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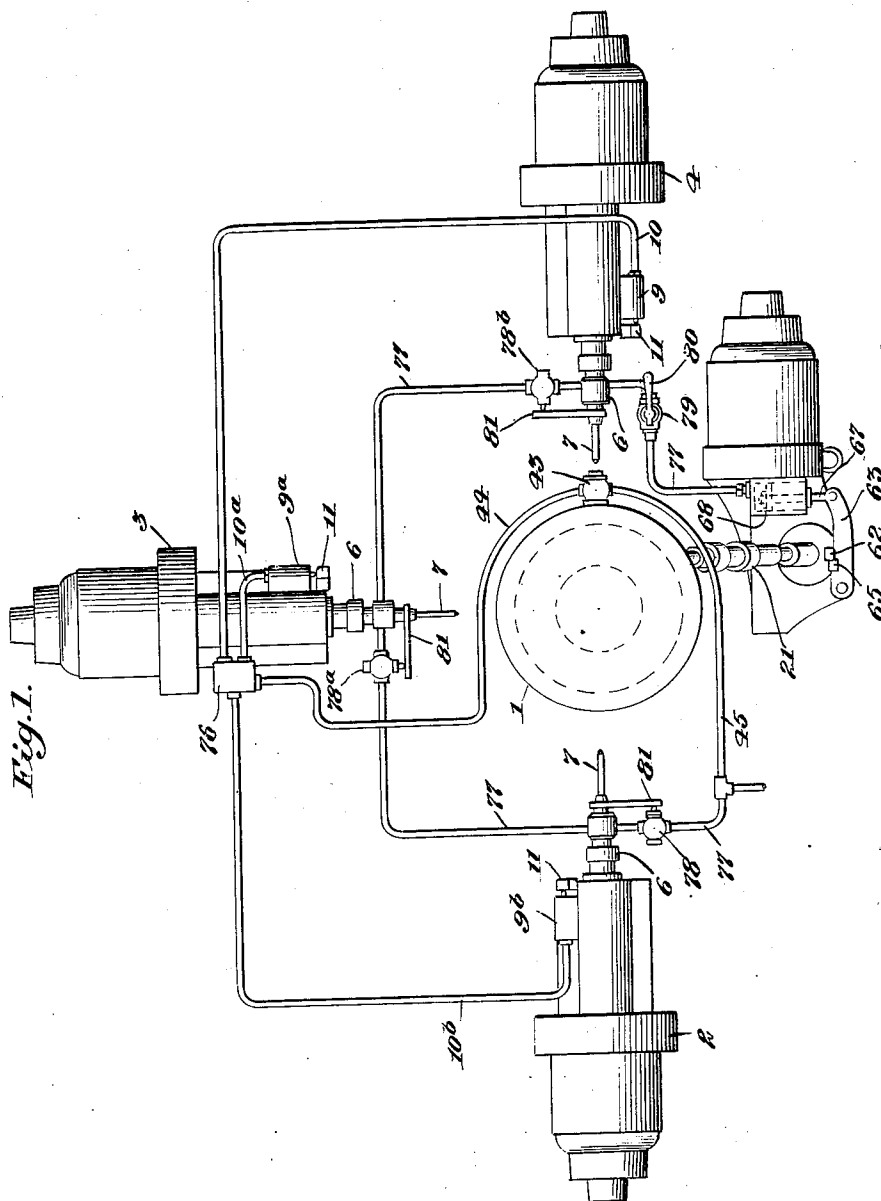
E. J. KINGSBURY ET AL

1,975,005

INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

Original Filed Nov. 6, 1929

6 Sheets-Sheet 1



Inventors.
Edward J. Kingsbury
Sumner Swahnberg
by
Sturtevant Mason
Att'ys.

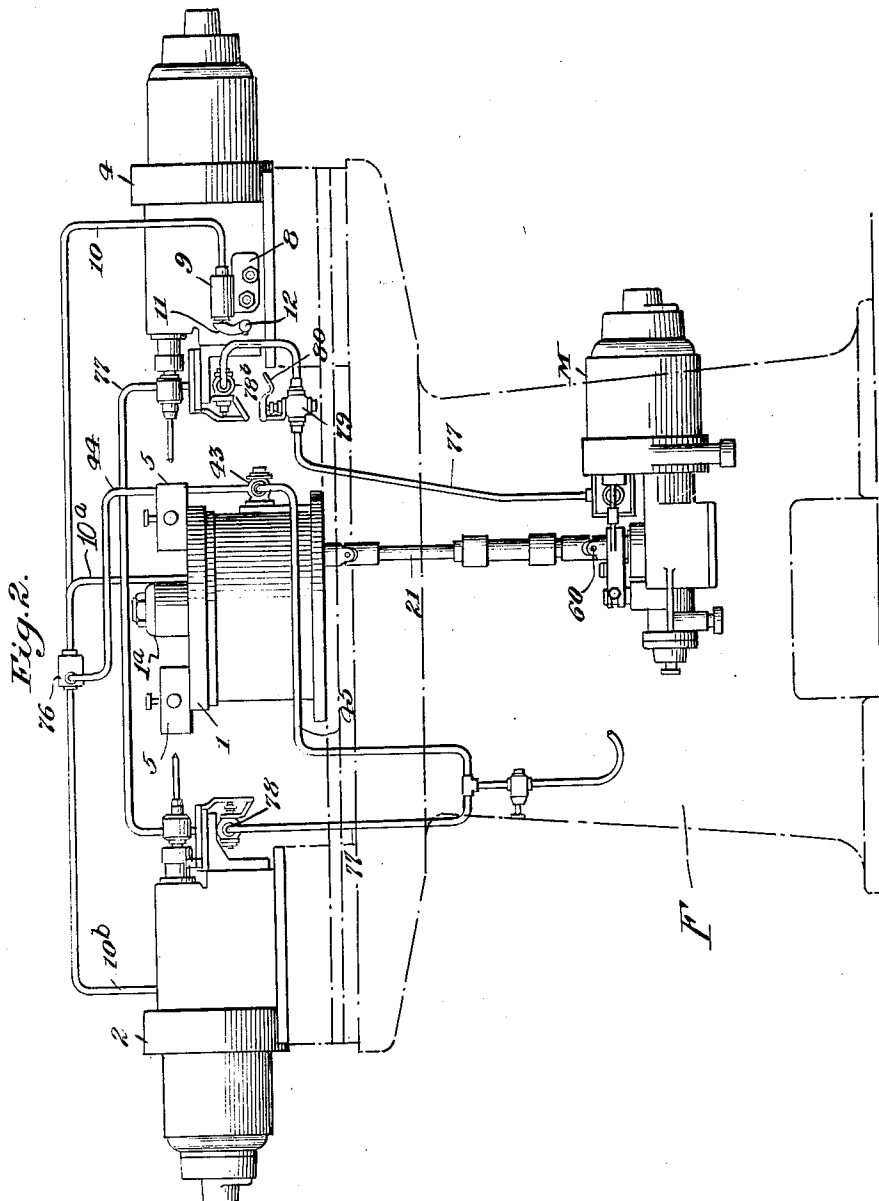
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E. J. KINGSBURY ET AL

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INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

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Inventors
Edward J. Kingsbury
Gunnar Swahberg
by *Sturtevant Mason*
Attys.

Sept. 25, 1934.

