pulled toward it, and the motion of the disk 259 is transmitted to gear 268 which in turn drives gear 269. The shaft 265 is geared to the gear driving the carriage and is driven by gear 269. If the magnet 261 is energized, it pulls the disk 259 toward it, and in turn gears 270, 271 and 272 are driven, causing shaft 266 to rotate in 125

the opposite direction to the rotation of the shaft 265. 266 is also geared to the gear engaging with the rack, and thus drives the carriage. A system of circuits can be devised, which, in connection with the selector and its arms and the other parts of the control mechanism, will send the currents at will through either of the magnets or none of them. Means can be provided, well known to the art to overcome the residual magnetism of the clutch, such as a momentary reversal of current upon its flow being stopped through either of the magnets or springs forcing the disk 259 away from the magnets.

In case it is desired to operate a machine requiring great power, in order to keep the control solenoids within reasonable size, instead of putting them on shafts at high speed of rotation relative to the driving gears, the solenoids can be made to operate slide valves of cylinders as shown in Fig. XXVIII. 273 is the usual solenoid of a unit element. It controls the well known device, the slide valve, which is shown in 274. Air or other fluid under pressure is admitted into the air chamber 276. 275 is the exhaust. As the position of the slide valve is controlled by the position of the plunger in the solenoid 273, the piston 277 is forced one way or the other, or not at all, carrying the shaft 278 with it. The clutches are operated by shaft 278. Applying this method to the transverse motion, for example, 278 becomes shaft 31, and the cylinder replaces the solenoid 33 on shaft 31. 33 is used to control the slide valve of the cylinder. Another method of causing the controlled motion of the unit elements, is to use an electric motor direct connected to the driving gear or connected through a train of gears to transmit its rotation at a reduced rate to the driving gear. A system of circuits can be arranged to vary the direction of the current through the motor or to stop the current through it, in connection with a record, selector and its arms. For example, let the motor be connected to shaft 43, Fig. XVII. As the current flows through the motor in one direction it causes the driving gear 17 to revolve one way, as the current is reversed through the motor, the driving gear 17 is revolved in the opposite direction. When no current flows, there is no driving force acting on the driving gear 17. Thus the transverse carriage can be driven back and forth, or not at all, according to how the motor is energized.

An all pneumatic control can be used analogous to the pneumo-electric control except that for electric currents, air currents are used. The pneumatic selector is similar to the electric selector, the contact pieces of the latter being replaced by the openings of

the tracker ducts t^1 , t^2 , t^3 , etc., referring to Figs. XXIV, XXV, and XXVI. The arms of the electric selector are replaced by the arms p^{44} , p^{45} , p^{46} , p^{48} and p^{47} . The disk 288, holding the tracker ducts t is fixed from rotation by being fastened to the frame, and the arms revolve with the driving shaft, or are geared to it. In the case where the selector is laid out in a line along the travel of the unit element as shown in Fig. XXIV, the arms travel over the tracker ducts as in the similar case of the pneumo-electric control. Similar tracker ducts u , over which the perforations of the record pass are used. These ducts as before lead to air-cylinders v^1 , v^2 , v^3 , etc. These air cylinders, which in the case of the pneumo-electric control connect the terminals a and b , here connect by means well known to the art, the tracker ducts t with the exhaust pump 287. The darkened areas on top of the ducts u , Fig. XXV, represent the openings of the ducts over which the perforations of the record pass. The arms p^{44} , p^{45} , etc., are so constructed that one end of them slides over the openings of the tracker ducts t , making an air tight connection with them. These arms are hollow. At the other end, they slide over channel shaped rings or areas, one of which is shown at 245 Fig. XXV. The arms make air tight connection with these areas. The ends of the arms are enlarged to completely inclose these areas. Each one of these areas connect by means of pipes 246 with one or more air cylinders. Fig. XXIV represents this diagrammatically. The arms and their areas are represented by rectangles p^{44} , p^{45} , p^{46} , p^{47} and p^{48} . The cylinders 247 and 248 connected to p^{44} and p^{45} respectively, control a clutch or clutches to take power off the power shaft and send the unit element in one direction. Arm p^{46} is not connected with a cylinder that causes motion of the unit element in any direction. It corresponds to the neutral arm 46 of the pneumo-electric control. The cylinder 252, to which p^{46} is connected controls a clutch on the feed shaft 76 of the record, as do also the cylinders 251 and 253. When the exhaust is connected to any one of these three cylinders, the record feeds. The arms p^{47} and p^{48} connect to cylinders 249 and 250 respectively. These cylinders control a clutch or clutches which take off power from the power shaft and drive the unit element in the opposite direction to that caused by the cylinders 247 and 248. To illustrate this, referring to Fig. XVII let the transverse motion be considered. The four cylinders 247, 248, 249 and 250 will control clutches mating with parts fixed to shaft 31. As the cylinder 247 or the cylinder 248 is actuated, it throws a clutch which causes the

gear 29 to drive. When the cylinder 249 or the cylinder 250 is actuated, it throws a clutch which causes the gear 28 to drive. According to the way these four cylinders are actuated, the driving gear 17 causes the proper travel of the carriage. All the cylinders just mentioned are similar in construction to 248 shown in section. When the exhaust is connected to the cylinder, the pressure is reduced behind the piston 254, and it is forced in. When disconnected from the exhaust, it is arranged that sufficient leakage takes place through the piston 254, that the spring 255 will soon force it out, disengaging the clutch.

The darkened areas of Fig. XXIV represent the tracker duct openings of t^1 , t^2 , t^3 , etc. The tracker ducts controlling the opening of the ports of the air cylinders v^1 , v^2 , v^3 , etc., are not shown on Fig. XXIV. Fig. XXV shows two of them. If a perforation in the record come over an opening u corresponding to v^7 and the arms are in the position shown in Fig. XXIV, the air cylinder v^7 by means well known to the art connects the exhaust pump 287 through the arm p^{45} and pipes 246 with cylinders 248 and 251. Then the cylinder 248 causes the unit element to be driven in one direction and the cylinder 251 causes the record to be fed.

The process of making the record for a unit element will now be described. It is shown here as a part of the operating machine. In practice it will be found much simpler to use a separate machine for recording, whereby all the mechanism not necessary for recording will be eliminated, and thereby a much simpler and easier working recording apparatus will be obtained. The general method of procedure in making the record is as follows:—A layer of material either cloth or paper is spread on the table. The various patterns or designs into which the cloth is to be cut are laid out in the most economical manner, so as to have the least waste, and the outlines marked on the material on the table. A pointer is then inserted into the piece 172, instead of the blade. The person recording then guides the pointer over the outlines of the figures marked, holding it at the desired angle to the path, and thereby causes the machine to describe the path which it afterward reproduces in the process of cutting or performing any of the other functions the machine is required to do. In the general case, the unit element is made to traverse the path, being guided by external means, that it is afterward to follow when the record is used. While this is being done, a blank sheet of record paper is passed over the tracker ducts, and by means which will be hereinafter explained, a series of punches are actuated which punch the perforations in the record sheet. The process is really a

reversal of the action of the machine when in operation.

Referring to Fig. VI, the plate 77 is provided with a series of holes L^1 , L^2 , L^3 , etc., on line with tracker ducts d^1 , d^2 , etc., and immediately back of same. A series of punches h^1 , h^2 , h^3 are placed so as to fit into the openings L^1 , L^2 , etc. A pin 96 is fixed to each punch and they in turn fit into inclined slots 226, in the ends of the plungers 240, of the series of solenoids, g^1 , g^2 , g^3 , etc. When one of the solenoids g^1 , etc., is energized, the plunger 240 is drawn in, and by means of pin 96, the punch is raised until it passes through L^1 , causing a hole to be punched in the paper. When the solenoid is deenergized, the spring 94 forces the plunger out, and in turn, the punch is pulled out. It will now be necessary to show how the solenoids are controlled and are made to operate at the proper intervals. It will be noted by referring to Fig. XXIII, that there are 16 tracker ducts for each unit element, but the selector contains a number of contact pieces which are several multiples of 16, the corresponding pieces of each cycle being connected to each other. For one unit element, there are 16 punches. In general there are as many punches as there are tracker ducts. Each one of the solenoids is electrically connected to the contact pieces on the selector, viz:—the electro-magnet g^1 is connected to contact piece c^1 ; g^2 is connected to c^2 , g^3 is connected to c^3 , etc. The other ends of these electro-magnets are connected to a series of contact springs, f^1 , f^2 , etc., which are fastened to insulating block 241. g^1 is connected to f^1 , g^2 to f^2 etc. The bar 88 consisting of good conducting material such as brass or copper is brought in contact with the contact springs f^1 , f^2 , f^3 , etc., and is held in place by the bent plate springs 90, attached to frames 89. When the machine is in operation, and not recording, the bar 88 is disconnected from f^1 , f^2 , etc., by sliding it out of place. The bar 88 is electrically connected to the interrupter 91, shown in detail in Figs. VI and VII, and which will be fully explained later. When the switch 92 is open, no current can flow through the contact arms 44, 45, 47 and 48, as will be evident by following the circuits in Fig. XXIII. A circuit r will however flow through contact arm 46, which controls the neutral circuit when the machine is in operation. Switches 67 and 242 are closed, and switches 92 and 243 are opened for recording. When the machine is used for recording, all the gearing used in the operation of driving the machine, will be disconnected by means well known to the art, but not shown in the drawings. The only gears being connected will be the ones leading from the gear or gears engaging with the driving rack to the shaft carrying the con-

