Sept. 7, 1926. 1,599,205

H. J. CALDWELL

FEED CONTROL MECHANISM FOR RECIPROCATING TYPE MACHINES

Filed Oct. 17, 1921 5 Sheets-Sheet 1

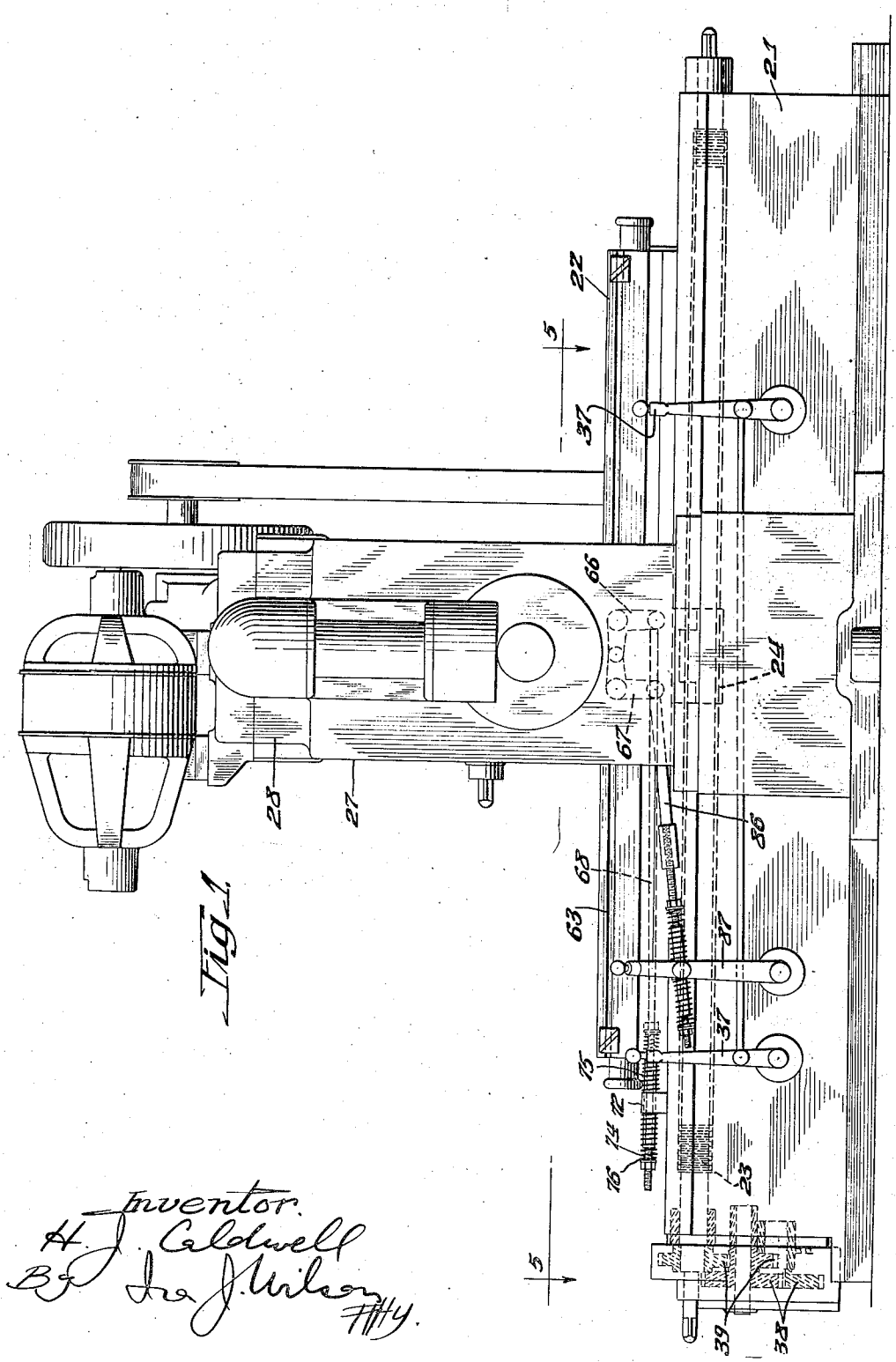


Fig. 1.

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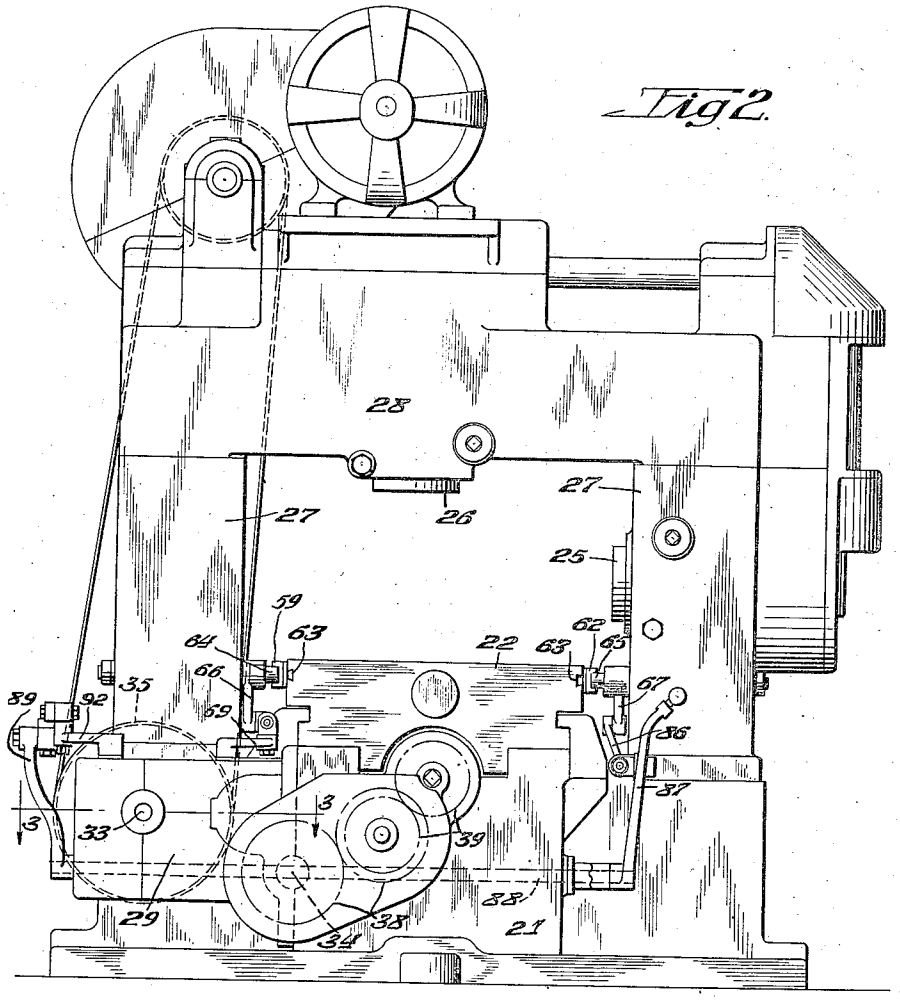
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FEED CONTROL MECHANISM FOR RECIPROCATING TYPE MACHINES

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Fig 2.



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FEED CONTROL MECHANISM FOR RECIPROCATING TYPE MACHINES

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Fig 3.

