Jan. 10, 1956 A. H. DALL ET AL 2,730,129

TRACER CONTROL MECHANISM

Filed May 20, 1952 2 Sheets-Sheet 1

Fig. 1

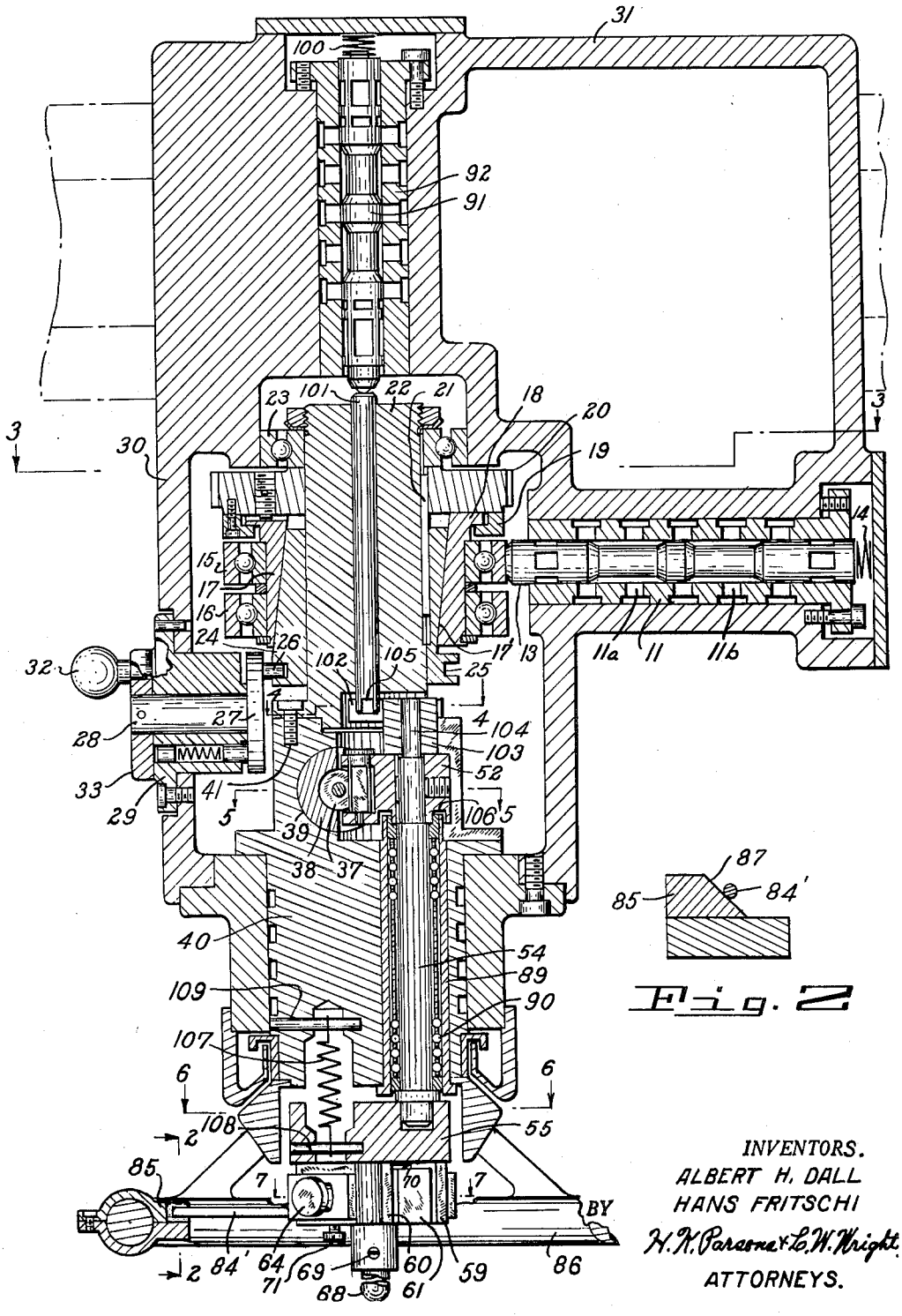


Fig. 2

INVENTORS.
ALBERT H. DALL
HANS FRITSCHI
H. K. Parsons & L. W. Wright
ATTORNEYS.

