No. 636,914. Patented Nov. 14, 1899.

O. MERGENTHALER.

UNIVERSAL MILLING MACHINE.

(Application filed May 11, 1898.)

(No Model.) 7 Sheets—Sheet 1.

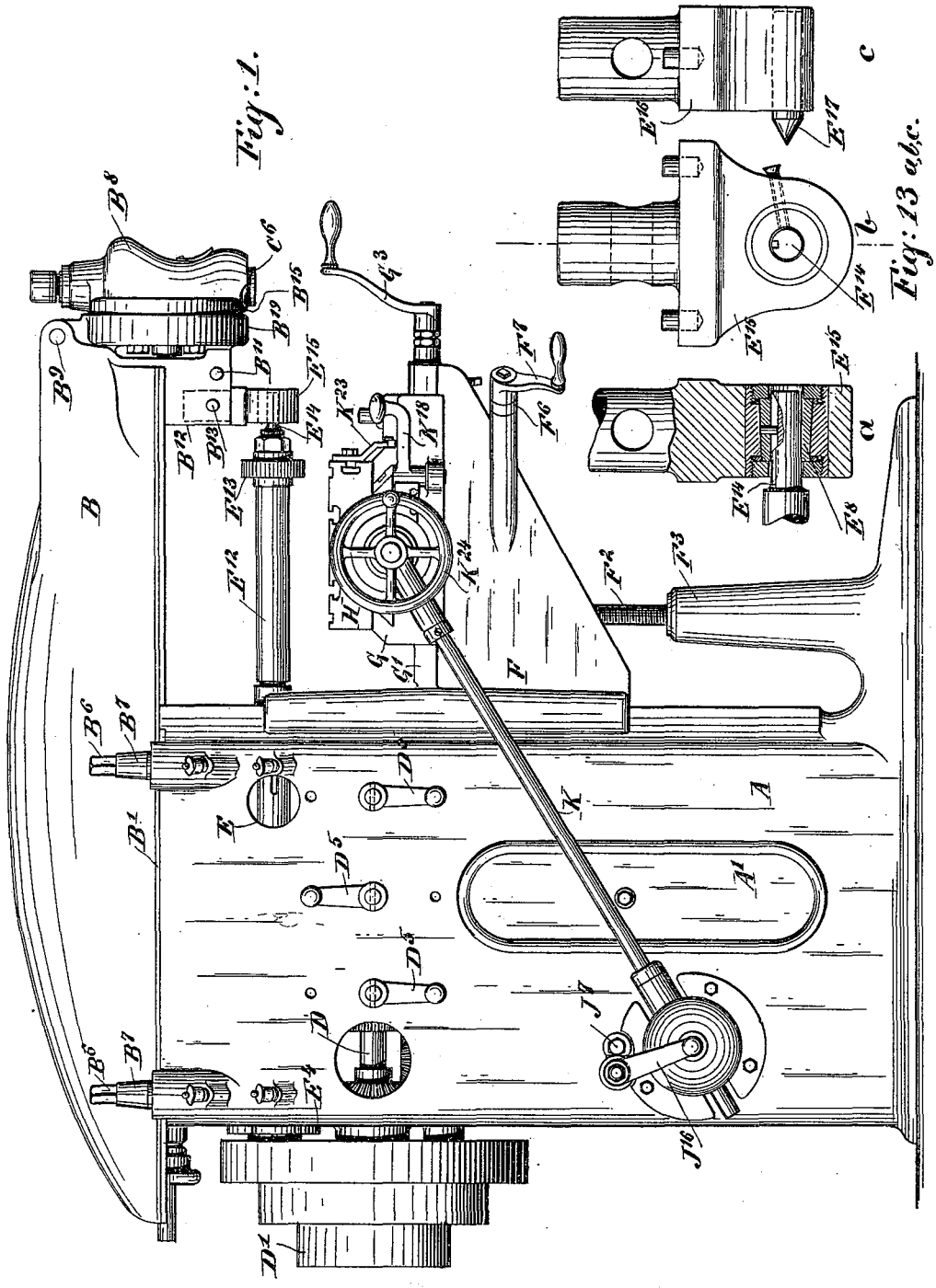

Fig: 1.

Fig: 13 a,b,c.

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(No Model.) 7 Sheets—Sheet 2.

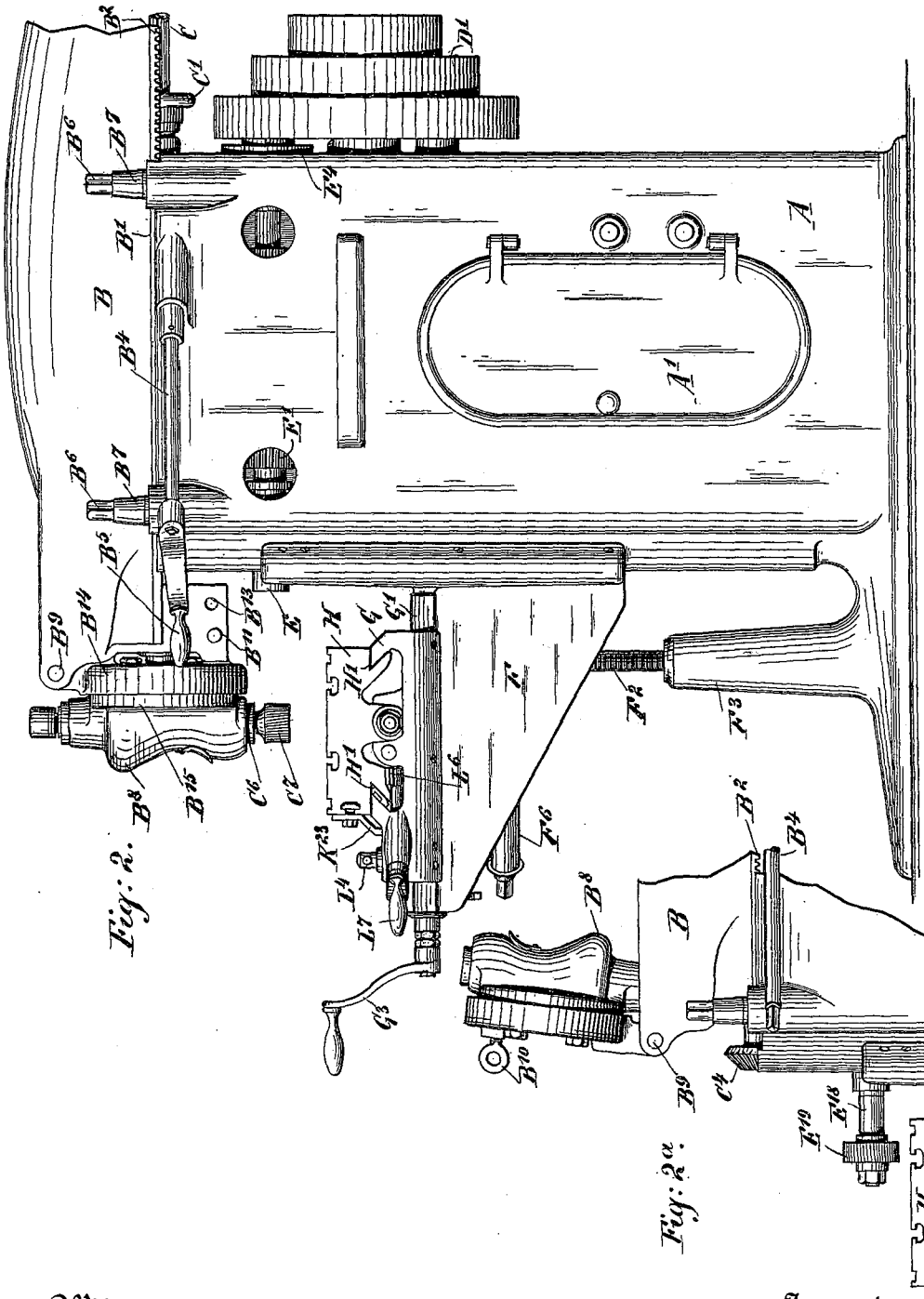

Fig. 2.