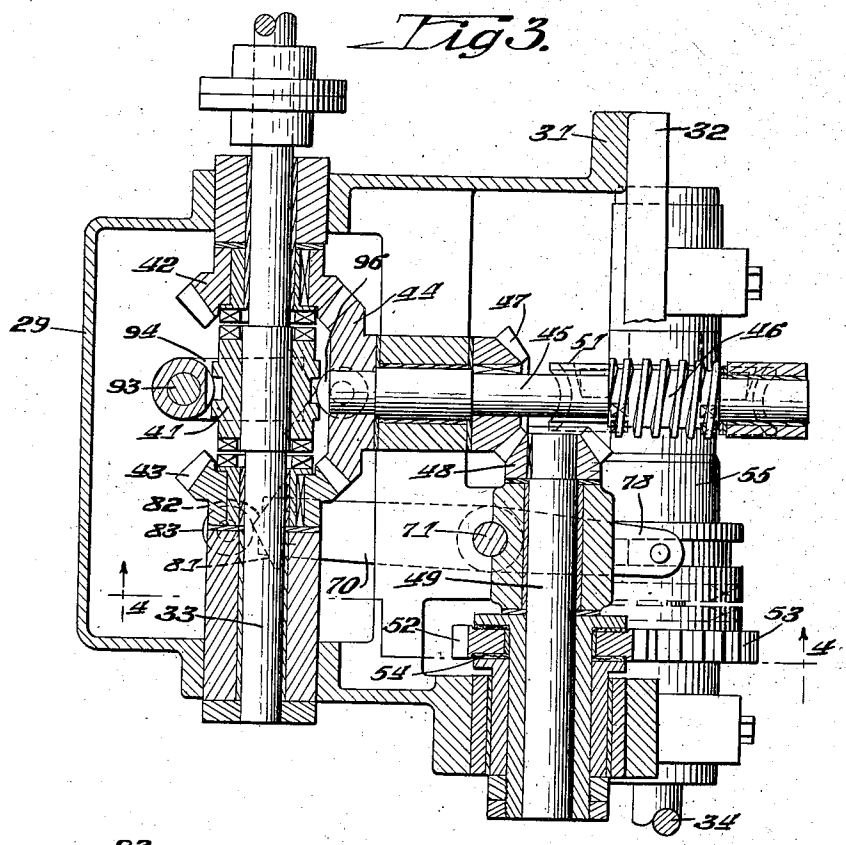
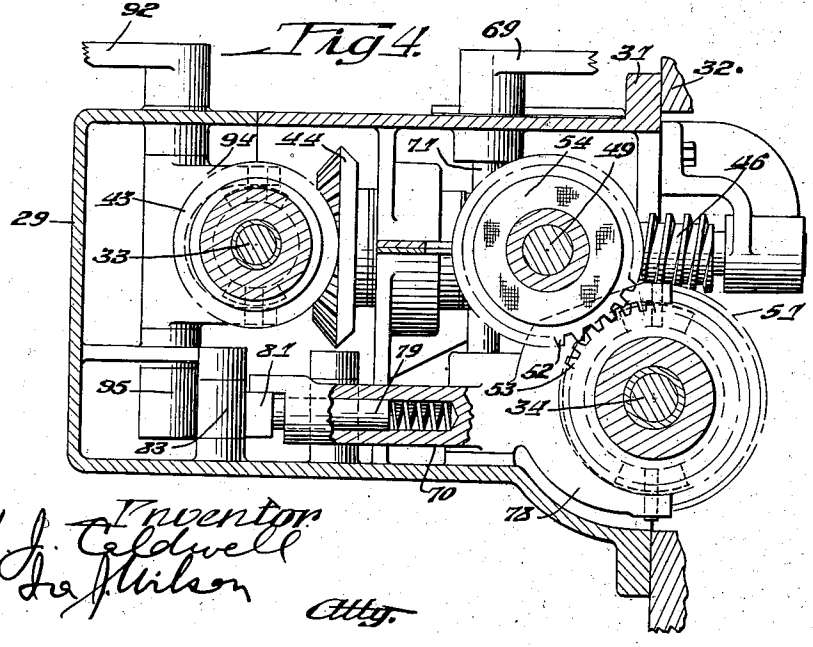


Fig 4.



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FEED CONTROL MECHANISM FOR RECIPROCATING TYPE MACHINES

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Fig 6.

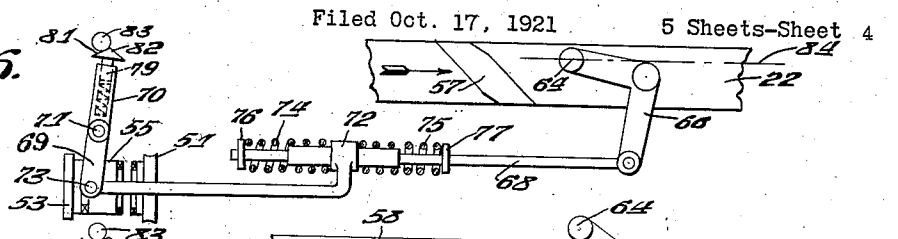


Fig 7.

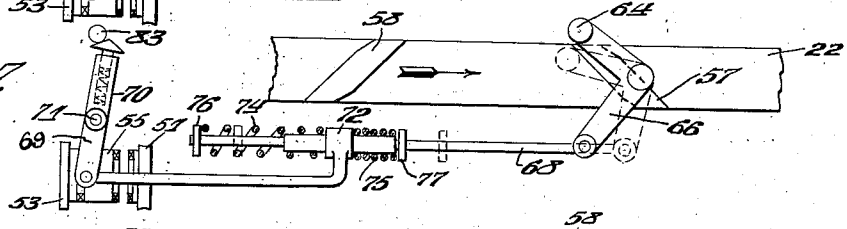


Fig 8

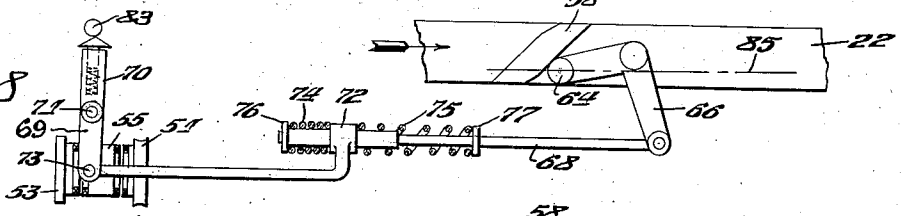


Fig 9.