tact arms of the selector. Taking the transverse carriage for illustration, the gear 30 will be disconnected from the gears 28 and 29. As the pointer is moved and the carriage is caused to travel, the rack 15 will cause gear 17 to rotate, and thus the shaft 43 and the contact arms which are connected to it are made to rotate. It will be hereinafter shown that as the record sheet is fed, the punches operate at regular intervals by means of the interrupter 91, but the particular punch actuated depends on the position of the contact arm 46 on the selector. Assume the arm 46 at the position shown in Fig. XXIII, and the interrupter in such position that the circuit r is closed. The current will travel then as indicated by the arrows from the source through switch 67, through interrupter 91 to bar 88, thence through contact spring f^s through electro-magnet g^s , thence through contact piece c^s of the selector, through the arm 46, through switch 242 and back to source. When a current is flowing through the circuit just described, the magnet g^s is energized and punch h^s operates. If the carriage is sent forward, so that arm 46 is now in contact with piece c^o the current will flow through magnet g^o and consequently punch h^o will operate. It is therefore evident that the position of arm 46, controls the particular punch at any particular interval. The position of the arm 46, is in turn controlled by the position of the carriage. When the record is being made, the throw clutch 93 is placed so that it runs idle, and the bellows do not operate. The current r does not pass through any of the solenoids 81^a, 81^b, 81^c, etc., and since it is necessary to have solenoid 102 energized, in order to keep the record feeding, as explained earlier, the auxiliary circuit passing through 102, is short circuited so that it does not pass through the armatures 87, on the electro-magnets 84, 85, 86, etc., but passes through solenoid 102 only, and thus keeps the clutches 107 and 109 in contact, and the record sheet is fed. By breaking the circuit through the solenoid 102 by means of a switch, the feeding of the record is stopped at will.

The interrupter 91, shown in Figs. VI and VII consists of a non-conducting disk 5, fixed to the framework of the recording mechanism and is stationary. A series of contact plates 13, are fixed to the disk 5, at equal distances apart. The arms 6, 7, 9 and 10 are attached to the record roller shaft 54, and rotate with it. Each one of these arms are wide enough to connect two contact pieces 13. Every alternate plate 13 is connected with the wire bringing the current from the source, while the other plates are connected with the wire carrying the current away. Every one of the arms closes the gap between adjacent pieces 13, and the record-

ing current is closed, and one of the punches h operates. As the arms travel around, the circuit is broken at regular intervals. The arms, 6, 7, 9 and 10 are symmetrically placed with regard to the pieces 13. One arm could be used, but additional arms are used to add greater certainty to the closing of the circuits. The plates 13 are so spaced that the circuit is closed only after there is a partial revolution of the feed shaft, and hence the record travels a prearranged amount before the punches operate. There are many other forms of interrupters which could be used to make or break the recording current as a certain prearranged length of record is fed. I do not limit myself to the one shown.

In making the record by the all pneumatic method, a special piece 256 is substituted for the arms p^{44} , p^{45} , etc. It revolves on a shaft just as they do. The piece 256 is a disk with a rim that fits air-tightly over the openings of the tracker ducts t . See Fig. XXVI. An opening in the rim at 258 corresponds to the neutral arm 46 in the pneumo-electric recorder.

257 is an exhaust pump.

The cylinders X control the perforating punches, similar to the solenoids g . As the driving gear rotates the piece 256 in making the record, the hole 258 is carried over the openings of the tracker ducts t . When the hole 258 is over a tracker duct, air at atmospheric pressure enters the bottom of the cylinder x , and forces up its piston, thereby actuating the punch y . The tracker ducts t are arranged in cycles, and connected in groups just as the contact pieces c of the pneumo-electric method, where the travel of the unit element is long.

The recording apparatus is shown here as independent of the control mechanism, although they could be combined.

The all pneumatic control described is an exhaust system. The compressed air or plenum system could be used instead by a reverse of the parts, as is familiar to any one conversant with the art.

In order to make a record of two carriages as shown on Fig. I each having a different path, but both acting at the same time, the record for one is made, then the record sheet is rewound on the spool 74. The feeding of the record sheet is started over again and the record of the other carriage is made by causing its pointer to travel the desired path.

On Fig. XIII are shown the tracker ducts and punching magnets for the six unit elements placed abreast. In making the record the punches for the three unit elements controlling one tool, perforate the left half of the sheet. After the sheet is rewound and put through again, the three unit elements for the other tool perforate the right half. In the general case for any number of tools, the punching magnets and tracker

ducts for all of them are placed abreast and the record for each is made. The record for several tools can be made at once, if there are several operators, all guiding their pointers at the same time. For several tools working together, all following similar paths, the record taken for one will suffice for all. The corresponding unit elements of the several tools will have common tracker ducts and air cylinders, with common terminals *a* and *b*.

The word energy as used in the claims is to embrace the idea of electrical energy and that form of mechanical energy which is transmitted by means of fluid substances. It is exclusive of mechanical energy transmitted through solid media. The words, "marked, markings, marking, marks, and mark" are to include the idea of perforation and the words "terminal" and "terminals" the idea of the termination of tubes or passages for the flow of fluid as well as of electric contact pieces.

Having thus fully described my invention, I claim as new, and wish to secure by Letters Patent:—

1. A mechanism comprising, a body suitably mounted adapted to have travel, mechanism for causing said travel, a source of energy, a plurality of energy conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said energy through them, a record of motion marked in accordance with the path the body is desired to follow, movable means adapted by its motions to stop and permit the transmission of the said energy through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions, whereby the successive extents and directions of travel of the body are caused in accordance with that called for by the record.

2. A mechanism comprising, a body suitably mounted adapted to revolve repeatedly in the forward or the backward direction, mechanism for causing the rotation of the body, a source of energy, a plurality of energy conductors adapted to control the actuation of the said rotation causing mechanism in accordance with the transmission of the said energy through them, a record of motion marked in accordance with the desired successive directions of rotation and the desired number of revolutions for each successive direction, movable means adapted by its motions to stop and permit the transmission of the said energy through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions, whereby the successive extents and directions of rotation of the body are caused in accordance with that called for by the record.

3. A mechanism comprising, a body suitably mounted adapted to have translation in all directions in a plurality of planes, mechanism for causing said motion, a source of energy, a plurality of energy conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said energy through them, a record of motion marked in accordance with the desired successive directions of motion, movable means adapted by its motions to stop and permit the transmission of the said energy through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions.

4. A mechanism comprising, a body suitably mounted adapted to have rotation about an axis of variable inclination, mechanism for causing said rotation and for controlling the inclination of the said axis, a source of energy, a plurality of energy conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said energy through them, a record of motion marked in accordance with the desired successive directions of rotation and the successive inclinations of the said axis, movable means adapted by its motions to stop and permit the transmission of the said energy through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions.

5. A mechanism comprising, a body suitably mounted adapted to have simultaneously translation and rotation, mechanism for causing said motions, a source of energy, a plurality of energy conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said energy through them, a record of motion marked in accordance with the desired successive kinds and directions of motion of the said body, movable means adapted by its motions to stop and permit the transmission of the said energy through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions, whereby the said motion causing mechanism causes translation or rotation of the said body or both simultaneously in accordance with that called for by the record and in the desired directions.

6. A mechanism comprising, a body suitably mounted adapted to have travel, mechanism for causing said travel, a source of electricity, a plurality of electric conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said electricity

through them, a record of motion marked in accordance with the path the body is desired to follow, movable means adapted by its motions to stop and permit the transmission of the said electricity through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions, whereby the successive extents and directions of travel of the body are caused in accordance with that called for by the record.

7. A mechanism comprising, a body suitably mounted adapted to have travel, mechanism for causing said travel, a source of energy, a plurality of energy conductors adapted to control the actuation of the said motion causing mechanism in accordance with the transmission of the said energy through them, a record of motion perforated in accordance with the path the body is desired to follow, the perforations of the record being adapted to control the selection of the said conductors and the transmission of the said energy through them, whereby the successive extents and directions of travel of the body are caused in accordance with that called for by the record.

8. A mechanism comprising, a body suitably mounted adapted to revolve repeatedly in the forward or backward direction, mechanism for causing the rotation of the body, a source of electricity, a plurality of electric conductors adapted to control the actuation of the said rotation causing mechanism in accordance with the transmission of the said electricity through them, a record of motion marked in accordance with the desired successive directions of rotation and the desired number of revolutions for each successive direction, movable means adapted by its motions to stop and permit the transmission of the said electricity through the said conductors, the markings of the record being adapted to control the selection of the said movable means and to control their motions, whereby the successive extents and directions of rotation of the body are caused in accordance with that called for by the record.

