Sept. 25, 1934. E. J. KINGSBURY 1,975,007

METAL WORKING MACHINE

Original Filed April 27, 1932 9 Sheets-Sheet 1

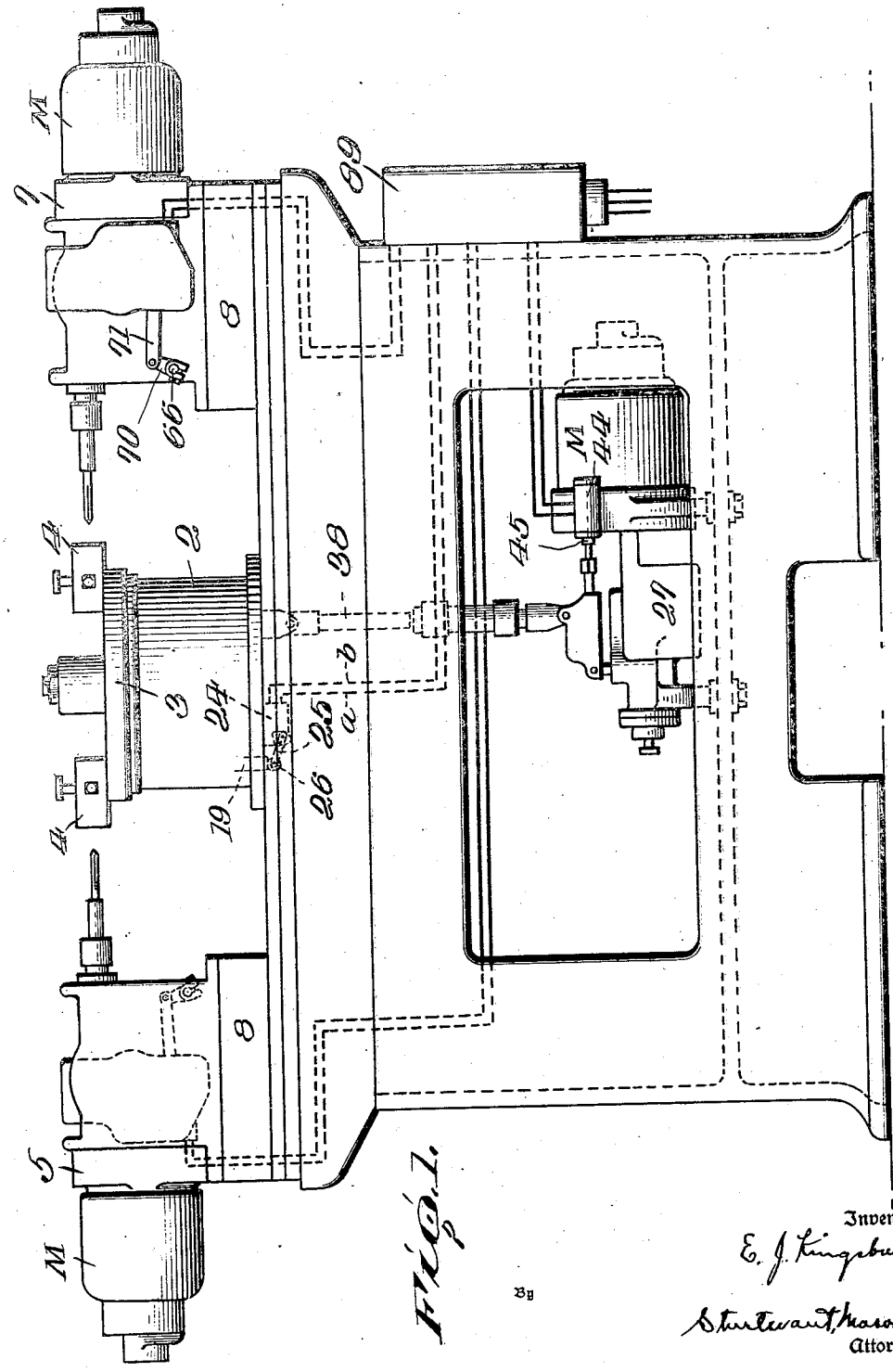


Fig. 1.

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METAL WORKING MACHINE

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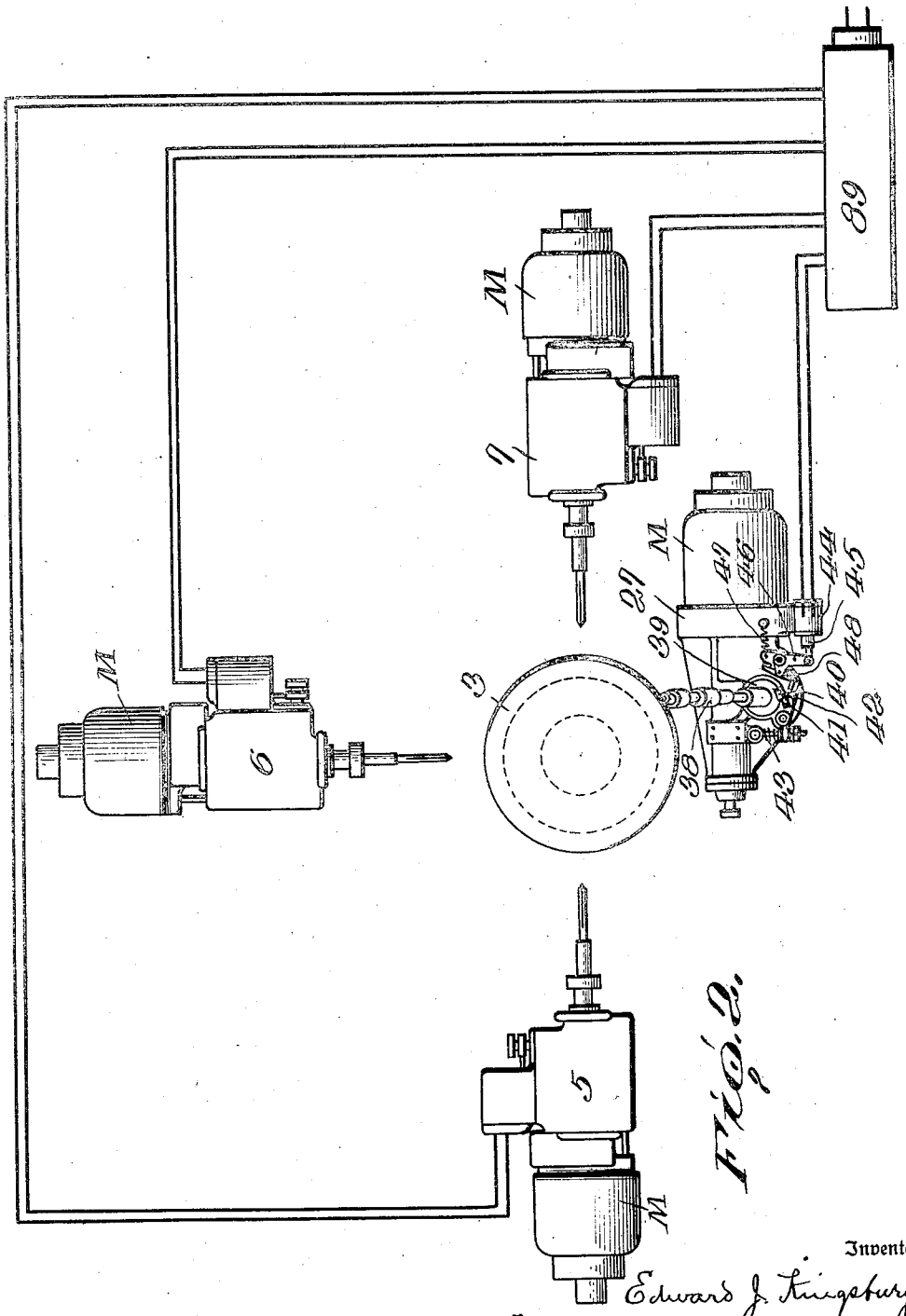


FIG. 2.

