April 27, 1954 R. LE BRUSQUE ET AL 2,676,507

DEVICE FOR AUTOMATICALLY REPRODUCING THROUGH THE COPYING OF TEMPLETS

Filed Oct. 23, 1948 4 Sheets-Sheet 1

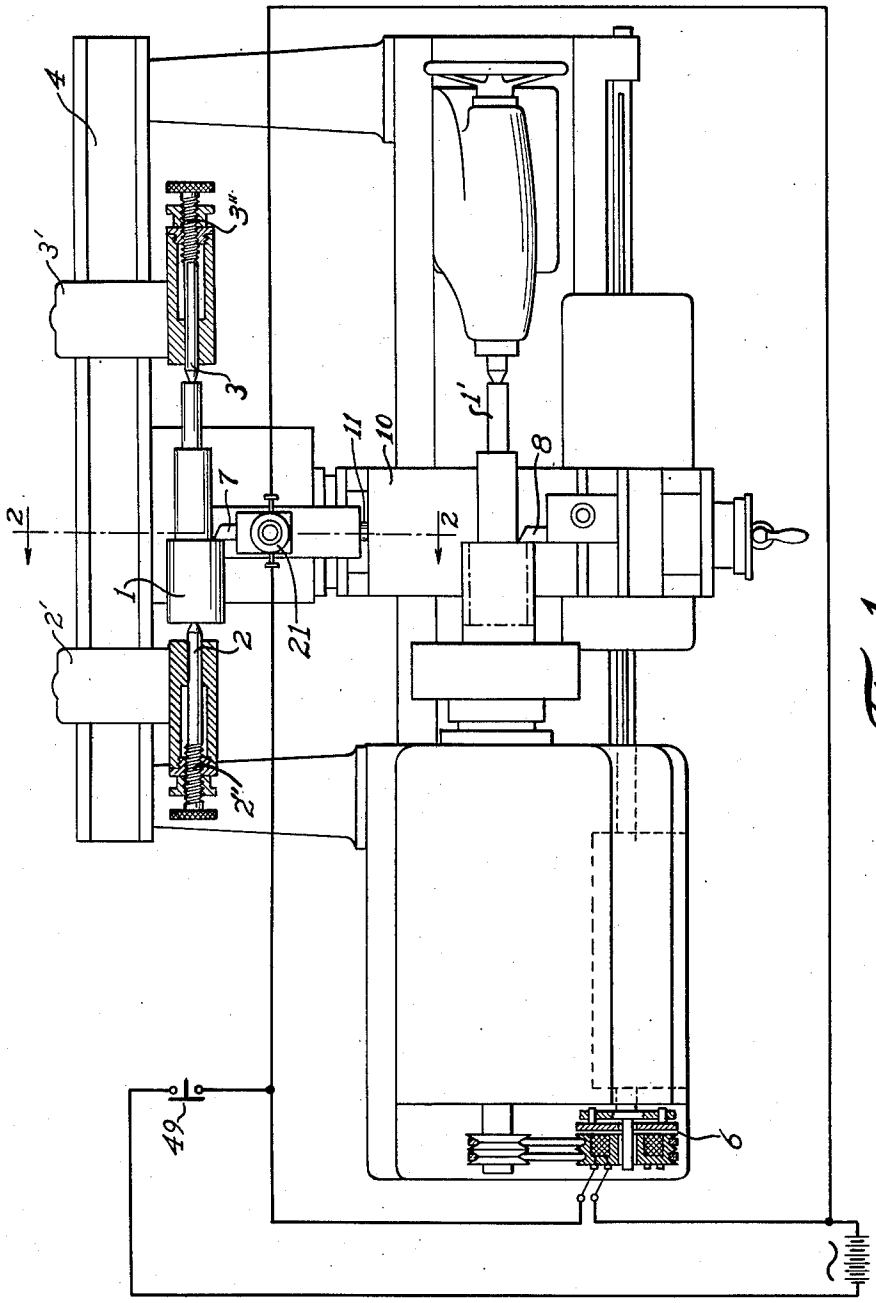


Fig. 1

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Filed Oct. 23, 1948 4 Sheets-Sheet 2