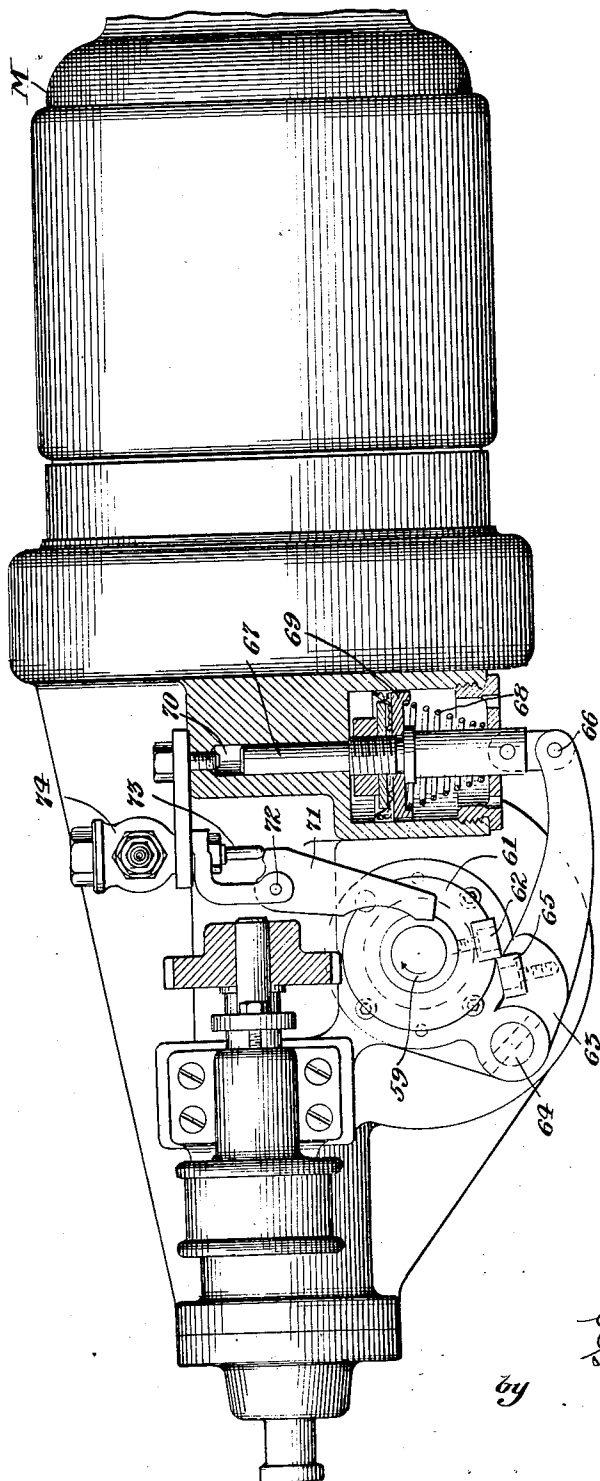
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INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

Original Filed Nov. 6, 1929 6 Sheets-Sheet 3

Fig. 3.



by

Inventors
Edward J. Kingsbury
Gunnar Swahberg
Sturtevant Mason
Attys.

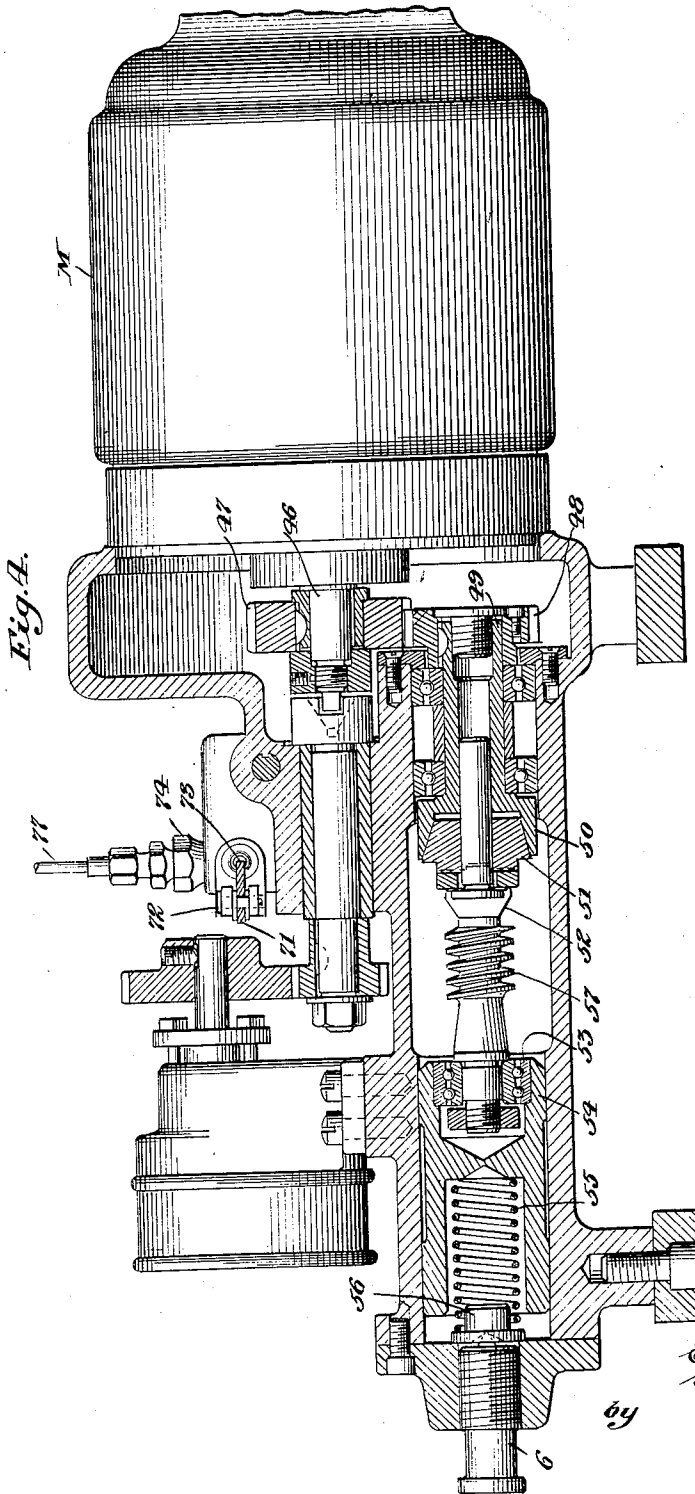
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INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

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Inventors
Edward J. Kingsbury
Sumner Swahinberg
by
Sturtevant & Mason
Att'ys.

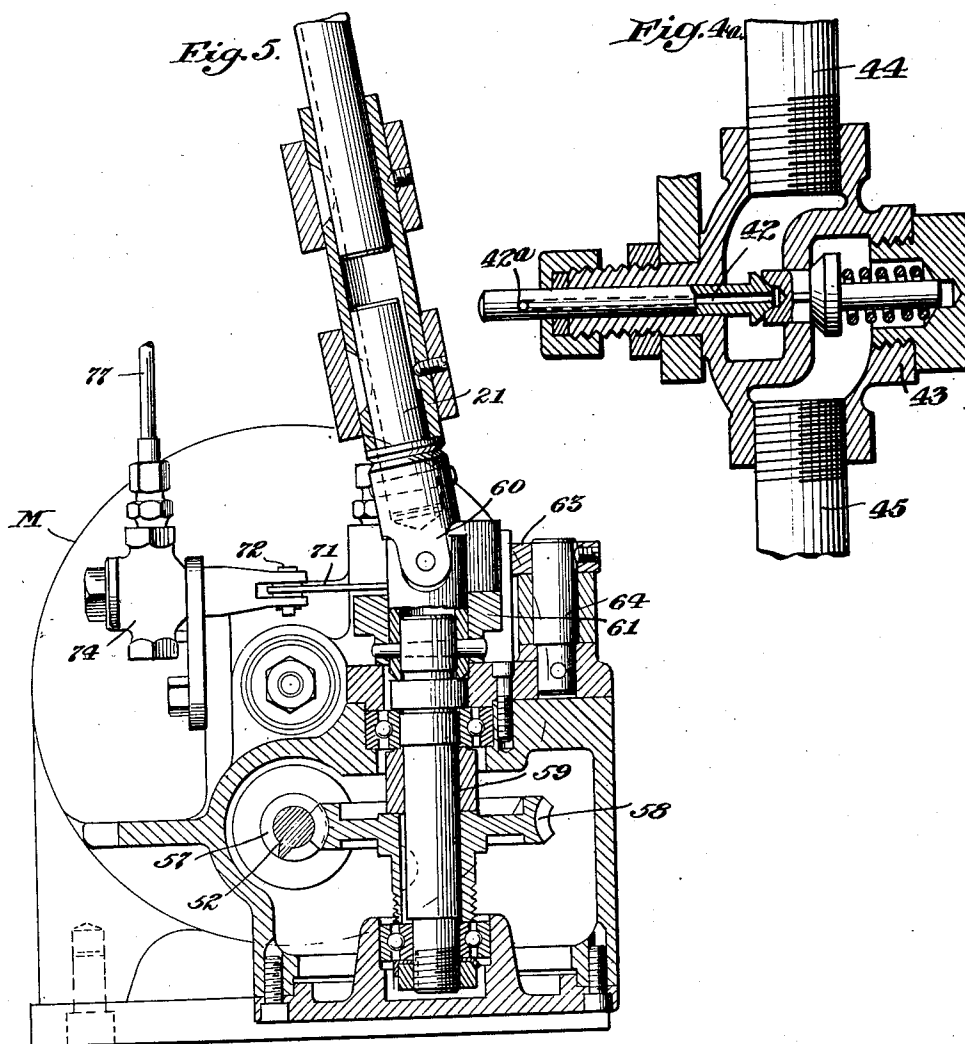
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E. J. KINGSBURY ET AL