Fig. 2a.

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7 Sheets—Sheet 3.

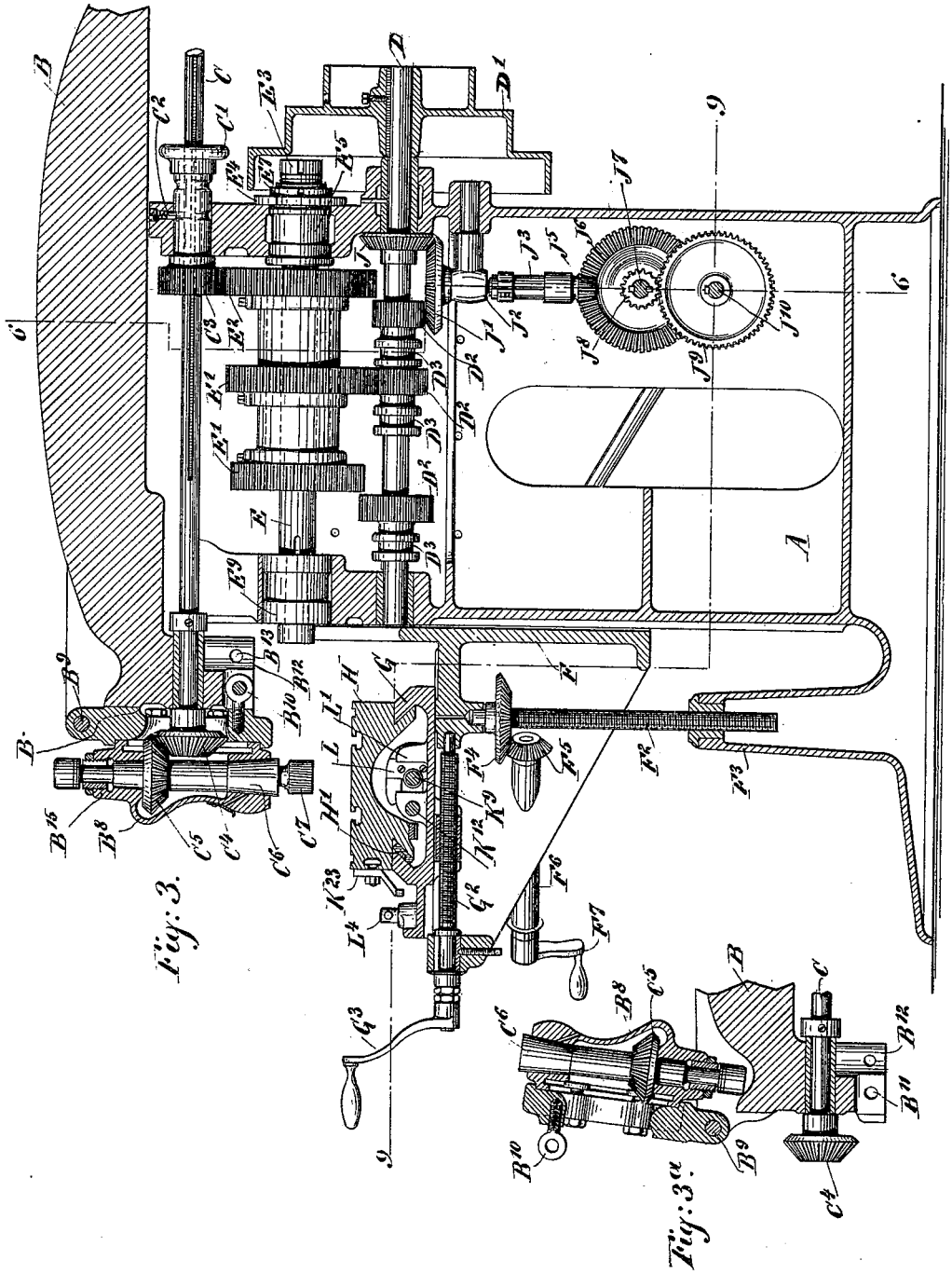

Fig. 3.

Fig. 3a.

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(Application filed May 11, 1898.)

(No Model.) 7 Sheets—Sheet 4.

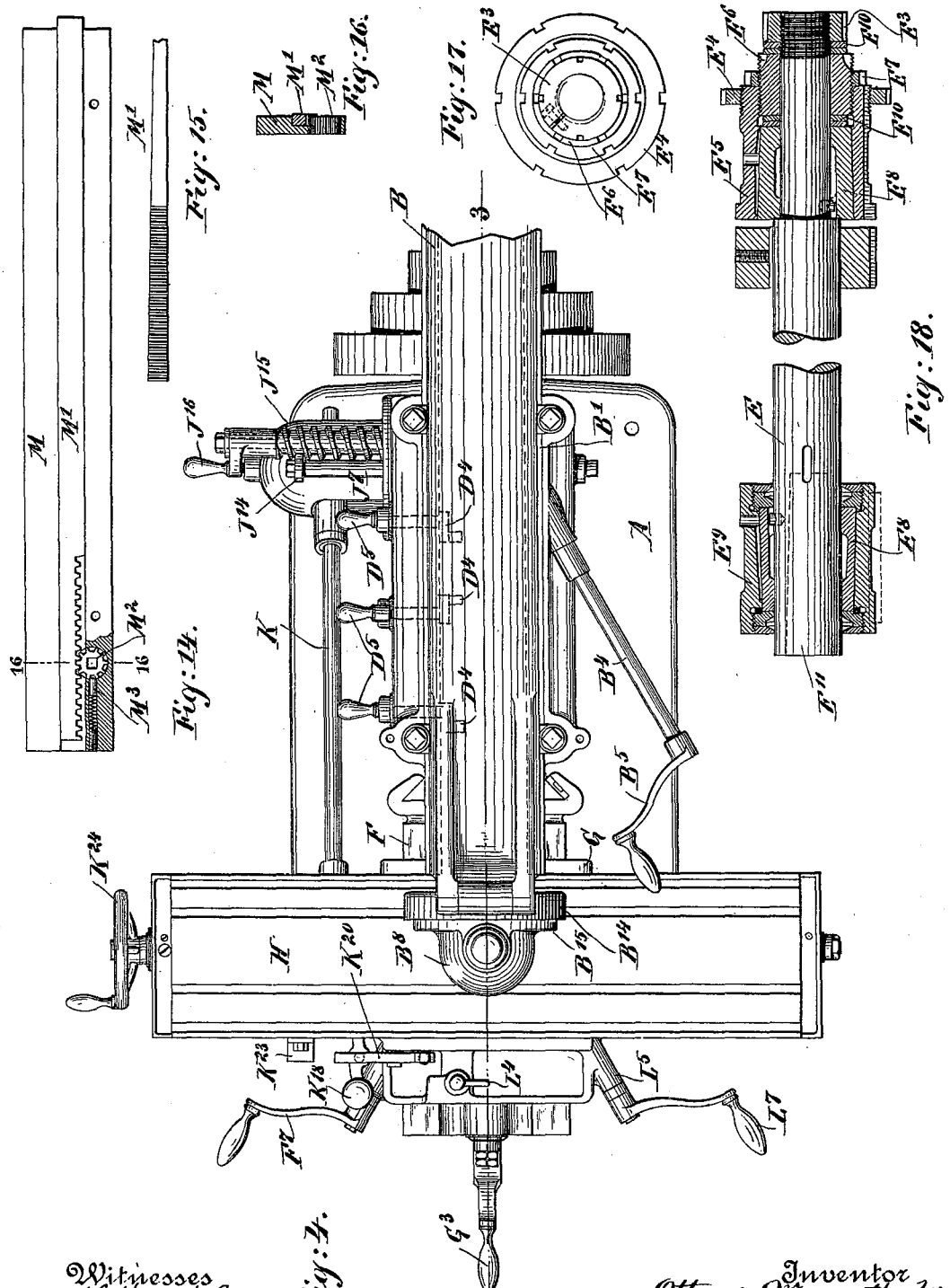

Fig. 4.