Fig. 2

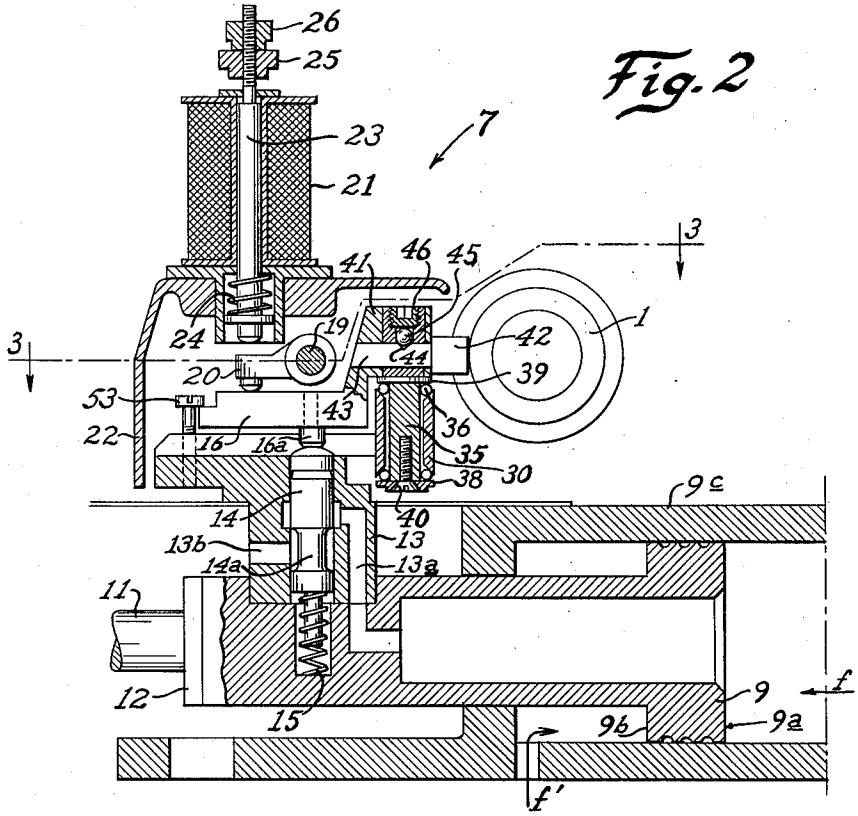
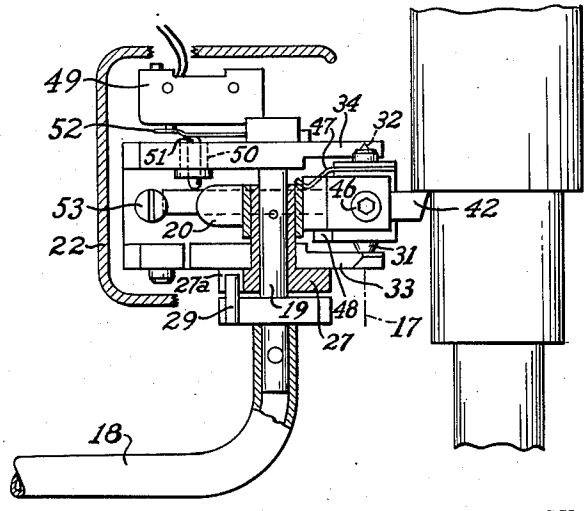


Fig. 3



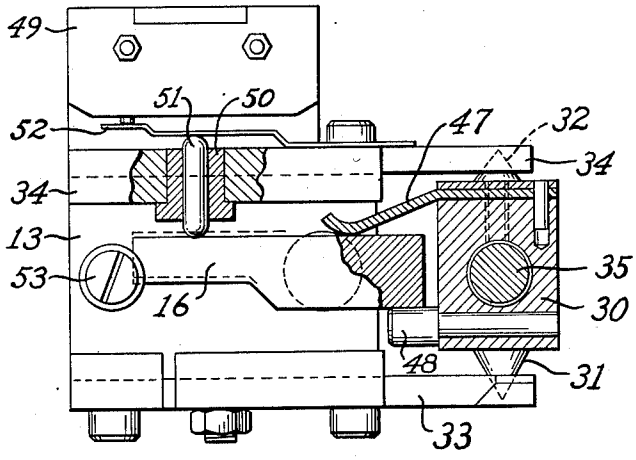
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Filed Oct. 23, 1948 4 Sheets-Sheet 3