9. A mechanism comprising, a body suitably mounted to revolve repeatedly in the forward or backward direction, mechanism for causing the rotation of the body, a source of energy, a plurality of energy conductors adapted to control the actuation of the said rotation causing mechanism in accordance with the transmission of the said energy through them, a record of motion perforated with the desired successive directions of rotation and the desired number of revolutions for each successive direction, the perforations of the record being adapted to control the selection of the said conductors and the transmission of the energy through

them, whereby the successive extents and directions of rotation of the body, are caused in accordance with that called for by the record.

10. A device comprising, a body suitably mounted adapted to have motion in different directions, mechanism for causing the motion of the said body, a source of electricity, a plurality of electric conductors of different resistances, a record marked in accordance with the desired successive extents and directions of motion, means for selecting the particular conductors by which the electric current is transmitted, the same means adapted to be actuated by the record, the said motion causing mechanism being controlled by the sequence of the magnitudes of the current flowing through the said mechanism, as determined by the sequence of the said conductors traversed by the said current.

11. A device comprising, a body suitably mounted to have motion, mechanism for causing the motion of the said body, a source of electricity, a plurality of electric conductors, a record of motion marked in accordance with the desired speeds and directions of motion of the said body, selecting means, for causing the current to flow through the said conductors in opposite directions, adapted to be actuated by the said record, the said motion causing mechanism being controlled by the sequence of the directions of the current through the said conductors, whereby the speed and direction of the motion of the body are controlled in accordance with that called for by the record.

12. A mechanism comprising, a body suitably mounted to have motion along a fixed path, mechanism for causing motion of the body backward and forward along the said path, a record marked in accordance with the successive directions of motion desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

13. A mechanism comprising, a body suitably mounted to have rotation, mechanism for causing rotation of the body in reversible directions, a record marked in accordance with the successive directions of rotation desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the rotation of the body, adapted by the relative position of the said two parts to cause actuation of the said rotation causing mechanism for rotation of the body in the forward direction

when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

14. A mechanism comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record marked in accordance with the motion desired for the body, a selector, suitably constructed to control electric currents, comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

15. A mechanism comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record perforated in accordance with the successive directions of motion desired for the body, a selector, comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

16. A device comprising, a body suitably mounted to have translation in all directions in a plurality of planes, mechanism for causing said motion, a source of energy a record of motion marked in accordance with the desired successive extents and directions of motion of the body, selecting means for controlling the transmission of the said energy to the said mechanism in such manner whereby motion of the body is caused in accordance with that called for by the record, the said selecting means comprising two parts, one part suitably constructed to be controlled by the relative movement of the record and the same said part and the other part suitably constructed to be controlled by the motion of the body.

17. A device comprising, a body suitably mounted to have rotation through variable angles in reversible directions about an axis of variable inclination, mechanism for causing said rotation and for controlling the inclination of the said axis, a source of energy, a record of motion marked in accordance with the desired successive directions and extents of rotation and the desired successive inclinations of the said axis, selecting means for controlling the transmission of the said energy to the said mechanism in such manner whereby the rotation of the body and the tilting of its axis of rotation are caused in accordance with that called for

by the record, the said selecting means comprising two parts, one part suitably constructed to be controlled by the relative movement of the record and the same said part and the other part suitably constructed to be controlled by the motion of the body.

18. A device comprising, a body suitably mounted to have simultaneously translation and rotation, mechanism for causing said motions, a source of energy, a record of motion marked in accordance with the desired successive kinds and directions of motion of the said body, selecting means for controlling the transmission of the said energy to the said mechanism in such manner whereby translation or rotation of the said body is caused or both simultaneously and in the desired directions in accordance with that called for by the record, the said selecting means comprising two parts, one part suitably constructed to be controlled by the relative movement of the record and the same said part, and the other part suitably constructed to be controlled by the motion of the body.

19. A mechanism comprising, a body suitably mounted to have motion, a source of energy, mechanism for imparting motion to the body in reversible directions, a record marked in accordance with the desired speeds and directions of motion, selecting means comprising two parts, one part suitably constructed to be controlled by the relative motion of the record and the same said part and the other part suitably constructed to be controlled by and in accordance with the motion of the body, the said selecting means adapted to cooperate with the markings of the said record to control the transmission of the said energy to the said motion imparting mechanism in such manner that the body is caused to be at every instant within the limits of a predetermined deviation from the position called for by the record at the corresponding instant, the construction of the said selecting means determining the extent of the said deviation.

20. A mechanism comprising, a body suitably mounted to have motion, a source of electricity, mechanism for imparting motion to the body in reversible directions, a record marked in accordance with the desired speeds and directions of motion, selecting means comprising two parts, one part suitably constructed to be controlled by the relative motion of the record and the same said part and the other part suitably constructed to be controlled by and in accordance with the motion of the body, the said selecting means adapted to cooperate with the markings of the said record to control the transmission of the said electricity to the said motion imparting mechanism in such manner that the body is caused to be at every instant within the limits of a predetermined deviation from the position called

for by the record at the corresponding instant, the construction of the said selecting means determining the extent of the said deviation.

5 21. A mechanism comprising, a body suitably mounted to have motion, a source of energy, mechanism for imparting motion to the body in reversible directions, a record perforated in accordance with the desired
10 speeds and directions of motion, selecting means comprising two parts, one part suitably constructed to be controlled by the relative motion of the record and the same said part and the other part suitably constructed
15 to be controlled by and in accordance with the motion of the body, the said selecting means adapted to cooperate with the perforations of the said record to control the transmission of the said energy to the said
20 motion imparting mechanism in such manner that the body is caused to be at every instant within the limits of a predetermined deviation from the position called for by the record at the corresponding instant, the construction of the said selecting means determining the extent of the said deviation.

22. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a record marked in accordance with the speeds and directions of motion desired for the body, mechanism for feeding the record suitably constructed to produce a continuous feeding motion, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said driving mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

45 23. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body, a selector actuated by and in accordance with the motion of the body, a source of energy, a record of motion, the markings of the said record being adapted to control the transmission of the said energy through the said selector, controlling thereby the actuation of the said driving mechanism, each succeeding mark,
50 being adapted to cause the said driving mechanism to cause the same extent of motion of the body, except where a mark immediately succeeds one in a similar position on the record.

60 24. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body, a selector actuated by and in accordance with the motion of the body, a source of energy, a record of
65 motion, mechanism for feeding the record

suitably constructed to produce a continuous feeding motion, the markings of the said record being adapted to control the transmission of the said energy through the said selector, controlling thereby the actuation
70 of the said driving mechanism, each succeeding mark being adapted to cause the said driving mechanism to cause the same extent of motion of the body, except where a mark immediately succeeds one in a similar position on the record.

25. A mechanism comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record marked in accordance
80 with the successive directions of motion desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position
85 of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead, the said record having its marks spaced close enough together in the direction of feed of the record so that there is always at least one mark of the record in control at every
95 instant.

26. A mechanism comprising, a body suitably mounted adapted to have motion, mechanism for causing motion of the body in reversible directions, a record perforated in accordance with the successive directions of motion desired for the body, a selector comprising two parts, adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative positions of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when the position of the body is ahead, the said record having its perforations spaced close enough together in the direction of feed of the record, so that there is always at least one perforation of the record in control at every instant.

27. A device comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a selector suitably constructed to be actuated by and in accordance with the motion of the body, a record of motion marked in accordance with the desired speeds and directions of motion of the body adapted to cooperate with the said selector to control the actuation of the said driving mechanism, the marks of the record being spaced with an overlap in the direction of the feed of the record.

28. A device comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a selector suitably constructed to be actuated by and in accordance with the motion of the body, a record of motion perforated in accordance with the desired speeds and directions of motion of the body, adapted to cooperate with the said selector to control the actuation of the said driving mechanism, the perforations of the record being spaced with an overlap in the direction of feed of the record.

29. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body, a selector actuated by and in accordance with the motion of the body, a source of energy, a record of motion, the markings of the said record being adapted to control the transmission of the said energy through the said selector, controlling thereby the actuation of the said driving mechanism, each succeeding mark being adapted to cause the said driving mechanism to cause the same extent of motion of the body except where a mark immediately succeeds one in a similar position on the record, all of the said marks being spaced close enough together in the direction of feed of the record so that there is always at least one mark in control at every instant.

30. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a record marked in accordance with the motion desired for the body, mechanism for feeding the record suitably constructed to produce a continuous feeding motion, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said driving mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when the position of the body is ahead, the said record having its marks spaced close enough together in the direction of feed of the record so that there is always at least one mark of the record in control at every instant.

31. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a selector actuated by and in accordance with the motion of the body, a source of energy, a record marked in accordance with the desired speeds and directions of motion, mechanism for feeding the record suitably constructed to produce a continuous feeding motion, the markings of the said record being adapted to control the transmission of the said energy through the said

selector controlling thereby the actuation of the said driving mechanism, each succeeding mark being adapted to cause the said driving mechanism to cause the same extent of motion of the body, except where a mark immediately succeeds one in a similar position on the record, all of the said marks being spaced close enough together in the direction of feed of the record so there is always at least one mark of the record in control at every instant.