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(No Model.) 7 Sheets—Sheet 5.

Fig. 10.

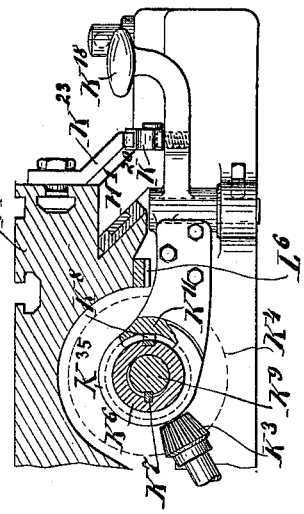


Fig. 11.

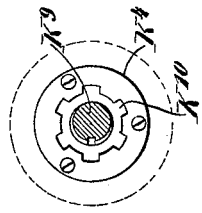


Fig. 12.

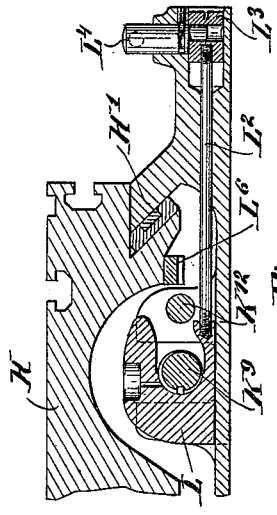
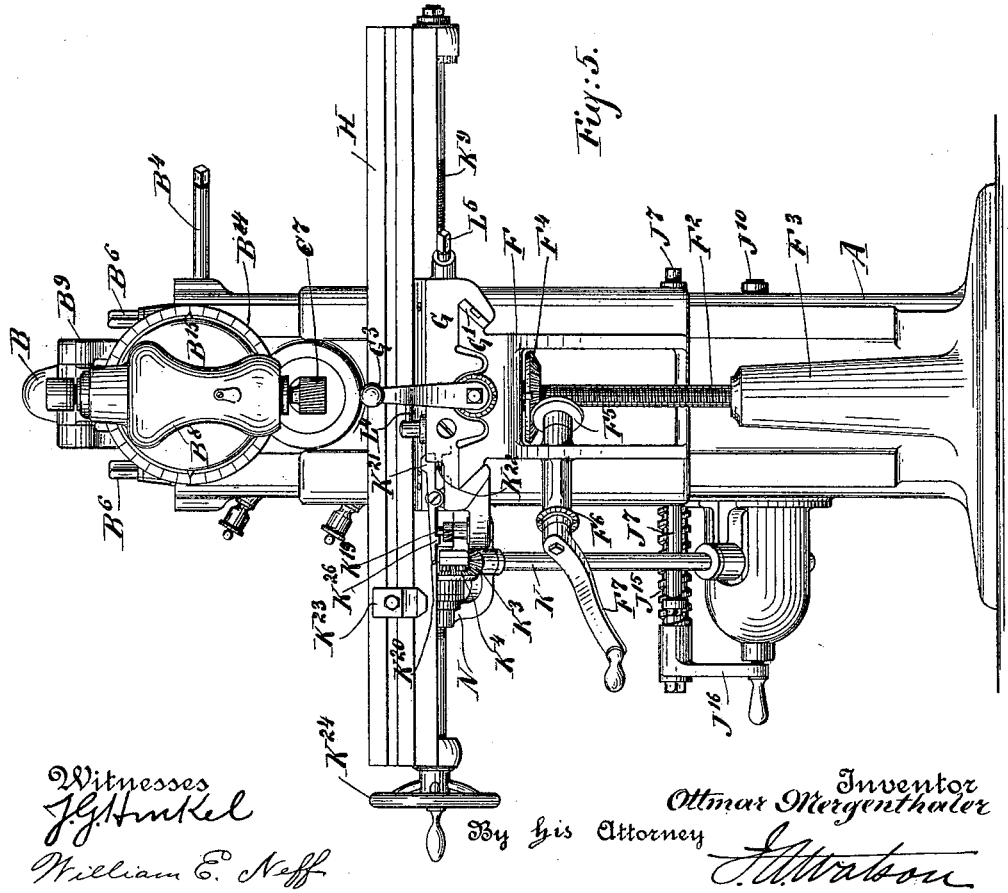


Fig. 5.



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O. MERGENTHALER.

UNIVERSAL MILLING MACHINE.

(No Model.) (Application filed May 11, 1898.) 7 Sheets—Sheet 6.

Fig: 6.

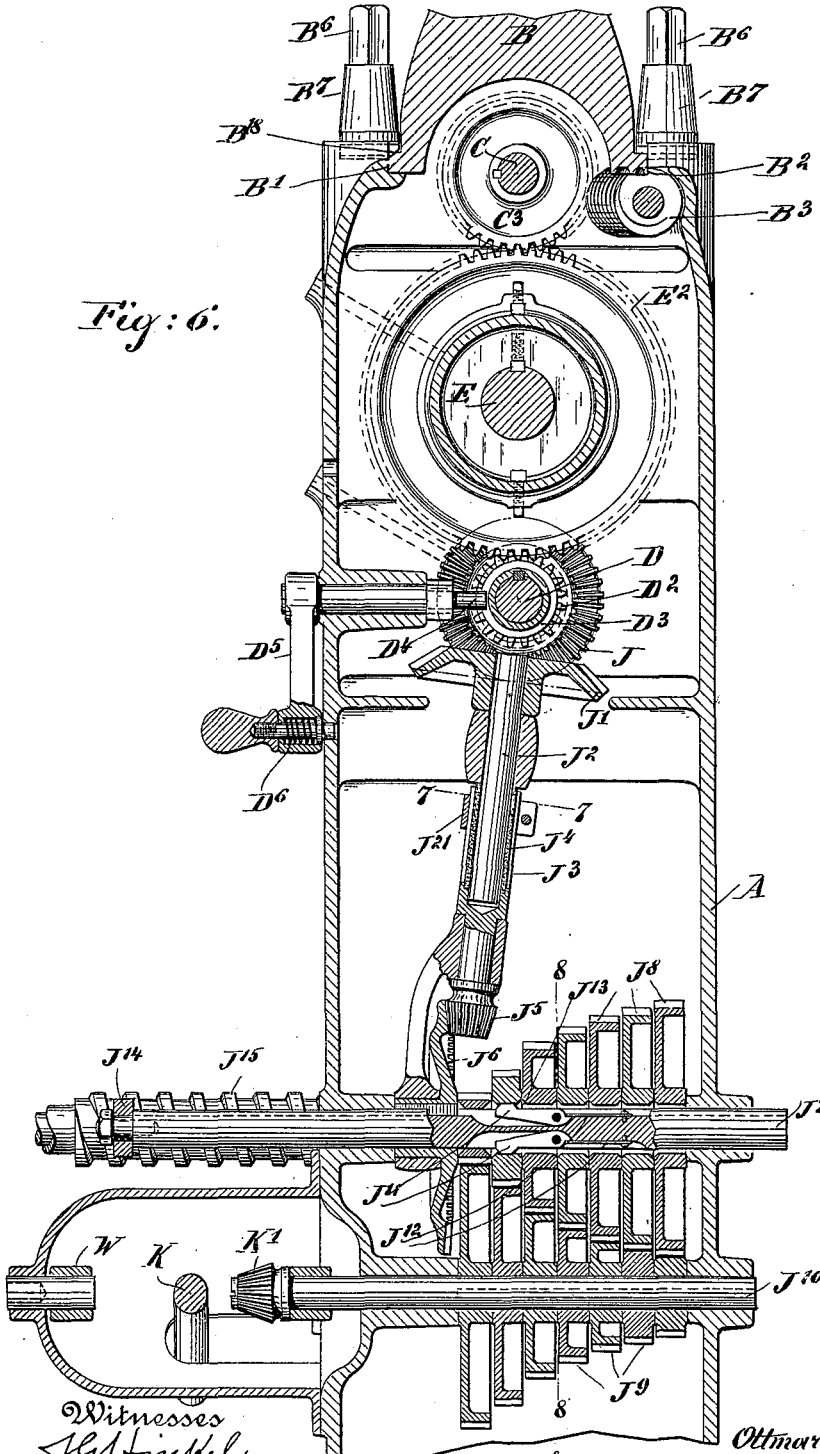


Fig: 7.