Fig. 4



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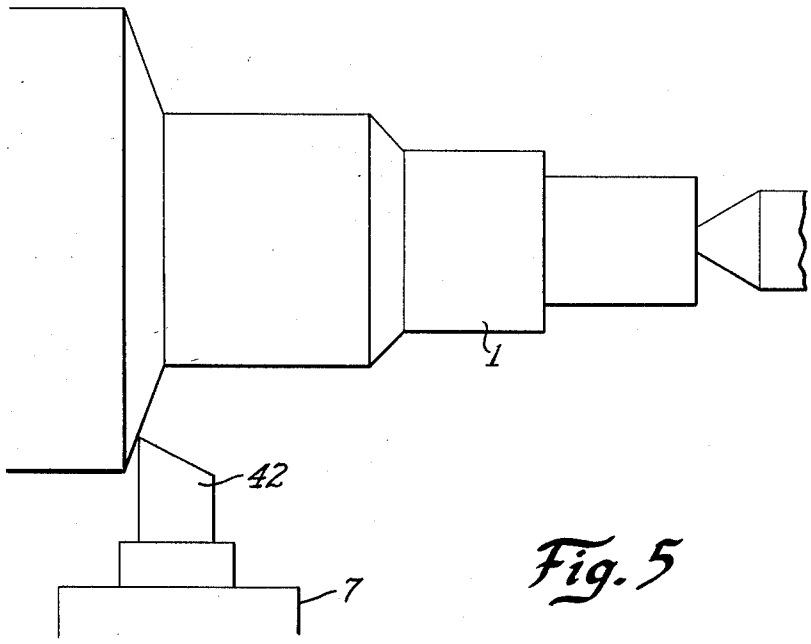
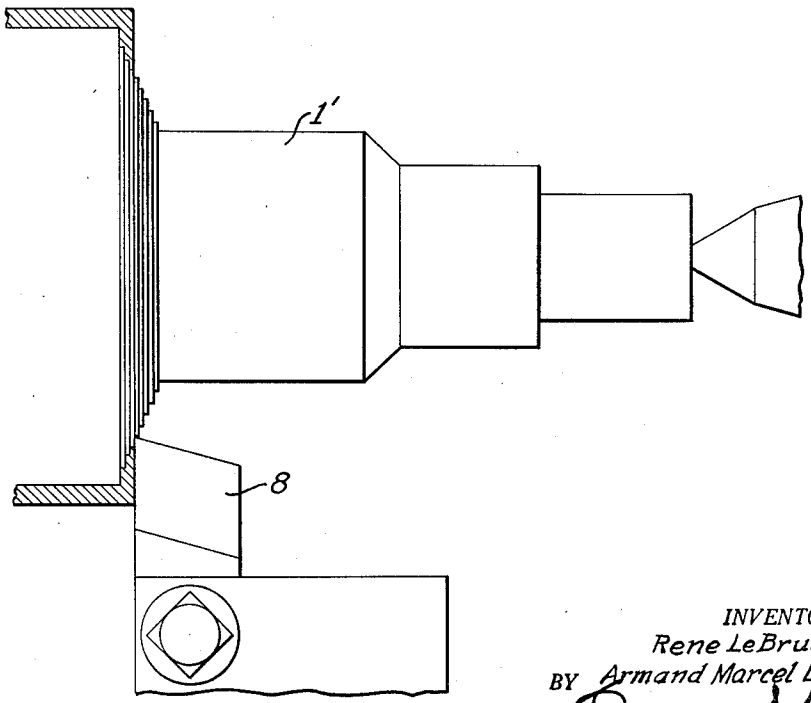


Fig. 5



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UNITED STATES PATENT OFFICE

2,676,507

DEVICE FOR AUTOMATICALLY REPRODUCING THROUGH THE COPYING OF TEMPLETS

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Application October 23, 1948, Serial No. 56,224

Claims priority, application France December 30, 1947

2 Claims. (Cl. 82—14)

1

The present invention relates to copying lathes, and is particularly directed to a device associated with a lathe for reproducing the form of a template in completely automatic operations.

This invention particularly relates to copying lathes wherein the tool carrier is moved in two directions which are respectively parallel and at right angles to the axis of rotation of the work piece and the longitudinal axis of the template, and an object of the invention is to provide a tracer mechanism in association with a lathe of this description which permits the accurate reproduction of templates having steeply inclined shoulders thereon, such reproduction being achieved in a fully automatic manner and without any supervision or manual control by an operator.

Another object is to provide a tracing mechanism for association with a lathe of the described character, wherein the movements of the tool in the direction at right angles to the axis of rotation of the work piece are effected by hydraulic actuation controlled through a suitable valve assembly, and wherein the valve assembly is manipulated mechanically by the tracer mechanism during the reproduction of slopes of 0° to 60° and an electrical assembly actuated by the tracing finger becomes operative to manipulate the valve assembly whenever slopes exceeding 60° are encountered on the template.

Another object is to provide a tracing mechanism in association with a lathe of the described character wherein the cross-slide carrying the tool has simultaneous longitudinal and transversal movements imparted thereto during the reproduction of slopes ranging in steepness up to a predetermined value, for example, 60°, and the reproduction of slopes of a steepness exceeding that predetermined value is carried out in steps by imparting successive and alternating longitudinal and transversal movements to the cross-slide.