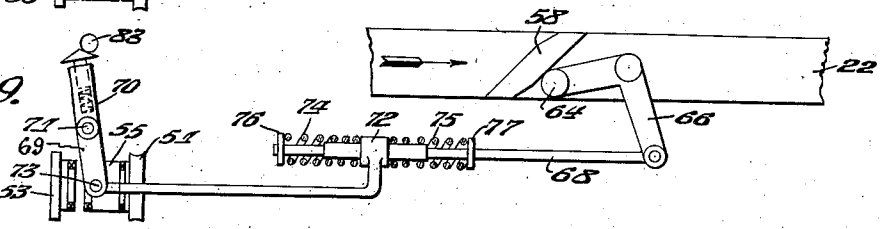
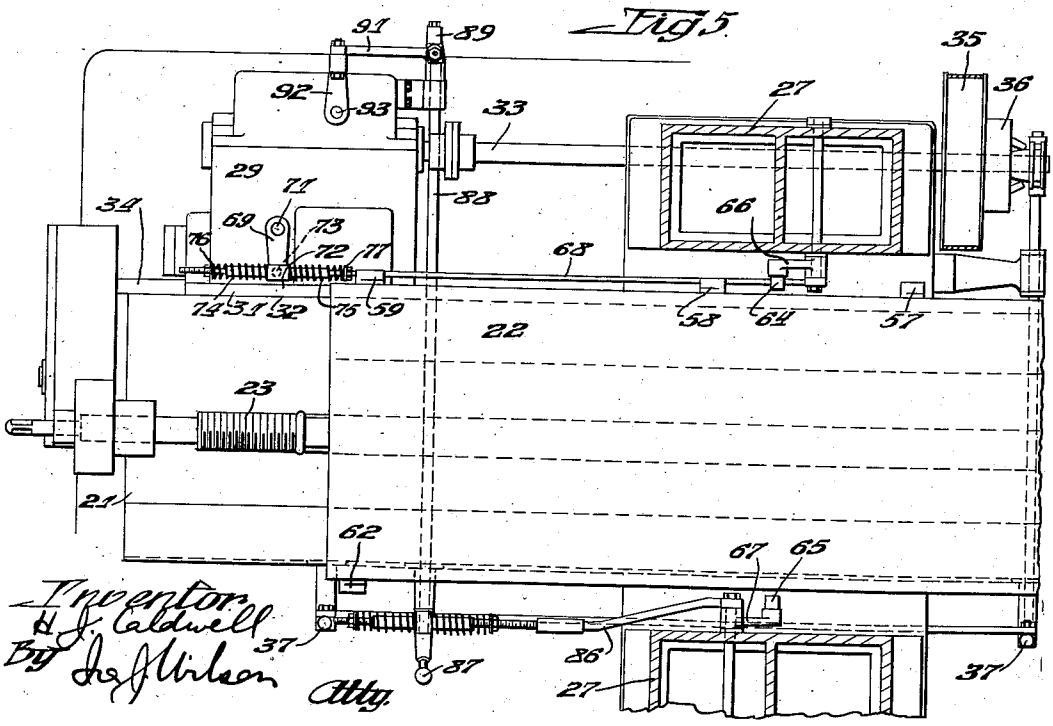


Fig 5.



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FEED CONTROL MECHANISM FOR RECIPROCATING TYPE MACHINES

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Fig. 10.

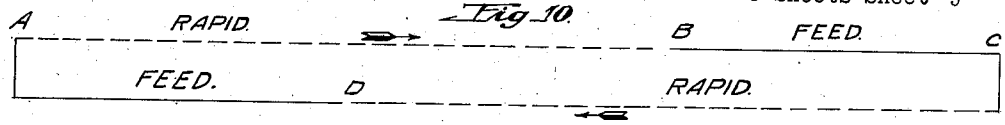


Fig. 11.

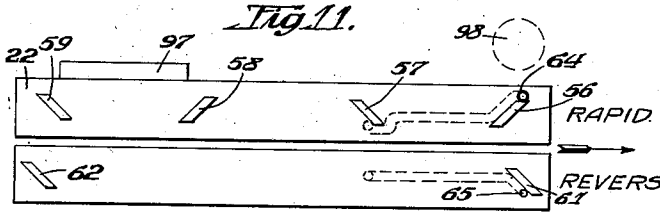


Fig. 12.

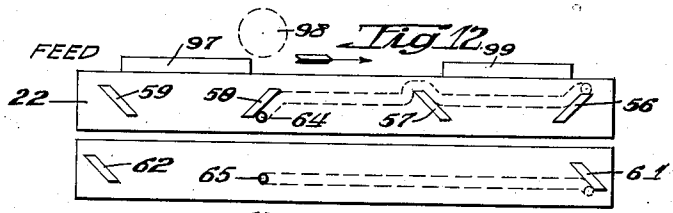


Fig. 13.

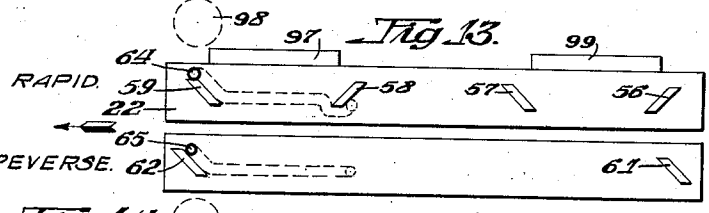


Fig. 14.

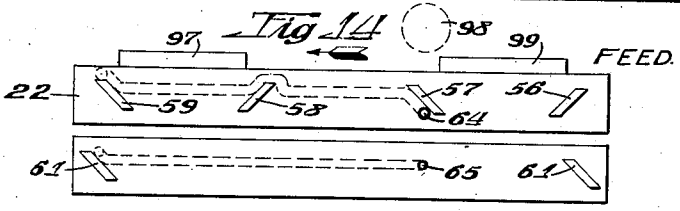


Fig. 15.

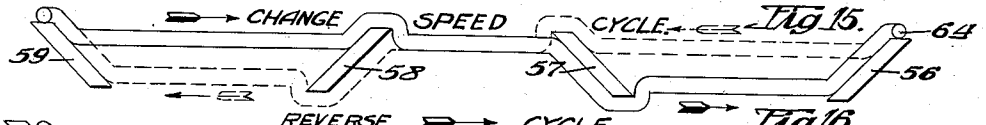


Fig. 16.

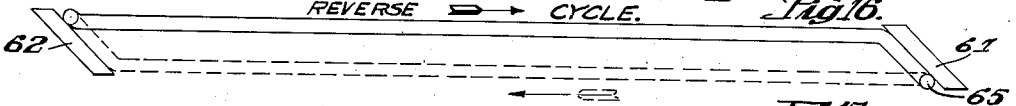


Fig. 17.

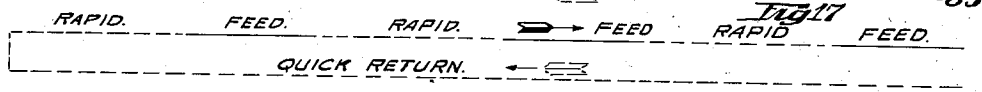


Fig. 18.

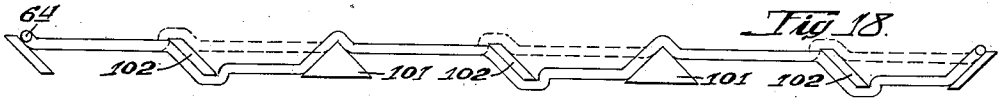
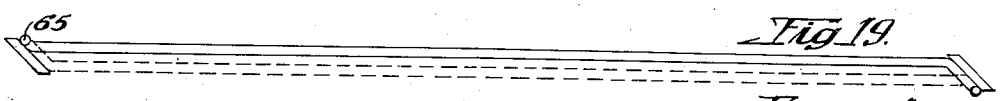


Fig. 19.



By Inventor
Harry J. Caldwell
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Patented Sept. 7, 1926. 1,599,205

UNITED STATES PATENT OFFICE.

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FEED-CONTROL MECHANISM FOR RECIPROCATING-TYPE MACHINES.

Application filed October 17, 1921. Serial No. 508,375.