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METAL WORKING MACHINE

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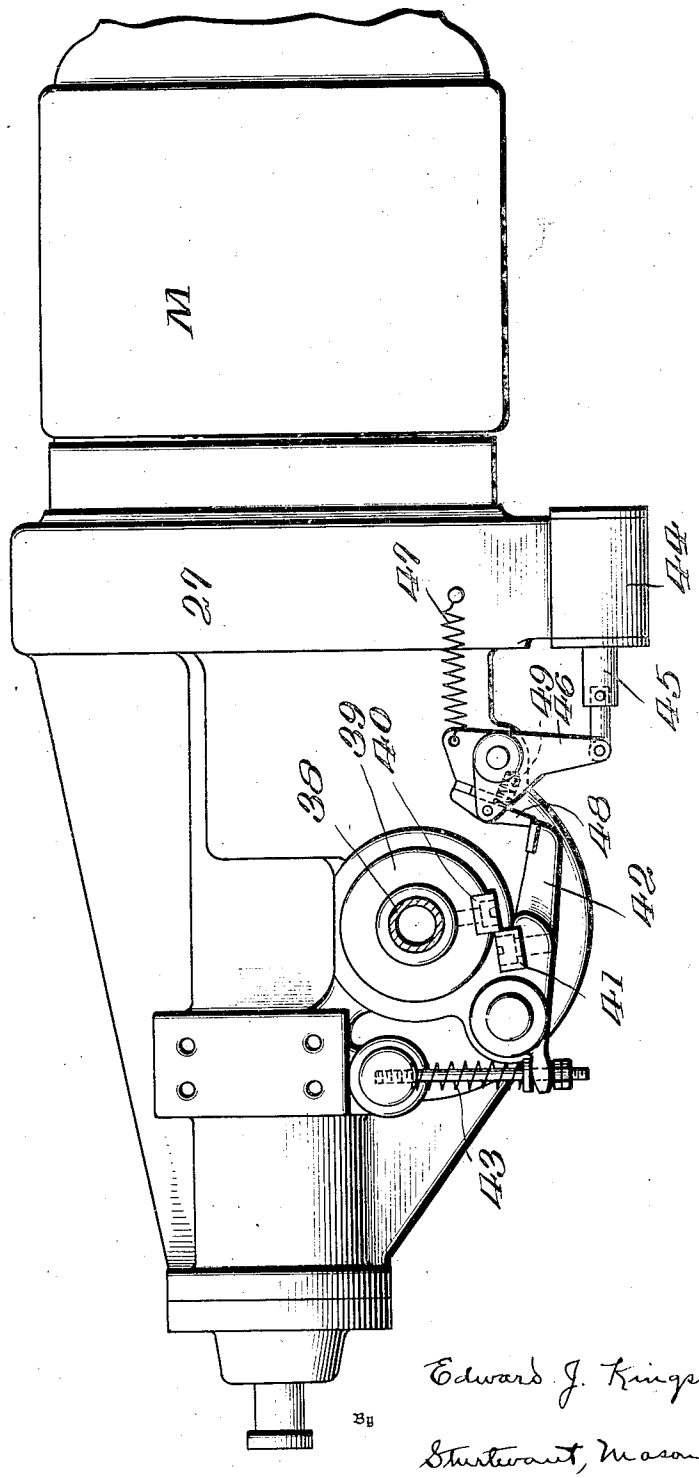


Fig. 3.

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METAL WORKING MACHINE

Original Filed April 27, 1932 9 Sheets-Sheet 4

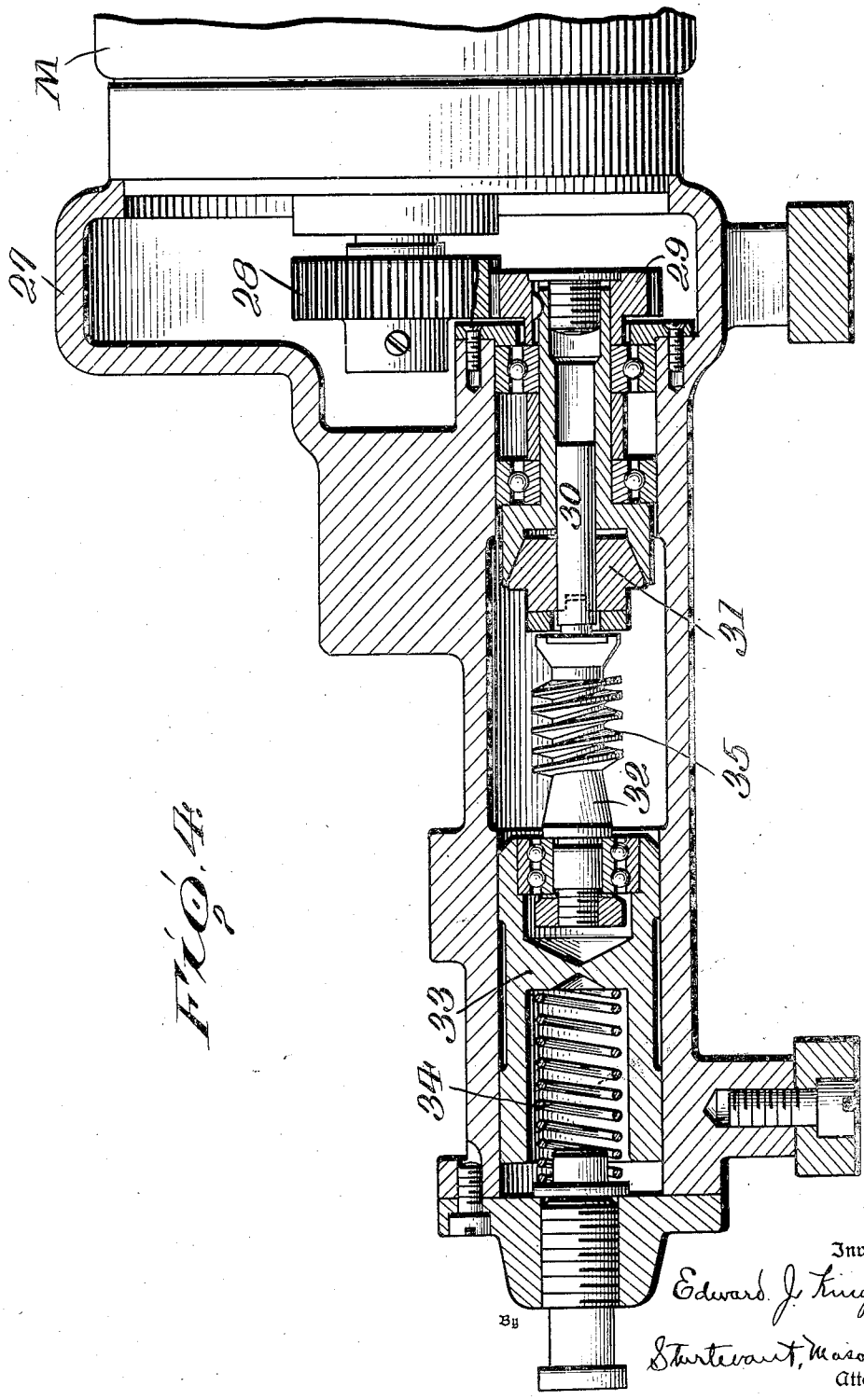


FIG. 4.

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METAL WORKING MACHINE

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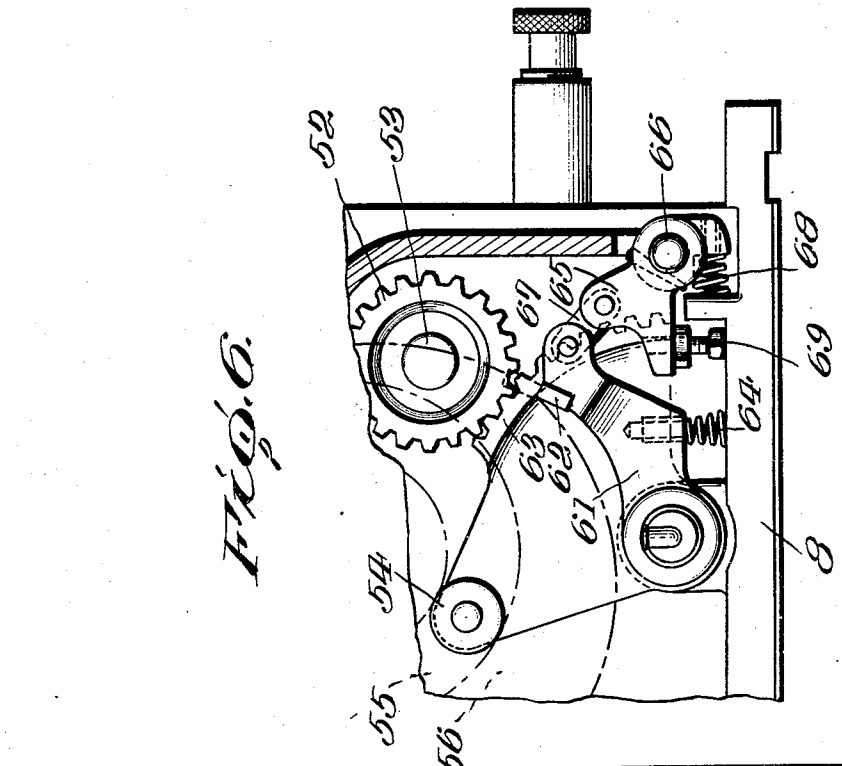


FIG. 6.