In accordance with the present invention, the above objects, and other objects, features and advantages thereof appearing in the following detailed description of an illustrative embodiment, are achieved by providing a copying lathe having a cross-slide carrying the cutting tool and movable longitudinally along a path parallel to the axis of rotation of the work piece and transversely at right angles to that axis. The fixed template to be copied or reproduced is mounted with its longitudinal axis parallel to the axis of rotation of the work piece and a tracer mechanism is mounted on the cross-slide to engage the

2

template and control the movements of the cross-slide in accordance with the shape of the template. The transversal movements of the cross-slide are effected by a hydraulic system which is controlled by a suitable valve assembly. The tracer mechanism includes a tracing member which is mounted pivotally for movement about a first axis which is parallel to the longitudinal movements of the cross-slide and a second axis which is perpendicular to the plane of the transversal and longitudinal movements of the cross-slide. The tracing member is provided with a valve actuating finger which manipulates the valve assembly controlling the hydraulic system in response to pivoting of the tracing member about the first axis. Pivoting of the tracing member about the second axis is resiliently resisted and control of the valve assembly, during the reproduction of slopes having less than a predetermined steepness, is effected only by pivoting of the tracing member about the first axis. However, when a slope on the template exceeding the predetermined steepness is encountered by the tracing member, the resultant force is sufficient to overcome the resilient resistance to pivoting of the tracing member about the second axis and the finger member in pivoting about the second axis actuates a switch in an electric circuit to open the latter. The electric circuit includes a normally energized solenoid having a plunger which is spring urged, when the solenoid is deenergized, against the valve actuating finger to effect further rocking of the latter about the first axis, thereby further manipulating the valve assembly of the hydraulic system actuating the cross-slide. The electric circuit further includes a magnetic clutch interposed in the lathe mechanism effecting longitudinal movement of the cross-slide so that, when the electric circuit is opened, the clutch is de-energized and the longitudinal movement of the cross-slide is momentarily halted. Therefore, when a slope of relatively great steepness is encountered on the template, the cross-slide is moved alternately and successively in the transversal and longitudinal directions and in a step-by-step manner to substantially reproduce the steep slope on the work-piece mounted in the lathe.

The foregoing features or characteristics of devices embodying the present invention will be apparent in the following detailed description of an illustrative embodiment, when the description is read in connection with the accompanying drawings which form a part hereof and wherein:

Fig. 1 is a top plan view, partly broken away

and in section, of a copying lathe incorporating tracing mechanism constructed in accordance with the present invention;

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1, but on an enlarged scale and showing the construction of the tracing mechanism;

Fig. 3 is a horizontal sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary plan view, partly broken away and in section and on an enlarged scale, of an assembly forming a part of the mechanism of Figs. 2 and 3; and

Fig. 5 is a diagrammatic representation of the related movements of the feeler mechanism and of the cutting tool in reproducing a shoulder of relatively great steepness on the fixed template.

Referring to the drawings in detail, and initially to Fig. 1 thereof, a copying lathe is there shown embodying tracing mechanism constructed in accordance with the present invention. The lathe, as usual, includes a chuck or face plate and a tailstock between which the work piece 1' is supported for rotation about its longitudinal axis. A carriage is slidable on the bed of the lathe for movement parallel to the axis of rotation of the work piece and such movement of the carriage is effected by the conventional worm screw. The drive for the worm screw includes a magnetic clutch 6 interposed between a belt and pulley transmission and the worm screw so that the latter is rotated, to effect longitudinal movement of the carriage, only when the clutch 6 is electrically energized. A cutting tool 8 is mounted upon a cross-slide 10 which is carried by the carriage and is movable relative to the latter at right angles to the axis of rotation of the work piece 1'. Such transversal movement of the cross-slide is effected hydraulically by an arrangement which includes a piston 9 (Fig. 2) working in a cylinder 9c fixed to the carriage. The piston 9 extends axially from the cylinder 9c and is coupled, as at 12, to a connecting rod 11 (Figs. 1 and 2) which is secured to the cross-slide 10. It is apparent that the position of the piston 9 within its cylinder determines the position of the cutting tool 8 relative to the work-piece.

The purpose of the described lathe is to reproduce the contours of a template 1 on the work piece 1', and the template 1 is accordingly mounted between suitable centers 2 and 3 with its longitudinal axis extending parallel to the axis of rotation of the work piece. In order to facilitate the mounting of the template, the centers 2 and 3 are preferably slidable in housings 2' and 3', respectively, which are movable along a bed or guide 4 fixed relative to the bed or frame of the associated lathe. The centers or points 2 and 3 are axially adjustable, to grip the template 1 therebetween, by manually adjustable screws 2'' and 3'', respectively. Thus, the centers 2 and 3 may be drawn apart to permit the removal or replacement of the template.