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INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

Original Filed Nov. 6, 1929 6 Sheets-Sheet 5



Inventors
Edward J. Kingsbury
Linnar Swahnberg
by
Stewart Mason
Att'ys.

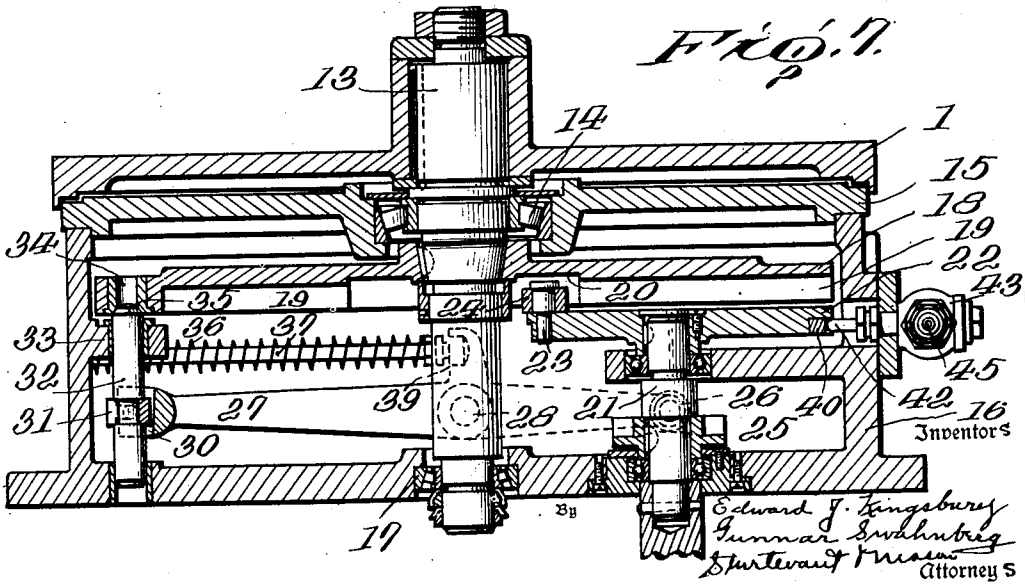
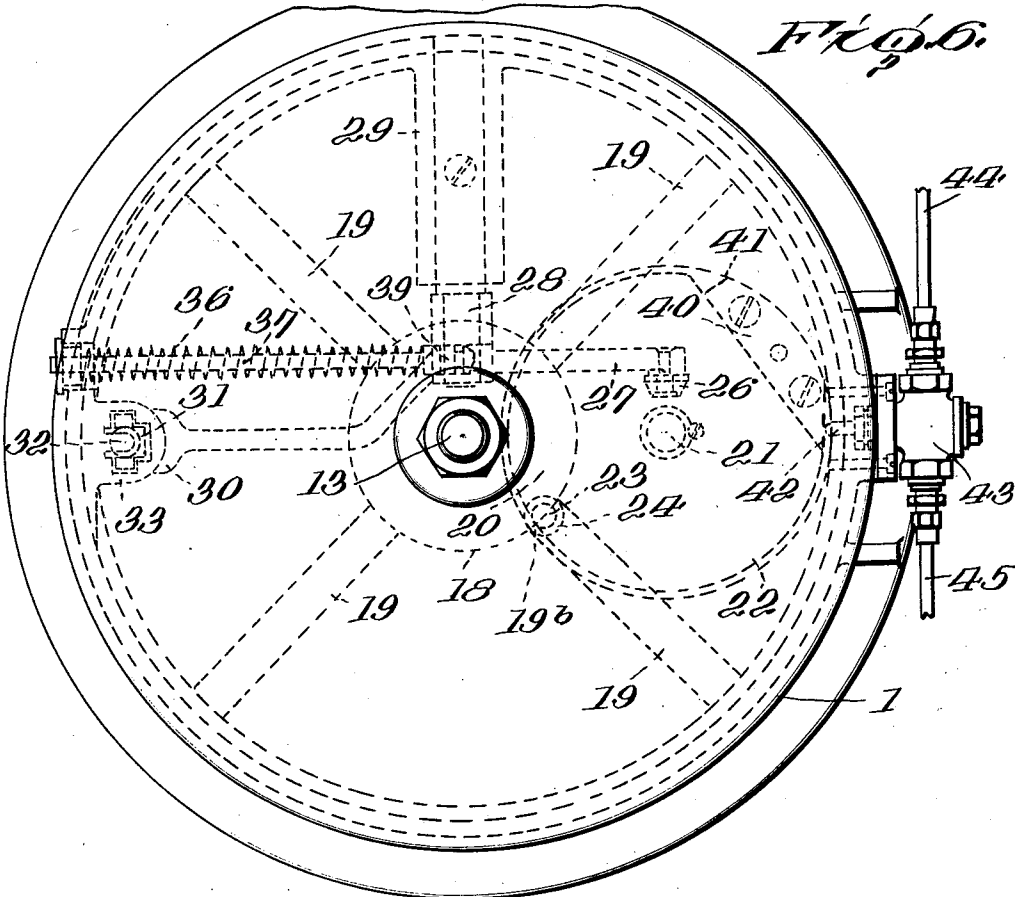
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INDEXING AND CONTROL MECHANISM FOR A METAL WORKING MACHINE

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UNITED STATES PATENT OFFICE

1,975,005

INDEXING AND CONTROL MECHANISM FOR
A METAL WORKING MACHINE

Edward J. Kingsbury and Gunnar Swahnberg,
Keene, N. H., assignors to Kingsbury Machine
Tool Corporation, Keene, N. H., a corpora-
tion of New Hampshire

Application November 6, 1929, Serial No. 405,172
Renewed February 21, 1934

40 Claims. (Cl. 29—38)

The invention relates to a new and useful im-
provement in an indexing and control mechanism
for a metal working machine wherein the material
to be operated upon is presented in succession to
a series of metal working units.

An object of the invention is to provide an in-
dexing and control mechanism for a machine of
the above character wherein the indexing device
operates through a control means for initiating
the operation of the metal working units and the
metal working units in turn operate through a
control mechanism for initiating the next cycle of
operation of the indexing device after each metal
working unit has completed its operation.