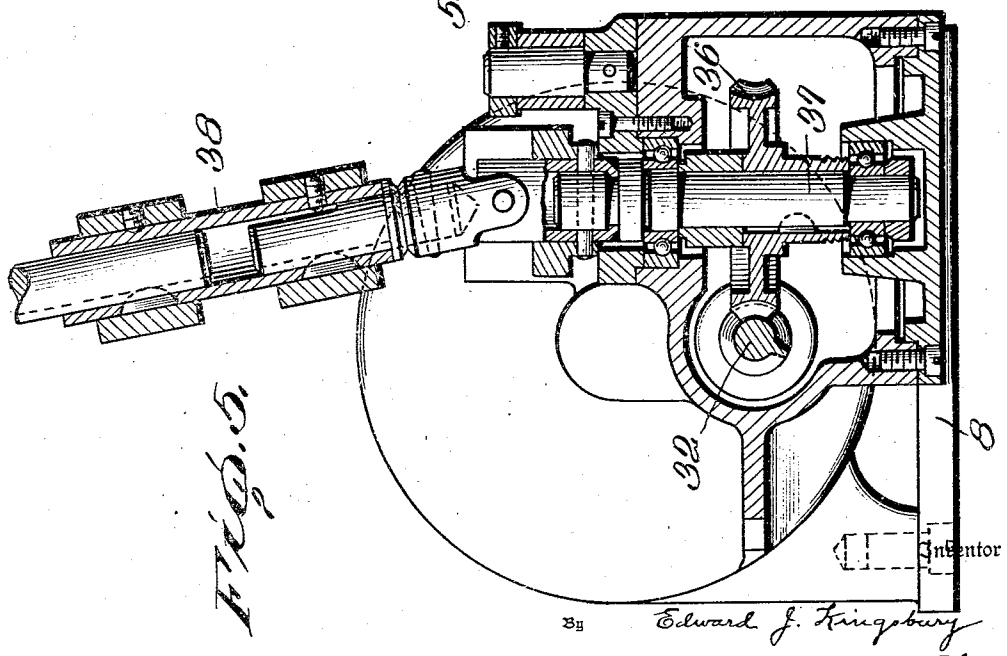


FIG. 5.

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METAL WORKING MACHINE

Original Filed April 27, 1932 9 Sheets-Sheet 6

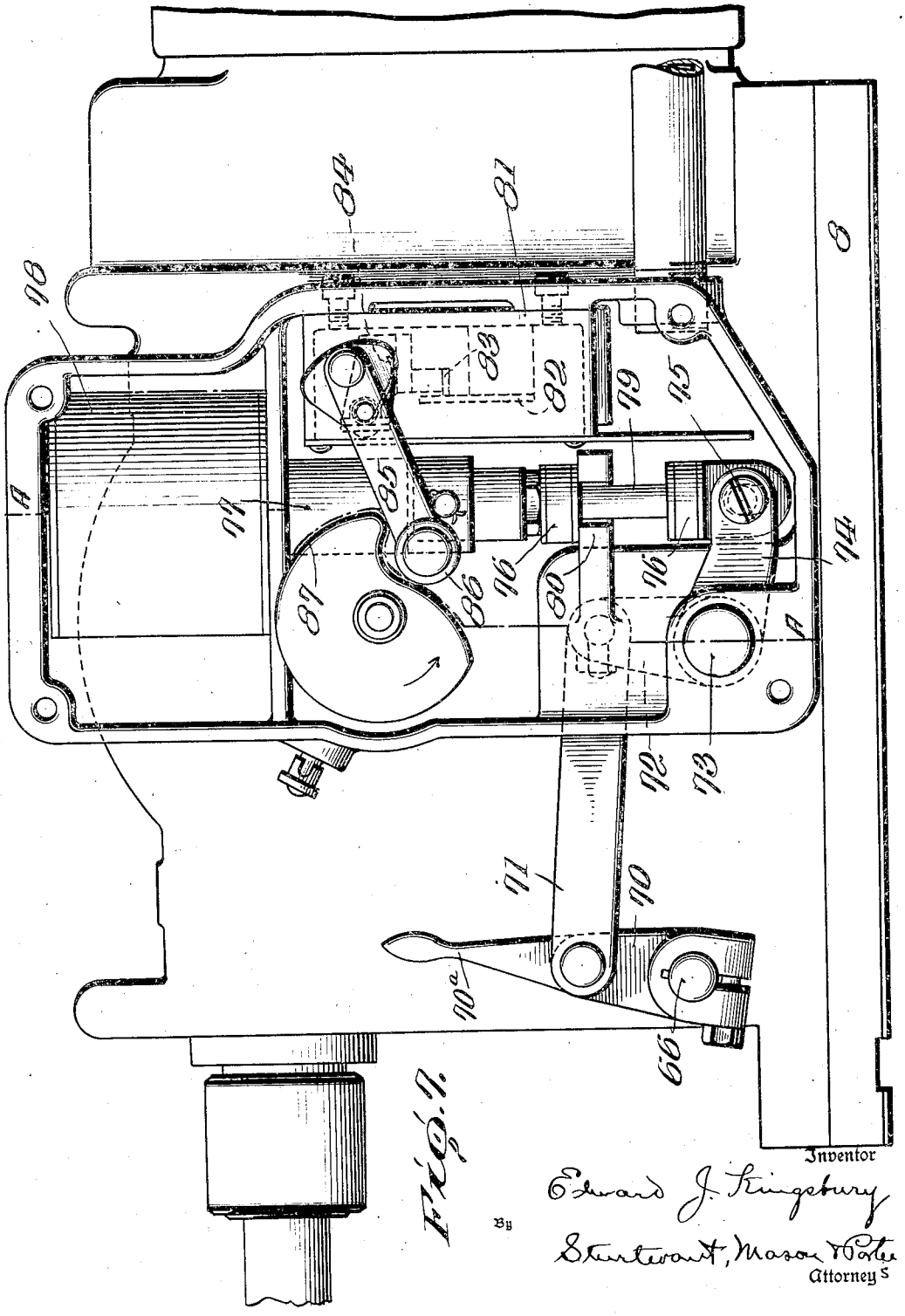


Fig. 7.