The tracing mechanism embodying the present invention is generally indicated by the reference numeral 7 and serves to control the transversal and longitudinal movements of the cutting tool 8 in accordance with the changing configuration of the template 1 as reproduction of the form of the template proceeds. In order to control the transversal movement of the cross-slide 10, and hence of the cutting tool, a valve assembly (Fig. 2) is associated with the piston 9 of the hydraulic system. This valve assembly includes a valve body or housing 13 mounted on a portion of piston 9 disposed outside of the cylinder 9c. A valve member 14 is vertically reciprocatable within a suitable bore formed in the body 13 and projects upwardly from the latter. A spring 15 is disposed below valve member 14 to continuously urge the latter upwardly. A hydraulic fluid, under pressure, is supplied to the cylinder 9c at the opposite faces of the piston 9, as indicated by the arrows *f* and *f'*, from a suitable source (not shown). Since the area of the face 9*a* of piston 9 is greater than the area of the face 9*b*, the piston 9 will move toward the left, as viewed in Fig. 2, when the pressure of the hydraulic fluid at the opposite sides of the piston is the same. Such movement of the piston 9 causes the cross-slide 10 to move transversely in the direction backing the tool 8 away from the work piece 1'. In order to control the relative pressures acting against the opposite faces 9*a* and 9*b* of the piston, a passage 13*a* is formed in the valve body 13 and communicates at one end through the piston 9 with the portion of the cylinder 9c facing toward face 9*a* of the piston. The passage 13*a* opens into the bore accommodating valve member 14 and an exhaust passage 13*b* also opens into that bore at a location spaced axially from the passage 13*a*. The valve member 14 is formed with a reduced diameter portion 14*a* which more or less communicates the passage 13*a* with the exhaust passage 13*b*, depending upon the position of the valve member 14 within the body 13. The various parts are dimensioned so that the pressure acting against face 9*a* of the piston is sufficiently reduced to equalize the forces acting against the faces 9*a* and 9*b* when the valve member 14 is raised a predetermined distance to provide partial communication between the passages 13*a* and 13*b*. When the valve member 14 is raised more than the above mentioned predetermined distance, the increased communication between the passages 13*a* and 13*b* further decreases the pressure in the fluid acting against the face 9*a* so that the force acting against the face 9*b* is predominant and the piston 9 moves to the right, as viewed in Fig. 2, to displace the cross-slide 10 and the tool 8 in the direction moving the latter toward the work piece 1'. Thus, the position of valve member 14 within the valve body 13 determines the position and movements of the piston 9 and the cross-slide 10.

In order to control the position of valve member 14, the tracing mechanism 7 illustrated in Figs. 2, 3 and 4 includes a pair of spaced apart, transversely extending support arms 33 and 34 secured to the top of the valve body 13 and directed toward the fixed template 1. A gimbal mount is supported by the free ends of arms 33 and 34 and includes a body 30 having trunnions 31 and 32 projecting from the sides thereof and received in suitable recesses formed in the confronting side surfaces of the support arms. Thus, the body 30 is rotatable about an axis 17 passing through the trunnions 31 and 32 parallel to the longitudinal axes of the template 1 and the work piece 1'. The body 30 is formed with a bore extending therethrough at right angles to the axis 17 for rotatably accommodating an axle 35. Axial movement of the axle 35 relative to the body 30 is restrained by suitable structure which may include a shoulder or rim 39 on the axle adapted to overlie the upper surface of the body 30 and a securing disc 38 fixed to the lower end of axle 35 below the under surface of body

30 by a machine screw 40. In order to reduce the frictional resistance to turning of axle 35 within the body 30, ball bearings 36 and 37 are disposed between the upper and lower faces of the body 30, which are preferably bevelled, and the rim 39 and disc 38, respectively.

The axle 35 has an upper portion above the rim 39 which supports a member 41 intended to carry a tracing member 42 in a position to ride upon the surface of the template 1. The member 41 is formed with a bore which receives the upper portion of axle 35, and the latter and the member 41 are formed with registering bores at right angles to the axis of axle 35 to receive a mounting stem 43 extending from the tracing member 42. In order to removably secure the stem 43, axle 35 and member 41 relative to each other, the stem 43 is formed with a notch 44 and the axle 35 has a tapped bore opening at the top thereof and communicating with the bore accommodating the stem 43 so that a ball or detent 45 disposed in the tapped bore may engage the notch 44 and locked in this position by a set screw 46 to prevent withdrawal of the stem 43 from the assembly. It will be noted that the longitudinal axis of the tracing member 42 is disposed substantially above the axis 17 of the trunnions 31 and 32 so that a force applied axially to member 42 in the direction toward the left, as viewed in Fig. 2, causes counter-clockwise rocking of the member 41, axle 35 and body 30 about the axis 17.