32. A device comprising, a body suitably mounted to have motion, a source of electricity, a plurality of electric conductors of different resistances, a record marked in accordance with the desired directions of motion, means for making and breaking the circuits through the several conductors adapted to be actuated by the record, selecting means, actuated by and in accordance with the motion of the body, cooperating with the said record, for selecting the particular conductors to be traversed by the current, mechanism for causing the motion of the body, adapted to be controlled by the sequence of the magnitudes of the current flowing through the said mechanism, as determined by the sequence of the conductors traversed by the said current.

33. A device comprising, a body suitably mounted to have motion, a source of electricity, a record marked in accordance with the desired directions of motion, means for making and breaking the circuits through the several conductors adapted to be actuated by the record, selecting means, cooperating with the said record and actuated by and in accordance with the motion of the body, for causing the current to flow through the said conductors in opposite directions, mechanism for causing the motion of the body adapted to be controlled by the sequence of the directions taken by the said current as determined by the combined action of the said record and the said selecting means.

34. A device comprising, a body suitably mounted to have motion, a source of power, clutches, adapted to take off the power in reversible directions from the power source for the motion of the body, adapted by their successive engagements and disengagements with the power source to control the motion of the said body, a record perforated in accordance with the desired speeds and directions of motion of the said body, a series of tracker ducts, the said clutches adapted to be controlled in their action by the relative movement of the record and the said tracker ducts.

35. A device comprising, a body suitably mounted to have motion, mechanism for imparting motion to the said body in reversible directions, a perforated record

marked in accordance with the desired directions of motion of the said body, a series of tracker ducts, means for producing relative movement between the said record and the said ducts, a source of electricity, the said motion imparting mechanism adapted to be controlled by the flow of electricity to it as effected by the sequence of the perforations of the record in their passage by the ducts.

36. A mechanism comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record perforated in accordance with the directions of motion desired for the body, a series of tracker ducts, means for causing relative movement between the record and the said ducts, a selector, comprising two parts adapted to have relative movement with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

37. A mechanism comprising, a body suitably mounted to have motion, mechanism for causing the motion of the body in reversible directions, a record perforated in accordance with the motion desired for the body, a series of tracker ducts, means for causing relative movement between the record and the said ducts, a selector, suitably constructed to control electric currents, comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and tracker ducts and in the backward direction when its position is ahead.

38. A device comprising, a body suitably mounted to have motion, a source of energy, mechanism for imparting motion to the said body, a record perforated in accordance with the desired speeds and directions of motion, a series of tracker ducts, means for producing relative movement between the record and tracker ducts, selecting means controlled in its action by and in accordance with the motion of the said body, adapted to cooperate with the perforations of the said record to control the transmission of the said energy to the said motion imparting mechanism in such manner that the body is caused to be at every instant within the limits of a predetermined deviation from the position called for by the record at the

corresponding instant, the construction of the said selecting means determining the extent of the said deviation.

39. A mechanism comprising, a source of energy, a body suitably mounted to have motion, means for controlling the said motion, a record marked in accordance with the desired directions of motion in combination with means for connecting the said source to a plurality of terminals, corresponding to predetermined positions of the body whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals, selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body, the said selector arms adapted, while registering with an actuating terminal, to control the means controlling the motion of the body.

40. A mechanism comprising, a body suitably mounted to have motion, means for controlling the said motion, a source of energy, a record of motion in combination with means for connecting the said source to a plurality of terminals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals corresponding to predetermined positions of the body, a plurality of selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body, each selector arm adapted to cause motion of the body in a particular direction, each of the said selector arms adapted, while registering with an actuating terminal, to cause motion of the body in the particular direction predetermined for the said selector arm.

41. A device comprising, a source of energy, a body suitably mounted to have motion, mechanism for controlling the motion of the body in combination with a plurality of energy conductors, the said mechanism adapted to have three states of actuation each state depending on the particular conductor of the said conductors through which the energy is transmitted, one state causing motion of the body in one direction, another state causing motion of the body in the opposite direction and the other state permitting the body to run free, a record of motion in combination with means for connecting the said source to a plurality of terminals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the record, the said terminals, a plurality of selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body, each arm operatively connected to one of the said conductors and adapted while reg-

istering with an actuating terminal to cause the transmission of the said energy through its corresponding conductor, thereby actuating the motion controlling mechanism in a particular manner.

42. A device comprising, a source of energy, a body suitably mounted to have motion, mechanism for controlling motion of the body in combination with a plurality of energy conductors, the said mechanism adapted to have three states of actuation, each state depending on the particular conductor of the said conductors, through which the energy is transmitted, one state causing motion of the body in one direction, another state causing motion of the body in the opposite direction and the other state permitting the body to run free, means for connecting the said source to a plurality of terminals, whereby the said terminals are caused to be the actuating terminals in continuous succession, the said terminals corresponding to predetermined positions of the body, a plurality of selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body, each arm operatively connected to one of the said conductors and adapted, while registering with an actuating terminal to cause the transmission of the said energy through its corresponding conductor, whereby the motion of the body is controlled in accordance with the succession of the terminals connected to the source.

43. A mechanism comprising, a body suitably mounted to have motion, mechanism for driving the body in reversible directions, a record marked in accordance with the directions of motion desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body adapted by the relative position of the said two parts to cause actuation of the said driving mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record, in the backward direction when its position is ahead and for suspension of the driving action when its position coincides with that called for by the record.

44. A device comprising, a body suitably mounted to have motion, a source of power in combination with driving mechanism for imparting motion to the said body, a source of energy, a plurality of energy conductors, means for controlling the engagement and disengagement of the power source and driving mechanism, the action of the said controlling means, depending on the distribution of the said energy through the said conductors, a record marked in accordance with the desired successive speeds of the body, means actuated by the record for connecting the said energy source to a plurality of ter-

minals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals, a plurality of selector arms adapted to have relative movement with the said terminals, each selector arm adapted to transmit the said energy through one of the said conductors to the means controlling the engagement and disengagement of the power source whereby some of the selector arms while registering with an actuating terminal cause the engagement of said driving mechanism with the power source and others of the said selector arms, while registering with an actuating terminal, cause the disengagement of the driving mechanism from the power source, whereby the motion of the body is controlled in accordance with the particular selector arm registering with an actuating terminal.

45. A mechanism comprising, a source of electricity, a body suitably mounted to have motion, means for controlling said motion, a record marked in accordance with the desired speeds and directions of motion in combination with electrical means for connecting the said source to a plurality of terminals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals, selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body the said selector arms adapted, while registering with an actuating terminal, to control the means for controlling the motion of the body.

46. A mechanism comprising, a source of energy, a body suitably mounted to have motion, mechanism for producing motion of the body, a record of motion in combination with means for connecting the said source through a plurality of conductors to a plurality of terminals, the said terminals arranged in cycles the corresponding terminals of the several cycles being connected to each other and to one of the said conductors, the said conductors, selecting means suitably constructed to have relative movement with the terminals in a fixed relation to the motion of the body for controlling the action of the said motion producing mechanism.

47. A mechanism comprising, a source of energy, a body suitably mounted to have motion, mechanism for producing motion of the body, a record of motion adapted by its marks to connect the said source through a plurality of conductors to a plurality of terminals, a separate mark of the record for each conductor, the said terminals arranged in cycles, the corresponding terminals of the several cycles being connected to each other and to one of the said conductors, the said conductors equal in number to the number

of terminals in a cycle, selecting means suitably constructed to have relative movement with the said terminals in a fixed relation to the motion of the body for controlling the action of the said motion producing mechanism.

48. A mechanism comprising, a body suitably mounted upon a plurality of mountings, adapting it to have simultaneously translation and rotation through variable angles in reversible directions, the said plurality of mountings, each mounting for a component motion of the body, a source of energy, a record of motion in combination with means for connecting the said source to a plurality of sets of terminals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said sets of terminals, a set for each of said components of the motion of the body, a plurality of sets of selector arms, a set of selector arms for each of said sets of terminals, each set of selector arms adapted to have relative movement with its respective set of terminals in a fixed relation to its corresponding component motion of the body, each selector arm adapted to control the motion of the body along its corresponding component, while registering with an actuating terminal.

49. A device comprising, a source of energy, a plurality of energy conductors, a body suitably mounted to have motion, mechanism for controlling the said motion, adapted to be actuated in accordance with the distribution of the energy through the said conductors, means for connecting the said source to a plurality of terminals whereby any of the said terminals can be caused to be actuating terminals, selecting means adapted to have relative movement with the said terminals in a fixed relation to the motion of the body and adapted to select the particular conductors of the said conductors through which the energy is caused to be transmitted in accordance with the relative positions of the said selecting means to be the actuating terminals, whereby the body is caused to be moved forward or backward in accordance with the succession of the said terminals connected to the said source.

50. A mechanism comprising, a body suitably mounted to have motion, a source of energy, mechanism adapted to be controlled in accordance with the transmission of energy to it for driving the said body, a record marked in accordance with the desired motion of the body, selecting means having a plurality of terminals corresponding to predetermined positions of the body, a predetermined length along the said terminals adapted to be suitably connected to the said driving mechanism for causing motion of the body in the forward direction and an-

other predetermined length along the said terminals adapted to be suitably connected to the said driving mechanism for causing motion of the body in the backward direction, each mark of the record in control at any instant adapted to cooperate with the said selecting means to transmit the energy through the length for motion of the body in the forward direction when the position of the body at any instant is behind that called for by the mark of the record in control, and to transmit the energy through the length for motion in the backward direction when the position of the body at any instant is ahead of that called for.