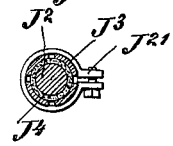
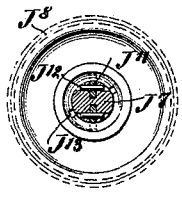


Fig: 8.



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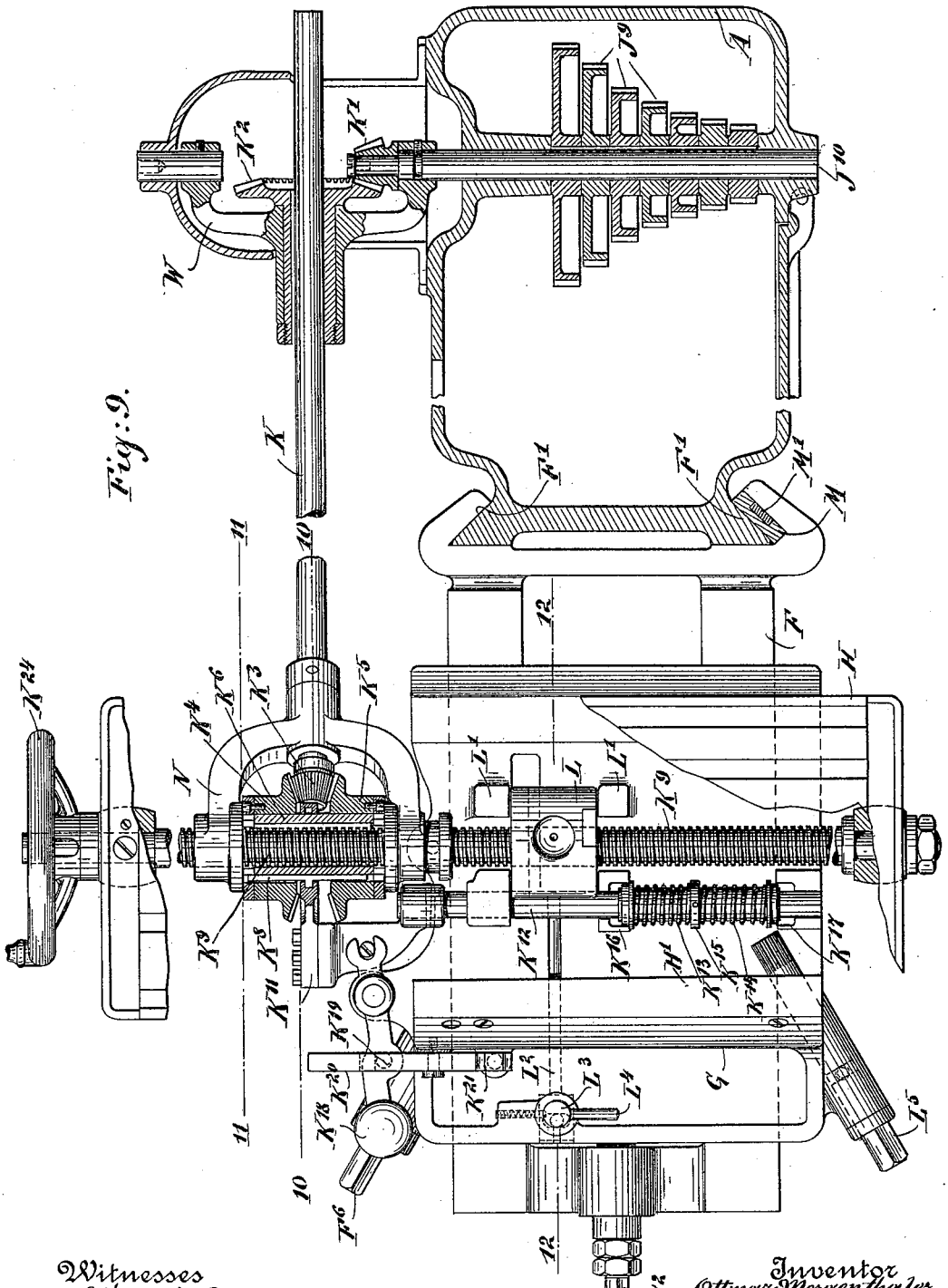
(Application filed May 11, 1898.)

(No Model.) 7 Sheets—Sheet 7.

Fig. 9.



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UNITED STATES PATENT OFFICE.

OTTMAR MERGENTHALER, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE OTT. MERGENTHALER COMPANY, OF SAME PLACE.

UNIVERSAL MILLING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 636,914, dated November 14, 1899.

Application filed May 11, 1898. Serial No. 680,399. (No model.)

To all whom it may concern:

Be it known that I, OTTMAR MERGENTHALER, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Universal Milling-Machines, of which the following is a specification.

My invention relates to universal milling-machines—that is to say, to milling-machines which are capable of general or universal work in which the various cutters or milling-tools may be arranged to act in various positions and at different angles.

My invention is designed to provide such a universal milling-machine as will obviate and remove the objections ordinarily advanced against machines of this class and to provide a mechanism which is simple and strong in construction, in which the various adjustments may be simply effected, and which may be employed for every kind and character of work.

To these ends the principal features of my invention consist in the novel construction and arrangement of the top slide, which takes the place of the overhanging arm ordinarily employed, together with the actuating-shaft for the vertical cutter, and of the means for supporting and actuating the vertical cutter, which are carried by and pivoted to the said slide; in the novel construction and arrangement of the speed-changing devices for the main spindle; in the novel construction and arrangement of the bearings for the spindles and arbors; in the novel construction and arrangement of the speed-changing devices for the work-table; in the novel construction and arrangement of the throw-out for the feed mechanism of the work-table, and in the novel construction and arrangement of the adjusting means for taking up the wear on the gibs. These various features will now be described with reference to the drawings, wherein similar letters of reference refer to the same parts throughout the different views.

Figure 1 is a side view of my improved milling-machine, taken from the left-hand side thereof. Fig. 2 is a similar view taken from the right-hand side, a portion of the overhanging arm or slide being broken away. Fig. 2^a is a detached detail view similar to Fig. 2 and showing the head for supporting the vertical cutter turned up and out of operative position. Fig. 3 is a vertical longitudinal sectional view taken substantially on the section-line 3 3 in Fig. 4. Fig. 3^a is a sectional detail view showing the pivoted head turned up and out of operative position. Fig. 4 is a top plan view of the machine, a portion of the overhanging arm or slide being broken away. Fig. 5 is a front view of the machine. Fig. 6 is a transverse vertical section, on an enlarged scale, taken substantially on the irregular section-line 6 6 in Fig. 3. Fig. 7 is a detail sectional view taken on the section-line 7 7 in Fig. 6. Fig. 8 is a detail sectional view taken substantially on the line 8 8 in Fig. 6. Fig. 9 is an irregular horizontal longitudinal sectional view, on an enlarged scale, taken substantially on the irregular section-line 9 9 in Fig. 3. Fig. 10 is a detail sectional view taken substantially on the line 10 10 in Fig. 9. Fig. 11 is a detail sectional view taken substantially on the line 11 11 in Fig. 9. Fig. 12 is a detail sectional view taken subtantially on the line 12 12 in Fig. 9. Fig. 13 presents three views, *a*, *b*, and *c*, of the supports employed for the outer end of the horizontal arbor, *a* and *b* showing, respectively, in vertical section and end elevation the bearing for the form of arbor shown in Fig. 1 and *c* showing a different form of bearing in the nature of a lathe-point. Fig. 14 is a view, partly broken away, showing the form of device employed for taking up the wear on the gibs. Fig. 15 is a detached view showing the wedge-shaped portion of this compensating device. Fig. 16 is a detail sectional view taken substantially on the line 16 16 in Fig. 14. Fig. 17 is an end view of the rear journal-box for the main spindle. Fig. 18 is a detached sectional view, on an enlarged scale, showing the bearings of the main spindle.