Jan. 10, 1956 A. H. DALL ET AL 2,730,129

TRACER CONTROL MECHANISM

Filed May 20, 1952 2 Sheets-Sheet 2

Fig. 3

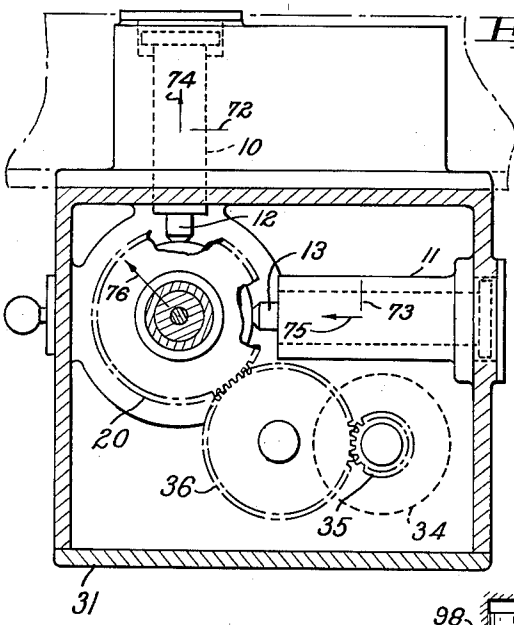
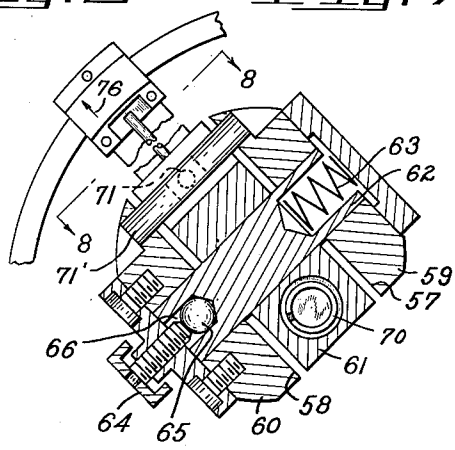


Fig. 7



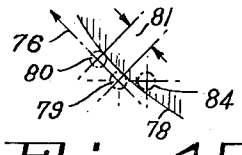


Fig. 10

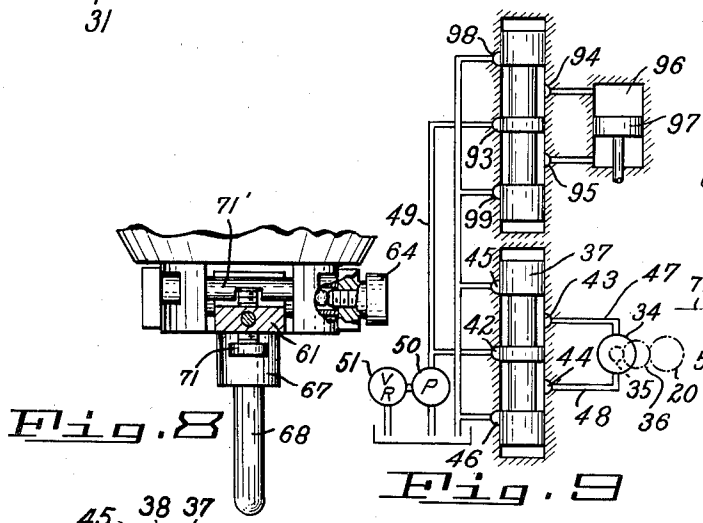


Fig. 8

Fig. 9

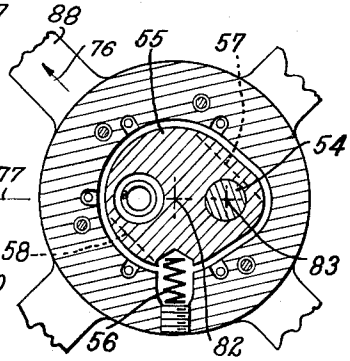


Fig. 6

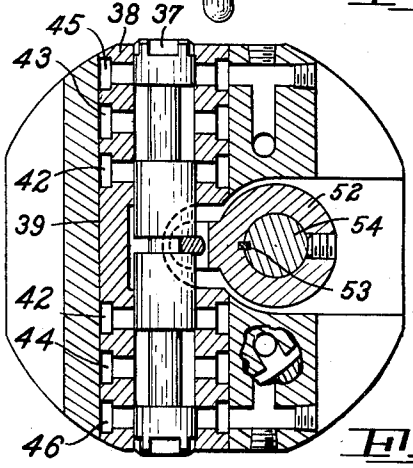


Fig. 5

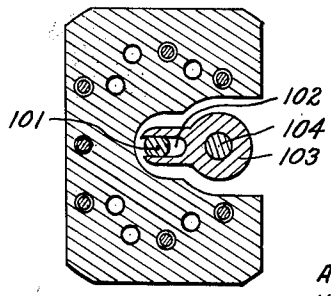


Fig. 4

INVENTORS.
ALBERT H. DALL
HANS FRITSCHI
BY
H. K. Parsons & L. W. Wright.
ATTORNEYS.