This invention pertains to mechanism for imparting movement to a traveling support, such for example as a work-carrying table, and for automatically controlling the movements of the table. More particularly, my invention relates to a change-speed and control mechanism especially adapted for milling machines for feeding the work-carrying table at relatively fast and slow speeds in both directions to obtain what might be termed a continuous cycle operation at different periods of which the work-pieces are loaded, milled and unloaded. It should be understood, however, that the invention is not limited to this particular use or to this class of machines, but it is generally applicable to propelling a support at different speeds in forward and reverse directions.

The primary object of the invention is to provide a generally improved and simplified feed control mechanism embodying such principles of construction as to enable efficient, automatic operation, a wide range of table movements, and refinement of the mechanism to such few parts as to enable production at a comparatively low cost.

In furtherance of the foregoing, my invention contemplates the provision of a novel train of gearing including a reversing clutch and a change speed clutch, whereby rapid traverse and feed movements may be obtained in both directions, also mechanism of novel construction for automatically controlling the shifting of said clutches by initial movement of the reciprocating table.

Another object of my invention is to provide a feed control mechanism particularly adapted for reciprocating type milling machines. Due to the size, proportions and heavy work characteristic of these machines, the frictional resistance to the work table is so great that there is no coasting of the table (as in lighter types of machines) that may be relied upon for throwing clutches. In the present instance, I utilize the table movement for disconnecting its propelling clutch and employ in a novel manner an additional force stored up by final movement of the table for throwing the clutch to establish the next succeeding change in speed or direction of travel.

Still another object is to provide a novel system of control cams and connections operated thereby for operating the several clutches.

Other objects and attendant advantages will be appreciated by those skilled in this art as the invention becomes better understood by reference to the following description when considered in connection with the accompanying drawings, in which—

Figure 1 is a front elevation of a reciprocating type milling machine embodying my invention;

Fig. 2 is an end elevation of the machine looking at the driving end thereof;

Fig. 3 is a horizontal section through the gear box taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section through the gear box taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is a fragmentary plan section taken substantially on the line 5—5 of Fig. 1;

Figs. 6 to 9 inclusive are diagrammatic views illustrating the action of the rapid traverse and feed clutches and the means for operating the same;

Fig. 10 is a diagram illustrating the table movement cycle;

Figs. 11 to 14 inclusive are diagrammatic views illustrating the cam dog action;

Figs. 15 and 16 are diagrammatic views of the change speed and reversing cycles, respectively;

Fig. 17, a diagrammatic view showing a modified table movement cycle; and

Figs. 18 and 19 are diagrammatic views illustrating the action of the clutch-operating elements for said modified table cycle.

The present exemplification of my invention is in connection with a reciprocable type milling machine, that is, one in which the work is carried on a table which moves back and forth past the cutting tool or tools. My invention has reference to the mechanism for reciprocating the table and likewise to the control of such mechanism from cams or dogs on the table. It is desired that the table shall be moved in rapid traverse and feed movements in both directions and that these movements shall be of different durations and periods in a cycle, according to the particular work at hand. In the present example, a continuous-cycle table movement is obtained in which the work-pieces are loaded at both ends of the machine, and

the cycle comprises a rapid traverse movement bringing the work-pieces at one end to the cutters, a feed movement in the same direction for feeding the work past the cutters, during which feeding period the fixture at the other end of the table will be loaded, reversal of the table into rapid traverse for bringing the new work-piece to the cutters, and a feed movement in the same direction for feeding the new work-piece past the cutters. During this feed movement the previously finished work-piece will be removed and replaced by an unfinished work-piece. This cycle will then be repeated, the entire operation being automatic. As another example, the table cycle may comprise a series of rapid traverse and feed movements in one direction and a quick return in the opposite. Various combinations of these movements may be obtained as will be apparent hereinafter. It should be understood, however, that my improvements are generally applicable to the operation and control of any traveling support whether in the form of a work or tool carrier which moves back and forth either in a continuous or an interrupted cycle.

The frame of the present machine comprises an elongated bed 21 upon which a work table 22 is mounted to reciprocate horizontally. The bed and table are of conventional construction, the table being mounted on the usual flat bearings and being propelled by means of a screw 23 held against axial translation on the bed and engaging a nut 24 carried by the table. In the present example, horizontal and vertical milling cutter spindles 25 and 26 respectively, are carried by side housings 27 and an overhead structure 28, the latter of which carries suitable mechanism for driving the spindles. The side housings are positioned midway between the ends of the bed so that the work table may be conveniently loaded when at either end of the bed. The cutter spindles are adapted for carrying surface milling cutters; but it should be understood that any type or arrangement of tools may be employed.

My invention comprehends the provision of gearing for propelling the table, and while the gearing may be suitably housed or supported on a machine, I prefer that it shall be supported in an independent housing or unit adapted to be incorporated with any of various machines for transmitting the desired movements. The gear box designated generally by 29, I have located in the present instance at the back of the machine adjacent to the driving end of the table screw. More particularly, the vertical side wall 31 of the gear box is bolted to the adjoining wall 32 of the bed. A change-speed and reversing train of gears within this gear box, best shown in Figs. 3 and 4, operates between a driving and a driven shaft 33 and 34, respectively. The shaft 33 may be continuously driven from any suitable source of power, such for example as by means of a belt pulley 35 through the agency of any suitable clutch 36 adapted to be thrown into and out of engagement by a hand lever 37 positioned at the front of the machine. The driven shaft 34 is in constant driving connection with the table screw 23 through the agency of reduction gearing comprising the pick-off or change-speed gears 38 and the gears 39, one of which is fixed to the feed screw 23. By means of gearing and clutches between the driving and driven shafts, the latter may be driven at either of two speeds in both directions. I have, therefore, devised a most simple and direct means for obtaining these results, and to this end have provided a reversing clutch on the driving shaft and a change-speed clutch on the driven shaft. The reversing clutch comprises a shiftable clutch element 41 splined on the shaft 33 and having the usual clutch teeth adapted for connection with either of the gears 42 or 43 loose on said shaft. An interposed bevel gear 44 meshes with both gears 42 and 43 and is fixed to a shaft 45 which carries a worm screw 46. This shaft 45 also carries a fixed bevel gear 47 meshing with the bevel gear 48 fixed to an intermediate shaft 49 suitably journaled in the gear box. The worm screw 46 meshes with a worm gear 51 loose on the driven shaft 34, and the shaft 49 carries a fixed spur gear 52 meshing with a spur gear 53, also loose on the driven shaft. A suitable friction connection 54 is provided between the gear 52 and the shaft 49 for absorbing any sudden shock such as is imposed when the speed is suddenly stepped up. A shiftable clutch element 55 splined on the shaft 34 has the usual clutch teeth adapted for engaging complemental teeth on the worm gear 51 and the gear 53. From the foregoing, it will be manifest that the drive from the rotator 33 may be transmitted to the shaft 34 in either direction according to the position of the clutch element 41, assuming of course, that the clutch element 55 is engaged with one of the drivers 51 or 53 on the shaft 34. It will likewise be evident that when the driver 51 is connected to the shaft 34 by means of the clutch element 55, the shaft will be driven at a relatively slow speed; and when the driver 53 is connected to the shaft the latter will be driven at a higher speed. The slower speed is for propelling the table for the feed and the higher speed is for the rapid traverse movement. It follows that the feed movement may be transmitted either forward or reverse according to the position of the reversing clutch; likewise that the rapid traverse may be either forward or reverse.

