No. 673,460. Patented May 7, 1901.

A. B. TENNEY.

METAL WORKING MACHINE.

(Application filed Feb. 5, 1900.)

(No Model.) 3 Sheets—Sheet 1.

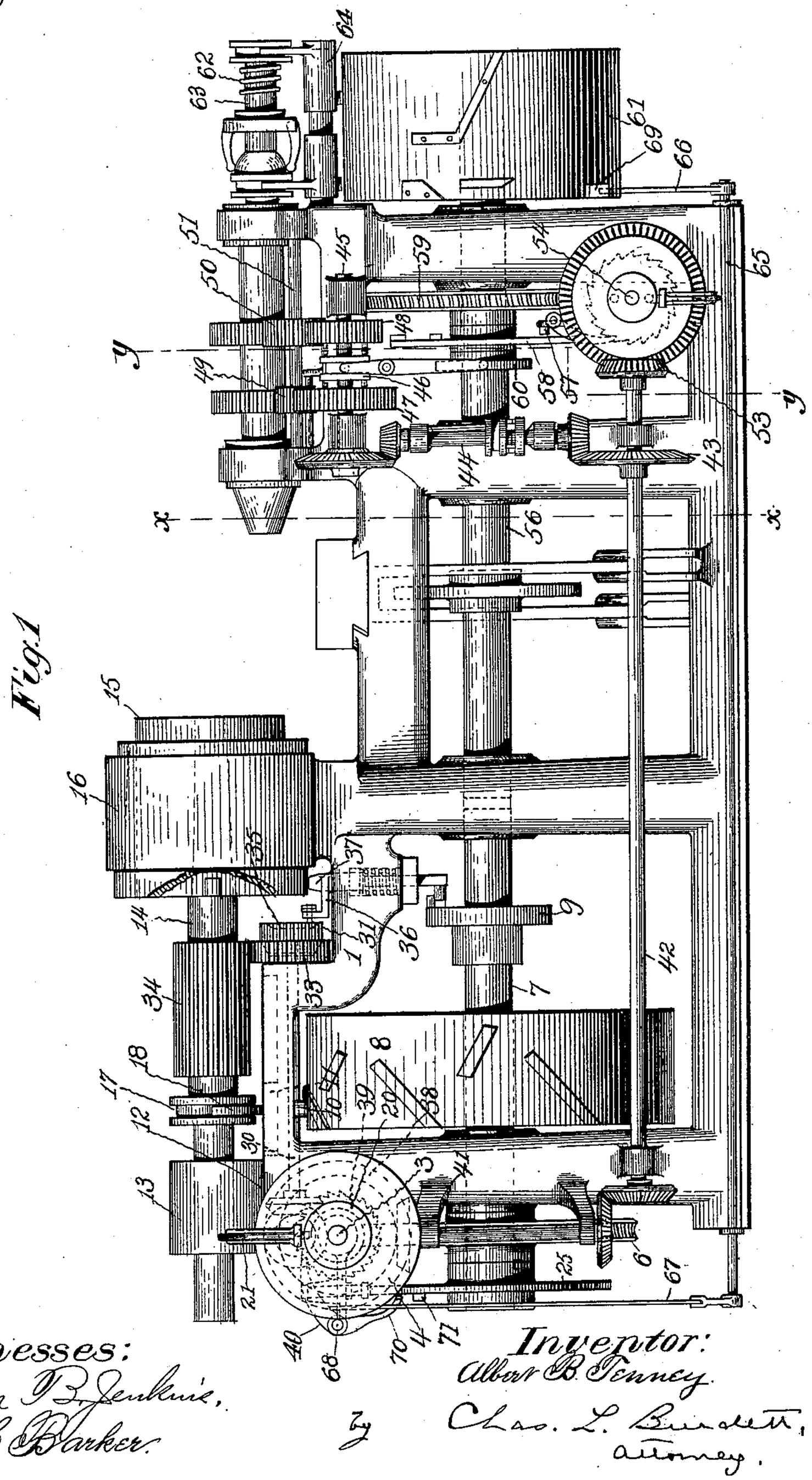

Fig. 1.