The main frame.—The main frame A of the machine may be of any suitable form, provided only that it has sufficient rigidity and weight to sustain the working parts. As it is shown in the drawings, it is preferably provided with doors or entrances A′ A′ to give access to the interior.

The overhanging arm or slide.—In a large number of milling-machines now in common

use the overhanging arm consists of a cylindrical bar or shaft for supporting the arbors and other connected parts, this shaft or bar being capable of a longitudinal movement and adapted to be held in the different adjusted positions in various ways. It is necessary, however, in order to procure any desired position of the overhanging arm to loosen the retaining means and then to move it to approximately the desired position, where it may be retained and held by means of the retaining devices. It is difficult, however, to effect an accurate and easy adjustment in this manner, and it is one of the features of my improved machine that I am enabled by means of the mechanism now to be described to effect an easy and accurate adjustment of the slide and to securely hold the same in its adjusted position.

The slide or overhanging arm B, as shown in the drawings, is preferably constructed in turtle-back form and rests upon the frame A of the machine, whereon it is suitably guided in the ways B′ thereon. This peculiar form of slide, in connection with the adjusting and retaining devices now to be described, possesses great strength and rigidity and is practically without vibration while the machine is being operated. Formed on the base of the slide B is the rack B^2, (see Figs. 2 and 6,) which meshes into the worm B^3, fast on the shaft B^4, journaled in the main frame and provided at its outer end with the crank-handle B^5. It will be obvious that the position of the slide may be readily adjusted by means of the parts described. When the slide has been moved to its desired position, it is firmly locked and held in place by means of the bolts B^6, which set into the main frame and which act upon the sleeves or washers B^7. These washers B^7 upon one side of the slide are formed with a bevel B^{18}, (see Fig. 6,) which acts upon a corresponding bevel on the slide B in such manner that when the bolts B^6 are screwed down the pressure of the washers B^7 through the bevel B^{18} will tend to move the slide B laterally, locking it firmly in position and also taking up any possible wear.

Pivoted at B^9 at the outer end of the slide B is the head B^8, which carries the vertical spindle for the cutters. This head B^8 is provided with a loop B^{10}, which enters a recess in the head B when in its downward or operative position and is securely locked in place in this position by means of a pin which passes through the hole B^{11} and loop B^{10}, as best shown in Figs. 1, 2, 3, and 3^a. Suitably journaled in the head B^8 is the vertical arbor or spindle C^6, which is adapted to receive the cutter or milling-tool C^7. The proper motion is given to the spindle C^6 by the bevel-gear C^5, fast thereon, which when the head is in its lower or operative position engages with the corresponding bevel-gear C^4, fast on the end of the shaft C. The shaft C is journaled at one end in the slide B and is further supported in a rotatable hub or sleeve C′, supported in the main frame of the machine. The sleeve or hub C′ is attached to the pinion C^3, which is splined to the shaft C in such manner as to rotate therewith, but to be capable of a longitudinal movement thereon. Motion is imparted to the pinion C^3, shaft C, and spindle C^6 by the gear E^2, which is fast on the main spindle E and gears into the pinion C^3 when the latter is in operative position. The hub or sleeve C′, to which the pinion C^3 is attached, is provided with two annular cuts or grooves, one of which will be engaged by the spring-pressed pin C^2, located in the main frame. In Fig. 3 the parts are shown in operative position, the pinion C^3 being maintained in engagement with gear E^2 by reason of the spring-pressed pin C^2 engaging with one of the grooves in the hub C′. When it is desired to throw out the pinion C^3 and to thereby stop the actuation of the shaft C, it is necessary merely to move the hub C′ inward till the pinion C^3 passes out of engagement with the gear E^2, when the spring-pressed pin C^2 will engage with the second of the grooves in the hub C′, thereby holding the parts in inoperative position. It will be apparent from Fig. 3 that the splined connection of the shaft C to the pinion C^3 also permits the longitudinal movement of the shaft C, due to the various adjustments of the slide B.

In order to permit of the angular adjustment of the spindle C^6, the head B^8 is formed in two portions B^{15} and B^{14}, as best shown in Figs. 3 and 5. The part B^{15} has an annular undercut flange B^{17}, which fits an annular recess in the part B^{14} in such manner as to permit of its rotation therein without the disengagement of the bevel-gears C^4 and C^5. A series of bolts B^{18}, having heads which engage the undercut flange B^{17}, unites the parts B^{14} B^{15} adjustably. The part B^{15} is provided with a pointer which, coöperating with a scale on the part B^{14}, permits of the proper angular adjustment of the spindle C^6 and cutter C^7. (See Fig. 5.) Figs. 2 and 3 show the machine as provided with and adapted to employ the vertical cutter C^7. As there shown, the pivoted head B^8 is in its lowermost position and firmly locked there. When it is desired to employ a long horizontal arbor, as shown in Fig. 1, the slide B is moved outward and an arbor-support E^{15} inserted in the socket B^{12}, formed in the slide, where it is retained in position by the pin B^{13} passing through a hole in the arbor-support E^{15}. This form of arbor-support is clearly shown in Fig. 13, *a* and *b*. If desired, the form of arbor-support E^{16} provided with the lathe-point E^{17}, as shown in Fig. 13^c, may be inserted, the point E^{17} supporting the end of the arbor in the manner well understood in the art. When it is desired to employ a short horizontal arbor E^{18}, which does not need an outward support, as shown in Fig. 2^a, it is desirable that the head B^8 should be turned about its pivot B^9 to the position shown in Figs. 2^a and 3^a, where it is not in the way of

the operation of the cutter E^{19}. It will be seen that this arrangement of the pivoted head permits by comparatively small changes in the supporting parts of the use of a vertical cutter which may be inclined at any desired angle, of a horizontal cutter on a long arbor supported at both ends, and of a horizontal cutter with a short arbor supported only at one end.

Power mechanism.—Power is transmitted from any suitable source to the machine by a belt which passes over and operates the cone-pulley D′, which is fast upon the main shaft D, suitably journaled in the frame. The shaft D carries the bevel-gear J, which is fast thereon for actuating the table mechanism, and also carries the three change-gears D^2, which are splined on said shaft in such manner as to be capable of a longitudinal motion thereon, but are compelled to rotate therewith. Each gear D^2 is provided with a grooved hub D^3, the groove of which is engaged by a crank-arm D^4, (shown in dotted lines in Fig. 4,) attached to which at the outside of the frame is the arm or handle D^5. (See Figs. 1 and 6.) As shown in Figs. 1 and 3, the middle gear D^2 is shown in engagement with the gear E′ on the main spindle E, and the two outer gears D^2 are shown in inoperative position. The engagement of any one of the gears D^2 with its corresponding gear on the spindle E may be effected by turning the handle D^5 to its uppermost position and the disengagement of the gear D^2 by turning the handle to its lowermost position, the handle being firmly secured in either position by the spring-pressed pin D^6, carried thereby, engaging with corresponding holes in the frame of the machine. (See Fig. 6.) The gears D^2 are formed of different diameters to correspond with the change-gears E′ E^2 on the spindle E, and it will be obvious when one or other of the gears D^2 is shifted into operative position that a corresponding and different rate of speed will be imparted to the spindle E.