Mechanism is now provided for operating the reversing and change-speed clutches to obtain predetermined movements. Each clutch is operated by an independent motion train or connection adapted to be actuated by cam dogs on the table. "Motion train" is used herein as meaning a mechanical train of parts through which motion is adapted to be transmitted from an operating part to an operated part, at present the operating part being a bell crank lever adapted to be actuated by one or more cam dogs on a traveling support or work table and the operated part being a clutch shifter included in a table propelling mechanism. Each motion train or connection is adapted to transmit control movement positively derived from movement of the cam dogs and to transmit an additional control movement as will be fully explained hereinafter. These connections may be actuated by dogs on one or both sides of the table, and in the present instance the change-speed clutch is controlled by dogs on the rear of the table and the reversing clutch by dogs on the front of the table. To produce the continuous cycle referred to above in which the work-pieces are loaded onto the table at both ends of the machine, change-speed dogs 56 to 59 inclusive are attached to the rear of the table in the arrangement shown in Fig. 11, and reversing dogs 61 and 62 are attached to the front of the table, as shown. These dogs may be suitably secured to the table and are adjustable lengthwise thereon in the slotways 63. The cam dogs may be of any suitable shape, but preferably having parallel faces inclined 45 degrees with respect to the vertical and beveled at their upper and lower obtuse angles, as shown in Fig. 6. These inclined vertical faces are adapted for moving cam-follower elements vertically for the purpose of disengaging the clutches. The cam-follower elements employed are rollers 64 and 65 carried by bell crank levers 66 and 67, respectively mounted on the inner sides of the housings 27 in the arrangement shown plainly in Figs. 1 and 5. Inasmuch as the connection between each bell-crank lever and its shiftable clutch element is very similar, a detail description of one will suffice. Referring to that for operating the change-speed clutch and particularly to Figs. 1, 5 and 6, it will be observed that the depending arm of the bell crank lever 66 is pivotally connected to a rod 68, which is connected at its opposite end to an arm 69 fixed to a rock shaft 71 on the gear box. The connection between the rod 68 and the arm 69 comprises a sleeve 72 pivotally connected on a vertical axis 73 to the arm 69, through which sleeve the rod is freely slidable. Coil compression springs 74 and 75 supported on opposite ends of the sleeve 72 are confined between shoulders on said sleeve and abutments 76 and 77 normally fixed on the rod 68 but adapted to be adjusted lengthwise thereon by means of the nuts threadingly engaged on said rod, as shown. The function of this spring connection will be presently apparent. The rock shaft 71 has fixed thereto a lever 70 providing a forked end 78 having the usual connection with the clutch element 55 for shifting the same and is provided at its opposite end with a spring-pressed plunger 79 having a pointed or arrow shaped head. The angular faces 81 and 82 of the plunger are adapted to be respectively urged against a roller 83 according to the position of the lever 70, the roller being in a fixed location in the gear box. The function of this spring-pressed plunger is to assist in throwing the clutch element 55 into engagement with either the rapid traverse or feed drives after one or the other has been disengaged, and for holding such engagement. The clutch is disengaged by table movement through the intermediary of a cam dog, bell-crank lever and the connection between the latter and the clutch. The instance, however, that the clutch teeth are disengaged so that the drive to the table is broken, the table will stop. There is no coasting of the table which may be utilized for continuing movement of the clutch shifting lever. Furthermore, inasmuch as the clutch shifting lever 70 must throw in both directions, it will not reach the dead-center position with relation to the roller 83 when the clutch teeth of either clutch have been disengaged. Consequently, an additional force is required to throw the lever 70 beyond the dead-center position, after which the tension stored in the plunger spring will be utilized in conjunction with its inclined head working against the roller 83 for throwing the opposite clutch into engagement. This additional force is supplied by one of the springs 74 or 75 as the case may be.

The operation will be apparent from the following concrete example, reference being had to Figs. 6 to 9 inclusive, which show diagrammatically the manner in which the rapid reverse and feed clutches are operated. In Fig. 6, the rapid traverse clutch is engaged, the table 22 being propelled to the right. The rapid traverse clutch is held engaged by the plunger face 81 engaging the roller 83, and the springs 74 and 75 are under equal compression. The cam-follower roller 64 occupies a position in the plane indicated by the center line 84. The cam dog 57 will be the first to engage the roller 64. The roller will simply ride over this cam in an idle clearance movement, as shown in Fig. 7, without disturbing the position of the clutch, such clearance movement and consequent action of the bell-crank lever and its connecting rod 68 being compensated

for by compression of the spring 75 as shown in said figure. After the dog 57 has passed the roller 64 the latter will be moved under the influence of the spring 75 back to its operative position in the plane 84 and in the path of the next following cam dog 58. This cam dog inclined in the opposite direction from the dog 57, will engage the roller 64 and move it downwardly to the plane 85, as shown in Fig. 8, thereby compressing the spring 74 and bringing the abutment 76 against the adjacent end of the sleeve 72, and by this action withdrawing the rapid traverse clutch. At this point, when the rapid traverse drive to the table has been disconnected, the table will momentarily or theoretically stop with the parts in the position shown in Fig. 8, in which it will be noted that the plunger lever 70 has not passed the dead-center position with respect to the roller 83. It will be observed, however, that in this condition, the spring 74 is under its maximum compression and the pressure thus stored will be utilized to move the lever 70 past the dead-center position and to assist the plunger spring in throwing said lever to the position shown in Fig. 9, in which to engage the feed clutch. The table will thereupon continue its movement to the right at a slower speed and the roller 64 will move under the dog 58 to clear the latter as explained above with reference to clearing the dog 57, except that in the present instance the spring 74 will be compressed to compensate for this clearance action, after which the roller 64 will return to the plane 85. Inasmuch as the act of disengaging one clutch and engaging the other takes place very rapidly, the propelling movement of the table is not apparently interrupted. The bell-crank lever 66 will be thrown in the opposite direction by the next following dog 59 for establishing the rapid traverse speed in the same manner as described with reference to engaging the slow speed.

The connection between the bell-crank lever 67 and the reversing clutch is as mentioned above, substantially the same as that described with reference to the change-speed clutch. This connection comprises, briefly stated, a connecting rod 86 between the bell-crank lever 67 and a hand lever 87 at the front of the machine, which hand lever is connected to a rock shaft 88 passing through the bed and connected through the agency of an upstanding arm 89 and link 91 to an arm 92 fixed to a rock shaft 93. This rock shaft carries a forked arm 94 and a plunger arm 95, the former for shifting the clutch element 41 and the latter arm 95 for carrying a spring-pressed plunger similar to the plunger 79, which co-operates with a roller 96 in the same manner described with reference to the roller 83. The plunger arm 95 fixed to the lower end of the shaft 93 as shown in Fig. 4, is positioned in the vertical plane of the forked arm 92 and in the horizontal plane of the plunger arm 70, and consequently is not shown in these figures, except that its beveled or pointed end is shown by dotted lines in Fig. 3 in co-operation with its roller 96. A spring connection is interposed between the rod 86 and the lever 87 similar to that between the rod 68 and the arm 69. The operation of the reversing clutch by the dogs 61 and 62 acting on the roller 65 is the same as just described with reference to the operation of the change-speed clutch with the exception of the differences in the respective cycles.