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Fig. 3

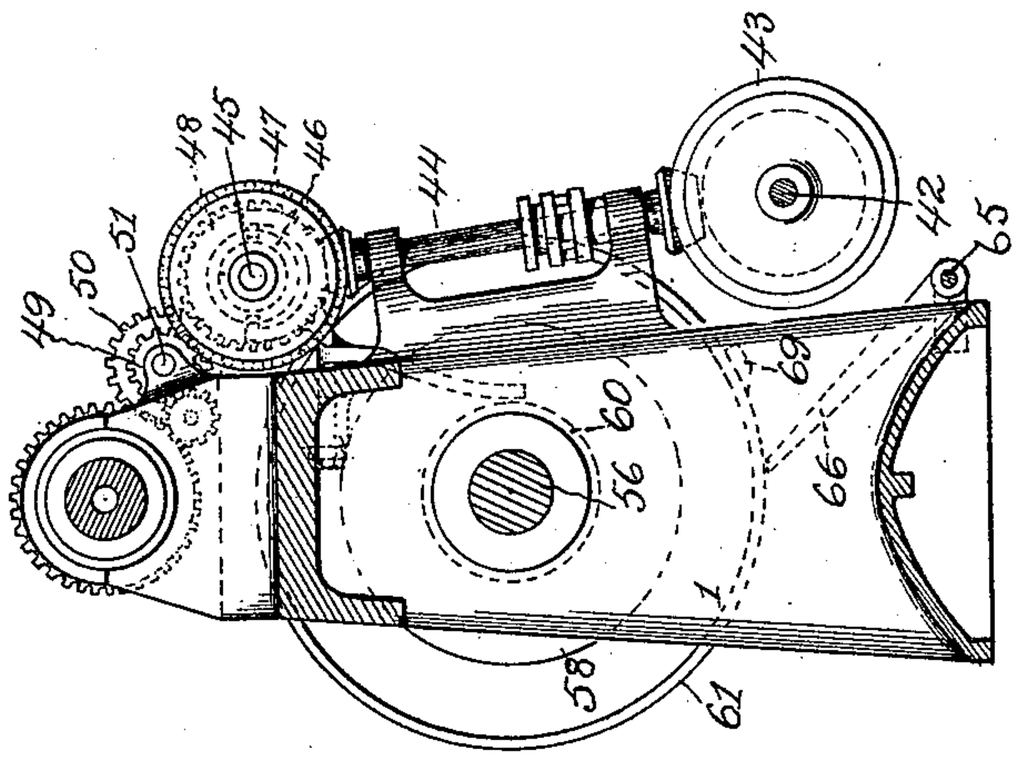

Fig. 2

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Fig. 5.

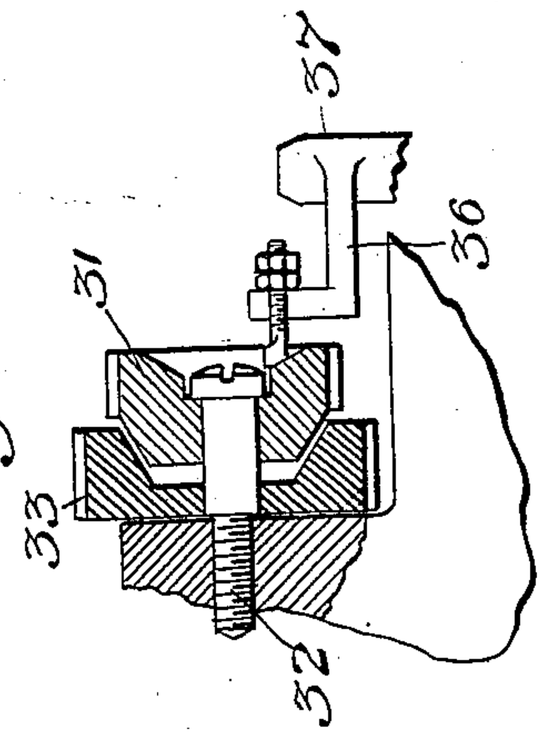


Fig. 6.