A further object of the invention is to provide
a machine of the above type wherein the operation
of the control means for the indexing device is
rendered ineffective until the working tool at each
metal working unit is fully retracted from engage-
ment with the material operated upon.

A further object of the invention is to provide
a machine of the above type with fluid pressure
controlled means operating in common on the
indexing device and the metal working units,
which fluid pressure means is under manual con-
trol for starting and stopping the machine.

A still further object of the invention is to pro-
vide an indexing device and control mechanism
of the above type wherein the indexing turret is
rotated intermittently by a motor driven actu-
ating device.

A still further object of the invention is to pro-
vide an indexing and control mechanism of the
above type wherein the motor driven actuating
device includes a friction clutch which is auto-
matically released upon stoppage of the move-
ment of the indexing turret.

These and other objects will in part be obvious
and will in part be hereinafter more fully dis-
closed.

In the drawings which show by way of illustra-
tion one embodiment of the invention:—

Figure 1 is a plan view showing diagrammati-
cally the layout of a machine embodying the in-
vention.

Fig. 2 is a similar diagrammatic layout in side
view of the machine, only two of the metal work-
ing units being illustrated.

Fig. 3 is a horizontal sectional view through the
motor driven actuating device for the indexing
turret.

Fig. 4 is a vertical sectional view through said
motor driven actuating device, in a plane parallel
to the motor shaft and showing the friction driv-
ing clutch.

Fig. 4a is a horizontal sectional view through
the fluid pressure control valve at the indexing
turret.

Fig. 5 is a vertical sectional view through said
motor driven mechanism in a plane at right angles
to the main actuating shaft and showing the
worm gear connection for driving the turret.

Fig. 6 is a top plan view of the indexing turret
with the work holders removed.

Fig. 7 is a vertical sectional view through the
indexing turret.

The invention is directed to an indexing and
control mechanism for a metal working machine
including a series of metal working units. These
metal working units may be drill spindles, milling
spindles or any other suitable metal operating
units. The metal working units are preferably
provided with tools for operating in sequence upon
a piece of metal for accomplishing the desired
result. Associated with these working units is a
work holding turret or indexing device which
presents the material first to one metal working
unit and then to another. The indexing turret
is operated by a motor driven actuating device
which preferably includes a friction clutch
adapted to separate and automatically discon-
nect the actuating mechanism from the indexing
turret provided said indexing turret in one oper-
ation engages an obstruction and stops. The in-
dexing turret is preferably driven by a motor
driven actuating device which imparts an inter-
mittent rotation thereto.

Each metal working unit is preferably motor
driven and includes an actuating spindle carry-
ing the operating tool. Means is provided for
rotating the tool and for feeding the tool forward
into engagement with the material and for re-
tracting the tool when the operation is completed.
Each working unit, therefore, includes an auto-
matic starting and stopping mechanism. The
motor driven actuating device for operating the
indexing turret is also provided with automatic
means for starting and stopping the actuation of
the turret. The control system for the index-
ing turret and the metal working units is prefer-
ably of the fluid pressure type. There is a pipe
leading from a source of fluid under pressure
which is connected with the control mechanism
for the indexing device and also connected with
each control mechanism for the metal working
units.

Associated with the indexing turret is a con-
trol valve for fluid pressure. There is a pipe
leading from the source of fluid supply to this
valve, and there is a pipe leading from this con-

trol valve to the automatic starting and stopping mechanism of each metal working unit. When the indexing turret has properly positioned the material for the operation of the metal working units, the valve is opened so as to start the metal working units, and after having started the metal working units, the valve closes, shutting off the fluid supply so that each metal working unit after it completes its cycle may be automatically stopped.

As noted, each metal working unit is provided with means for automatically stopping the same when the tool has finished its operation and is withdrawn from the material. Associated with each metal working unit is a valve which is connected to the pressure controlled means so that the fluid pressure is shut off from the indexing and control mechanism until each of the metal working units has completed its operation after which the actuating mechanism for the index device is set into operation.

Referring more in detail to the drawings, in Figs. 1 and 2 of the drawings, the layout of the machine embodying the invention is shown diagrammatically and the machine includes an indexing turret 1 associated with which is a series of metal working units, three of which are indicated in the drawings at 2, 3 and 4 respectively. It is understood that a number of units may be provided and the control system readily adjusted to the additional units. The indexing device is provided with a series of work holders 5, 5. Each metal working unit includes a spindle 6 provided with a working tool 7. The metal working units illustrated are of the type shown in Patent #1,780,083 granted to Edward J. Kingsbury, October 28, 1930. Each metal working unit includes not only the spindle 6 and the working tool 7, but a feeding means which advances and retracts the tool spindle. There is also a motor mounted in said unit for independently operating the spindle and feeding means. This metal working unit also includes a friction clutch between the motor and the feeding mechanism and an automatic control means whereby the feeding of the spindle is started or set into operation and after the feed has completed a cycle and the spindle is retracted, the feed is automatically stopped. This feeding mechanism and the starting and stopping mechanism therefor is all disclosed in detail in the patent referred to and further description thereof is not thought necessary. These metal working units as embodied in the present machine are separately and independently mounted on the bed or frame F and disposed in a predetermined fixed position relative to the work supporting turret as indicated in Figure 1 of the drawings.

Attached to each metal working unit is a supporting bracket 8 on which is mounted a control cylinder 9. Attached to this control cylinder is a fluid pressure pipe 10. When fluid is admitted to the pipe 10 the piston within the cylinder 9 operates the plunger which engages the arm 11 on the control shaft 12 which initiates the operation of the feeding mechanism for the drill spindle. The initiating of the feeding mechanism of the metal working unit is accomplished by withdrawing the block from the path of travel of the stop on the control cam for feeding the spindle. When the cylinder 9 is cut off from the fluid supply, and opened to the atmosphere, then the spring will shift the block into the path of travel of the stop, and this will automatically stop

the feed of the metal working units. Each metal working unit, therefore, completes a cycle of movement and is then automatically stopped. All of the metal working units are similar in construction and each is provided with its own fluid controlled starting mechanism.

The indexing turret or table 1 (see Figs. 6 and 7) includes a center shaft 13 to which the turret 1 is attached. It is understood that this turret 1 is provided with a hub 1a and that different types of work holders may be mounted on this turret. The shaft 13 is mounted in a suitable supporting bearing 14 carried by the support 15 which is in turn mounted on the frame of the machine. Beneath the turret 1 is a housing 16 in which the actuating mechanism for the turret is placed. The lower end of the shaft 13 is mounted in a ball bearing 17 carried by the housing 16. Attached to the shaft 13 is a disc 18 provided with a series of radial slots 19. These radial slots are spaced for position in a predetermined angular relation to each other. There is an annular recess 20 in the under face of the disc at the inner end of these radial slots so that the radial slots extend from the periphery of the disc 18 to this annular recess 20 which is preferably of slightly greater depth than the radial slots.

Mounted in the housing 16 is a shaft 21. The shaft 21 carries a disc 22 at its upper end on which is mounted a crank pin 23 carrying a roller 24. As the shaft 21 rotates this roller 24 will enter the radial groove 19a (see Fig. 6) and will cause said disc and turret to rotate in the direction of the arrow until the slot reaches the position 19b when the roller passes out of the slot. The roller then moves in the annular recess and leaves all control of the disc until it enters the next radial slot. Also mounted on this shaft 21 is a locking cam 25. This locking cam 25 operates upon a roller 26 attached to a lever 27 pivotally mounted on a stub shaft 28 which in turn is fixed to a bearing 29 formed in the part of the housing 16. This lever 27 has a forked end 30 which straddles a lug 31 projecting from a locking bolt 32. The locking bolt 32 is mounted to slide vertically in suitable bearings 33, 33. The disc 18 is provided with a series of bushings 34 adapted to receive the upper rounded end 35 of the locking bolt 32. A spring 36 surrounds a rod 37 which bears against an abutment arm 39 carried by the lever 27. The other end of the spring bears against the housing and the rod passes freely through the housing. The spring bears against a shoulder on the rod adjacent the arm 39 and normally tends to swing the lever 27 in a clockwise direction so as to hold the roller 26 in engagement with the cam face 25. This cam is so constructed and timed that when the roller 24 moves out of the radial slot so as to release control of the disc 18 and the indexing turret attached thereto the lever will be oscillated and the locking bolt 32 projected into locking engagement with the disc 18.