The driving mechanism is under the immediate control of the operator who by operation of the levers 37 at either end of the machine may start or stop the table propelling mechanism, it being observed that this mechanism is never in the neutral position shown in Fig. 3, except momentarily when the clutch elements are being shifted and that except for the momentary break in the drive when shifting the clutches the table is either being propelled at the fast or slow speed.

The complete cycle of the table movement will now be described, reference being had to Figs. 10 to 16 exclusive. This cycle especially adapted for loading workpieces at both ends of the table, is shown diagrammatically in Fig. 10, it being assumed that the dotted line from A to B represents rapid traverse of the table to the right and from B to C the feed movement at the completion of which the table reverses into rapid traverse, and at D slows down to the feed movement which is continued until the end of the cycle when the table reverses into rapid traverse, and repeats the cycle. Assuming as shown in Fig. 11, that the rollers 64 and 65 have been moved into the full line positions for establishing the rapid reverse, the workpiece 97 which has been loaded on the table 22 will be carried to the cutter 98 in a rapid movement, the roller 64 traversing the vertical path indicated in dotted lines in Fig. 12 in which it has cleared the dog 57 and has been shifted to its lower operated position by the dog 58, thereby engaging the feed clutch. During the feed movement, a new work-piece 99 will be loaded onto the opposite end of the table. The feed of the workpiece 97 past the cutter or cutters as the case may be, will continue until the roller 64 has been actuated by the dog 59, as shown in Fig. 13, for engaging the rapid traverse clutch and shortly thereafter the dog 62 will actuate the roller 65 to shift the reverse clutch, thereby traveling the table rapidly to the left until the new work-piece 99 has been brought to the cutter, as shown in Fig. 14, whereupon the dog 57 will actuate the

roller 64 and engage the feed clutch. During this feed movement the finished workpiece 97 will be removed and a new workpiece will be loaded onto the table. The feed in this direction will continue until the dogs 56 and 61 actuate their respective rollers as shown in Fig. 11 for effecting the rapid reverse movement shown in Fig. 13. Development of the cycles of the change-speed clutch roller 64 and of the reversing clutch roller 65 are shown respectively in Figs. 15 and 16.

It will be manifest that by changing the location of the cam dogs on the table the duration of the rapid traverse and feed movements may be varied, and also by changing the number and location of the cam dogs the cycle may be varied. For example, in Fig. 17, I have shown a diagram representing a series of alternate rapid traverse and feed movements in one direction and a quick return to starting position. To produce this cycle the cam dogs will be set as shown in Figs. 18 and 19 for operating the rollers 64 and 65. It will be observed that triangular cam dogs 101 are employed at intervals, so that on the quick return of the table the rollers 64 will ride over all of the dogs and maintain the rapid traverse clutch engaged, and while moving in the opposite direction the roller 64 will be actuated by the dogs 102 for engaging the feed clutch.

The gearing disclosed herein is claimed in my copending application Serial No. 78,515, filed December 31, 1925, which is a division of my application Serial No. 508,374 filed concurrently with the present application.

It should be understood that the foregoing conveys simply an illustration of several possible uses of my invention; that my invention is applicable to the operation of any tool or work-carrying support which travels back and forth; and that any suitable change-speed and reversing mechanism may be applied in the general combination. It is believed that the objects of the invention are clearly illustrated by the foregoing, and it should be understood that considerable change might be made in construction and arrangement without departing from the spirit and scope of the invention as expressed in the appended claims, in which—

I claim:—

1. In combination, a traveling support, mechanism for propelling it including a device for changing either the speed or direction of travel of the support, shifter means movable past one side of a dead-center position to establish one operative condition of said device and past the opposite side to establish another operative condition, said shifter means including a spring-pressed plunger for throwing it beyond said dead-center position, and means positively operated by travel of the support for operating said shifter means, including spring means supplemental to said spring-pressed plunger for moving the shifter means through and beyond said dead-center position.

2. In combination, a traveling support, mechanism for propelling it including either a change-speed or a reversing clutch, a shifter for the clutch, a spring-pressed plunger to yieldingly hold the shifter past one side or the other of a dead center position at each side of which a different clutch face will be engaged, and means positively operated by travel of the support for operating the clutch shifter to disconnect either clutch face including means supplemental to said spring-pressed plunger for building up a spring pressure by said positive operation, which pressure is utilized to move the shifter through and beyond said dead-center position.

3. Control mechanism of the character described comprising a traveling support, mechanism for propelling it at different speeds and in different directions, a plurality of cams on the support, and means adapted to be actuated by said cams for controlling said mechanism including a motion-train having an operating part adapted to be positively actuated by said cams, an operated part for transmitting control motion, and means for transmitting a control motion additional to that produced by a positive actuation of said operating part and permitting said operating part to ride around the cams in a clearance movement.

4. Feed control mechanism of the character described comprising, in combination with a reciprocating table and mechanism for reciprocating the latter including a reversing clutch and a change-speed clutch, means for operating each clutch comprising an element adapted to be moved back and forth, dogs on the table for moving said elements back and forth, a spring-actuated plunger adapted to move past a dead-center position for holding each clutch engaged, and spring-actuated means interposed in each connection for throwing said plungers past the dead-center position.

5. Feed control mechanism of the character described comprising a reciprocable table, gearing for reciprocating the table including a clutch, a series of inclined cam dogs on the table, an element adapted to be moved back and forth by said inclined dogs and connected with the clutch for shifting the same, the travel of said element from one extreme clutch-shifting position to another being less than the length of its actuating dog, and means in the connection of said clutch-shifting element allowing idle movement thereof for clearing said dog without interfering with the operative condition of the clutch.

6. The combination of a traveling support, mechanism for imparting rapid and feed movements to said support, including a change-speed and a reversing clutch, cam dogs on said support, connections adapted to be actuated by the cam dogs for operating the clutches, said connections including a spring-actuated means for throwing in the clutches after they have been disengaged by movement of said support, and another spring-actuated means for holding the clutches engaged.

7. The combination of a traveling support, mechanism for imparting rapid and feed movements to said support, including a change-speed and a reversing clutch, cam dogs on said support, connections adapted to be actuated by the cam dogs for operating the clutches, said connections including a member adapted to be moved in one direction for engaging the rapid speed clutch, in the opposite direction for engaging the feed clutch, and in each direction in a dog-clearance movement without disturbing the clutches.

8. The combination of a traveling support, mechanism for imparting rapid and feed movements to said support, including a change-speed and a reversing clutch, cam dogs on said support, connections adapted to be actuated by the cam dogs for operating the clutches, said connections including a member adapted to be moved in one direction for engaging the rapid speed clutch, in the opposite direction for engaging the feed clutch, and in each direction beyond its clutch actuating movement without disturbing the clutches.

9. Feed control mechanism of the character described comprising, in combination, a traveling support, means for propelling it including a pair of opposed clutch elements and an intermediate shiftable clutch element, shifter means to move said intermediate clutch element past one side of a dead-center position to yieldingly hold it engaged with one of said opposed clutch elements and past the opposite side to yieldingly hold it engaged with the other clutch element, a spring-pressed plunger to urge and hold said intermediate clutch element past either side of said dead-center position, cam means on said traveling support, and a connection positively actuated by said cam means for operating said shifter means, including means in addition to said spring-pressed plunger for throwing the shifter means through and beyond said dead-center position when either of said opposed clutch elements has been disengaged by said positive operation.