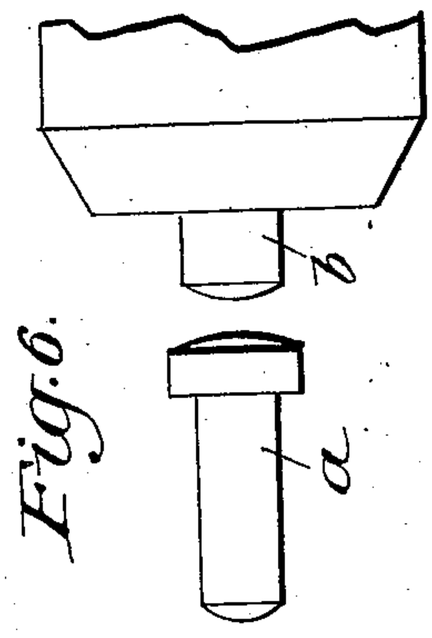
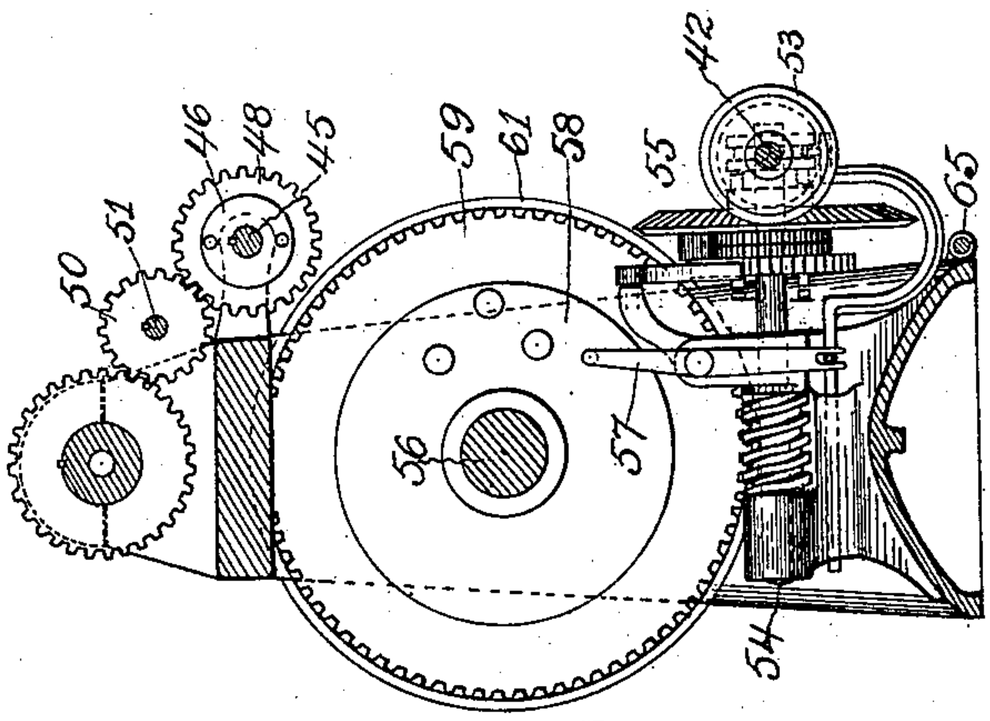


Fig. 4



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UNITED STATES PATENT OFFICE.

ALBERT BALL TENNEY, OF EVERETT, MASSACHUSETTS.

METAL-WORKING MACHINE.

SPECIFICATION forming part of Letters Patent No. 673,460, dated May 7, 1901.

Application filed February 5, 1900. Serial No. 3,988. (No model.)

To all whom it may concern:

Be it known that I, ALBERT BALL TENNEY, a citizen of the United States, residing at Everett, in the county of Middlesex and State of Massachusetts, have invented a new and useful Metal-Working Machine, of which the following is a specification.