The main spindle and bearings.—The main spindle E is journaled in the main frame and has rigidly secured thereto a sleeve carrying its three actuating-gears E′ E′ E^2, which vary in diameter and are adapted to impart different rates of rotation to the spindle E in the manner previously described. The gear E^2 is adapted also, as previously described, to engage with and impart motion to the shaft C for actuating the vertical spindle and cutter. As ordinarily employed, the spindles and arbors are highly and accurately finished to insure the accurate work of the cutter, and in order to secure exact alinement and to prevent the wear of the spindles and arbors, and consequently to save expense, I have provided a form of bearing now to be described. The spindle E is supported at one end in the box E^5 and at its other end in the box E^9. (See particularly Figs. 3, 17, and 18.) Rigidly secured to the spindle E are the bearing-sleeves E^8, preferably of hardened steel, (see Fig. 18,) which are in the form of a truncated cone to permit of the ready disengagement of the bearing from its box and to be set up to compensate for wear. It will be seen that the bearing-pieces E^8, which are attached to the spindle E so that they turn therewith, will take up the friction and wear due to rotation of the spindle and that these bearings when worn may be set up or readily replaced by others, thereby saving the expense which would be involved in replacing the spindle or arbor as a whole. As shown in Figs. 17 and 18, the bearing E^8 is adjusted in the box E^5 and rigidly secured therein by means of the exteriorly-screw-threaded nut E^6, turned into the box E^5, between which and the bearing-sleeve E^8 are interposed friction disks or washers E^{10}, which take up a large portion of the wear. This nut E^6 is further held in position by the exterior nut E^7, which turns up and impinges against the end of the box E^5. The end of the spindle E is screw-threaded, and the nut E^3 is turned up over it and impinges against the nut E^6 and draws the spindle E rearward, thus forcing the part E^8 into the bearing E^5. Additional friction disks or washers E^{10} may be interposed between the nuts E^3 and E^6, if desired. The nut E^4, which engages the exterior rim of the box E^5, is employed to hold the box in position in the frame. As before mentioned, the box E^9 at the other end of the spindle is also provided with a similar friction-sleeve E^8, which turns with the spindle E. At its operative end the spindle E is provided with the usual conical recess E^{11} to receive and hold the end of the arbor, which may be either the long arbor E^{12}, provided with the cutter E^{13}, as shown in Fig. 1, or the short arbor E^{18}, provided with the cutter E^{19}, as shown in Fig. 2^a. It will be noted that I have also shown a similar bearing-sleeve E^8 in connection with the end E^{14} of the arbor E^{12}. (See Fig. 13^a.)

The knee and slide-rest.—The bracket or knee F is, as usual, adapted to slide vertically upon the guides F′ of the frame A. (See Fig. 9.) The various vertical positions of the knee are obtained by means of the screw F^2, one end of which is journaled to turn freely in the knee and which is adapted to engage a screw-threaded support F^3 on the main frame A. The rotation of the screw F^2 will move the knee vertically, and this rotation of the screw may be effected from the bevel-gear F^4, fast thereon, which engages with the bevel-pinion F^5, fast on the shaft F^6, journaled in the knee and adapted to be turned by the handle F^7. The slide-rest G rests upon the knee F and is guided by the gibs G′ thereon in such manner that the slide-rest may be given an inward-and-outward horizontal movement. This movement of the slide-rest is secured by the screw G^2, journaled in the knee F and engaging a screw-threaded portion of the slide-rest G. (See Fig. 3.) The rotation of the screw G^2, and the consequent inward-and-outward movement of the slide-rest G, may be

secured by turning the handle G^3, fast upon the end of the screw G^2.

The work-table and its feed.—The work-table H rests upon the slide-rest G and is guided thereon by the gibs H′ in such manner that a movement of the table transverse to the cutting instruments may be permitted. This movement of the table H is effected by the rotation of the worm-screw K^9, which is loosely journaled at either end in the table H and which engages a screw-threaded nut L, whose specific construction is hereinafter to be described. This nut L rests upon the slide-rest G, (see Fig. 9,) and is held against longitudinal movement on the slide-rest by the guide-stops L′ in such manner that the rotation of the worm-screw K^9 will be resisted by the nut L, and consequently cause the feed of the table H. At the end of the worm-screw K^9 and fast thereon is the hand-wheel K^{24}, which permits the manual turning of the worm-screw K^9 and the consequent shifting of the table H. It is, however, necessary that an automatic movement of the table should be provided for, and this movement I also secure through the medium of the screw K^9 by the employment of certain mechanism now to be described. The bevel-gear J on the main shaft D, previously described, gears into the bevel-gear J′, fast on the short shaft J^2, as clearly shown in Figs. 3 and 6, and by a train of direct gearing from the shaft J^2 the automatic and intermittent rotation of the worm-screw K^9 and the movement of the table H are effected. The advantages of a direct and positive gearing from the main shaft of the machine to the table-feed as compared with the systems of belting as ordinarily employed in machines of this class need not be specifically dwelt upon, save in so far as to note that the feed of the table is always positive and at a uniform rate. The main advantages that have induced the employment of belting for the actuation of the table-feed have been that in the event of undue strain, due to an unusual hardness of the material operated on by the cutter or for other reasons, the belting has permitted a sufficient yield and slip to prevent the breakage of parts. I accomplish this same result, however, by connecting the short shaft J^2 with the sleeve J^3 in such manner that the sleeve J^3 will ordinarily rotate with and in unison with the shaft J^2, but is permitted to slip thereon in the event of an unusual strain and to prevent the breakage of parts. This I accomplish by inserting between the sleeve J^3 and the shaft J^2 some yielding (preferably leather or fibrous) material J^4, which has sufficient resistance to ordinarily compel the rotation of the sleeve J^3, but which permits it to slip upon the shaft J^2 when undue strain is applied to the parts. This mode of connection is clearly shown in Figs. 6 and 7, the clamp J^{21} being employed to unite the shaft J^2 and sleeve J^3. Fast to the bottom of the sleeve J^3, which is suitably journaled in the frame of the machine, is the bevel-pinion J^5, which gears into the bevel-gear J^6. The bevel-gear J^6 is splined upon the shaft J^7 in such manner that its rotation compels the rotation of the shaft J^7, which, however, is free to move through the gear longitudinally. Loose upon the shaft J^7 are a series of change gear-wheels J^8, formed at their bores with notches or recesses J^{13}, adapted to be engaged by the latches J^{11}, which are pivoted in recesses in the shaft J^7 and are normally pressed outward into operative position by the flat springs J^{12}, also attached to the shaft J^7. The outer ends of the latches J^{11} are formed with double bevels, as clearly shown in Fig. 6, so that the longitudinal movement of the shaft J^7 through the bores of the gears J^8 will cause the latches J^{11} to be moved inwardly against the pressure of the springs J^{12} in such manner that they may pass through the gears J^8 until they arrive in position in the recesses J^{13} of the gear J^8 which it is desired to connect to the shaft J^7. (See Figs. 6 and 8.) It will be thus seen that by the proper longitudinal movement of the shaft J^7 the latches J^{11} may be caused to engage any one of the series of the gears J^8 and that the engagement of the latches J^{11} with the recesses J^{13} of the said gear will, in effect, unite the said gear with the shaft J^7 and cause it to turn rigidly therewith. This longitudinal movement of the shaft J^7 may be conveniently secured through the medium of the piece or link J^{14}, journaled at the end of the shaft J^7, one end of which piece or link engages the thread on the worm J^{15}, suitably journaled in the main frame and provided at one end with the handle J^{16}, whereby rotation may be imparted to the worm J^{15}. The thread on the worm J^{15} is preferably arranged of such form and with such an angle that one complete revolution of the handle J^{16} will advance or retract the piece J^{14} the exact distance necessary to move the shaft J^7 longitudinally the extent of the thickness of one of the gears J^8. This arrangement affords a simple and accurate method of connecting the rotatable shaft J^7 with any one of the gears J^8 which may be desired. Each change-gear J^8 meshes into and turns a corresponding change-gear J^9, fast on the shaft J^{10}, in the manner well understood, so that different speeds may be imparted to the shaft J^{10}. Fast upon one end of the shaft J^{10} is the bevel-pinion K′, which meshes into and turns the bevel-gear K^2, which imparts rotary motion to the shaft K. The gear K^2 is journaled in the pivoted bracket W and is provided with a sleeve splined upon the shaft K in such manner as to permit the longitudinal movement of the shaft K through the gear, but to compel its rotation. The pivoted bearing W and the splined connection between the shaft K and gear K^2 (see Fig. 9) are provided to permit the shaft K to assume various longitudinal positions to correspond with the adjustments of the knee F and slide-rest G. The