In order to translate such rocking movement of the member 41 into vertical displacement of the valve member 14, a finger 16 extends from the member 41 in the direction opposite to the tracing member 42 and offset downwardly relative to the latter, and overlies the upper end of the valve member 14 projecting from the body 13. The finger 16 preferably carries an abutment 16*a* for engaging the upper end of valve member 14 so that, when the member 41 is rocked about axis 17 in the counter-clockwise direction, as viewed in Fig. 2, the valve member 14 will be depressed against the force of spring 15 to further restrict communication between the passages 13*a* and 13*b* and thereby cause movement of piston 9 toward the left, in the manner previously described. Further, it is apparent that, when the axial force is removed from the tracing member 42, the spring 15 raises valve member 14 to increase the communication between passages 13*a* and 13*b* thereby causing movement of piston 9 toward the right, as viewed in Fig. 2, and the upward movement of valve member 14 causes rocking of member 41 about axis 17 in the clockwise direction, as viewed in Fig. 2. A bolt 53 is preferably threaded into the top surface of the valve body 13 with its head overlying the free end portion of finger 16 to provide an adjustable stop for limiting upward movement of the finger 16.

A housing 22 for the tracing mechanism is suitably secured on top of the valve body 13 and with the latter forms a head which opens toward the template 1 to permit the tracing member 42 to project therefrom. A shaft 19 is journalled in the side walls of housing 22 for rotation about an axis parallel to the longitudinal axis of the template. An arm 20 is fixed on shaft 19 by a pin or the like and overlies the finger 16. Thus, when the shaft 19 is rocked in the counter-clockwise direction, as viewed in Fig. 2, the free end of arm 20 bears downwardly on finger 16 to depress the latter and cause downward movement of valve member 14. In order to permit manual rocking of the shaft 19, a handle 18 is coupled to an end of the shaft 19 extending from the housing 22, as in Fig. 3, and the handle 18 extends to a location at which it can be conveniently manipulated by the operator of the machine. The separable coupling of handle 18 to the shaft 19 is preferably achieved by a pin 29 extending axially from the handle at an eccentric location and into a recess or notch 27*a* of a flanged sleeve 27 which is fixed to the shaft 19. Thus, the handle 18 may be removed from the shaft 19 or assembled, as in Fig. 3, when a manual control is desired.

In order to provide the previously mentioned step by step reproduction of slopes of a steepness exceeding a predetermined value, the tracing mechanism 7 includes the following structure, illustrated in detail in Fig. 4. A cantilever spring member 47 extends from the body 30 alongside the finger 16 and bears against the latter to continuously urge the finger 16, member 41 and tracing member 42 to rotate in the counter-clockwise direction, as viewed in Fig. 4, about the axis of axle 35. The spring urged rotation of finger 16 about the axis of axle 35 is limited by a stop 48, which may be formed by the head of a bolt extending from the body 30. A plunger 51 is axially slidable in a bearing 50 carried by the support arm 34 and engages at one end the adjacent side face of the finger 16. A resilient element 52 is secured to the outside of support arm 34 and is engaged by the other end of the plunger 51. A micro-switch 49 is mounted on top of the valve body 13 adjacent the outside of support arm 34, and the resilient element 52 engages the actuating plunger of the micro-switch. The micro-switch 49 is of conventional construction and is arranged so that the contacts thereof are closed, when the actuating plunger is permitted to project from the switch housing, and so that the contacts are separated to break the associated electrical circuit, when the actuating plunger is depressed into the switch housing. Thus, when the finger 16 is in its normal position, shown in full lines in Fig. 4, the contacts of switch 49 are closed; and, when the finger 16 is rocked in the clockwise direction to the broken-line position of Fig. 4, the plunger 51 urges the resilient element 52 against the actuating plunger of the switch 49 to depress the last mentioned plunger and thereby separate the switch contacts.

As seen in Fig. 2, a solenoid 21 is mounted on top of the housing 22 and includes a vertically movable core 23 which is positioned above the arm or lever 20. A spring 24 is provided around the lower portion of the core 23 to yieldably urge the latter downwardly against the arm 20, and suitable adjustable stop nuts 25 and 26 are threaded onto the upper portion of core 23 to limit such downward movement of the core. However, the solenoid 21 is arranged so that the core 23 is held in an elevated and inoperative position (Fig. 2) against the action of the spring 24 when the coil of the solenoid is electrically energized.