10. The combination of a traveling support, mechanism for propelling said support at different speeds, including a shiftable device adapted to be moved past one side of a dead-center position to establish one speed and past the opposite side to establish another speed, means adapted to move said shiftable device beyond either side of its dead-center position and to yieldingly hold it in each shifted position, means actuated by movement of said support for initiating the shifting movement of said shiftable device, and additional means actuated by said initial shifting movement and acting to automatically move said shiftable device through and beyond said dead-center position.

11. Feed control mechanism of the character described comprising a traveling support, mechanism for moving it back and forth including a pair of opposed clutch faces and an intermediate shiftable clutch element for engagement therewith, a clutch shifter, a spring-actuated plunger cooperating with said clutch shifter for yieldingly holding it beyond one side of a dead-center position at which said clutch element engages one of said clutch faces and beyond the opposite side at which it engages the other clutch face, cams on the support, and shifter-operating means adapted to be positively operated by said cams to disengage either of the clutches, including spring elements supplemental to said spring-actuated plunger for moving the clutch shifter through and beyond said dead-center position after said cam action.

12. In mechanism of the character described, the combination with a traveling support and mechanism for propelling it at different speeds, of means actuated by the support for controlling the operation, said mechanism comprising a series of cam dogs on the support in a substantially common plane, an element adapted to be moved by said cams to and from an upper and a lower operative position in each of which to establish one of said speeds, and means whereby said element may move beyond one of said planes without interfering with the operation of said mechanism for clearing one of the cam dogs and for returning to its normal operative position in which to be actuated by the next succeeding cam dog.

13. Feed control mechanism of the character described comprising in combination a reciprocable table, gearing for reciprocating the table including a change-speed clutch and a reversing clutch, cam dogs on the table, bell-crank levers adapted to be oscillated by the cam dogs, and connections between said levers and clutches for operating the latter including a spring-pressed plunger connected with each clutch element for throwing it beyond a dead-center position, and including spring means for moving said plunger through and beyond said dead-center position.

14. Feed control mechanism of the char-

acter described comprising in combination a reciprocable table, gearing for reciprocating the table including a change-speed clutch and a reversing clutch, cam dogs on the table, bell-crank levers adapted to be oscillated by the cam dogs, and connections between said levers and clutches for operating the latter including a spring-pressed plunger connected with each clutch element for throwing it beyond a dead-center position, and including spring means for moving each plunger through and beyond its dead-center position and for assisting in throwing in its respective clutch.

15. Feed control mechanism of the character described comprising in combination a reciprocable table, gearing for reciprocating the table including a change-speed clutch and a reversing clutch, cam dogs on the table, bell-crank levers adapted to be oscillated by the cam dogs, and connections between said levers and clutches for operating the latter including a spring-pressed plunger connected with each clutch element for throwing it beyond a dead-center position, one of said bell-crank levers adapted to be oscillated in both directions by cam dogs which pass the levers, and spring means permitting idle movement of said bell-crank lever in clearing the cam dogs when the latter pass.

16. The combination of a traveling support, mechanism for moving it back and forth including clutches, inclined cams on said support, means adapted to be actuated by said cams for controlling operation of said mechanism, including an element adapted to be moved back and forth by said cams for disengaging one clutch and engaging another when moved in one direction, said operation of said element being effected during movement of said element through part of the cam length, and said element being movable through the remainder of the length of said cam in clearing the cam without disturbing its clutch.

17. The combination with a traveling support and clutch-operated mechanism for moving the support back and forth, an element for operating one of said clutches and normally disposed in an upper plane determinative of one clutch position or in a lower plane determinative of another clutch position, and inclined cams on said support for moving said element to and from said planes, said cams reaching above and below said planes, whereby said element may be either intercepted by the cam and moved to the opposite plane or will be moved beyond the cam in a clearance action according to which incline is engaged by said element.

18. Feed control mechanism of the character described, comprising a traveling support, mechanism for propelling said support in opposite directions, including a clutch element shiftable between opposed clutch elements, and a motion-train adapted to be actuated by said support for shifting said clutch element, said motion-train including a spring-pressed plunger moving with said shiftable element and adapted to yieldingly urge and hold the latter past either side of said dead-center position, said motion-train also including an additional spring means adapted to be actuated by movement of the support for building up pressure, said motion-train being positively actuated by movement of the support to disconnect said shiftable element from either clutch element, whereupon the built up pressure of said additional spring means will be exerted to move said shiftable element beyond said dead-center position, whereupon said shiftable element will be moved into engagement with the opposite clutch element by the combined action of said spring-pressed plunger and said additional spring means.

19. The combination of a traveling support, cam dogs thereon, mechanism for propelling the support including change-speed and reversing devices, a bell-crank lever adapted to be operated by said cam dogs, and a motion-train between said bell-crank lever and one of said devices including a compensating connection allowing movement of said bell-crank lever in both directions without disturbing said device.

20. The combination of a traveling support, cam dogs thereon having inclined parallel faces beveled at their obtuse corners, mechanism for propelling the support, and a swinging element adapted to be actuated by said cam dogs and having operating connection with said mechanism.

21. In combination, a traveling support, mechanism for propelling it including a device for changing either speed or direction of travel of the support, means movable past one side of a dead-center position to establish one operative condition of said device and past the opposite side to establish another operative condition, means for yieldingly holding said shifter means in its respective shifted position, and means positively operated by travel of the support for operating said shifter means to disconnect said device, including spring means supplemental to said yielding means for building up a spring pressure by said positive operation, which pressure is utilized to move said shifter means past said dead-center position.

22. In combination, a traveling support, mechanism for propelling it including opposed clutch faces and an intermediate shiftable clutch element, a clutch shifter, a spring-pressed plunger connected with the clutch shifter and movable past one side of a dead-center position to hold the shiftable clutch element engaged with one clutch face and the opposite side to hold it engaged with

the other clutch face, and means for operating the clutch shifter positively operated by travel of the support to disengage the shiftable clutch element, including means supplemental to said spring-pressed plunger for building up a spring pressure by said positive operation, which pressure is utilized to move said clutch shifter means past said dead-center position.

23. In a machine of the character described, the combination of a bed, a work table thereon, a screw for reciprocating said table on the bed, a train of gearing for driving said screw including a reversing clutch and a change-speed clutch, cams on the table, means actuated by said cams for operating said clutches, said cams adapted for operating said means to positively disengage said clutch and said clutch-operating means including devices movable past one side of a dead-center position to establish one driving connection and the opposite side to establish another driving connection, and additional means for moving said devices through said dead-center positions.

24. The combination of a traveling support, mechanism for moving the support including opposed clutch elements, a shiftable clutch element interposed between said clutch elements, a motion-train for operating said shiftable clutch element, means on the support for actuating said motion-train, including a coil compression spring on the operating part at each side of the operated part, and abutments on the operating part for taking the outer thrust of said springs.

25. The combination of a traveling support, mechanism for moving the support including opposed clutch elements, a shiftable clutch element interposed between said clutch elements, a spring-pressed plunger movable with said shiftable clutch element past either side of a dead-center position for yieldingly holding it engaged with the complemental clutch element at said side, a motion-train for operating said shiftable clutch element, means on the support for actuating said motion-train, said motion-train including spring means carried by and moving with it and adapted to be compressed by the positive action of said support in operating the motion-train to disengage one clutch, and the pressure stored in said spring means being utilized to engage the other clutch.