My invention relates to improvements in metal-working machines in which the work is clamped within a rotating spindle and in which tools are carried by a turret adapted to be intermittently turned to bring the tools successively into position to operate upon the work, the turret being so mounted that it may be reciprocated to bring the tools up to the work carried by the spindle; and the objects, among others, of my invention are to provide a machine that shall produce accurate and uniform work and one in which the capacity of the machine shall be increased as compared with prior machines. A machine by means of which these objects may be attained is illustrated in the accompanying drawings, in which—

Figure 1 is a view in front elevation of the entire machine. Fig. 2 is an end view looking toward the left of the machine as illustrated in Fig. 1. Fig. 3 is a detail view in vertical section on plane denoted by line *x x* of Fig. 1 and looking toward the right and with the change-speed mechanism omitted. Fig. 4 is a detail view in section on plane denoted by line *y y* of Fig. 1. Fig. 5 is a detail view, on enlarged scale, showing the clutch-pinion. Fig. 6 is a detail view showing a piece of work produced on the machine.

In the accompanying drawings the numeral 1 denotes the frame of the machine, on one end of which are located bearings 2 for the main driving-shaft 3, that has a pulley 4 or like device which is driven, as by means of a belt or like means, from any suitable source of power. In the form of the device herein shown and described this pulley forms one member of a clutch device, by means of which the shaft 3 may be driven at different rates of speed. The construction and purpose of the speed-changing mechanism, of which this pulley forms one member, will be hereinafter fully described.

A worm 5 is secured to the shaft 3 and is in mesh with a worm-wheel 6, secured to the turret member 7 of a sectional cam-shaft located in bearings in the frame, preferably underneath the main operative parts of the machine. A turret-feed cam-wheel 8 and a turret-locking cam-wheel 9 are secured to the section 7 of the cam-shaft, the turret-feed cam-wheel 8 bearing cams properly located thereon to timely engage a stud 10, secured to the turret-feed slide 11, mounted in slideways in the frame of the machine. An arm 12 extends upward from the machine-frame and has at its upper end a bearing 13 for one end of the turret-shaft 14.

The turret 15 is arranged with its axis horizontal and supported in a bearing 16 on the frame. The turret is supported by this bearing for the greater part of its length, being located in a flanged collar, to which it is splined, and it is secured to the turret-shaft 14, by means of which it receives its rotary movement to bring the tools successively into position to operate upon the work held in the chuck on the work-holding spindle. A grooved collar 17 is secured to the turret-shaft 14, a forked arm 18 extending from the turret-feed slide 11 upward, engaging the groove in this collar and communicating the reciprocating movement of the slide thereto.

The driving-pulley 4 bears one member 19 of a clutch device, the other member 20 of which is splined to the main driving-shaft 3 and has a groove engaged by one end of a shifter-bar 21, mounted in bearings on the frame of the machine. This shifter-bar is preferably arched over the pulley 4, and a connecting-lever 22 is connected at one end to the shifter rod or bar and at the other end to a rock-shaft 23, mounted in a bearing on the frame of the machine. This rock-shaft bears a lever 24, arranged in position to be operated by cams on the shifter cam-wheel 25, the cams being arranged to cause timely movement of the shifter-lever to operate the clutch parts.

The shaft 3 bears a gear 26 in mesh with a pinion 27, secured to a bevel-gear 28, the two parts last-mentioned being mounted to rotate freely on a stud 29, fast to the frame of the machine. The bevel-gear 28 is in mesh with a bevel-gear on the end of a turret-driving shaft 30, mounted in bearings on the frame of the machine. The opposite end of this

shaft bears a gear in mesh with a clutch-pinion 31, mounted on a stud 32, secured to the frame of the machine. A turret-driving gear 33 is also mounted on this stud and is in mesh with a turret-shaft gear 34, secured to the turret-shaft 14. The clutch-pinion 31 has a slight longitudinal movement on the stud 32 and is provided with a recess 35, into which projects an arm 36 from an index or locking bolt 37. The recess 35 has a beveled wall, against which a shoe on the arm 36 is adapted to press. The index-bolt 37 is held normally in an upward position as by means of a spring, as shown in Fig. 1 of the drawings, and is moved downward by means of a turret-unlocking cam 9 engaging a projecting part from the index-bolt. It will be seen that this construction provides means for causing the two clutch parts 31 and 33 to be engaged in the movement of the index-bolt 37 to unlock the turret, the clutch parts operatively engaging just after the index-bolt has unlocked the turret and said parts being disengaged just before the index-bolt operates to lock the turret.