As seen diagrammatically in Fig. 1, the magnetic clutch 6 and the solenoid 21 are electrically connected in parallel with each other and in series with the contacts of switch 49 across the lines of a suitable source of electric current. Thus, so long as the contacts of the switch 49 are closed, the clutch 6 and the solenoid 21 are continuously energized, however, when the con-

tacts of switch 49 are separated in response to rocking of the finger 16 about the axis of axle 35, both the solenoid 21 and the magnetic clutch 6 are simultaneously de-energized. It is preferable to provide an electrically actuated brake (not shown) of conventional construction in association with the driven part of the clutch 6 to instantly and automatically halt rotation of the driven part when the clutch is deenergized.

When the solenoid 21 is deenergized, the core 23 presses downwardly on the arm 20 which in turn depresses the finger 16 to displace the valve member 14 downwardly thereby interrupting communication between the passages 13a and 13b to cause the piston 9 to move in the direction displacing the tracing member 42 and the cutting tool 8 transversely away from the template 1 and the work piece 1', respectively. At the same time, the deenergization of the magnetic clutch 6 interrupts the drive of the worm screw causing longitudinal movement of the carriage with the cross-slide 10. Thus, whenever the contacts of switch 49 are separated, the longitudinal movement of the cutting tool ceases and the tool is moved transversely away from the work piece.

The operation of the above described device in reproducing the form of a template will now be described:

The template 1 and work piece 1' are mounted between the centers or points 2 and 3 and the chuck and tail plate of the lathe, respectively, with the tracing member 42 of the tracing mechanism 7 and the cutting tool 8 being positioned the same distance from the longitudinal axes of the template and work piece and with the carriage and cross-slide 10 being longitudinally positioned so that the tracing member 42 is adjacent the right hand end of the template, as viewed in Fig. 1. If the tracing member 42 is initially spaced transversely from the template, no force will be exerted on the tracing member 42 and the valve member 14 will be moved upwardly by the spring 15 to provide the maximum communication between the passages 13a and 13b allowed by the stop 53 (Fig. 2) thereby producing transverse movement of the piston 9 and cross-slide 10 in the direction displacing the tracing member and cutting tool toward the template and work piece, respectively. When the tracing member 42 contacts the template, a force is exerted on the tracing member 42 causing the member 41 and finger 16 to rock about the axis 17 in the direction depressing the valve 14, thereby decreasing communication between passages 13a and 13b to equalize the forces acting on the opposite faces of the piston 9 and halt the transverse movement of the cross-slide 10. It is to be understood that the lathe carriage and its cross-slide are longitudinally moved at a substantially continuous rate during normal operation of the copying lathe in the direction from right to left as viewed in Fig. 1. Thus, the tracing member 42 moves longitudinally along the surface of the template 1. When a slope of a steepness less than a predetermined value is encountered on the template by the tracing member 42, the force acting on the member 42 in the direction transversal with respect to the axis of the template is initially increased to cause further rocking of member 41 and finger 16 about the axis 17 in the direction further depressing the valve member 14. This further depression of valve member 14 again decreases the communication between passages 13a and 13b so that the piston 9 and cross-slide 10 are displaced transversely to move the tool 8 transversely away from the axis of rotation of the work piece at a rate corresponding to the slope of the template then being reproduced. While the force acting on the tracing member 42 in the direction tending to produce rocking of the member 41 and finger 16 about the axle 35 is increased when the tracing member encounters a slope on the template, the spring 47 (Fig. 4) is sufficiently strong to prevent rocking about the axle 35 so long as the slope does not exceed a predetermined steepness, for example, a steepness of 60°. Therefore, for normal slopes on the template, the transverse movement of the cross-slide is controlled only by rocking of the tracing member 47, member 41 and finger 16 about the axis 17.

However, when a slope exceeding the predetermined steepness is encountered by the tracing member 42 on the template 1, a strong force is imposed on the tracing member in the direction parallel to the longitudinal axis of the template, and the force of spring 47 is overcome so that the member 42, member 41 and finger 16 are rocked together about the axle 35 in the clockwise direction, as viewed in Fig. 4, to separate the contacts of switch 49 through the previously described action of the plunger 51 and resilient element 52. The separation of the contacts of switch 49 causes deenergization of the magnetic clutch 6 and of the solenoid 21. Therefore, longitudinal movement of the carriage and cross-slide 10 is momentarily halted, and the core 23 of the solenoid acts on the finger 16 through the arm 20 to further depress valve member 14 and cause transverse movement of the cross-slide in the direction moving the tool 8 and tracing member 42 away from the work piece and template, respectively. As soon as the cross-slide has been moved transversely in the above indicated manner, the forces acting on the tracing member 42 to cause rocking about the axle 35 are reduced so that the spring 47 can again return the finger 16 to its position against the stop 48 and the contacts of switch 49 are again closed to energize the solenoid 21 and the magnetic clutch 6. Thus, the longitudinal feed of the carriage is resumed and the core 23 of the solenoid is raised to permit valve member 14 to return to a position equalizing the forces on both sides of the piston 9. However, the resumed longitudinal movement of the carriage again presses the tracing member 42 against the steep slope of the template to again cause opening of the contacts of switch 49 in the manner described above for interrupting the longitudinal movement and producing transversal movement of the cross-slide. Thus, as the tracing member 42 of the tracing mechanism 7 rides on a relatively steep slope of the template 1, as in Fig. 5, the tool 8 will have successive and alternating transversal and longitudinal movements imparted thereto so that the steep slope is reproduced on the work piece 1' in a step-by-step manner, as illustrated.