other end of the shaft K is journaled in a bracket N, attached to the slide-rest G, and is provided with a bevel-pinion K^3. The bevel-pinion K^3 gears into and turns two oppositely-placed gear-sleeves K^4 and K^5, located within the bracket N and provided at their inner sides with bevel-gear teeth, as plainly shown in Fig. 9. These sleeves K^4 and K^5, which in effect are bevel-gears, are mounted upon the feed-screw K^9 in such manner as to turn freely on said feed-screw and without effecting its rotation unless connected thereto by means of the mechanism now to be described. Splined to the feed-screw K^9 by the spline K^7 (see Fig. 10) is the sleeve K^6, located between and within the sleeves K^4 and K^5 in such manner that a rotation of the sleeve K^6 effects the rotation of the feed-screw K^9, although the latter may move longitudinally therethrough. Suitably connected to the sleeve K^6 is the longitudinally-movable feather K^8, Figs. 9 and 10, which is of such length that in its central position it is inoperative, but which is capable of a longitudinal movement on the sleeve K^6 in such manner that it may be caused to engage with one of the notches K^{10}, (see Fig. 11,) formed in the sleeves K^4 and K^5. When the feather K^8 is caused to engage with one or the other of the sleeves K^4 or K^5, the sleeve K^6 is caused to rotate with the sleeve K^4 or K^5, and through its connection with the feed-screw K^9 the latter is also caused to rotate with the sleeve K^4 or K^5, as may be selected. It will thus be obvious that the feed-screw K^9 may be caused to rotate in either direction in company with either the sleeve K^4 or the sleeve K^5, which, from their arrangement and their actuation on opposite sides of the bevel-gear K^3, are oppositely rotated. The position of the feather K^8 is controlled by the sliding piece K^{11} and slide-rod K^{12}, attached thereto and suitably supported on the slide-rest. This slide K^{11} is formed with a cylindrical extension K^{35} (see Fig. 10) to surround the sleeve K^6 and control the feather K^8, and is itself under the control of a pivoted hand-lever K^{18}. The slide-rod K^{12} is provided with two springs K^{13} and K^{14}, which are secured to a central sleeve K^{15}, rigidly attached to the slide-rod K^{12}. The outer end of the spring K^{13} is adapted in one position of the slide-rod K^{12} to impinge against and be compressed by its contact with the stop K^{16} on the slide-rest, while the outer end of the spring K^{14} is similarly adapted to impinge against and be compressed by the stop-piece K^{17} on the slide-rest in the other position of the slide-rod K^{12}. The hand-lever K^{18} is provided with a stop-pin K^{19}, which is adapted to be engaged and held by a projection K^{26} on the outer end of the pawl K^{20}, pivoted on the slide-rest. A spring K^{22}, interposed under the opposite end of the pivoted pawl K^{20}, normally presses the projection K^{26} downward in such position that it will engage the pin K^{19} on the hand-lever at one side or the other. Adjustably secured to the carriage H is the cam-piece K^{23}, so located that in the traverse of the carriage H it will impinge against the bevel-piece K^{21} at the inner end of the pivoted pawl K^{20}. (See Fig. 5.) Assuming the parts to be in the position shown in Fig. 9, it will be seen that the pin K^{19} on the hand-lever K^{18} has been set so as to be engaged by the projection K^{26} of the pawl K^{20} at its inner side, thereby moving the slide K^{11} and connected feather K^8 into engagement with one of the notches K^{10} in the sleeve K^4, thereby compelling the rotation of the sleeve K^6 and the feed-screw K^9 in unison with the sleeve K^4 and, through the resistance of the nut L, previously described, effecting the longitudinal movement of the feed-screw K^9 and the table H. In this position of the parts it will be seen that the spring K^{13} is compressed between the stop-piece K^{16} and the sleeve K^{15}. The table will continue its longitudinal movement until the cam-piece K^{23} thereon impinges against the projection K^{21} on the pivoted pawl K^{20}, whereby the piece K^{26} on the said pawl will be freed from the stop-pin K^{19} on the hand-lever K^{18} and will permit the spring K^{13} to retract the slide-rod K^{12} and slide K^{11} in such manner that the feather K^8 will be disengaged from the sleeve K^4, thereby stopping the rotation of the sleeve K^6 and feed-screw K^9, to which it is connected. The position of the springs K^{13} and K^{14} on the slide-rod K^{12} is such that in their normal position and unless one or the other of them be compressed by reason of the pawl K^{20} engaging the pin K^{19} the feather K^8 will be held in its intermediate position and out of engagement with both the sleeve K^4 and the sleeve K^5, and it will be apparent that when the cam-piece K^{23} actuates the pawl K^{20} in the manner previously described the action of the spring K^{13} will be such as to restore the feather K^8 to its intermediate position, and thereby to stop the rotation of the feed-screw K^9 and the feed of the table H. In order to effect the feed of the table H in the opposite direction, it is necessary that the feather K^8 should be engaged with the sleeve K^5, and this is effected by moving the slide K^{11} and slide-rod K^{12} in such manner as to compress the spring K^{14}, when the parts may be retained in operative position by the engagement of the pin K^{19} on the hand-lever K^{18} with the other side of the projection K^{26} on the pawl K^{20}. It will be apparent that the feed-screw K^9 will then be actuated in the opposite direction through the connection of the sleeve K^6 with the sleeve K^5 by the feather K^8 and that the work-table will be continuously moved in the opposite direction until the cam-piece K^{23} comes in contact with the projection K^{21}, thereby raising the pawl K^{20} and permitting the spring K^{14} to restore the feather K^8 to its intermediate position through the medium of the slide K^{11} and slide-rod K^{12}. As before stated, the cam-piece K^{23} may be adjustably located at any point in the length of the table H, so as to

adapt it to stop the traverse of the table at any desired point in whichever direction the table may be moved.

Quick-return mechanism.—As before stated, the nut L, which engages with the feed-screw K^9 and is held from longitudinal movement on the slide-rest G by the stops L′, causes the feed-screw in its rotation to be moved longitudinally, and it will be obvious that to effect the quick return of the table H and the feed-screw K^9 it will be necessary to provide means for disengaging the nut L from the feed-screw K^9, so that the latter may be moved freely and longitudinally across the slide-rest. This I effect by constructing the nut L in the form best shown in Fig. 12—namely, as a half-nut, which engages only one side of the feed-screw K^9 and in such manner that when the nut L is moved rearwardly through the stop-pieces L′ it becomes disengaged from the feed-screw K^9. To effect this rearward movement of the nut L, I have shown it as attached to a rod L^2, which is connected at its other end to a crank-piece or eccentric L^3 at the front of the slide-rest. The crank-piece or eccentric L^3 may be operated manually by the handle L^4 attached thereto in such manner that the turning of the handle L^4 frees the nut L from engagement with the feed-screw K^9, leaving the table H and the attached feed-screw free to be given a quick-return movement. This quick-return movement is effected manually by the short shaft L^5, journaled in the slide-rest and provided at its rear end with gear-teeth which engage in a corresponding rack L^6, formed on the bottom of the table H. The shaft L^5 is provided with a handle L^7 at the front of the machine to permit of its rotation at will.