The main driving-pulley 4 is recessed on one face, and in this recess, rigidly secured to the pulley, is a bevel-gear 38 and also sun-gears, one of which is secured to the shaft 3 and the other of which is secured to a ratchet 39, mounted to rotate freely on the shaft 3. A planet-gear is mounted on a stud on the pulley and is in mesh with each of the sun-gears, which are constructed with a different number of teeth. This construction of pulley with sun-and-planet gears is old and well known, and further description herein is deemed unnecessary, as the operation will be readily understood by any one skilled in the art. A pawl 40 is pivoted in position to engage the ratchet and hold it against backward movement in order to drive the shaft 3 forward at slow speed when the clutch parts 19 and 20 are disengaged and the pawl 40 is in engagement with the ratchet, the shaft being driven forward at fast speed when the clutch parts 19 and 20 are in engagement.

The bevel-gear 38 on the driving-pulley is in mesh with a bevel-gear on a vertical shaft 41, the opposite end of this vertical shaft having a bevel-gear in mesh with a bevel-gear on a connecting-shaft 42, mounted in bearings on the frame of the machine near the bottom and extending lengthwise thereof. A bevel-gear 43 on this connecting-shaft meshes with a bevel-gear on a vertical shaft 44, that has a bevel-gear in mesh with a bevel-gear on the spindle-driving shaft 45. A clutch member 46 is secured to the shaft 45 and bears clutches adapted to engage clutches on the pinions 47 and 48, that are loosely mounted on the shaft 45. These pinions mesh with gears 49 and 50, each secured to the spindle 51. A single pinion is interposed between one of the pinions on the spindle-driving shaft and its companion gear on the driving-spindle as a connecting means, and two pinions are interposed between the other pinion on the spindle-driving shaft and its companion gear on the spindle, so that the spindle may be driven in opposite directions by the action of the pinions 47 and 48. The spindle and the parts supported thereon and connected therewith are of ordinary and well-known construction as to chucking and feeding mechanism and their operative parts, and for this reason a detailed description is omitted herein. The vertical shaft 41 may be made in two sections, with a clutch device connecting the sections as a matter of convenience in camming the machine.

A bevel-gear 53 on the connecting-shaft 42 meshes with a bevel-gear on a cam-shaft driver 54, mounted on the frame of the machine. This driver 54 has a clutch mechanism 55 connected therewith, similar to that already described in connection with the main driving-shaft 3, this mechanism being employed for the purpose of rotating the spindle-driving section 56 of the sectional cam-shaft at different rates of speed. A shifter-bar 57 is operated by cams on a cam-wheel 58, secured to the section 56 of the cam-shaft. This section of the cam-shaft is driven by means of a worm-wheel 59 in mesh with a worm on the cam-shaft driver 54. This section of the cam-shaft bears the spindle-controlling cam-wheels, consisting of the spindle-reversing cam-wheel 60 and the chucking and feeding cam-wheel 61. This chucking and feeding mechanism is of the ordinary construction common to machines of this class, and a detailed description of the same is therefore omitted, with the exception, however, that a spring 62 is placed on the feed-tube 63 for the purpose of holding the stud on the feed-tube slide 64 in continuous engagement with the cams of the cam-wheel 61 so long as said cams are in operative position with relation to said stud.

It is found that in operating a machine of this class at high speed the spring 62 prevents any excessive movement of the slide 64, or when it is forced forward beyond a point desired the spring acts to force the tube quickly back into its proper position and before the chuck-jaws grasp the stock, thus preventing excessive feeding movement of the feeding mechanism.