51. A mechanism comprising, a body suitably mounted to have motion, a source of energy, mechanism adapted to be controlled in accordance with the transmission of energy to it for driving the said body, a record marked in accordance with the desired motion of the body, selecting means having a plurality of terminals corresponding to predetermined positions of the body, a predetermined length along the said terminals adapted to be suitably connected to the said driving mechanism for causing motion of the body in the forward direction, another predetermined length for causing motion in the backward direction and another predetermined length for causing the suspension of its driving action, each mark of the record in control at any instant adapted to cooperate with the said selecting means to transmit the energy through the length for motion in the forward direction when the position of the body at any instant is behind that called for by the mark of the record in control, through the length for motion in the backward direction when its position at any instant is behind and through the length for suspension of the driving action when its position at any instant coincides with that called for.

52. A device comprising, a body suitably mounted to have motion, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon the unit-element, a record marked in accordance with the desired directions of motion of the body, having its marks in suitable order to cause the said terminals to be made actuating terminals in consecutive succession, selecting means adapted to have relative motion with the said terminals in a fixed relation to the motion of the body, the said means adapted to cause motion of the body in accordance with that called for by the record.

53. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion, a plurality of terminals, the terminals of a unit-element being

placed adjacent to each other, any two adjacent terminals corresponding to adjacent positions of the body upon the unit-element, mechanism adapted to control the connection of the said source to the said terminals, means suitably constructed to produce continuous relative movement of the record and the said mechanism, the said mechanism adapted to be actuated thereby in accordance with the marking of the record, whereby the said terminals are caused to become actuating terminals in the succession called for by the marks of the record, selecting means, suitably constructed to have relative motion with the said terminals in a fixed relation to the motion of the body, for controlling the motion of the said body, in direction in accordance with that called for by the marking of the record and in speed, in accordance with the said marking and in accordance with the speed of the said relative movement of the record.

54. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon the unit-element, mechanism adapted to control the connection of the said source to the said terminals, means suitably constructed to produce continuous relative movement of the said record and the said mechanism, the said mechanism adapted to be actuated thereby in accordance with the marking of the record, whereby the said terminals are caused to become actuating terminals in the succession called for by the marks of the record, the said marks being spaced close enough together in the direction of feed of the record so that there is always at least one actuating terminal at every instant, selecting means, suitably constructed to have relative motion with the said terminals in a fixed relation to the motion of the body for controlling the motion of the said body in speed and direction in accordance with that called for by the marking of the record and in accordance with the speed of the said relative movement of the record.

55. A device comprising, a body suitably mounted to have motion, a source of energy, a record marked in accordance with the desired motion of the body, a plurality of terminals, the terminals of a unit-element being placed adjacent to each other, any two adjacent terminals corresponding to adjacent positions of the body upon a unit-element, mechanism adapted to control the connection of the said source to the said terminals, means suitably constructed to produce continuous relative movement of the record and the said mechanism, the said mechanism adapted to be actuated thereby in accordance with

the marking of the record, whereby the said terminals are caused to become the actuating terminals in the succession called for by the marks of the record, the said marks being spaced close enough together in the direction of feed of the record so that there is always at least one actuating terminal at every instant and located transversely in suitable order to cause the said terminals to become actuating terminals in consecutive succession, selecting means, suitably constructed to have relative movement with the said terminals in a fixed relation to the motion of the body, adapted to send the body backward or forward depending upon whether the body is ahead or behind, at any instant, of the position called for by the record at the corresponding instant.

56. A device comprising, a body suitably mounted to have motion, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon a unit-element, a record marked in accordance with the desired speeds and directions of motion of the body, having the marks in suitable order to cause the said terminals to be made actuating terminals in consecutive succession the said marks being spaced close enough together in the direction of feed of the record so that there is always at least one actuating terminal for a unit-element, selecting means suitably constructed to have relative motion with the said terminals in a fixed relation to the motion of the body, for controlling the motion of the body in accordance with that called for by the record.

57. A device comprising, a body suitably mounted to have motion, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon the unit-element, a record of motion having marks in suitable order to cause the said terminals to become actuating terminals in accordance with the speed desired for the body, the said record having groups of marks in immediate succession corresponding to the same terminals whereby any of the said terminals at various times are caused to remain actuating terminals for prolonged intervals, all the marks of the record being spaced close enough together in the direction of feed of the record so that there is always at least one actuating terminal at every instant for a unit-element, selecting means, suitably constructed to have relative movement with the said terminals in a fixed relation to the motion of the body, for controlling the motion of the said body, the speed of the body depending thereby on the frequency of recurrence and the lengths of the said prolonged intervals.

58. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the speed desired for the

body, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon a unit-element, a source of energy, mechanism adapted to control the connection of the said source to the said terminals, means suitably constructed to produce continuous relative movement between the said record and the said mechanism, the said mechanism adapted to be actuated thereby in accordance with the marking of the record, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marks of the record, the said record having groups of marks in immediate succession corresponding to the same terminals, whereby any of the said terminals, at various times are caused to remain actuating terminals for prolonged intervals, all the marks of the record being spaced close enough together in the direction of feed of the record so that there is always at least one actuating terminal at every instant for a unit-element, selecting means suitably constructed to have relative movement with the said terminals in a fixed relation to the motion of the body for controlling the motion of the said body, the speed of the body depending thereby on the frequency of recurrence and the length of the said prolonged intervals and upon the speed of the said relative movement of the record.

59. A device comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record marked in accordance with the motion desired for the body, a selector comprising two parts, namely, a series of terminals arranged in a ring and selecting means adapted to have relative rotation with the said terminals in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

60. A device comprising, a body suitably mounted to have motion, mechanism for causing motion of the body in reversible directions, a record marked in accordance with the motion desired for the body, a selector comprising two parts, namely, a series of terminals arranged in a ring, in a series of cycles, similar terminals of the several cycles being connected to each other, and selecting means adapted to have relative rotation with the said terminals in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for

by the record and in the backward direction when its position is ahead.

61. A mechanism comprising, a body suitably mounted to have motion, a source of energy, a plurality of energy conductors, mechanism for causing motion of the body in reversible directions adapted to be controlled by the distribution of the energy through the said conductors, a record marked in accordance with the desired directions of motion of the body, means for controlling the transmission of the energy through the said conductors, the said means adapted to be selected and actuated by the markings of the record, selecting means comprising two parts suitably constructed to have relative rotation with each other in a fixed relation to the motion of the body, for interchanging the connections of the several conductors, cooperating with the record, whereby the motion of the body is kept to that called for by the record.

62. A mechanism comprising, a body suitably mounted to have motion, a source of energy, a record marked in accordance with the desired directions of motion adapted automatically to control the transmission of the said energy to a selector, the said selector comprising two parts the first of the said parts having a plurality of terminals and the second of the said parts adapted to control the transmission of the said energy through the said terminals, mechanism, intervening between the body and the selector, suitably constructed to cause the motion of the body to cause relative movement between the said terminals and the said means for controlling the transmission of the said energy through the said terminals at a faster rate than the motion of the body and in a fixed relation thereto, the record and the selector coacting, whereby the motion of the body is kept to that called for by the record.

63. A mechanism comprising, a body suitably mounted to have motion, a source of energy, a record marked in accordance with the desired successive directions of motion, adapted automatically to control the transmission of the said energy to a selector, the said selector comprising two members, one of the said members having a plurality of terminals arranged in a ring, the other of the said members being rotatable, one end of the said rotatable member being adapted to be swung around the said ring of terminals, controlling thereby the transmission of the said energy through the said terminals, mechanism, intervening between the body and the said rotatable member suitably constructed to cause the motion of the body to rotate the said rotatable member at a rate causing the motion of the end of the said rotatable member past the terminals at a faster rate than the motion of the body, and in a fixed relation thereto, the record and the se-

lector coacting, whereby the motion of the body is kept to that called for by the record.

64. A mechanism comprising, a body suitably mounted to have rotation, a source of energy, a record of motion adapted to control the transmission of the said energy to a selector, the said selector comprising two members, one of the said members having a plurality of terminals arranged in a ring, the other of the said members being rotatable, one end of the said rotatable member being adapted to be swung around the said ring of terminals, controlling thereby, the transmission of the said energy through the said terminals, mechanism, intervening between the body and the said rotatable member, suitably constructed to cause the rotation of the body to rotate the said rotatable member at a faster rate than the rotation of the body, and in a fixed relation thereto, the record and selector coöperating, whereby the rotation of the body is kept to that called for by the record.

65. A mechanism of the character described, comprising a source of energy, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion in combination with means for controlling the connection of the said source to a plurality of terminals, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals arranged in a ring, selector arms adapted to swing around the said ring of terminals, the rotation of the selector arms being in a fixed relation to the motion of the body, means actuated in accordance with the relation of the actuating terminals to the selector arms, for controlling the operation of the mechanism.