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METAL WORKING MACHINE

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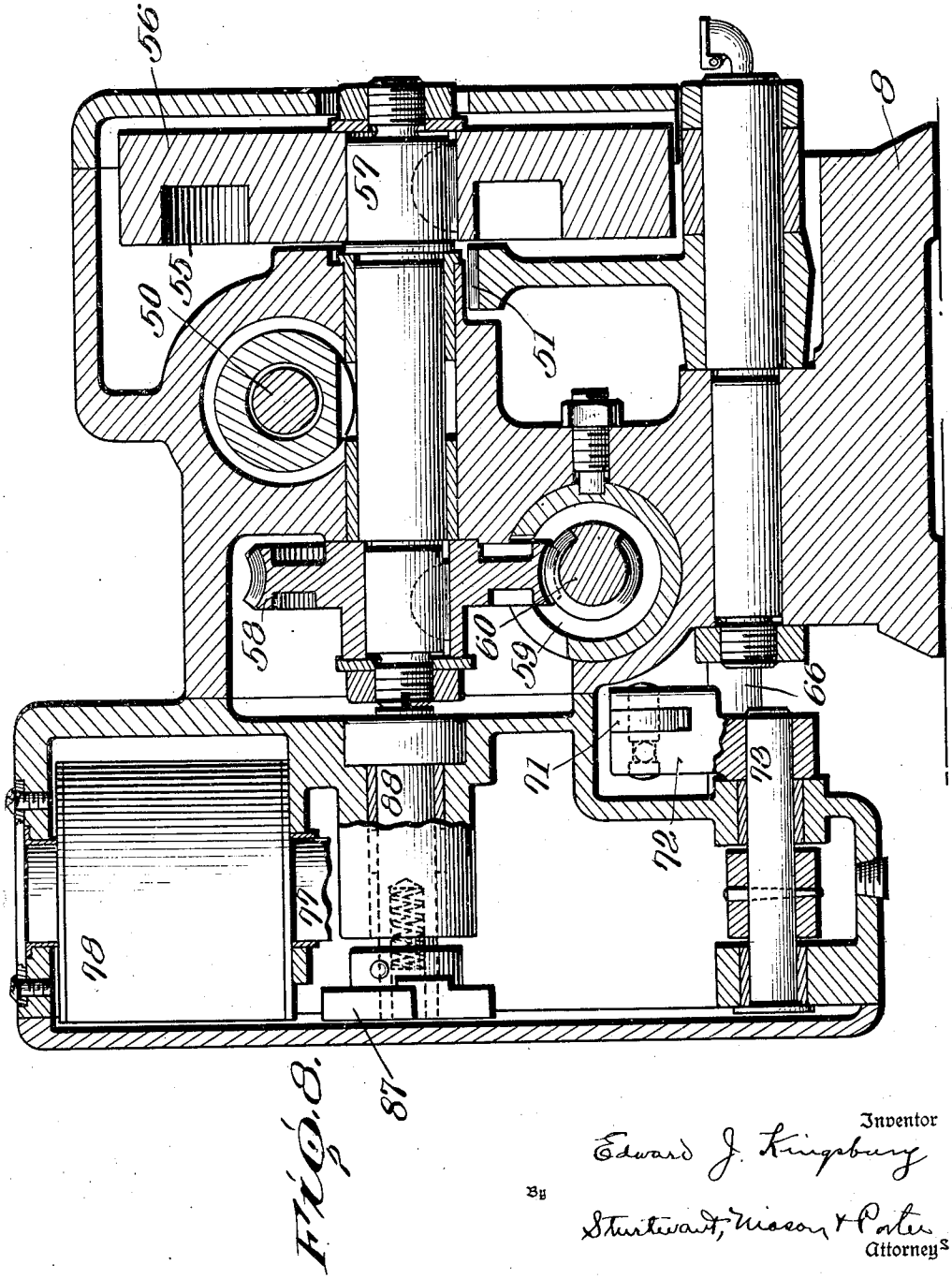


FIG. 8.

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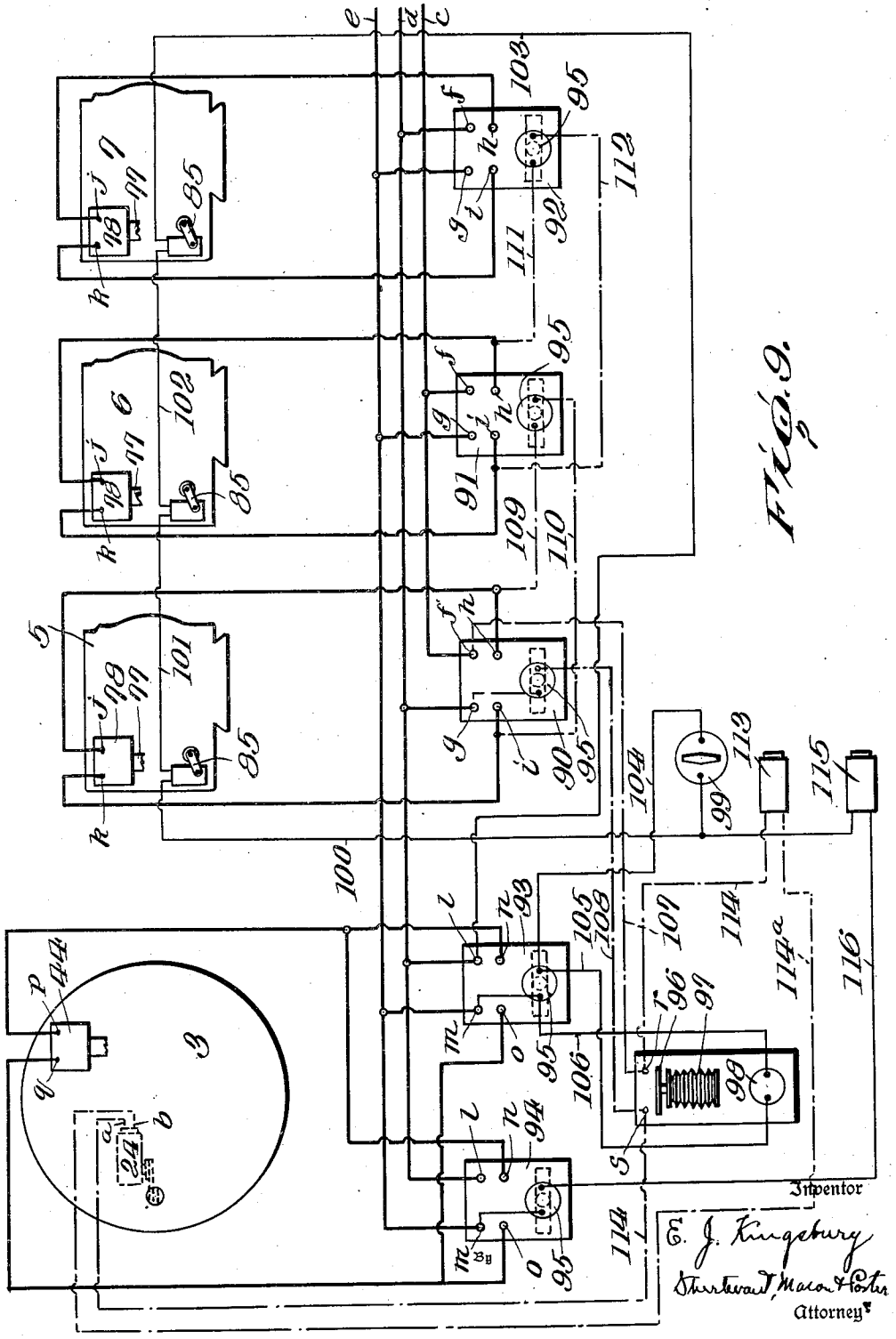


Fig. 9.

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Fig. 11.