A rock-shaft 65 is mounted on the frame of the machine, extending lengthwise thereof, one end of the rock-shaft bearing an arm 66, adapted to be operated by cams 69 on the cam-wheel 61. The opposite end of this rock-shaft is connected with a rod 67, that is connected with a rock-shaft 68, to which the pawl 40 is secured.

By the operation of the parts just described it will be noted that movements of the turret end of the machine are controlled by movement of the opposite end of the machine; but I do not intend to limit my invention to a machine in which any one specific part is controlled by the movements of another specific

part, as it is obvious that this idea may be variously applied to different parts and yet come within the scope of the invention.

The cam-wheel 25 is provided with cams 71, arranged to operate on the lever 70, secured to the rock-shaft 68 to disengage the pawl 40 from the ratchet-wheel 39, which operation stops the movement of all parts located on this end of the machine, with the exception, of course, of the pulley 4. To start the turret-operating mechanism at slow speed, it is necessary simply to reëngage the pawl with the ratchet, which is done by so timely arranging the cams 69 on the cam-wheel 61 as to cause the arm 66 to be thrown outward, rocking the shaft 65, pulling on the rod 67, and tilting the pawl into engagement with the ratchet. It will be understood that the bearing-contact between the rock-shaft 68, which supports the pawl 40 and its support, has sufficient friction to prevent movement of the shaft except when caused by the operation of the cams 69 or 71.

In machines of this class prior to my invention, in which the several operative parts are so connected as to always have the same relative speeds, a difficulty has been found from the fact that when one set of mechanism has completed its work some time often elapses before another set of mechanism can commence its work for the reason that the cams on the cam-wheels of the last-mentioned set are not in proper position to immediately commence the work upon the completion of the work of the other set. This has been obviated to some extent by double camming. A fault is present in such operation, however, from the fact that it is practically impossible to so set two cams that they will operate precisely alike, and this is a serious difficulty when it is required that work to be turned out by the machine shall not vary even to the thousandth part of an inch.

By my improved machine I have provided means whereby a single set of cams for performing a certain part of the operation may be employed, thus turning out perfect work, and I have also provided means whereby each set of mechanisms is ready to at once commence its operation upon the completion of the work of another set. This is enabled by reason of the construction of the cam-shaft in sections, so that when a section of the cam-shaft at one end of the machine is causing the operation of that mechanism upon a piece of work the section of the cam-shaft at the opposite end of the machine may be started at higher speed if required to bring a tool into position to commence its operation immediately on the finish of the operation at the opposite end of the machine, or if the mechanism at one end of the machine shall be brought into position to begin its work before the opposite end of the machine has completed its operation the first-mentioned mechanism may be stopped at that point and then immediately started when the mechanism at the opposite end of the machine has finished its work.

An important feature of my invention resides in the arrangement of the mechanism whereby the above results may be accomplished, one section of the cam-shaft operating at a different speed or being stopped, while the opposite section may be operating at the same speed or at a different speed and the operation of succeeding tools or mechanisms commencing promptly upon the finish of the work by a preceding tool or mechanism and without any pause in the operations upon a piece of work for a cam to get into proper position to act upon its part, as in prior machines. To illustrate this, a description of the operation of the machine in turning out a piece of work *a*, Fig. 6, is given as follows: The cams and other parts having been set and adjusted to timely and properly perform their several functions and the machine being operated by means of a belt passing around the pulley 4, power is transmitted to shaft 54, the shafts 3 and 54 turning at the same rate when both are running at fast or slow speed and the change-speed mechanisms appurtenant to each having gears of the same ratio. The cam-wheel 61 operates at fast speed the chucking and feeding mechanism in the usual manner to feed up the required amount of stock *b*, the turret end of the machine having during this operation moved at fast speed to bring the proper tool into position to commence its work and the turret end of the machine then having been stopped by the operation of the cam-wheel 25 on the change-speed mechanism. The work-holding spindle has a continuous rotation, and at about the time the chucking and feeding operations are completed the cam 69 operates on the mechanism to start the turret end of the machine at slow speed, so that a roughing-box tool held by the turret shall begin its operation immediately on the completion of the chucking and feeding operations. The turret end of the machine is now operated at fast speed to withdraw the roughing-box tool, to withdraw the index-bolt 37, and to rotate the turret to bring a finishing-box tool into position, at which time the cam-wheel 25 operates the change-speed mechanism so that the turret is operated at slow speed to cause the operation of the finishing-box tool. The turret end of the machine is then operated at fast speed to withdraw the finishing-box tool, withdraw the index-bolt, and rotate the turret to bring a die-holder into position, properly disposed cams on the cam-wheel 8 advancing and withdrawing the turret, the cam 9 withdrawing the index-bolt and causing the rotation of the turret. The die-holder is now fed up by the turret, moving at slow speed, to cut a thread on the blank. At the completion of the cutting of the thread the cam, working in connection with the cut-off slide, moves said slide to bring a cutting-tool into operative position, and the cam-wheel 60