Wear-pieces for the gibs.—As is common in machines of this class, the knee F, slide-rest G, and table H are held and guided in their movements on the respective gibs F′, G′, and H′. In order to secure accuracy of movement and to take up possible wear, I have devised wear-pieces for use in connection with the gibs, which I will now describe and which are best shown in Figs. 14, 15, and 16. These wear-pieces consist, essentially, of two parts, the part M and the part M′, sliding thereon and suitably connected to the part M, so as to be retained thereon. Either or both of the parts M M′ may be tapered longitudinally, so as to form a compound wedge in manner substantially similar to a printer's quoin. I prefer to construct the piece M′ with a rack formed thereon which may be engaged by a pinion M^2, which turns on the part M and which is normally held in position by means of the spring-pressed pin M^3, which engages between the teeth of the pinion. As shown in Fig. 14, the pinion M^2 may be provided with a square hole, so that it may be engaged by a tool and turned to advance the part M′ along the part M in such manner that the enlargement of the wedge will tend to take up the wear of the gib and to make a close connection. It is my purpose to employ these wear devices in connection with the several gibs F′, G′, and H′, and they are so shown in the drawings, although to avoid confusion in the figures on a smaller scale I have not lettered all these parts. Their mode of application is, however, clearly shown in Fig. 9.

Operation of the machine.—The construction and functions of the various parts of the machine having been described, their operation will be understood to proceed in the following manner: The arbor C^6 is fitted with a vertical cutter C^7, if a vertical cutting instrument be required, and the shaft C is geared to the gear-wheel E^2 by the longitudinal movement of the pinion C^3 on the shaft C^2. If, however, a horizontal cutter is desired, the pinion C^3 is retained in its inoperative position and a horizontal arbor E^{12} and cutter E^{13} are secured in the end of the spindle E and supported at the outer end in the bearing E^{15} or E^{16} previously described, or if it be desired to employ a horizontal cutter with a short arbor the head B^8 is turned upwardly about its pivot B^9 until it is in inoperative position, as shown in Fig. 2^a, and the short arbor E^{18} and cutter E^{19} are secured in the end of the spindle E. When the desired cutter has been placed in position and the slide B and head B^8 properly adjusted in the manner before described, the work is attached to the table H in the ordinary manner. The handle J^{16} is manually operated to turn the worm J^{15}, so as to move the shaft J^7, in order that the desired pair of change-gears J^8 J^9 may be engaged in the manner previously described for the actuation of the table-feed. The hand-lever K^{18} is then moved in the desired direction to engage the feather K^8 with either the sleeve K^4 or K^5, according to the direction in which it is desired that the table H should be moved, and is retained in this position by the engagement of the piece K^{26} of the pawl K^{20} with the pin K^{19} on the lever K^{18}. The power having been applied to the machine, the cutter is actuated and the proper traverse is given to the table H by the engagement of the feed-screw K^9 with the rotating sleeve K^4 or K^5 and the resistance of the nut L until the piece K^{23} impinges upon the projection K^{21}, which raises the pawl K^{20} and releases the pin K^{19} on the lever K^{18}, whereupon the spring K^{13} or K^{14}, through the parts previously described, returns the feather K^8 to its intermediate and inoperative position. In order to secure the quick return of the table H, the handle L^4 is turned in such manner as to disengage the nut L from the feed-screw K^9, when the table may be returned by the handle L^7 through the shaft L^5 and rack L^6. As before described, the vertical adjustment of the knee F and the horizontal adjustment of the slide-rest G may be secured by turning the respective handles F^7 and G^3. The wheel K^{24} at the end of the feed-screw K^9 enables the operator to manually rotate the screw K^9

and give a slow motion to the table H when the feed-screw K^9 is in proper engagement with the nut L.

It is to be understood that changes may be made in the mechanism as herein described and shown and that mechanical equivalents may be substituted without departing from the spirit of my invention.

It will be seen that my improved machine obviates and removes many objections against machines of this class and that I have provided a mechanism which is simple and strong in construction, in which the various adjustments may be simply effected and which may be employed for every kind and character of work.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a milling-machine, the solid slide or overhanging arm adapted to slide on the frame of the machine in combination with the head hinged to said arm and comprising two parts, one of said parts being capable of rotary adjustment and provided with a spindle, substantially as described.

2. In a milling-machine, the slide or overhanging arm adjustable longitudinally, in combination with the two-part head, one of said parts being hinged to said arm, and the other being swiveled on said hinged part, a spindle carried by said swiveled part, a shaft carried by the slide, and gearing between the said spindle and shaft, substantially as described.

3. In a milling-machine, the solid slide or overhanging arm adapted to slide on the frame of the machine and means for adjusting the same, in combination with bolts and washers for holding the slide in adjusted position, the washers being formed with bevels to engage corresponding bevels on the slide, whereby the bolts when screwed down will move the slide laterally and hold it firmly in adjusted position and take up possible wear, substantially as described.

4. In a milling-machine, the slide and the spindle carried thereby, in combination with a shaft for operating said spindle arranged to move longitudinally with the slide, gearing for actuating said shaft, and means for connecting and disconnecting the actuating-gearing for said shaft, substantially as described.

5. In a milling-machine, the slide provided with the pivoted head for carrying the spindle and means for securing said head in its operative position, and further provided with a socket for the bearings to sustain the outer ends of the horizontal arbors, substantially as described.

6. In a milling-machine, the slide movable on the main frame, the head pivotally connected to the slide and the spindle mounted in the head, said head consisting of two parts, one of which is adjustable angularly upon the other about an axis which is parallel to the line of movement of the slide whereby the spindle may be set at any desired angle, substantially as described.

7. In a milling-machine, the combination with the main spindle provided with a series of change-gears, of the main shaft provided with a corresponding series of change-gears splined thereon, and a separate shifting device for each of said latter change-gears, substantially as described.

8. In a milling-machine, the feed mechanism for the work-table embracing a longitudinally-movable shaft suitably rotated from the main shaft, said shaft being provided with a series of change-gears loose thereon and having means for connecting it with any one of the change-gears, combined with a screw and suitable connections to said shaft whereby the rotation of the screw effects the longitudinal movement of said shaft, substantially as described.

9. In a milling-machine, the feed mechanism for the work-table positively driven by suitable mechanism from the main shaft of the machine, said mechanism embracing a two-part shaft having its parts clamped frictionally together so as to permit of a yield in the event of undue strain, substantially as described.

10. In a milling-machine, the work-table provided with a feed-screw, combined with a pair of gears normally actuated in opposite directions, means for connecting said feed-screw to either of the said gears, and means for automatically disconnecting said gears, substantially as described.

11. In a milling-machine, the feed mechanism for the work-table embracing a feed-screw, a pair of gears normally rotated in opposite directions, a sleeve splined to said feed-screw, and a feather carried by and movable independently of said sleeve adapted to engage the sleeve with either of the gears as may be desired, substantially as described.

12. In a milling-machine, the feed mechanism for the work-table embracing a feed-screw, a pair of gears normally rotated in opposite directions, a feather connected to said feed-screw and adapted to engage either of the said gears, and a slide controlling the movement of said feather, said slide being provided with springs for normally holding the feather in inoperative position, and means for locking said slide so that the feather may be engaged with either of the gears, substantially as described.

13. In a milling-machine, the combination with the work-table, of a feed-screw for feeding the table, mechanism for actuating said screw in either direction, devices for locking said mechanism in operative engagement with the screw, and means connected with the work-table for unlocking and releasing said screw from the actuating mechanism at the proper period in the travel of the work-table, substantially as described.

14. The combination in a milling-machine,

with a movable slide or table, of a wear-piece consisting of oppositely-tapered parts movable relatively to increase their transverse section and take up wear, substantially as described.

15. The combination, in a milling-machine, with the slide or table, of wear-pieces, consisting of the tapered parts suitably connected with each other, one of the parts being provided with a rack and the other with a pinion in such manner that the movement of the pinion will change their relative position to increase the space occupied by them, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

OTT. MERGENTHALER.

Witnesses:

WILLIAM H. BERRY,

MURRAY HANSON.