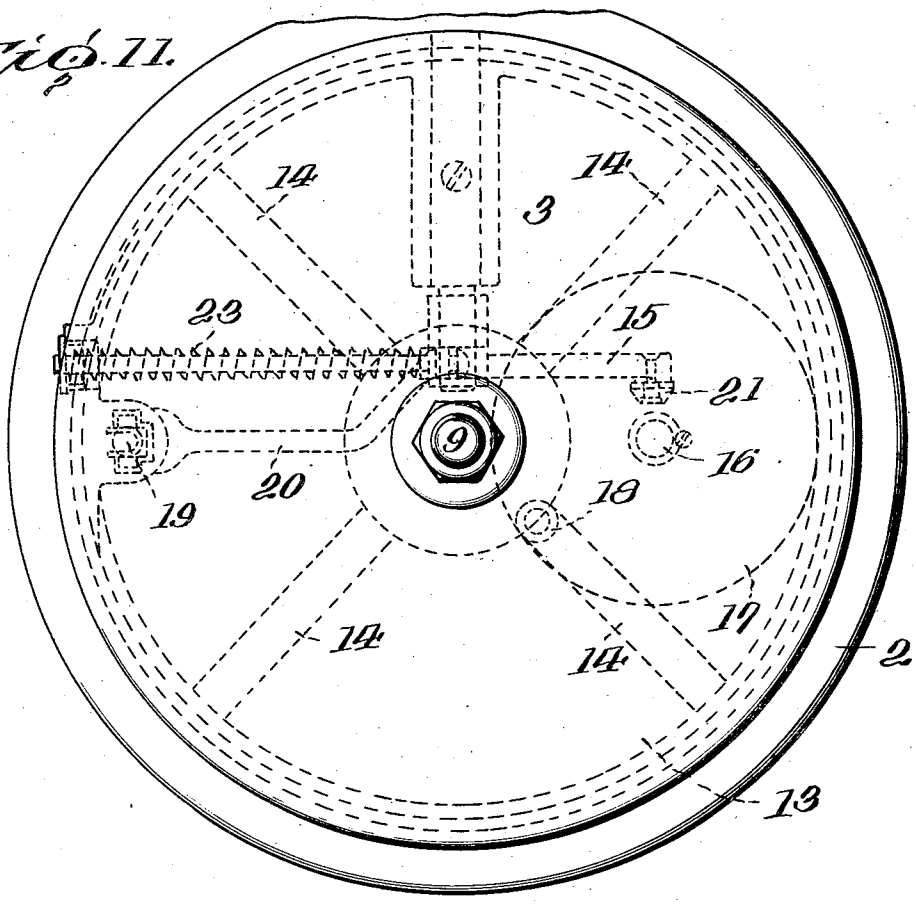
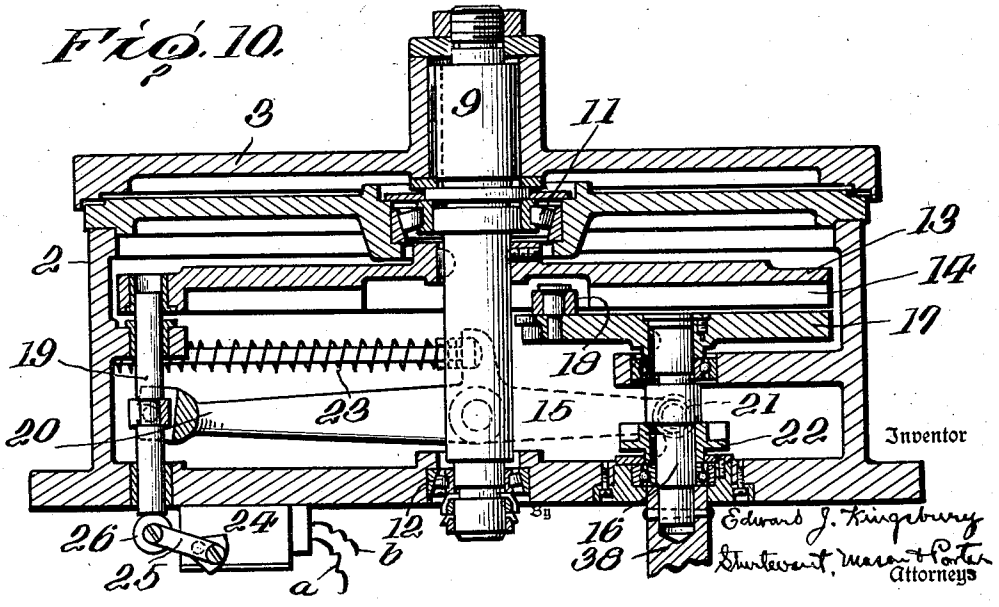


Fig. 10.



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UNITED STATES PATENT OFFICE

1,975,007

METAL WORKING MACHINE

Edward J. Kingsbury, Keene, N. H.

Application April 27, 1932, Serial No. 607,839
Renewed April 10, 1934

23 Claims. (Cl. 29—38)

The invention relates to new and useful improvements in metal working machines, and more particularly to a metal working machine wherein the material to be operated upon is presented in succession to a series of self-contained metal working units.

An object of the invention is to provide an indexing and control mechanism for a machine of the above type wherein the metal working units and indexing mechanism may be simultaneously initiated and the operation of the metal working unit delayed to permit the completion of a normal operation of the indexing mechanism before the metal working units are brought into operation on the material.

A further object of the invention is to provide an indexing and control mechanism for a machine of the above type wherein the operation of the metal working units is initiated by the last metal working unit to complete its feed cycle, and through a mechanism whereby the operation of the metal working units on the material is delayed to permit the indexing of the work supporting turret.

A still further object of the invention is to provide an indexing and control mechanism for a machine of the above type wherein the initiation of the operation of the metal working units is controlled by the indexing of the turret, so that the initiation of the metal working units can only occur when the indexing operation of the turret has been completed.

A still further object of the invention is to provide an indexing and control mechanism for a machine of the above type wherein the initiation of the metal working units is accomplished through an electrically controlled mechanism including a time delay switch, so that the operation of the metal working units will commence a predetermined time after the initiation of the operation of the same.

These and other objects will in part be obvious and will in part be hereinafter more fully disclosed.

In the drawings which show by way of illustration one embodiment of the invention—

Figure 1 is a view showing more or less diagrammatically and in side elevation a machine embodying the improvements;

Fig. 2 is a plan view showing the arrangement of the metal working units to the turret indexing mechanism and the control circuits therefor;

Fig. 3 is a plan view of the operating unit for the turret;

Fig. 4 is a sectional view through the operating unit for the turret;

Fig. 5 is a vertical sectional view through the operating unit for the turret;

Fig. 6 is a side view partly in section of a portion of one of the metal working units showing the control cam for the feed spindle;

Fig. 7 is an enlarged view of a portion of the opposite side of the metal working unit;

Fig. 8 is a sectional view on the line A—A of Fig. 7;

Fig. 9 is a diagrammatic view showing the circuits for controlling the metal working units and the indexing mechanism;

Fig. 10 is a sectional view through the turret housing and showing the means for operating the turret and for locking the same in a set position;

Fig. 11 is a plan view of the turret;

The invention is directed to a metal working machine of the above type wherein there is a series of self-contained metal working units. The machine includes a supporting frame or stand which is diagrammatically indicated at 1 in Fig. 1 of the drawings. Mounted on this frame is a housing 2 which supports the turret 3 having a series of work holding chucks 4, 4. This turret is intermittently rotated and is automatically stopped after it is turned through a predetermined angle. The mechanism for operating the turret will be described later. In the present illustrated embodiment of the invention, the turret is rotated through an angle of ninety degrees and then comes to a stop. This provides four working stations. One of these stations is preferably an idle station where the material may be placed in the chuck for operation thereon and removed from the chuck at the completion of the operation of the metal working units thereon. At each of the other three stations there is a metal working unit. These are illustrated diagrammatically in Fig. 2 at 5, 6 and 7. The metal working units are each provided with a base member 8 which is attached to the frame 1. The metal working units may be set in various positions on the frame so that the operating tool carried thereby may operate on the material at different angles. The tool may be of any desired character, and may be a drilling tool or a milling tool. It is essential that the tool for all of its adjustments shall be within range of the material at the station where the turret comes to rest.

The turret is shown in detail in Figures 10 and 11. The work holders have been omitted from these figures. The turret 3 is mounted on a ver-

tical shaft 9 which in turn is mounted in suitable bearings 11 and 12 in the housing 2. The turret is placed above the housing and the shaft extends down into the housing. The shaft carries a disk 13 having a series of radial grooves 14, 14 spaced ninety degrees apart, and terminating at their inner ends in a recessed portion 15. Mounted in the housing 2 is a shaft 16 carrying a disk 17 at its upper end, which is provided with a roller 18 set eccentrically thereon, and this roller is adapted to enter one of the radial grooves 14 from the inner end thereof, and while in the groove, the roller turns the turret from one set position to another set position. It then passes out of the radial groove into the recess 15 and the turret comes to a stop. The shaft 16 also comes to a stop, as will be described hereinafter, and when it is again started, the roller enters the next groove 14 for imparting another angular movement to the turret. Thus it is that the chucks carrying the material are moved from one station to another, and remain at a standstill while the tools are operating thereon.

There is a locking pin 19 carried by a lever 20 which is adapted to engage an opening in the disk 13. The lever 20 is provided with a roller 21 which engages a cam 22 on the shaft 16. This cam is so shaped and timed relative to the roller 18 that the pin will be lowered and disengaged from the disk 13 just prior to the time when the roller engages the disk for imparting motion thereto. In other words, the cam unlocks the disk. A compression spring 23 connected to the lever and the housing operates to raise the pin 19. The pin bears against the under side of the disk, and when the opening in the disk registers with the pin, it will move into the opening and thus lock the disk from movement.

The turret may be equipped with an electric switch, the box containing the same being indicated at 24. The wires *a* and *b* lead to this switch. The switch is controlled by a lever arm 25 which carries the roller 26 located directly beneath the pin 19. When the pin 19 is moved downward, it will turn the arm 25 so as to open the switch. When the locking pin moves up into the opening in the disk, then the arm is raised by suitable spring means within the switch, which closes the switch. The purpose of this switch will be described later.