operates the mechanism to reverse the direction of rotation of the work-holding spindle to back the die-holder off from the work. During the operations of the turret the section 56 of the cam-shaft is rotated at fast or slow speeds, as may be required, to bring the cam-wheels into proper position to operate immediately upon the completion of the preceding operation, and the cam-wheel 58 now operates the change-speed mechanism so that the spindle shall be reversed at fast speed. While the spindle is reversing the cutting-off tool is approaching the stock, also at quick speed; but a slow cam is located on the cam-wheel 58 to operate this sectional cam-shaft at slow speed as soon as the cutting-off tool shall have come into engagement with the work. The cam-wheel 8 now backs the turret to its rearward position, and said turret is revolved to bring the roughing-box tool into position, this all being done at quick speed, and the cam for moving the turret to operate the roughing-box tool is brought into contact with the stud 10, at which time the cam-wheel 25 acts to withdraw the pawl 40 from the ratchet 39 and stop the operation of this end of the machine. The cutting-off tool completes its operation, at the end of which the cam-wheel 60 operates to reverse the direction of rotation of the work-holding spindle, and the cam 58 operates to place this end of the machine again on the fast speed. The turret end of the machine has thus been carried around to its first position and stopped while the cutting-off tool has been completing its work, and the former is ready to operate again as soon as new stock has been chucked. During the interval between the feeding and chucking and the cutting-off operation the work-holding end of the machine has been running at fast and slow speeds, to an extent determined by experiment, to bring the parts into timely position to rotate at fast speed as soon as the spindle is reversed to bring the cutting-off tool into position, at which time this end of the machine is again placed on the slow speed while the cutting-off tool is operating and then again on the fast speed when the stock is being chucked and fed, and the succeeding operation is then begun.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a metal-working machine, a work-holding spindle having feeding and chucking mechanism, a tool-holding turret, a sectional cam-shaft, one section of which controls the feeding and chucking mechanism and the other section of which controls the turret-operating mechanism, and means for varying the relative speeds of the sections of the cam-shaft.

2. In a metal-working machine, a work-holding spindle having feeding and chucking mechanism, a sectional cam-shaft one section of which controls the entire operations of the work-holding spindle, a tool-holding turret having a rotary and a reciprocating movement, another section of said cam-shaft controlling the entire operations of the turret, a single driving member common to both sections of said cam-shaft, and means for varying the relative speeds of the sections of the cam-shaft.

3. In a metal-working machine, in combination with a work-holding spindle with means for operating it, a turret, a clutch mechanism for rotating the turret, and an index-bolt for locking the turret, said bolt having a cam-surface adapted to operate to throw the parts of the clutch mechanism into or out of engagement.

4. In a metal-working machine, in combination with a work-holding spindle with means for operating it, a turret, a sliding shaft secured to the turret, a gear secured to said shaft, a gear in continuous engagement with the turret-shaft gear and connected with a clutch device, means for reciprocating said shaft, and means for operating the clutch mechanism to operate the turret.