This provides a mechanism whereby the disc 18 will be rotated positively at intervals and after it has passed through a certain angular range of motion it will come to a stop and be locked and held in this position until the next operation of the roller thereon. The cam, of course, releases the bolt at the time that the roller takes up the disc for rotating the same. This provides an intermittent rotating turret which will position the material first at one operating station and then at another operating station. The metal working units are, of course, so positioned relative to the

turret as to operate upon the material while the turret is at a standstill.

On the rotating disc 22 is an inserted hardened cam plate 40. This cam plate is provided with a high point 41. As the disc 22 rotates this high point of the hardened plate comes into contact with a rod 42 which is the stem of an air control valve. This air control valve is of the usual construction and includes a valve casing 43 which is attached to the housing 16. The rod 42 is pressed by a spring in a direction toward the indexing turret so that when the control cam on the indexing turret releases the stem, the valve will close. The valve stem has an opening 42a therein which leads to the atmosphere, and when the valve seats and closes, this opening is outside of the casing of the valve and is uncovered and it will vent the pipe lines leading to each metal working unit in the usual manner of fluid pressure control valves. The cam, as noted, has a high point 41, and this high point is timed so that the valve is opened to start the metal working units after the turret comes to a stop, but it releases the valve so as to shut off the fluid supply before the cam comes to a stop. A pressure pipe 44 leads to the trips for the metal working units as will be more fully disclosed, and a pressure pipe 45 leads from this valve casing to the supply. The purpose of this valve is to open this supply pipe so that the fluid pressure will be released for starting or setting into operation the metal working units. It is essential that the metal working units shall be restrained from operation until the indexing turret has come to a standstill and the material properly positioned for the metal working units to operate thereon. The valve when it closes cuts off the fluid supply to the control cylinders 9 at the metal working units, releasing the fluid pressure on said cylinders so as to permit the automatic stopping of the metal working units when the feed cycle has been completed.

The shaft 21 which operates the indexing turret is in turn operated by a motor actuating mechanism. This motor actuating mechanism is shown in detail in Figs. 3, 4 and 5. Said mechanism includes a motor M which actuates a shaft 46. On said shaft 46 is a gear wheel 47 which meshes with a gear wheel 48 on a countershaft 49. The countershaft 49 carries a friction clutch sleeve 50 which cooperates with a friction clutch member 51. The friction clutch member 51 is carried by a shaft 52 which is journaled in a bearing 53 carried by a movable sleeve 54. A spring 55 bears against the sleeve at one end and against an adjustable abutment 56 at the other end and normally moves the shaft section 52 so as to bring the friction clutch members into engagement. On this shaft section 52 is a spiral gear 57. The spiral gear 57 meshes with a worm gear 58 attached to a vertical shaft 59 which is connected to the shaft 21 by a universal joint connection 60. It will thus be seen that as the motor turns the main shaft this spiral gear 57 will be rotated as long as the friction clutch members are in engagement and will impart rotation to this shaft 21. If the shaft 21 is stopped by means of the turret striking an obstruction, then the spiral gear will travel on the worm so as to unseat the friction clutch. This stops the rotation of the shaft 21 until the obstruction is removed so that the turret can move forward. This provides a means whereby the turret is driven by a motor actuating mechanism and

whereby in case of stoppage the actuating mechanism for the turret is disconnected.

Mounted on the shaft 59 is a hub 61 carrying a stop lug 62. A stop lever 63 is pivoted at 64 to the casing in which the shaft 59 is mounted and this stop lever carries a hardened stop block 65. When the lever is in the position shown in Fig. 3 the stop block 62 on the hub contacts with the stop block on the stop lever and the parts will be held from rotation. When the stop lever is holding the shaft 59 from rotation then the spiral gear 57 will travel on the worm and disconnect the friction clutch members. The motor is not stopped but the shaft 59 is stopped and, therefore, the actuating mechanism comes to rest. When the stop lever is withdrawn from the path of rotation of the stop block 62, then the shaft 59 will make one rotation and if the stop lever is again pressed so that the block on the rotating part engages the block on the stop lever, then the shaft will again be stopped.

In other words, the shaft makes one complete rotation and then stops. This is the cycle of operation of the indexing mechanism. The parts are so timed that when the roller on the disc 22 has completed its rotation of the indexing device and has moved out of one of the radial slots said roller will, therefore, remain at rest in the annular recess, thus giving the operating units time to perform their operations before the indexing device is again set into operation to move the material to the next operating station. The cam 40 as already noted, has a high point which engages the stem of the air-controlled valve for opening the same, as soon as the high point passes, the valve closes. This is accomplished before the rotating shaft carrying the disk 22 comes to a stop, although the turret ceased its movement when the roller left the radial recess. The metal working units are, therefore, disconnected from the air pressure and can stop after completing a cycle of operation in the manner which has been described above.

The stop lever 63 is connected by means of a link 66 with a piston rod 67 associated with a fluid pressure cylinder 68. On said rod is a piston 69. When fluid under pressure is admitted to the end 70 of the cylinder 68 the piston 69 is moved downwardly as viewed in Fig. 3 and this will move the stop lever 63 so as to withdraw the block 65 from the path of movement of the blocks 62 and permit the shaft 59 to rotate.

Associated with this control mechanism is a pressure releasing device which includes a lever 71 pivoted at 72 to a suitable bracket carried by the frame of the machine. This releasing lever 71 overlies the rotating hub 61. The block 62 as it rotates engages this releasing lever and swings the same in a counterclockwise direction causing the lever to press on a valve rod 73 which operates on a valve in a casing 74 to release the cylinder 68 from the fluid pressure. Thus it is that after the shaft 59 is set into operation it operates automatically to release the fluid pressure from the piston 69 and the spring 74a will move the piston in the cylinder and position the stop lever so that the block 62 will engage the block 65 when the shaft has completed its rotation.

The remainder of the control mechanism for the metal working units and the motor driven actuating mechanism will now be described. The pressure pipe 44 extends to a common distributing chamber 76. The pipe 10 leads from this

common supply chamber 76 to the cylinder 9 which has been described above. There is a pipe 10 leading to the control cylinder for the metal working unit 4, a pipe 10a which leads to the cylinder 9a for the metal working unit 3, and a pipe 10b which leads to the cylinder 9b for the metal working unit 2. A pipe 77 leads from the supply pipe 45 to a valve casing 78 associated with the metal working unit 2. The pipe passes from this valve casing and is connected with a similar valve casing 78a associated with the metal working unit 3. It passes from this valve casing to the valve casing 78b associated with the metal working unit 4. It passes from this valve casing 78b to a valve casing 79. The valve in the valve casing 79 is controlled by a hand lever 80. The pipe 77 passes from this valve casing 79 to the cylinder 68.