The turret is rotated by a self-contained operating unit which is shown in detail in Figures 3 to 5. This operating unit includes a housing 27 on which is mounted a motor indicated at M. The operating unit for the turret includes a control means whereby the operation of the turret may be initiated, and after the turret has been turned through the desired angle, the actuating shaft for the turret automatically stops. This actuating unit for the turret which may be started and automatically stopped, is shown, described and claimed in the application filed by Edward J. Kingsbury and Gunnar Swahnberg, November 6, 1929, Serial No. 405,172. In the prior application referred to, the control is by pneumatic means, while in the present application, the control is electrical. The motor carries a gear 28 which meshes with a gear 29 carried by a shaft 30 which is provided with one member of a friction clutch 31. The other member of this clutch is attached to a shaft section 32 which is mounted in bearings in the housing 33, and this housing is moved by the spring 34 so as to bring the clutch members into contact, and thus the shaft 32 is driven by the motor. This shaft 32 is provided with a worm gear 35 which meshes with a worm 36 on the shaft 37. The shaft 37 is connected to a shaft 38 which in turn is connected to the shaft 16. Fixed to the shaft 37 is a control disk 39 carrying a lug 40 which is adapted to engage a lug 41 on a control lever 42. A spring 43 is continually urging the lever so as to place the lug 41 in the path of travel of the lug 40. When the lug 40 engages this lug 41, it stops the rotation of the shaft 37. When the shaft 37 is stopped, the worm gear 35 will travel on the worm 36 to the left as viewed in Fig. 4, and this will open the friction clutch 31 and stop the movement of the shaft 32. When the lug 41 is moved out of the path of travel of the lug 40 so that the shaft can turn, the spring 34 will move the shaft endwise, bringing the friction clutch members together, and this sets the shaft into operation.

From the above it will be apparent that when the lever 42 is moved in a clockwise direction, the motor will operate the turret to turn the same from one set position to another, thus carrying the material from one station to another. As the shaft 38 is set into motion, it will, through the cam 22, release the locking pin, and then turn the turret, and when the turret has completed its movement, the pin will drop into the opening and lock it in its set position, and at this time, the lug 40 will again contact with the lug 41 and stop the rotation of the shaft 38.

Electric means has been provided for initiating the indexing mechanism. This electric means includes a solenoid 44. The movable core 45 thereof is connected by a link to a lever 46. A spring 47 is attached to this lever and to the housing of the unit, and normally swings the lever in a clockwise direction. This lever carries a dog 48 which is moved by a spring 49 so that the rear end thereof engages the stop. In this set position, the dog engages the lever 46. When the solenoid is energized, the lever 46 will swing in a counter clockwise direction, and the dog 48 bearing on the lever 42 will swing the lever so as to move the lug 41 out of the path of travel of the lug 40. The lever 46 is so mounted and the dog 48 so positioned that the full swing thereof through the action of the solenoid will cause the dog to release the lever 42, and the spring 43 will, therefore, move the lug 41 both into the path of travel of the lug 40, so that when the shaft 38 has completed its rotation, it will be automatically stopped.

The metal working units are similar in construction to those shown in my prior Patent No. 1,780,083, granted October 28, 1930. The unit described in said patent is mechanically controlled, while the present unit is adapted to be automatically controlled, and the unit has been changed to include the mechanism necessary for accomplishing this automatic control. The units are all similar in construction and the description of one will answer for the others. Each unit includes a motor M which is geared to a drill spindle 50 and continuously rotates the same. The drill spindle is moved back and forth in the housing of the metal working unit by means of a segment lever 51 which is provided with a gear meshing with a gear 52 attached to the shaft 53, and the shaft 53 carries a gear which in turn meshes with a rack on the feed sleeve for the drill spindle. The lever 51 carries a roller 54 which runs in a groove 55 in a cam disk 56 attached to the shaft 57. The shaft 57 carries a worm gear 58 which meshes with a worm gear 59 on the shaft 60. This shaft 60 is driven through a friction clutch

operated from the motor shaft, and one member of the friction clutch is carried by a section of the shaft which is capable of endwise movement in the housing, so that when the metal working tool has completed its operation on the material and has been retracted, the feed of the spindle may be automatically stopped. This mechanism is shown and described in full in my prior Patent No. 1,780,083. This stopping of the feed is accomplished by a lever 61 carrying a lug 62 which is adapted to move into the path of the lug 63 carried by the cam disk 56. A spring 64 urges the lever in a clockwise direction and moves the lug 62 into the path of travel of the lug 63. As clearly set forth in my prior patent, when this lug 62 is engaged by the lug 63, the cam disk stops, and this will stop the rotation of the worm gear 58, and the worm gear 59 will then travel on the worm gear 58, moving the shaft section 60 endwise. thus separating the clutch members. When the lug 62 is moved out of the path of the lug 63, then the spring operating on the shaft section 60 moves the same endwise and causes the clutch members to be engaged. It will be apparent, therefore, that when the lug 62 has moved out of the path of the lug 63, the operation of the metal working unit is started and the feed of the spindle begins at once, and after it has traveled through its cycle of movement and reached its retracted position, then the lug 62 which has moved back into the path of travel of the lug 63 will stop the feed spindle.

The lever 61 is moved for starting the metal working unit by a rock arm 65 which is fixed to a shaft 66. This rock arm is attached to a link 67 which is in turn attached to the lever 61. A spring 68 bearing on a lug carried by the rock arm 65 is tending to move the rock arm so as to shift the lever 61 to bring the lug 62 into the path of travel of the lug 63. An adjustable stop 69 is provided for limiting the movement of the rock arm 65. The shaft 66 extends through the base of the metal working unit as shown in Fig. 8, where it is provided with an upstanding arm 70. This arm 70 is connected by a link 71 to an arm 72 carried by shaft 73. The shaft 73 is provided with an arm 74 which is slotted to engage the pivot pin 75 carried by the head 76 which is connected to a core 77 operating in a solenoid 78. There are two heads 76 connected by a rod 79 which slides in a guiding bracket 80. When the solenoid is energized, the core 77 is raised, which will oscillate the shaft 66 in a counter clockwise direction. This movement of the shaft 66 in a counter clockwise direction as viewed in Fig. 7, turns the shaft in a clockwise direction, as viewed from the other side of the machine, and as indicated in Fig. 6, and the lever 61 will be moved so as to release the metal working unit and set it into operation. Mounted on each metal working unit is a pilot switch, the box of which is indicated at 81 in Fig. 7 of the drawings. A portion of the inner structure of the pilot switch is shown in broken lines. It includes spaced terminals, one of which is indicated at 82 and a contact member 83 which joins the terminals for closing the circuit through the switch. The contact member 83 is moved for closing the switch by a spring 84 so that the spring is normally held closed. The switch is opened by a lever arm 85 carrying a roller 86 which cooperates with a cam 87. When the parts are in the position shown in Fig. 7, the arm 85 is moved through the action of the spring so that the switch is closed. This control cam 87 turns in the direction of the arrow shown in Fig. 7. The control cam 87 is carried by a short shaft 88 which is in alinement with the shaft 57 and is connected thereto so as to be turned by the shaft 57. When the solenoid is energized, it at once starts the metal working unit. At this time the pilot switch is closed. As soon as the metal working unit starts into action, the pilot switch is opened by the control cam 87 and will be held open until the metal working unit has completed its cycle of operation, and the metal working tool retracted. Then the arm 85 is released, so that the spring closes the switch. In other words, this pilot switch is closed during the starting or initiating of the metal working unit. It is at once opened and remains open until the metal working unit has completed its feed cycle, at which time the pilot switch is closed.

The control mechanism whereby the operation of the metal working units may be initiated, and also the operation of the indexing mechanism for the turret, is shown in detail in Fig. 9 of the drawings. Mounted on the frame 1 is a control box 89. In this control box is a control switch for each of the metal working units, and also control switches for the indexing mechanism. The control switch for the metal working unit 5 is indicated at 90 in the diagrammatic view. The control switch for the metal working unit 6 is indicated at 91, and the control switch for the metal working unit 7 is indicated at 92. There is a control switch 93 for the indexing mechanism, and a control switch 94 also used, under certain conditions, with the indexing mechanism. These control switches are all of a similar character and have only been indicated diagrammatically in the drawings. Each includes a solenoid 95 which, when energized, operates to swing knife blades of the usual construction into contact with the terminals associated therewith. As shown in the drawings, there are three power lines *c*, *d* and *e*. The power lines *c* and *d* are connected, respectively, to the terminals *f* and *g* of the control switch 90. The power lines *c* and *e* are connected to the terminals *f* and *g* of the control switch 91, and the power lines *d* and *e* are connected to the terminals *f* and *g* of the control switch 92. The terminals *h* and *i* of the control switch 90 are connected to the terminals *j* and *k* of the solenoid 78. The terminals *h* and *i* of the control switch 91 are likewise connected to the solenoid of the metal working unit 6, and the terminals *h* and *i* of the control switch 92 are likewise connected to the terminals of the solenoid of the metal working unit 7. When the control switches are closed, then the metal working units are connected to the power lines, so that the solenoids will be energized and the metal working unit started into operation.