66. A mechanism of the character described, comprising a selector comprising, a plurality of electrical terminals, a plurality of contact strips and a plurality of electrically conductive selector arms, an arm corresponding to each of the said strips, one end of each selector arm adapted to register with any of the said terminals, the other end of each selector arm adapted to remain in contact with its corresponding contact strip, a body suitably mounted to have motion, a source of electricity, a record suitably marked to connect the said source with the said terminals in the required succession to cause the desired motion of the body, the said selector arms adapted to have relative movement with the said terminals in a fixed relation to the action of the body, whereby any terminal can be connected to any of the said contact strips by the relative movement of the said selector arms and the said terminals, mechanism for controlling the motion of the body adapted to be actuated in accordance with the succession of contact

strips placed in circuit with terminals connected to source by the record.

67. A mechanism of the character described, comprising a body suitably mounted to have motion, a selector comprising, a plurality of electrical terminals arranged in a ring, a plurality of slip rings and a plurality of electrically conductive selector arms, an arm corresponding to each of the said rings, one end of each selector arm adapted to swing around the said ring of terminals and to register with any of the said terminals, the rotation of the selector arms being in a fixed relation to the motion of the body, the other end of each selector arm adapted to remain in contact with its corresponding slip ring, whereby any terminal can be connected to any of the said slip rings by the rotation of the said selector arms, a source of electricity, a record suitably marked to connect the said source with the said terminals in the required succession to cause the desired motion of the body, mechanism for controlling the motion of the body adapted to be actuated in accordance with the successive contact strips placed in circuit with terminals connected to source by the record.

68. In a mechanism of the character described, a selector comprising, a plurality of electrical terminals arranged in a series of cycles, each terminal being connected to its corresponding terminals of the several cycles, a plurality of contact strips and a plurality of electrically conductive selector arms, an arm corresponding to each of the said strips, one end of each selector arm adapted to register with any of the said terminals the other end of each selector arm adapted to remain in contact with its corresponding contact strip, the said selector arms adapted to have relative movement with the said terminals, whereby any terminal can be connected to any of the said contact strips by the relative movement of the said selector arms and the said terminals.

69. A mechanism comprising, a body suitably mounted to have motion, clutches for causing motion of the body in reversible directions, a record marked in accordance with the directions of motion desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said clutches for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead.

70. A mechanism comprising, a body suitably mounted to have motion, clutches for causing motion of the body in reversible directions, a record marked in accordance

with the speeds and directions of motion desired for the body, a selector comprising two parts adapted to have relative motion with each other in a fixed relation to the motion of the body, adapted by the relative position of the said two parts to cause actuation of the said clutches for motion of the body in the forward direction when the position of the body is behind that called for by the record, in the backward direction when its position is ahead, and to cause the actuation for the suspension of their driving action when the position of the body coincides with that called for by the record.

71. A mechanism comprising, a body suitably mounted to have motion, a source of electricity, a plurality of electric conductors, mechanism for driving the said body, a solenoid with a movable plunger, for controlling the action of the said driving mechanism, adapted to be variably energized, the successive energizations being determined by the distribution of the current through the said conductors, a record marked in accordance with the desired speeds and directions of motion of the body, means for controlling the flow of the current through the said conductors, the said means adapted to be selected and actuated by the markings of the said record, selecting means, comprising two parts suitably constructed to have relative motion with each other in a fixed relation to the motion of the body for interchanging the connections of the several conductors, coöperating with the record, whereby the motion of the body is kept to that called for by the record.

72. A device comprising, a body suitably mounted to have motion, clutches for driving the said body, electro-magnetic means for controlling the action of the said clutches, a source of electricity, a record marked in accordance with the desired speeds and directions of motion of the said body, selecting means, comprising two parts suitably constructed to have relative motion with each other in a fixed relation to the motion of the body, for controlling the flow of the electricity to the said electro-magnetic means, whereby the speed and direction of the motion of the body, for every instant, are in accordance with the record.

73. A mechanism comprising, a body suitably mounted to have motion, friction clutches for controlling the motion of the body, means for controlling the action of the said clutches, a source of energy, a record marked in accordance with the desired directions of motion, movable means adapted to be selected and actuated by the markings of the record for controlling the transmission of the energy to a selector, the said selector comprising two parts suitably constructed to have relative motion with each other in a fixed relation to the motion of the

body adapted to coöperate with the said movable means for controlling the transmission of the energy to the said clutch controlling means, whereby the motion of the body is kept to that called for by the record. 70

74. A mechanism comprising, a body suitably mounted to have motion, clutches for controlling the motion of the body, a record of motion perforated in accordance with the speeds and directions of motion desired for the body, a selector, comprising two parts suitably constructed to have relative motion with each other in a fixed relation to the motion of the body, adapted to coact with the perforations of the record to cause motion of the body in accordance with that called for by the record. 75

75. A mechanism comprising, a source of electricity, a solenoid, a plunger adapted to occupy a plurality of positions in the solenoid, a body suitably mounted to have motion, mechanism for driving the said body adapted to be controlled in accordance with the position of the said plunger, one position adapted to cause the said driving mechanism to cause motion in the forward direction, another position for motion in the backward direction and another to suspend the driving action, a record marked in accordance with the desired motion in combination with means for connecting the said source to a plurality of terminals whereby the said terminals are caused to be actuating terminals in the succession called for by the marking of the record, the said terminals corresponding to predetermined positions of the body, selector arms adapted to have relative movement with the terminals in a fixed relation to the motion of the body, the said selector arms having suitable connections whereby each selector arm while registering with an actuating terminal, causes a particular energization of the said solenoid whereby the plunger is made to occupy a particular position in the solenoid predetermined for the selector arm. 80 85 90 95 100 105 110

76. A device comprising, a body suitably mounted to have motion, mechanism for causing the said motion in reversible directions, a record perforated in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record and a part of the said motion causing mechanism whereby the motion of the body is controlled, means controlled by the motion of the body adapted to control the actions of the said means for producing the relative movement of the record, and adapted to coöperate with the said record to control the actuation of the said mechanism for causing the motion of the body, whereby the motion of the body and the relative movement of the record are kept in synchronism. 115 120 125

77. A device comprising, a body suitably 130

mounted to have motion, mechanism for causing the said motion in reversible directions, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record and a part of the said motion causing mechanism, whereby the motion of the body is controlled, means, controlled by the motion of the body, adapted to control the action of the said means for producing the relative movement of the record, and adapted to cooperate with the said record to control the actuation of the said mechanism for causing the motion of the body, whereby the motion of the body, and the relative movement of the record are kept in synchronism.

78. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion, mechanism for causing the said motion in reversible directions, means for producing relative movement between the said record and a part of the said motion causing mechanism whereby the motion of the body is controlled, means, for stopping automatically the said relative movement, adapted to be actuated when the motion of the body lags behind that called for by the said relative movement and by the marking of the record.

79. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion, mechanism for causing the said motion in reversible directions, means for producing relative movement between the said record and a part of the said motion causing mechanism whereby the motion of the body is controlled, means, for stopping automatically the said relative movement, adapted to be actuated when the motion of the body becomes faster than that called for by the said relative movement and by the marking of the record.

80. A device comprising, a body suitably mounted to have motion, mechanism for driving the said body in reversible directions, a record perforated in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record and a part of the said motion causing mechanism whereby the motion of the body is controlled, means, for stopping automatically the said relative movement, adapted to be actuated when the motion of the body lags behind that called for by the said relative movement and by the marking of the record.

81. A device comprising, a body suitably mounted to have motion, mechanism for controlling the said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record

and a part of the said motion controlling mechanism whereby the motion of the body is controlled, means, controlled by the motion of the body for stopping the said relative movement, adapted to be actuated when the motion of the body lags behind by more than a predetermined amount from that called for by the said relative movement and by the marking of the record, means, controlled by the motion of the body, for automatically moving forward the body toward the position called for by the marking and the position of the record, means, controlled by the motion of the body, adapted to be suitably actuated for causing the said relative movement of the record when the body is behind less than the said predetermined amount.

82. A device comprising, a body suitably mounted to have motion, mechanism for controlling the said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, means, controlled by the motion of the body for stopping the said relative movement adapted to be actuated when the motion of the body runs ahead by more than a predetermined amount of that called for by the said relative movement and by the marking of the record, means, controlled by the motion of the body for automatically causing the body to assume the position called for by the marking and the position of the record, means, controlled by the motion of the body, adapted to be suitably actuated for causing the said relative movement of the record when the body is ahead less than the said predetermined amount.

83. A device comprising, a body suitably mounted to have motion, mechanism for controlling the said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, means for stopping automatically the motion of the body when the motion of the body becomes slow enough to cause the record and body to be out of their proper relation by more than a predetermined amount.

84. A device comprising, a body suitably mounted adapted to have motion, mechanism for controlling said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, means for automatically stopping the motion of the body when the motion of

the body becomes fast enough to cause the record and the body to be out of their proper relation by more than a predetermined amount.