From the foregoing description of an illustrative embodiment of our invention it is apparent that all transverse movements of the cross-slide 10 result from hydraulic actuation, and that an electrical control for that hydraulic actuation comes into operation in reproducing slopes on a template which exceed a predetermined steepness. Thus, the simplicity and accurate performance of hydraulic actuation are achieved while producing a copying lathe of the described

character capable of reproducing steep slopes, for example, slopes of from 60 to 90°.

While an illustrative embodiment of the invention has been described in detail, it is to be understood that the invention is not limited to the precise details thereof and that various changes and modifications may be made therein without departing from the spirit or scope of the invention as defined in the appended claims.

What is claimed is:

1. A tracing mechanism for use in a machine duplicating the contours of a template; said tracing mechanism comprising a tracing head mounted for movement longitudinally along a template and for transverse movement toward and away from the template, a tracer member disposed for contact with the surface of the template, pivotal mounting means supporting said tracer member on said head for rocking relative to said head about a first axis parallel to the direction of longitudinal movement of said head and about a second axis normal to said first axis, hydraulic means for effecting transverse movement of said head toward and away from the template, valve means operative to control the operation of said hydraulic means and engaged by said tracer member to control said hydraulic means in response to rocking of said tracer member about said first axis, normally closed switch means, switch actuating means engaged by said tracer member and operative to open said switch means in response to rocking of said tracer member about said second axis, resilient means yieldably resisting rocking of said tracer member about said second axis in the direction causing opening of said switch means so that said tracer member normally rocks only about said first axis and rocks about said second axis only when a slope is encountered on the template having a steepness exceeding a predetermined value, a solenoid coil on said head, a movable core in said coil, spring means continuously urging said core to project from said coil, said coil being arranged to move said core in the direction opposite to the action of said spring means when said coil is energized, means interposed between said tracer member and said core to be engaged by the latter when said coil is de-energized and to rock said tracer member about said first axis in the direction causing transverse movement of said head away from the template, means for effecting longitudinal movement of said head along the template and including electrically energized transmission means, a source of electric current, and electric circuit means having said switch means interposed therein and connecting said coil and said transmission means to said source so that said transmission means and said coil are de-energized when said tracer member rocks about said second axis to halt the longitudinal movement of said head and to simultaneously cause transverse movement of the head away from the template.

2. A tracing mechanism for use in a machine duplicating the contours of a template; said tracing mechanism comprising a tracing head mounted for movement longitudinally along a template and for transverse movement toward and away from the template, a tracer member disposed for contact with the surface of the template, means supporting said tracer member on said head for movement relative to the latter in the directions of said longitudinal and transverse movements of said head, hydraulic means controlled in response to the movement of said tracer member in said direction of the transverse movement of said head for effecting said transverse movement of the head toward and away from the template, normally closed switch means, switch actuating means operated by said tracer member and effective to open said switch means in response to movement of said tracer member in said longitudinal direction of movement of said head, resilient means yieldably resisting movement of said tracer member in said longitudinal direction of movement of said head in the sense causing opening of said switch means so that said tracer member normally moves relative to said head only in said transverse direction of movement of the latter and moves in the other of said directions only when a slope is encountered on the template having a steepness exceeding a predetermined value, a solenoid coil on said head, a movable core in said coil, spring means yieldably urging said core to move in one direction relative to said coil, said coil being arranged to move said core in the direction opposite to the action of said spring means when said coil is energized, means interposed between said tracer member and said core to be engaged by the latter when said coil is de-energized and to act against said tracer member in the direction causing transverse movement of said head away from the template, means for effecting longitudinal movement of said head along the template and including electrically energized transmission means, a source of electric current, and electric circuit means having said switch means interposed therein and connecting said coil and said transmission means to said source so that said transmission means and said coil are de-energized when said tracer member moves in the direction causing opening of the switch means to halt the longitudinal movement of said head and to simultaneously cause transverse movement of the head away from the template.

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