26. Control mechanism of the character described comprising a traveling support, mechanism for propelling it at different speeds and in different directions, a plurality of cams on the support having inclined faces, and means adapted to be actuated by said cams for controlling said mechanism including a part normally disposed in the path of any one of the cams so as to be actuated thereby for transmitting a control motion and adapted to have a clearance movement around either end of the cams without transmitting control motion.

27. Control mechanism of the character described comprising a traveling support, mechanism for propelling it, a plurality of cam dogs on the support having inclined faces, and means adapted to be actuated by said cam dogs for controlling said mechanism including a part adapted to be actuated by the inclined faces of the cam dogs for transmitting control motion and a non-control transmitting movement for clearing either end of one of the cam dogs.

28. Control mechanism of the character described comprising a traveling support, mechanism for propelling it, a plurality of cam dogs on the support having inclined faces and means adapted to be actuated by said cam dogs for controlling said mechanism including a part adapted to be moved in one direction by an inclined face on one cam dog and in the opposite direction by an oppositely inclined face of another cam dog for transmitting control motion, said part being adapted to move in either direction beyond its said control motions for clearing the ends of said cam dogs and returning to a normal position in which to be actuated by a succeeding cam dog.

29. Control mechanism comprising a traveling support, mechanism for propelling it at different speeds and in different directions, cams on the support, and means adapted to be actuated by the cams for controlling said mechanism including a cam actuated part adapted to be moved back and forth between two limits for transmitting during each such movement a control motion and adapted for movement beyond said limits for clearing the end of certain cam dogs without transmitting control motion.

30. The combination with a traveling support, mechanism for propelling it including a clutch, a plurality of cam dogs on the support, a bell crank lever mounted so that one arm is adapted to be moved back and forth by said cam dogs, a rod pivotally connected to the other arm, a shifter for said clutch, and a compensating connection between said rod and shifter permitting the cam-operated end of the bell crank to ride over one or more of said cam dogs in a clearance action without operating said shifter.

31. In combination, a traveling support, mechanism for propelling it including opposed clutch faces and an intermediate shiftable clutch element, a clutch shifter, means connected with the clutch shifter movable past one side of a dead-center position to hold the shiftable clutch element engaged with one clutch face and the opposite side to hold it engaged with the other clutch face, said clutch shifter means including spring pressure means for urging it into either clutch engaging position, and

a motion-train for operating the clutch shifter positively operated by travel of the support to disengage the shiftable clutch element, said motion-train including means for building up a spring pressure by said positive operation, which pressure is supplemental to that of said clutch shifter means and is utilized to move said clutch shifter means through and past said dead-center position.

32. Control mechanism of the character described comprising in combination with a traveling support and mechanism for propelling it at different speeds and in different directions, cam dogs on the support, and means adapted to be actuated by said cam dogs for controlling said mechanism including a motion-train positively moved by the action of a cam dog for transmitting control motion to said mechanism and constructed for transmitting additional control motion to said mechanism subsequently to and independently of the cam dog action and permitting further movement of the cam-actuated part of said motion-train for clearing the cam dog.

33. Control mechanism of the character described comprising in combination with a traveling support and mechanism for propelling it at different speeds and in different directions, cam dogs on the support, and means including a part adapted to be actuated by one or more of said cam dogs for controlling said mechanism, one of the cam dogs having an operative and a non-operative cam surface and said part adapted to be operated by the operative cam surface for transmitting a control movement and to ride over said non-operative cam surface in a clearance movement to a position in operative relation to a succeeding cam dog.

34. Control mechanism of the character described comprising in combination with a traveling support and mechanism for propelling it at different speeds and in different directions, a plurality of cam dogs upon the support of substantially the same length and positioned in a common plane, certain of said cam dogs having operative cam surfaces on opposed sides in overlapping relation and non-operative cam surfaces, and means including a part adapted to be actuated by a plurality of said cam dogs for transmitting control movements to said mechanism, said part being adapted to be operated by said operative and non-operative cam surfaces for transmitting control movements by the former and non-control movements by the latter, by which non-control movement said part is adapted to clear a cam dog and return to a position in which to be actuated by the operative cam surface of a succeeding cam dog.

35. The combination with a traveling support and mechanism for propelling it, cam dogs on the support, and means operated thereby for controlling said mechanism, one of said cam dogs having inclined, substantially parallel faces, each of which comprises an operating and a non-operating portion, the operating portion being adapted for actuating said means for transmitting control motion to said mechanism and the non-operative portion being adapted for actuating said means to permit the latter to clear one or more dogs.

36. In combination a traveling support, mechanism for propelling it including opposed clutch faces and an intermediate shiftable clutch element, a clutch shifter, a spring-pressed plunger tending to hold the clutch shifter either at one side or the other of a dead-center position at which side to hold the shiftable clutch element engaged with the respective clutch face, and a motion-train for operating the clutch shifter positively operated by travel of the support to disengage said clutch element from either clutch face, said motion-train including means for building up a spring pressure by said positive operation, which pressure is supplemental to that of said spring-pressed plunger and is utilized to move said clutch shifter through and past said dead-center position.

37. The combination of a traveling support, propelling mechanism therefor including a shiftable motion-changing device, a cam dog on the support, and a motion-train for operating the shiftable element of said device including a part adapted to me moved back and forth to different operated positions by the action of opposed surfaces on the cam dog and further adapted to move in an idle clearance movement for riding over a non-operating part of the cam dog.

38. The combination of a traveling support, mechanism for propelling it including a pair of driving clutch elements and a shiftable clutch element adapted for engaging either of said clutch elements, cam dogs on the support, a bell crank lever, one arm of which is adapted to be moved back and forth by the cam dogs, a rod pivotally connected to the other arm, a member slidable on said rod and connected to the shiftable clutch element, an abutment on the rod spaced from each end of said member, and a compression spring interposed between each abutment and said member.

39. The combination of a traveling support, mechanism for propelling it including a pair of driving clutch elements and a shiftable clutch element adapted for engaging either of said clutch elements, cam dogs on the support, a bell crank lever, one arm of which is adapted to be moved back and forth by the cam dogs, a rod pivotally connected to the other arm, a member slidable on said rod and connected to the shift-

able clutch element, an abutment on the rod spaced from each end of said member, a compression spring interposed between each abutment and said member, and a spring-pressed plunger connected to move with said shiftable clutch element and co-operating with a stationary support for holding said shiftable element engaged with either of the driving clutch elements.

40. Control mechanism of the character described comprising a traveling support, mechanism for propelling it at different speeds and in different directions, cam dogs on the support, a bell crank lever one arm of which is adapted to be directly actuated by said cam dogs, and a motion-train between the other arm of said bell crank lever and said mechanism for transmitting control motion to the latter including a compensating connection allowing relative movement between the bell crank lever and the operated end of the motion-train.

41. Control mechanism of the character described comprising a traveling support, mechanism for propelling it at different speeds and in opposite directions, cam dogs on the support having cam faces inclined with respect to the vertical, a part pivotally mounted on a horizontal axis and disposed with its free end in the path of said cam faces and adapted to be positively moved back and forth thereby, and means positively operated by said part for directly transmitting control motion from the cam dogs including means for transmitting a control motion to said mechanism additional to said direct action of the cam dogs.

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