Associated with the valve casing 78 is a valve which is operated by the return of the spindle of the metal working unit to its retracted idle position. Attached to the spindle is a projecting arm 81. This arm 81 engages a projecting valve stem and opens the valve so that the valve in the valve casing 78 is opened allowing a free passage of the fluid pressure through the pipe. There is a similar valve associated with each unit and the pipe 77 leads through all of these valves in series to the hand controlled valve 80. Therefore, no fluid can be passed through the pipe 77 from the supply to the hand controlled valve 80 except when the spindles of each metal working unit are retracted and in idle position. After the material to be operated upon has been properly placed in the work holders on the turret the operator depresses the valve 80 and allows the pressure fluid flowing through the pipe 77 to pass to the cylinder 68 and this will operate to move the stop lever so as to release the shaft 59 and the shaft 59 will rotate through one cycle of rotation. The machine is usually provided with an idle station for the positioning of the material in the work holder on the turret and after it is positioned then this rotation of the turret through the releasing of the valve 80 will carry the material to the first operating station where the metal working unit performs its operation thereon. After the shaft 59 is released the turret is rotated by the rotation of the shaft 21. The roller on the disc 18 when set into motion passes into one of the radial slots. The rotation of the shaft also releases the turret and it is turned through one step movement or cycle and the material positioned as stated above. When the turret has completed this step movement then the roller passes out of the radial slot; the turret is locked and at this time the shaft 59 has completed its rotation; the stop lever has been returned to operative position so as to stop the shaft 59. At the same time the turret comes to its proper position for presenting the material to the metal working units. The cam 40 on the disc 22 releases the control valve in the supply pipe so that fluid pressure is supplied to the distributing head 76 and through the pipe 10 to the control valves at each metal working unit. Thus it is that the metal working units are started or set into operation. The high point 41 on the cam 40 passes the stem of the valve 43 so as to release the valve before the disc 22 carrying the cam comes to a stop. This also releases the pressure on the control cylinders at the metal working units so that each metal working unit after it completes its cycle will automatically stop. The spindle moves forward and the tools perform

their operation upon the material after which they are retracted and the metal working unit brought to a stop. Upon the retraction of the spindles the valves in the supply pipe 77 are all opened so that fluid pressure is again supplied to the cylinder 68 and this releases the block 62 and starts the shaft 59 thus initiating the next cycle of operation of the index actuating means. From the above description it will be noted that a metal working machine has been provided which comprises a series of self-contained independently operable metal working units which are separately mounted on a supporting frame, each unit comprises a tool spindle and a feeding or translating means for advancing and retracting the spindle and also a control means for starting the feeding movement of the spindle and automatically stopping the feeding means at the end of the feed cycle when the tool is retracted. The machine also includes a work supporting turret which is intermittently rotated for presenting the material operated upon in succession to these metal working units and control means for starting the turret, and for automatically stopping the same in predetermined set positions. In addition to the control means for the turret and the control means for each metal working unit, there is a control mechanism including flexible elements; that is, the pipes which interconnect the starting means for the metal working units with the rotating means for the turret so that the movement of the means which rotates the turret will control the starting of the metal working units, and this control mechanism is of such a character that the metal working units will not be started until the turret has properly positioned the material for the operation of the tools thereon. This control mechanism also includes flexible elements interconnecting the starting means for the turret with the metal working units, so that the control mechanism only initiates the operation of the turrets when all of the metal working units have completed their feed cycles and the tool spindles thereof are retracted.

Through the use of these self-contained metal working units and the flexible interconnecting means the metal working units may be placed as desired, so long as they are within the range of the material for operation thereon.

It is obvious that minor 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 fully described our invention, what we claim as new and desire to secure by Letters Patent, is:—

1. An indexing and control mechanism for a metal working machine including a series of metal working units, a rotatable turret for presenting the material operated upon in succession to the working units, means for rotating said turret intermittently including a vertical shaft, an actuating motor, a sectional shaft operated by the motor carrying a spiral gear meshing with a worm gear on said vertical shaft, said sectional shaft being connected by friction clutch members, spring means for moving the shaft section carrying the spiral gear so as to cause said clutch members to engage with each other, a stop mechanism for stopping said vertical shaft when it has made one complete rotation, fluid pressure means controlled by the metal working units for releasing the stop mechanism so as to permit the shaft to rotate and the turret to be

turned from one set position to another set position after all of the metal working units have completed their operation.

2. An indexing and control mechanism for a metal working machine including a series of metal working units, a rotatable turret for presenting the material operated upon in succession to the working units, means for rotating said turret intermittently including a vertical shaft, an actuating motor, a sectional shaft operated by the motor carrying a spiral gear meshing with a worm gear on said vertical shaft, said sectional shaft being connected by friction clutch members, spring means for moving the shaft section carrying the spiral gear so as to cause said clutch members to engage with each other, a stop mechanism for stopping said vertical shaft when it has made one complete rotation, fluid pressure means controlled by the metal working units for releasing the stop mechanism so as to permit the shaft to rotate and the turret to be turned from one set position to another set position after all of the metal working units have completed their operation, said stop mechanism having means for releasing the fluid pressure during the cycle of rotation of the vertical shaft whereby said stop mechanism may become effective to stop the shaft upon completion of its rotation.

3. A metal working machine comprising in combination a series of self-contained motor operated metal working units each including a starting and automatic stopping mechanism for stopping the unit after each feed cycle, a work supporting turret for presenting the material operated upon in succession to the working units, a motor operated indexing mechanism for intermittently rotating said turret including a driving shaft, a driven shaft, friction clutch members between said shafts, an actuated shaft operated by said driven shaft for turning said turret from one fixed set position to another fixed set position, a locking means for holding the turret in a set position controlled by said actuated shaft, a stop mechanism for separating the clutch members and stopping the driven shaft, means controlled by the metal working units for releasing the stop mechanism and starting the indexing mechanism after each metal working unit has completed its cycle of operation, and means operated by the indexing mechanism for starting the metal working units after the indexing mechanism has completed its cycle of operation.

4. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, a power operable means in said working unit for independently operating the spindle and feeding means, and a control means for starting and for automatically stopping the feeding means at the end of a feed cycle when the tool is retracted, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units, a control means for starting and for automatically stopping the turret in predetermined set positions, and a control mechanism including flexible elements inter-connecting the starting means for the metal working units with the rotating means for the turret and the starting means for the turret with the

metal working units and operating to simultaneously initiate the operation of the metal working units as the turret completes its movement to set position and operating to initiate the operation of the turret when all the metal working units have completed their feed cycle and the tool spindles thereof are retracted.

5. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, 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 mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units including friction clutch members, a control means for automatically stopping the turret and separating said friction clutch members, a starting means for releasing the turret and for closing said clutch members, a control mechanism including flexible elements inter-connecting the starting means for the metal working units with the rotating means for the turret and the starting means for the turret with the metal working units and operating to simultaneously initiate the operation of the metal working units as the turret completes its movement to a set position, and operating to initiate the operation of the turret when all the metal working units have completed their feed cycle and the tool spindles thereof are retracted.

6. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable spindle, power operable means for independently rotating and translating said spindle, means controlled by the translating means of each unit for stopping said translating means on the completion of a work cycle, and a fluid pressure control means associated with each metal working unit for starting the new work cycle, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units, fluid pressure control means for starting and for automatically stopping the turret in predetermined set positions, a fluid pressure line connected to the control means of each unit, a valve in said line and means operable by the turret rotating means for opening the valve as the turret completes its movement to a set position for releasing a fluid pressure for simultaneously initiating the operation of the metal working units, a fluid pressure line connected to the starting means for the turret, a valve in said line at each metal working unit operated by the feed spindle for releasing a fluid pressure when all of the valves at the metal working units are open for initiating the operation of the turret.