5 85. A device of the character described, comprising a body suitably mounted, adapted to have motion, mechanism for causing said motion, means for controlling said mechanism, a record marked in accordance with the desired successive directions of motion, means for producing relative movement between the record and a part of said mechanism controlling means, whereby motion of the said body is controlled, means for automatically stopping both the motion of the body and the relative movement of record and said part of mechanism controlling means, when they are out of proper relation by more than a predetermined amount.

20 86. A device comprising, a body suitably mounted adapted to have motion, mechanism for controlling said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the said record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, electrical means, actuated in accordance with the position of the body, for automatically controlling the action of the said means for producing the relative movement of the record whereby the said relative movement is kept in proper relation to the motion of the body.

35 87. A mechanism comprising, a body suitably mounted to have motion, mechanism for controlling said motion, a record marked in accordance with the desired speeds and directions of motion, means for producing relative movement between the record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, means for causing the said relative movement of the record while the body is not in the position called for by the marking and the position of the record until a predetermined amount of error is exceeded, means for stopping the said relative movement adapted to be actuated when said error is exceeded, whereby retardation of the operation of the mechanism is reduced.

50 88. A device of the character described, comprising, a body suitably mounted to have motion, mechanism for controlling the said motion, a selector having a plurality of terminals and selector arms, the relative movement between the said selector arms and the said terminals being in a fixed relation to the motion of the body, a record of motion, means for producing relative movement of the record and a part of the said motion controlling mechanism, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, each of the said se-

lector arms adapted, while registering with an actuating terminal, to control the motion of the body in the particular manner predetermined for the selector arm by its connections and to cause the said relative movement of the record, the said selector arms adapted to register simultaneously with several of said terminals, thereby permitting the several terminals to become actuating terminals without corresponding motion of the body, means for stopping the said relative movement of the record adapted to be actuated when an actuating terminal occurs beyond the range of the said selector arms, whereby retardation of the operation of the device is reduced.

89. A device comprising, a source of electricity, a plurality of electric conductors, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion of the body, mechanism for controlling the motion of the said body, actuated in accordance with the sequence of the said conductors transmitting the current, selecting means for controlling the sequence of the said conductors through which the current is caused to flow, the said selecting means adapted to be controlled in accordance with the motion of the body and by the said record, electromagnetic means for causing relative movement of the record and a part of the said selecting means, whereby the successive marks of the record are enabled to become operative, the said electro-magnetic means being suitably connected to some of the said conductors, to cause the said relative movement of the record while the current is flowing through some of the said conductors and to stop causing the said relative movement while the current is flowing through others.

90. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired speeds and directions of motion of the said body, in combination with selecting means comprising two parts, the said two parts adapted to have relative movement with each other in a fixed relation to the motion of the body, mechanism, for causing the motion of the body, in one direction or another, controlled in accordance with the relative motion of the record and one of the said parts and by the marking of the record and in accordance with the relative movement of the said parts with each other, means for producing the said relative motion of the record, a source of power for driving the said means for producing the said relative motion of the record, clutches adapted to engage and disengage the means for producing the relative motion of the record with the power source, the said selecting means adapted to actuate the said clutches to cause the engagement of the said means for producing the relative

movement of the record with the power source when the position of the body at any instant is within a predetermined deviation from the position called for by the record at the corresponding instant, and the disengagement when the position of the body is out more than the said predetermined deviation.

91. A device comprising, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion, mechanism for controlling the said motion, a friction clutch for controlling the relative movement of the said record and a part of the said motion controlling mechanism, whereby the successive marks of the record are enabled to become operative, means actuated by and in accordance with the motion of the body for controlling the action of the said clutch.

92. A device comprising, a body suitably mounted to have motion, mechanism for controlling the said motion, a record marked in accordance with the desired successive directions of motion, means for producing relative movement between the said record and a part of the said motion controlling mechanism, whereby the motion of the body is controlled, a solenoid adapted to control the action of the said means for producing the relative movement of the record, means, controlled by the motion of the body, adapted to control the energization of the said solenoid whereby the said relative movement of the record is controlled by the motion of the body.

93. A mechanism comprising, a source of energy, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion in combination with means for connecting the said source to a plurality of terminals by the relative movement of the record and a part of said means, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals, selector arms adapted to have relative movement with the said terminals in a fixed relation to the motion of the body, adapted while registering with an actuating terminal to control the motion of the body and to control the relative movement of the record.

94. A mechanism comprising, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion in combination with means for causing the motion of the body by the relative movement of the record and a part of the said means, means for producing the said relative movement, a neutral selector arm, moving in a fixed relation to the motion of the body, adapted when the position of the body coincides within a predetermined limit of error with the position

called for by the record, to suspend the driving action of the said motion causing means and to actuate the said means for producing the relative movement of the record to cause the said relative movement.

95. A mechanism comprising, a body suitably mounted to have motion, a plurality of terminals, any two consecutive terminals corresponding to adjacent positions of the body upon the unit element, a record marked in accordance with the successive directions of motion desired for the body, a source of energy, movable means adapted by their action to stop and permit the transmission of the said energy to the said terminals, means for producing relative movement between the record and a part of the said movable means whereby the marks of the record are adapted to select and actuate the said movable means, mechanism for causing motion of the body in reversible directions, selecting means, suitably constructed to have relative motion with the said terminals in a fixed relation to the motion of the body, adapted to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is behind that called for by the record and in the backward direction when its position is ahead, the said selecting means at the same time adapted to cause actuation of the said means for producing the relative movement of the record to produce the said relative movement when the position of the body deviates less than a predetermined amount from that called for, and to cause actuation for slowing down the said relative movement when the deviation is more than the said amount.

96. A mechanism comprising a body suitably mounted to have motion, a series of terminals corresponding to predetermined positions of the body, a record marked in accordance with the successive directions of motion desired for the body, a source of energy, movable means adapted by their action to stop and permit the transmission of the said energy to the said terminals, means for producing relative movement between the record and a part of the said movable means whereby the marks of the record are adapted to select and actuate the said movable means, mechanism for causing motion of the body in reversible directions, selecting means, suitably constructed to have relative motion with the said terminals in a fixed relation to the motion of the body, adapted to cause actuation of the said motion causing mechanism for motion of the body in the forward direction when the position of the body is more than a predetermined amount behind that called for by the record, in the backward direction when its position is ahead more than the said amount and to cause cessation of the driving action

of the said motion causing mechanism when its position is out less than the said amount, the said selecting means at the same time adapted to cause actuation of the said means for producing the relative movement of the record to produce the said relative movement when the position of the body deviates less than a second predetermined amount, larger than the said first mentioned amount, and to cause actuation for slowing down the said relative movement when the said deviation is more than the said second amount.

97. A mechanism comprising, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion in combination with means for controlling the motion of the body by the relative movement of the record and a part of said means, means for producing the said relative movement, a source of electricity, selector arms having a fixed relation to the motion of the body and adapted to control the flow of electricity from said source through the means for producing the said relative movement of the record whereby the said relative movement of the record is controlled in accordance with the motion of the body.

98. A mechanism comprising, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion in combination with means for controlling the motion of the body by the relative movement of the record and a part of said means, means for producing the said relative movement, a source of energy, selector arms having a fixed relation to the motion of the body and adapted to control the transmission of the said energy from said source through the means for producing the relative movement of the record whereby actuation is produced for stopping the said relative movement of the record when not in proper relation to the motion of the body.

99. A mechanism comprising, a body suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion in combination with means for controlling the motion of the body by the relative movement of the record and a part of said means, means for producing the said relative movement, a source of energy, selector arms having a fixed relation to the motion of the body and adapted to control the transmission of the said energy from said source through the means for producing the relative movement of the record in such manner whereby the said relative movement of the record is caused when a proper relation obtains between the body and the record.

100. A mechanism comprising, a source of energy, a body suitably mounted to have motion, a record marked in accordance with

the desired successive directions of motion in combination with means for connecting the said source to a plurality of terminals by the relative movement of the record and a part of said means, whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, the said terminals, means for causing the said relative movement of the record, selector arms adapted to have relative movement with said terminals in a fixed relation to the motion of the body and adapted, while registering with an actuating terminal, to cause motion of the body and to stop the said relative movement of the record.

101. A device of the character described, comprising, a body suitably mounted to have motion, mechanism for controlling said motion, a selector having a plurality of terminals and a plurality of selector arms; the relative movement between said selector arms and said terminals being in a fixed relation to the motion of the body, a record marked in accordance with the desired directions of motion, means for producing relative movement of the record and a part of said motion controlling mechanism whereby the said terminals are caused to be the actuating terminals in the succession called for by the marking of the record, means adapted to stop the motion of the body and to stop the relative movement of the record, when an actuating terminal occurs beyond the range of the said selector arms.

102. A device comprising, a plurality of bodies suitably mounted adapted to have different motions, means for controlling the said motions, a record marked in accordance with the desired individual speeds and directions of motion of the several bodies, means for producing relative movement between the said record and a part of the said motion controlling means, whereby the motions of the several bodies are controlled, means, controlled by the motions of the several bodies, adapted to control the action of the said means for producing the relative movement of the record, and adapted to cooperate with the said record, to control the actuation of the means for controlling the motions of the several bodies, whereby the motions of the several bodies are kept in synchronism with each other and with the relative movement of the record.