5. In a metal-working machine, in combination with a work-holding spindle with means for operating it, a turret, a reciprocating shaft secured to the turret, a slide loosely engaging said shaft for causing its reciprocating movement, means for operating the slide, a gear secured to the shaft and connected with a clutch device, and means for operating the clutch device to operate the turret.

6. In a metal-working machine in combination with a work-holding spindle with means for operating it, a turret horizontally arranged, a shaft secured to the turret, means for reciprocating the shaft longitudinally, a gear secured to the shaft and connected with a clutch device, means for operating the clutch mechanism to operate the turret, and an index-bolt for locking the turret, said bolt controlling the operations of the clutch mechanism.

7. In a metal-working machine, in combination, a frame, a main driving-shaft mounted on the frame, a turret operatively connected with the driving-shaft, a work-holding spindle, a spindle-driving shaft operatively connected with the main driving-shaft, a clutch device borne on the spindle-driving shaft, and means for reversing the movement of the spindle by the operation of the clutch device.

8. In a metal-working machine, in combination, a frame, a main driving-shaft mounted on the frame, a rotating turret, a stock-holding spindle, a sectional cam-shaft having each section operatively connected with the main driving-shaft, one section controlling the operations of the turret and the other section controlling the operations of the spindle, means for varying the relative speeds of the sections of the cam-shaft, and connections between the sections of the cam-shaft whereby the operation of one is controlled by the operation of the other.

9. In a screw-machine, in combination, a rotating turret, a stock-holding spindle, a sectional cam-shaft one section controlling the operations of the turret and the opposite section controlling the operations of said spindle, means for varying the relative speeds of said sections, and connections between said sections of the cam-shaft whereby the operation of one is controlled by the movements of the other.

10. In a screw-machine, in combination, a rotating turret, a stock-holding spindle, a sectional cam-shaft one section controlling the operations of the turret and the other section controlling the operations of said spindle, means for varying the relative speeds of said sections, a main driving-shaft common to each section of the cam-shaft, and connections between the sections of the cam-shaft whereby the operation of one is controlled by the movements of the other.

11. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with one of said mechanisms and including sun-and-planet gears and a ratchet with a pawl, and means for automatically disengaging the pawl from engagement with the ratchet.

12. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with one of said mechanisms and including sun-and-planet gears and a ratchet with a pawl, means for automatically disengaging the pawl from engagement with the ratchet, and means for automatically causing the pawl to engage the ratchet.

13. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with the turret-operating mechanism and consisting of sun-and-planet gears, a ratchet and a pawl, means for automatically disengaging the pawl from the ratchet, and connections with the spindle-operating mechanism for causing the pawl to engage the ratchet.

14. In combination in a screw-machine, a sleeve mounted in the frame of the machine, a turret mounted in the sleeve and adapted to rotate therewith but having reciprocating movement lengthwise thereof, a locking-bolt for engaging the sleeve, means for operating the turret, and means for operating the locking-bolt.

15. In a metal-working machine, in combination with a work-holding spindle with means for operating it, a turret, a shaft secured to the turret to rotate it, means for reciprocating the shaft longitudinally, a gear secured to the shaft and connected with a clutch device, means for operating the clutch mechanism to operate the turret, and an index-bolt for locking the turret, said bolt controlling the operations of the clutch mechanism.

16. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with each of said mechanisms, and including sun-and-planet gears and a ratchet with a pawl, and means for automatically disengaging the pawl from engagement with the ratchet.

17. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with each of said mechanisms and including sun-and-planet gears and a ratchet with a pawl, means for automatically disengaging the pawl from engagement with the ratchet, and means for automatically causing the pawl to engage the ratchet.

18. In a screw-machine, in combination, a rotating turret with means for operating it, a stock-holding spindle with means for operating it, a variable-speed device connected with one of said operating means, and consisting of sun-and-planet gears, a ratchet and pawl, means for automatically disengaging the pawl from the ratchet, and connections with the other operating means for causing the pawl to engage the ratchet.

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