7. In a metal working machine in combination with a bed, a table rotatable thereon, and a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said table and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon sep-

- arate pieces of work and successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same and intermittently reciprocating the same toward and away from the pieces of work, each power operable means being arranged for single cycle automatic operation, and a single means for simultaneously initiating the reciprocation of each of said tools.
8. In a metal working machine in combination with a bed, a table rotatable thereon, and a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said table and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon separate pieces of work and a successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same and intermittently reciprocating the same toward and away from the pieces of work, each power operable means being arranged for single cycle automatic operation, a reciprocation movement starting control, and means remotely operable and operatively associated with each starting control for simultaneously and remotely initiating the reciprocation of each of said tools.
9. In a metal working machine in combination with a bed, a table rotatable thereon, and a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said table and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same and intermittently reciprocating the same toward and away from the pieces of work, each power operable means being arranged for single cycle automatic operation, and a single means for simultaneously initiating the reciprocation movement of each of said tools, said single means including a manually operable control member adjacent the loading and unloading station of said machine.
10. In a metal working machine in combination with a bed, a table rotatable therein, and a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said table and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same and intermittently reciprocating the same toward and away from the pieces of work, each power operable means being arranged for single cycle automatic operation, each power operable means including a starting control, and means remotely operable and operatively associated with each starting control for simultaneously and remotely initiating the reciprocation of each of said tools, said single means including a manually operable control member adjacent the loading and unloading station of said machine.
11. A metal working machine comprising in combination a supporting frame, a turret rotatable thereon, a plurality of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable means for independently rotating and feeding said spindle, said metal working units being arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said turret and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tool spindles for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, means controlled by the feeding means for stopping the feed automatically when said spindle is fully retracted, means associated with each metal working unit for starting the feed thereof, means independent of said metal working units for rotating said turret and a single control means for simultaneously initiating the feeding means of the metal working units.
12. A metal working machine comprising in combination, a supporting frame, a turret rotatable thereon, a plurality of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and axially movable tool spindle, feeding means for advancing and retracting said spindle, power operable means for rotating and feeding said spindle, said metal working units being arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said turret and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tool spindles for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, means controlled by the feeding means for stopping the feed automatically at the end of each cycle of operation, means associated with each metal working unit for starting the feed thereof, means independent of said metal working units for rotating said turret and a single control means operated from said turret rotating means for simultaneously initiating the feeding means for the metal working units, said control means including flexible elements interconnecting the starting means of the metal working units and the single control means.
13. A metal working machine comprising in combination, a supporting frame, a turret rotatable thereon, a plurality of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and axially movable tool spindle, feeding means for advancing and retracting said spindle, a motor for operating the spindle and feeding means, said metal working units being arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said turret and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tool spindles for simultaneous operation upon the same piece of work, means controlled by the feeding means for stopping the feed automatically at the end of each cycle of operation, means associated with each metal working unit for starting the feed thereof, means for rotating said turret to

set positions and means controlled by said rotating means for locking the turret in a set position while the metal working units are operating on the work, a pneumatically operated control means for simultaneously initiating the reciprocation of said tool spindles, and a single valve for controlling the same.

14. A metal working machine comprising in combination, a supporting frame, a work supporting turret rotatable thereon, a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said turret and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same, and intermittently feeding the same toward and away from the pieces of work, means controlled by each power operable feeding means for stopping the feed automatically at the end of each cycle of operation, means associated with each tool for starting the feed thereof, including a control cylinder, a plunger therein adapted to start the feed of the tool when operated, a control valve, a source of fluid pressure connected thereto, and a pipe extending from said control valve to each cylinder whereby fluid pressure may be simultaneously admitted to all of said cylinders for starting the feed of the tools.

15. A metal working machine comprising in combination, a supporting frame, a work supporting turret rotatable thereon, a plurality of tools arranged in spaced relation for successive operation upon a piece of work and positioned adjacent thereto, a plurality of work holders arranged in spaced relation upon said turret and similarly spaced for simultaneously presenting a plurality of like pieces of work to said tools for simultaneous operation upon separate pieces of work and successive operation upon the same piece of work, independent power operable means for each tool for continuously rotating the same, and intermittently feeding the same toward and away from the pieces of work, a spring-positioned trip lever associated with each metal working unit for automatically stopping the feeding means when the spindle is fully retracted, and a fluid pressure control means for simultaneously moving said trip levers of the metal working units for initiating the feeding means.

16. An automatic indexing and control mechanism for a metal working machine including a series of metal working units, a rotatable turret for presenting the material operated upon in succession to the working units, means for rotating said turret intermittently, including an operating shaft, a crank carried thereby, an indexing disk having radial slots into and out of which the crank passes for moving the turret, a worm gear for driving said operating shaft, a spiral gear meshing with said worm gear, a shaft section carrying the spiral gear, a driving shaft section in alignment with the shaft section carrying the spiral gear, clutch members interposed between said shaft sections, a spring for moving said shaft section carrying the spiral gear endwise for closing the clutch members, and an adjustable abutment member bearing on said spring whereby the tension on the spring may be varied.

17. An automatic indexing and control mechanism for a metal working machine including a

series of metal working units, a rotatable turret for presenting the material operated upon in succession to the working units, means for rotating said turret intermittently, including an operating shaft, a crank carried thereby, an indexing disk having radial slots into and out of which the crank passes for moving the turret, a worm gear for driving said operating shaft, a spiral gear meshing with said worm gear, a shaft section carrying the spiral gear, a driving shaft section in alignment with the shaft section carrying the spiral gear, clutch members interposed between said shaft sections, a spring for moving said shaft section carrying the spiral gear endwise for closing the clutch members, an adjustable abutment member bearing on said spring whereby the tension on the spring may be varied, a stop member moving with said shaft operating the turret, and a control member adapted to move into the path of the stop member for stopping the same when said operating shaft from the turret has completed one revolution, said spiral gear operating to move the shaft section on which it is mounted endwise upon the stopping of said operating shaft so as to separate the clutch members until said control member is released.

18. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable in said working unit for independently rotating the spindle and operating the feeding means, a control means for starting and automatically stopping the feeding means at the end of a feed cycle when a tool is retracted, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material to be operated upon in succession to the metal working units, a control means for starting and for automatically stopping the turret in predetermined set positions, and a single means for starting all of the metal working units effective only when said indexing turret is in a set position, said single means consisting of flexible elements.

19. A metal working machine comprising in combination a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable means in said working unit for independently rotating the spindle and operating the feeding means, a control means for starting and automatically stopping the feeding means at the end of a feed cycle when a tool is retracted, a work supporting turret mounted on said frame, a continuously operating motor, means operated thereby for intermittently rotating said turret for presenting the material to be operated upon in succession to the metal working units, a control means for starting and automatically stopping the turret in predetermined set positions without stopping the motor, and a single means for starting all of the metal working units effective only when said turret is in a set position, said single means consisting of flexible elements.

20. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool

- spindle, feeding means for advancing and retracting said spindle, power operable means in said working unit for independently rotating the spindle and operating the feeding means, a control means for starting and automatically stopping the feeding means at the end of a feed cycle when a tool is retracted, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units, including friction clutch members, means for automatically separating said clutch members in case the turret strikes an obstruction, and for automatically restoring the connection of the clutch members when the obstruction is removed, and means for separating said clutch members for stopping the turret in a predetermined set position.
21. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable means in said working unit for independently rotating the spindle and operating the feeding means, a control means for starting and automatically stopping the feeding means at the end of a feed cycle when a tool is retracted, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units, including friction clutch members, means for automatically separating said clutch members in case the turret strikes an obstruction and for automatically restoring the connection of the clutch members when the obstruction is removed, means for separating said clutch members for stopping the turret in a predetermined set position, and a single means for starting all of the metal working units when the turret is in a set position, said single means consisting of flexible elements.
22. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable means in said working unit for independently rotating the spindle and operating the feeding means, a control means for starting and automatically stopping the feeding means at the end of a feed cycle when a tool is retracted, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the metal working units, including friction clutch members, means for automatically separating said clutch members in case the turret strikes an obstruction, and for automatically restoring the connection of the clutch members when the obstruction is removed, means for separating said clutch members for stopping the turret in a predetermined set position, and means operated by said turret positioning means for starting all of the metal working units when said turret is in a fixed position.
23. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable tool spindle, feeding means for advancing and retracting said spindle, power operable means in said working unit for independently rotating the spindle and feeding means, and a control means for starting and stopping the feeding means at the end of a feed cycle when the tool is retracted, a work conveyor mounted on said frame, means for intermittently feeding said conveyor for presenting the material operated upon in succession to the metal working units, a control means for starting and for automatically stopping the conveyor in predetermined set positions and a control mechanism including flexible elements interconnecting the starting means for the metal working units with the feeding means for the conveyor and the starting means for the conveyor with the metal working units and operating to simultaneously initiate the operation of the metal working units as the conveyor completes its movement to a set position, and operating to initiate the operation of the conveyor when the metal working units have completed their feed cycles and the tool spindles thereof are retracted.
24. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units, each 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 mounted on said frame, means for intermittently rotating said turret, a control means for starting and for automatically stopping the turret in predetermined set positions, and means operated by said rotating means for locking the turret in a set position, and a control mechanism including flexible elements interconnecting the starting means for the metal working units with the rotating means for the turret and the starting means for the turret with the metal working units and operating to simultaneously initiate the operation of the metal working units as the turret completes its movement to a set position and operating to initiate the operation of the turret when all of the metal working units have completed their feed cycles and the tool spindles thereof are retracted.
25. A metal working machine comprising in combination, a supporting frame, a series of cyclically operating work units, each having a self-contained power operating mechanism, means for stopping said operating mechanism on the completion of a cycle of operation, means for effecting the starting of a new cycle, a work supporting turret mounted on said frame, independent power operable means for intermittently rotating said turret for presenting the material operated upon in succession to the work units, a control means for starting and for automatically stopping the turret in predetermined set positions, and a control mechanism interconnecting the starting means for the work units with the rotating means for the turret and the starting means for the turret with the work units and operating to simultaneously initiate the operation of the work units as the turret completes its movement to a set position and operating to initiate the operation of the turret when all of the work units have completed their cycles of operation.
26. A metal working machine including a frame, a self-contained metal working unit adapted to be mounted in any position on said frame, said unit comprising a rotary and translatable

spindle, a motor mounted in said working unit for rotating and translating said spindle, means controlled by the translating means of each unit for stopping said translating means on the completion of a work cycle, and means associated with said working unit for starting a new work cycle, a work supporting turret mounted on said frame, a constantly revolving motor for intermittently rotating said turret for presenting the material operated upon to said metal working unit, a control means for starting and for automatically stopping the turret in predetermined set positions and a control mechanism including flexible elements interconnecting the starting means for the metal working unit with the rotating means for the turret and the starting means for the turret with the metal working unit and operating to initiate the operation of the metal working unit as the turret completes its movement to a set position, and operating to initiate the operation of the turret when the metal working unit has completed its feed cycle.

27. A metal working machine comprising in combination, a supporting frame, a series of self-contained cyclically operating work units each having a self-contained power operating mechanism, means for stopping the operation on the completion of a cycle, and a control means for effecting the start of a new cycle, a work supporting turret mounted on said frame, means for intermittently rotating said turret for presenting the material operated upon in succession to the work units, fluid pressure control means for starting and for automatically stopping the turret in predetermined set positions, a fluid pressure line connected to the control means of each unit, a valve in said line and means operable by the turret rotating means for opening the valve as the turret completes its movement to a set position for releasing a fluid pressure for simultaneously initiating the operation of the work units, a fluid pressure line connected to the starting means for the turret, a valve in said line at each work unit opened by the operating mechanism of each work unit for releasing a fluid pressure when all of the valves at the work units are opened for initiating the operation of the turret.

28. A metal working machine comprising in combination, a supporting frame, a series of self-contained, independently operable 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, means controlled by said indexing means for locking the turret in said set position while the tools are operating on the work, manually controlled means for initiating the operation of the indexing mechanism and means controlled by each metal working unit for rendering said manually controlled means inoperative except when the tools of the metal working units are retracted.

29. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and for automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, means for rotating said turret to set positions and means controlled by said rotating means for locking the

turret in a set position while the tools are operating on the work, and means interconnecting each metal working unit with the rotating means for the turret for rendering said rotating means inoperative except when the tools of the metal working units are retracted.

30. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and for automatically stopping the feed of the spindle when the tool is retracted, a control means associated with each metal working unit and rendered operative when said spindle is fully retracted, a turret rotatable to set positions, means for locking the turret in a set position, mechanism for controlling the locking means, and flexible means interconnecting said mechanism with the control means at each metal working unit whereby said mechanism can be operated to unlock the turret only when the tools of the metal working units are retracted.

31. A metal working machine comprising in combination, a supporting frame, a series of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a tool spindle, feeding means for advancing and retracting said spindle, means for starting and for automatically stopping the feed of the spindle when the tool is retracted, a work supporting turret, means for rotating said turret to set positions, a control means for starting and for automatically stopping the turret in the set positions, flexible means interconnecting each metal working unit with the starting means for the turret for initiating the rotation of the turret when all of the tool spindles are retracted, and a control means for simultaneously initiating the feeding means of the metal working units at a predetermined time after the initiation of the turret rotating means and after said turret has been brought to a set position.

32. A metal working machine comprising in combination, a supporting frame, a plurality of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable spindle, feeding means for advancing and retracting said spindle, power operable means for rotating and feeding said spindle, means controlled by the feeding means of each unit for stopping said feeding means on the completion of a work cycle, and means associated with each metal working unit for starting a new work cycle, a work supporting turret mounted on said frame, power operable means for rotating said turret to set positions and means controlled by said rotating means for locking the turret in a set position while said metal working units are operating on the work, and a single control means operated from said turret rotating means for simultaneously operating the starting means for each metal working unit after said turret is rotated to a set position.

33. A metal working machine comprising in combination, a supporting frame, a plurality of self-contained independently operable metal working units separately mounted on said frame, each unit comprising a rotary and translatable spindle, feeding means for advancing and retracting said spindle, power operable means for rotating and feeding said spindle, means controlled by the feeding means of each unit for stopping

39. A metal working machine including a frame, a rotatable turret mounted on said frame adapted to present material carried thereby to different stations for operation thereon by a metal working unit, and means for rotating said turret and stopping the same at each station including a power-operated shaft held against axial movement, a driven shaft in axial alinement therewith, clutch members carried by the adjacent ends of said shafts, yielding means for moving the driven shaft axially for causing engagement of the clutch members, a spiral gear carried by said driven shaft, a worm gear meshing with said spiral gear, devices operated by said worm gear for rotating said turret from one station to another, said spiral gear and said work gear being disposed so that the driving torque tends to move said driven shaft axially for releasing the clutch members, a stop lever for preventing the rotation of the turret whereupon the driving torque will release the driving connection between the clutch members, said yielding

means operating upon the release of the stop lever to establish driving connection of said clutch members, a stop movable with said worm gear, a stop lever, a spring for moving the stop lever into the path of travel of the stop for stopping the turret, means for moving said stop lever to release the turret for initiating the movement thereof, and means controlled by the turret for releasing the stop lever so that the spring may return the same to the path of travel of the stop for stopping the turret at the end of its feed cycle.

40. A metal working machine comprising in combination, a supporting frame, a series of cyclically operating work units each having its individual power operating mechanism, means for stopping said operating mechanism on the completion of a cycle of operation, means for effecting the starting of a new cycle of operation,

a work supporting turret mounted on said frame, independent power operable means for intermittently rotating said turret for presenting the material operated upon in succession to the work units, a control means for starting and for automatically stopping the turret at a predetermined set position, a control mechanism interconnecting the starting means for the work units with the rotating means for the turret and the starting means for the turret with the work units, and operating to simultaneously initiate the operation of the work units as the turret completes its movement to a set position, and operating to initiate the operation of the turret when all of the work units have completed their cycles of operation.

EDWARD J. KINGSBURY.
GUNNAR SWAHNBERG.

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