103. A device comprising, a plurality of bodies, suitably mounted to have motion, means for controlling the said motion, a record perforated in accordance with the desired successive directions of motion of the several bodies, means for producing relative movement between the said record and a part of the said motion controlling means, whereby the motions of the several

bodies are controlled, selecting means, controlled by the motions of the several bodies adapted to cooperate with the said record to control the actuation of the said means for controlling the motions of the several bodies, and adapted to control the actuation of the said means for producing the relative movement of the record whereby the relative movement of the record is retarded when out of proper relation with any of said bodies.

104. A mechanism comprising a plurality of bodies suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion of the several bodies in combination with means for controlling the motions of the several bodies by the relative movement of the record and a part of said means, means for producing the said relative movement, a source of energy, selector arms having a fixed relation to the motions of their respective bodies, adapted to coact to control the transmission of the said energy from the said source through the means for producing the relative movement of the record in such manner whereby the said relative movement of the record is caused when the record is in proper relation to the motions of all of the said bodies.

105. A device of the character described, comprising, a plurality of bodies suitably mounted to have motion, a record marked in accordance with the desired successive directions of motion of the several bodies in combination with means for controlling the motions of the several bodies by the relative movement of the record and a part of said means, means for producing the said relative movement, a source of energy, selector arms having a fixed relation to the motions of their respective bodies, each selector arm, independently of the rest, adapted to control the transmission of the said energy from the said source through the means for producing the relative movement of the record whereby actuation is caused for stopping the relative movement of the record when it is out of proper relation with the motion of any of the said bodies.

106. A mechanism comprising, a body suitably mounted adapted to be guided in its motion, a piece of material adapted to be marked as a record of said motion for automatically controlling the action of a mechanism for reproducing the said motion, a source of energy, means for marking the said piece controlled by the transmission of energy through a part of said means, means actuated by the motion of the body for controlling the transmission of the energy through the marking means, whereby the kind, speed and direction of motion of the body are recorded.

107. A mechanism comprising, a body suitably mounted upon a plurality of mountings, adapted to be guided in its motion, the said plurality of mountings adapting the motion of the body to be divided into components, each mounting for a predetermined component motion of the body, a blank adapted to be marked as a record of said motions, a source of energy, a series of means for marking the said blank, the said means controlled in their action by the transmission of the energy through them, mechanism for feeding the said blank by the said marking means independent of whether the body is in motion or at rest, a plurality of sets of terminals, a set for each of the said components of the motion of the body, the terminals of a set adapted to correspond to given sections of their corresponding component, each terminal connected to corresponding marking means, the said marking means adapted to represent on the said blank the said given sections by corresponding marks in predetermined locations transversely to the feed of the said blank, a plurality of selector arms, each arm adapted to have relative movement with its respective set of terminals in a fixed relation to its corresponding component motion of the body and adapted, while registering with a terminal to control the transmission of the energy through the marking means corresponding to the said terminal, means adapted to interrupt the transmission of the energy to selected marking means at predetermined intervals.

108. A mechanism for producing a record of motion comprising, a body suitably mounted to be given simultaneously a motion of translation and rotation, a plurality of marking means, mechanism for feeding a record blank past the said marking means independent of whether the body is in motion or at rest, means adapted as the body is given a motion of translation and rotation to actuate a particular succession of the said marking means corresponding to the successive positions of the body at instants a predetermined interval apart.

109. A mechanism comprising, a body suitably mounted adapted to be guided in its motion, a blank adapted to be marked as a record of said motion, a source of electricity, a series of means for marking the said blank, the said means controlled by the flow of electricity through them, mechanism for feeding the said blanks by the said marking means independent of whether the body is in motion or at rest, a plurality of terminals corresponding to given sections of a unit element, each terminal connected to corresponding marking means, the said marking means adapted to represent on the said blank the said given sections by corresponding marks in predetermined loca-

tions transversely to the feed of the said blank, a selector arm adapted to have relative movement with the said terminals in a fixed relation to the motion of the body and adapted while registering with a terminal to control the current through the marking means corresponding to the said terminal, means for interrupting the current through marking means in selection at predetermined intervals, whereby the motion of the body causes a particular succession of the said marking means to be actuated corresponding to its motion, and thereby the speed and direction of the motion of the body are recorded.

110. A mechanism comprising, a body suitably mounted adapted to be guided in its motion, a blank adapted to be marked as a record of said motion, a source of energy, a series of means, for marking the said piece adapted to represent on the said blank predetermined sets of equidistant positions of the body by corresponding marks, a special mark always in the same location transversely to the feed of the blank for each set the said marking means controlled by the transmission of the energy through them, a plurality of terminals corresponding to predetermined positions of the body arranged in a series of cycles, the corresponding terminals of the several cycles being connected to each other and to the same marking means, a selector arm adapted to have relative movement with the said terminals in a fixed relation to the motion of the body and adapted, while registering with a terminal, to control the transmission of the energy through the marking means corresponding to the said terminal, means for interrupting the transmission of the energy through the marking means in selection at predetermined intervals whereby the motion of the body causes a particular succession of the said marking means to be actuated, corresponding to its motion, and thereby the speed and direction of the motion of the body are recorded.

111. A mechanism comprising, a body suitably mounted adapted to be guided in its motion, a blank adapted to be marked as a record of said motion, a source of energy, a series of means for marking the said pieces, the said means controlled by the transmission of the energy through them, means independent of the motion of the body for interrupting the said transmissions at predetermined intervals, a plurality of terminals, arranged in a ring, each terminal being connected to corresponding marking means, a selector arm adapted to swing around the said ring of terminals, the rotation of the said selector arm being in a fixed relation to the motion of the body, the said selector arm adapted, while registering with a terminal to control the transmission of the energy

through the marking means corresponding to the said terminal whereby the motion of the body causes a particular succession of the said marking means to be actuated corresponding to its motion and thereby the speed and direction of the motion of the body are recorded.

112. A mechanism for recording the motions of a body upon a record blank, comprising, a body suitably mounted to be given the desired motion, a plurality of marking means adapted to represent on the record blank any given position of the body by a corresponding mark always in the same location transversely to the feed of the record blank, mechanism adapted to feed the record blank past the said marking means while the body is in motion or at rest, means adapted to actuate the said marking means in the succession corresponding to successive positions of the body at instants a predetermined interval apart.

113. A mechanism for recording the motions of the body upon a record blank, comprising, a body suitably mounted to be given the desired motion, a series of terminals corresponding to given sections of a unit element, a series of marking means, corresponding to the said terminals, adapted to represent on the record blank the said given sections by corresponding marks, in predetermined locations transversely to the feed of the record blank, mechanism adapted to feed the record blank past the said marking means while the body is in motion or at rest, a selector arm, adapted, to contact with the successive terminals in a fixed relation to the motion of the body, for selecting a corresponding succession of the said marking means, means adapted to actuate the marking means in selection at instants a predetermined interval apart.

114. A mechanism for producing a record of motion comprising, a plurality of marking means, mechanism for feeding a record blank past the said marking means, a body suitably mounted adapted to be given the desired motion, means adapted, while the body is in continuous motion, to actuate a particular succession of marking means corresponding to the successive positions of the body at instants a predetermined interval apart, the said marking means adapted to represent on the record blank predetermined positions of the body by corresponding marks in fixed locations transversely to the feed of the record blank.

115. A mechanism for producing a record of motion, comprising, a body suitably mounted to be given the desired motion, a series of marking means adapted to represent on a record blank predetermined positions of the body by corresponding marks in fixed locations transversely to the feed of the record blank, mechanism for feeding the

record blank with a continuous running motion past the said marking means, means adapted to select a succession of the marking means corresponding to the successive positions of the body, means adapted to actuate the marking means in selection at instants a predetermined interval apart.

116. A mechanism for producing a record of motion, comprising, a plurality of marking means, mechanism for feeding a record blank with a continuous running motion past the said marking means, a body suitably mounted adapted to be given the desired motion, means adapted, while the body is in continuous running motion, to actuate a particular succession of marking means corresponding to the successive positions of the body at instants a predetermined interval apart, the said marking means adapted to represent on the record blank predetermined positions of the body by corresponding marks in fixed locations transversely to the feed of the record blank.

117. A mechanism for producing a record of motion, comprising, a body suitably

mounted to be given the desired motion, a series of marking means adapted to represent on a record blank predetermined positions of the body by corresponding marks in fixed locations transversely to the feed of the record blank mechanism for feeding a record blank past the said marking means, means adapted to select a succession of the marking means corresponding to the successive positions of the body, means adapted to actuate the marking means in selection at instants an interval apart equal to the time taken for the record blank to feed a predetermined distance, the said predetermined distance being small enough to cause the marks to overlap each other in the direction of feed of the record, whereby the successive positions of the body overlap each other as marked on the record.

In testimony thereof, I hereby annex my signature, this 14th day of December, 1912.

EMANUEL SCHEYER.

Witnesses:

ALBERT E. HILL,
SAMUEL SINGER.