The terminals *l* and *m* of the control switch 93 are connected to the power lines *d* and *e*, and the terminals *l* and *m* of the control switch 94 are connected to the same power lines. The terminals *n* and *o* of the control switch 93 are connected to the terminals *p* and *q* of the solenoid 44. The terminals *n* and *o* of the control switch 94 are likewise connected to the terminals *p* and *q*. These connections between the switches 93, 94 and the solenoid 44 are in multiple. When the solenoid 95 of the control switch 93 is energized, the switch is closed, and this will connect the solenoid 44 to the power lines, so that it will be energized, and it will start into operation the indexing mechanism. Likewise, when the solenoid 95 of the control switch 94 is energized, it will close the switch, and will start into opera-

tion the indexing mechanism. In the control box 89 there is a time delay switch of the usual character which is indicated diagrammatically in Fig. 9. It includes terminals *r* and *s* which are connected by a contact plate 96. Associated with the contact plate is a bellows 97. A solenoid 98 controls the movement of the contact plate 96, but said movement is delayed by a small adjustable valve controlling the escape of air from the bellows. When this time delay relay or switch is initiated, a predetermined time period elapses before the contact plate 96 engages the terminals *r* and *s* and really closes the switch.

There is a single pole snap switch 99, one terminal of which is connected through the line 100 with one terminal of the pilot switch of the metal working unit 5. The other terminal of the pilot switch of the metal working unit 5 is connected through the line 101 with one of the terminals of the pilot switch of the metal working unit 6. The other terminal of this pilot switch is connected through the line 102 with one terminal of the pilot switch of the metal working unit 7. The other terminal of this pilot switch of the metal working unit 7 is connected through the line 103 with the terminal *l* of the control switch 93. The other terminal of the snap switch 99 is connected through the line 104 with one terminal of the solenoid controlling the control switch 93, while the other terminal of this solenoid is connected to the terminal *m*. When the snap switch is closed, the power lines *c* and *d* will be connected to the control switch 93, provided all of the pilot switches which are in series in the line are closed. It will be apparent, therefore, that if the snap switch is closed manually, the indexing mechanism will be started into operation, provided all of the metal workng units are retracted and the pilot switches closed. This insures that the indexing of the turret cannot be effected by closing the snap switch 99 unless all of the metal working units are retracted so as to permit the free turning of the turret. One of the terminals of the solenoid 95 of the control switch 93 is connected by a line 105 to one of the terminals of the solenoid 98. The other terminal of the solenoid 95 of the control switch 93 is connected through the line 106 with the other terminal of the solenoid 98. When the solenoid 95 is energized, the solenoid 98 which is in multiple therewith, will also be energized. The closing of the snap switch 99 not only operates the control switch 93 under the conditions stated, but also initiates the operation of the time delay switch.

The terminal *r* of the time delay switch is connected through the line 107 to the terminal *f* of the control switch 90. The terminal *s* of the time delay switch is connected through the line 108 with one terminal of the solenoid 95 and the other terminal of the solenoid is connected to the terminal *g*. When the relay switch closes, the solenoid 95 of the control switch 90 will be energized from the power lines *c* and *d*. This will close the switch and connect these power lines to the solenoid 78 of the metal working unit 5 and thus start the operation of this metal working unit. One terminal of the solenoid 95 of the control switch 91 is connected by a line 109 to the terminal *h* of the control switch 90. The other terminal of the solenoid 95 of the control switch 91 is connected through the line 110 with the terminal *i* of the control switch 90. Therefore, when the control switch 90 is closed, it at once energizes the solenoid 95 of the control switch 91 and closes said control switch, which will set into operation the metal working unit 6. The terminals of the solenoid 95 of the control switch 92 are similarly connected through the lines 111 and 112 with the terminals of the control switch 91 so that when this control switch is closed, the solenoid is energized which closes the control switch 92. Therefore, the closing of the time delay switch will start into operation at once the metal working unit 5, which at once starts the metal working unit 6, and the starting of the metal working unit 6 through the closing of the control switch therefor, starts the operation of the metal working unit 7. The closing of the delay switch is so timed as to give a sufficient period for the complete indexing of the metal working turret. Let us assume that the snap switch, when closed, remains closed. This will start into operation the metal working units, after the completion of the indexing, and as each metal working unit completes its cycle, it will close the pilot switch associated therewith, and the last metal working unit to complete its feed cycle closing the last pilot switch in the series, will operate the control switch 95 and also the time delay switch. Thus it is that the indexing is initiated and begins at once, while the next cycle of movement of the metal working units is also initiated, but the operation of the metal working units is delayed through this time switch to enable the completion of the movement of the turret before the metal working units are started, or at least, before the metal working units are brought into engagement with the material. In other words, the metal working units may possibly be started before the indexing movement of the turret is quite completed, but it is essential that the completion of the movement of the turret must be accomplished before the metal working tools engage the material.

When the snap switch is closed, the metal working units will be set into operation and will automatically repeat their feed cycles, and between each feed cycle the material will be shifted so that it is automatically positioned for the operation of one tool and then another. This is assuming that the snap switch remains closed. If it is opened after it is closed to start the operation of the metal working units, then after the completion of the last metal working unit, the units will all stop and no indexing will take place until the snap switch is again closed.

A hand control for the tripping into action of the metal working unit alone is provided by the manually operated hand switch 113. One terminal of the hand control switch 113 is connected through the line 114 with the terminal *a* of the pilot switch 24. The other terminal of the hand control switch 113 is connected through the line 114^a with the terminal *b* of the pilot switch 24. The line 114 leads first to the terminal *r* of the relay switch, and from the terminal *s* of the relay switch to the pilot switch. If the pilot switch 24 is closed, which only happens when the locking pin 19 is in engagement with the opening in the turret and the turret is stopped, then the relay switch is closed and the metal working unit 5 will be started, and this will in turn start the metal working units 6 and 7. The operation of this hand control switch 113 will start the metal working units only under the condition that the turret is in a set position and locked in said set position. In other words, the position of the locking bolt determines whether or not the metal working

units can be initiated by this hand control switch 113.

A hand control has been provided for operating the indexing turret only, and this is accomplished through the control switch 94. One terminal of a hand switch 115 is connected to the line 100. The other terminal is connected through the line 116 with one terminal of the solenoid 95 of the control switch 94. The other terminal of this solenoid 95 is connected with the terminal *m*. When the hand switch 115 is closed, a circuit is established through the solenoid 95 of the control switch 94, provided all of the pilot switches are closed. When this solenoid 95 is energized, the switch 94 is closed, and this energizes the solenoid 44 and initiates the operation of the indexing mechanism. This initiation of the indexing mechanism, however, cannot be effected through this hand control switch 115, unless all of the metal working tools are retracted and the pilot switches closed.

Through the aid of the hand switch 115 the operator may cause the turret to be turned step by step, as desired, without initiating the operation of the metal working units, and through the hand switch 113, the operator may initiate the operation of the metal working units, whenever it is desired. Through the snap switch 99, the operator may cause the machine to pass through one cycle of movement, indexing the material, stopping the turret, initiating the operation of the metal working units, and the stopping of the same when they have completed their feed cycle. The operator may also, upon leaving the snap switch closed, initiate continued cycles of operation of the machine, as the metal working units when they have completed their operation, will initiate the indexing of the turret and will also initiate their own next cycle of operation, but at a delayed time sufficient to permit the indexing of the turret under normal conditions.

It will be noted that the arm 70 is extended so as to provide a handle 70^a (see Fig. 7). Each metal working unit has a similar handle, and the purpose thereof is to enable the operator to manually start any metal working unit without starting the others, if desired.

While an electrically operated control mechanism has been described in detail, it will be understood that from certain aspects of the invention other types of control may be used, but it is essential that there shall be a time delay means which will give sufficient time for the indexing of the turret so that the metal working units may initiate their own operation. It is also obvious that changes in the details of construction and the arrangement of the parts may be made without departing from the spirit of the invention as set forth in the appended claims.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent, is—

1. A metal working machine comprising in combination a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, means for operating each metal working unit including feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, means independent of the operating means for the metal working units for indexing the turret, a control mechanism for directly initiating the feed of the metal working units and for directly initiating the indexing of the work supporting turret, including a time delay means whereby said metal working units may be initiated simultaneously with the initiating of the indexing mechanism and the starting of the metal working units delayed to permit the normal operation of the indexing mechanism before the tools of the metal working units are brought into operation on the material.

2. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, and means for starting and automatically stopping the feed of said spindle when the tool is retracted, including an electrically operated member, an electrically actuated control switch for each member, a pilot switch in each unit which is automatically closed when the tool spindle is retracted, and a control circuit connecting in series the pilot switches for operating the control switches, whereby said switches can be closed for initiating the operation of the metal working units only when the tool spindles are retracted.

3. A metal working machine comprising in combination a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, means for indexing the turret, and an electrically controlled mechanism for initiating the feed of the metal working units and indexing the work supporting turret including a time delay switch whereby said metal working units may be initiated simultaneously with the initiating of the indexing mechanism and the starting of the metal working units delayed to permit the normal operation of the indexing mechanism before the tools of the metal working units are brought into operation on the material.

4. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, and means for starting and automatically stopping the feed of said spindle when the tool is retracted, including an electrically operated member, an electrically actuated control switch for each member, a pilot switch in each unit which is automatically closed when the tool spindle is retracted, a work supporting turret, means for indexing the turret including an electrically operated member, an electrically actuated control switch for said last-named member, a time delay switch, and a control circuit connecting in series the pilot switches and the delay switch, said control circuit connecting in multiple the delay switch and the operating means for the control switch for the indexing mechanism whereby when said circuit is closed, the operation of the indexing mechanism and the delay switch will be simultaneously actuated for immediately initiating the operation of the indexing mechanism and for starting the operation of the metal working units after the indexing mechanism has completed its operation.

5. A metal working machine comprising in combination a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, feeding means for advanc-

ing and retracting said spindle and means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, means for indexing the turret, an electrically controlled mechanism for starting the metal working units including an electrically actuated control switch for each unit, an electrically actuated control switch for starting the indexing mechanism, a pilot switch in each unit which is automatically closed when the tool spindle is retracted, an electrically actuated time delay switch, a circuit controlled thereby for actuating the control switches of the metal working units and a control circuit containing the pilot switches in series for actuating the indexing control switch and the time delay control switch simultaneously, said delay switch being timed so as to permit the completion of the normal operation of the indexing mechanism before the metal working units are brought into operation on the material.

6. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, and an electrically controlled mechanism for initiating the operation of the indexing mechanism and for starting the metal working units a predetermined time after the initiation of the indexing mechanism.

7. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, and an electrically controlled mechanism for initiating the operation of the indexing mechanism and for starting the metal working units a predetermined time after the initiation of the indexing mechanism, said electrically controlled mechanism including devices whereby the initiation of the indexing mechanism can only be accomplished when all of the metal working spindles are retracted.

8. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, and an electrically controlled mechanism for initiating the operation of the indexing mechanism and for starting the metal working units a predetermined time after the initiation of the indexing mechanism, said electrically controlled mechanism including a pilot switch in each metal working unit which is closed when the spindle is fully retracted, said switches being connected in series with the control circuit for initiating the indexing mechanism whereby said indexing mechanism can only be initiated when all of the pilot switches are closed by the retracting of the metal working units.

9. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, an electrically controlled mechanism including an electrically controlled switch for starting each metal working unit, a pilot switch in each metal working unit closed only when the spindle is retracted, a control circuit including in series said pilot switches for closing the switch for starting one of said metal working units, and a circuit controlled by said switch for starting another metal working unit when said switch is closed.

10. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, an electrically controlled mechanism including an electrically controlled switch for starting each metal working unit, a pilot switch in each metal working unit closed only when the spindle is retracted, a control circuit including in series said pilot switches for closing the switch for starting one of said metal working units, a circuit controlled by said switch for starting another metal working unit when said switch is closed, and a pilot switch associated with said work supporting turret and closed only when said turret is stopped, said pilot switch being in series with the control circuit for the switches for the metal working units whereby said circuit can only be closed to start the metal working units when the work supporting turret is stopped.

11. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, an electrically controlled mechanism for initiating the operation of the indexing mechanism and for starting the metal working units a predetermined time after the initiation of the indexing mechanism, and a control means for initiating the operation of the indexing mechanism only when the spindles of the metal working units are fully retracted.

12. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping said turret in a predetermined position, an electrically

controlled mechanism for initiating the operation of the indexing mechanism and for starting the metal working units a predetermined time after the initiation of the indexing mechanism, and a control means for initiating the operation of the metal working units only when the work supporting turret is locked in a stationary position.

13. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for turning said turret and for locking the same in a predetermined position, electrically controlled means for initiating the operation of the metal working units and means controlled by the turret for rendering said electrically controlled means inoperative except when the indexing turret is in a set stationary position.

14. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping the turret in a predetermined position, and electrically controlled mechanism for initiating the operation of the metal working units including a switch controlled by the turret whereby said metal working units can be initiated only when the work supporting turret is in a predetermined stationary position.

15. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning said turret to a predetermined position and for locking said turret in a stationary position, and electrically controlled mechanism for initiating the operation of the metal working units including a switch controlled by the locking means for the turret whereby said metal working units can only be initiated when the turret is locked in a stationary position.

16. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning, and stopping the turret in a predetermined position, electrically controlled mechanism for initiating the operation of the indexing mechanism and means controlled by each metal working unit for rendering said electrically controlled mechanism inoperative except when the tools of the metal working units are retracted.

17. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for turning and stopping the turret in a predetermined position, manually controlled means for initiating the operation of the metal working units and means controlled by the turret for rendering the manually controlled means inoperative except when the work supporting turret is in a stationary position.

18. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for turning and stopping the turret in a predetermined position, manually controlled means for initiating the operation of the turret, means for rendering said manually controlled means inoperative except when the metal working tools are retracted, manually controlled means for initiating the operation of the metal working units and means for rendering said last-named manually controlled means inoperative except when the turret is in a stationary position.

19. A metal working machine comprising in combination a supporting frame, a series of self-contained, independently operated metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, indexing means for automatically turning and stopping the turret in a predetermined position, electrically controlled mechanism manually operated for initiating the operation of the indexing mechanism, means for rendering said electrically controlled mechanism inoperative except when the tools of the metal working units are retracted, an electrically controlled mechanism manually operated for initiating the operation of the metal working units and means for rendering said last-named electrically controlled mechanism inoperative except when the turret is in a stationary position.

20. A metal working machine comprising in combination, a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, means for operating each metal working unit including a feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed of the spindle when a tool is retracted, a work supporting turret, means independent of the actuating means for the metal working units for indexing the turret, a control mechanism for simultaneously initiating the feed of the metal working units and indexing the work supporting turret including means for delaying the starting of the metal working units to permit the normal operation of the indexing mechanism before the tools of the metal working units are brought into operation on the material.

21. A metal working machine comprising in combination, a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, means for operating each metal working unit including a feeding means for advancing and retracting said spindle, means for starting and automatically stopping the feed

of the spindle when the tool is retracted, a work supporting turret, means independent of the actuating means for the metal working units for indexing the turret, and a control mechanism including flexible elements interconnecting the starting means for the metal working units, and the means for indexing the turret for simultaneously initiating the operation of the metal working units and the turret including means for delaying the starting of the metal working units until the indexing turret has been operated and brought to a predetermined stationary position.

22. A metal working machine comprising in combination, a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, means for operating each metal working unit including a feeding means for advancing and retracting said spindle, a work supporting turret, means independent of the actuating means for the metal working units for indexing the turret, a control mechanism for simultaneously initiating the feed of the metal working units and indexing the work supporting turret including means for delaying the start of the metal working units to permit the normal operation of the indexing mechanism before the tools of the metal working units are brought into operation with the material.

23. A metal working machine comprising in combination, a supporting frame, a series of self-contained metal working units, each unit comprising a tool spindle, means for operating each metal working unit including a feeding means for advancing and retracting said spindle, a work supporting turret, means independent of the actuating means for the metal working units for indexing the turret, and a control mechanism including flexible elements interconnecting the means for operating the metal working units and the means for indexing the turret for simultaneously initiating the operation of the metal working units and the turret including means for delaying the start of the metal working units until the indexing turret has been operated and brought to a predetermined stationary position.

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