United States Patent Office

2,730,129

Patented Jan. 10, 1956

2,730,129

TRACER CONTROL MECHANISM

Albert H. Dall, Cincinnati, and Hans Fritschi, Amberley Village, Ohio, assignors to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio

Application May 20, 1952, Serial No. 288,806

7 Claims. (Cl. 137—622)

This invention relates to pattern controlled machines and more particularly to automatic tracer control mechanisms therefor.

One of the objects of this invention is to improve the construction of tracer control mechanisms to obtain better pressure conditions between the tracer and the pattern.

Another object of this invention is to provide an improved tracer control mechanism for simultaneous three direction control between a tool and work piece in pattern controlled machines.

A further object of this invention is to provide a tracer control mechanism in which the weight of the tracer control valve is independent of and bears no relation to the tracer finger pressure on the pattern.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

Referring to the drawings in which like reference numerals indicate like or similar parts:

Figure 1 is a sectional elevation through the tracer head which is illustrative of one embodiment of the invention.

Figure 2 is a detail section on the line 2—2 of Figure 1.

Figure 3 is a sectional view taken on the line 3—3 of Figure 1.

Figure 4 is a section on the line 4—4 of Figure 1.

Figure 5 is a section on the line 5—5 of Figure 1.

Figure 6 is a section on the line 6—6 of Figure 1.

Figure 7 is a section on the line 7—7 of Figure 1.

Figure 8 is a section on the line 8—8 of Figure 7.

Figure 9 is a diagrammatic view of the hydraulic connections from the tracer controlled valves to the other operative parts of the machine, and

Figure 10 is a diagrammatic view showing the relationship of the tracer finger and supporting parts when the tracer finger is in contact with the pattern.

This invention is an improvement on the construction of tracer mechanisms such as that shown in United States Letters Patent 2,322,533, issued to Roehm on October 26, 1943.

In the tracer control mechanism of the patent the rate and direction of relative movement between two right angularly moving slides of a pattern controlled machine are governed by a pair of rate and direction control valves which are indicated in general by the reference numerals **10** and **11** in Figure 3 of the present drawings. One of these valves, **11**, is shown in section in Figure 1 of the drawings, and it will be understood that it has ports **11***a* and **11***b* hydraulically connected to a piston and cylinder for controlling the actuation of one slide; and the other valve, indicated generally by the reference numeral **10**, has similar ports connected to a cylinder for controlling actuation of a second slide movable at right

angles to the first slide. It has been the custom to arrange the valves in the machine in such relationship that the axis of the valve **11** lies parallel to the axis of movement of its connected slide, and the axis of the valve **10** arranged parallel to the axis of its controlled slide. The valve plungers **12** and **13** of the valves **10** and **11** respectively are continuously urged by springs or the like, such as the spring **14** in Figure 1, into contact with control cams or eccentrics such as indicated by the reference numerals **15** and **16** in Figure 1, so that the rotational position of these cams or eccentrics determine the relative position of the two valve plungers and thereby the resultant movement produced by the two slides. It will be obvious that if two slides are arranged at right angles to one another, and one carries the tool and the other the work, and both move at the same rate that the resultant cutting path will be in a direction at 45 degrees to the axis of the two valves.

In the patent and in the construction shown in Figure 1 the control cams or eccentrics **15** and **16** are annular rings, the ring **15** being engaged by the valve plunger **13**, and the ring **16** being engaged by the valve plunger **12**, and these rings are anti-frictionally supported on a member **17** which is laterally movable with respect to a fixed axis of rotation whereby the eccentricity of the rings may be varied. The member **17** is provided with an annular shoulder **18** which overlaps a flanged member **19** attached to the underside of a gear **20**. The gear **20** is connected by a key **21** to the upper part **22** of the rotatable tracer head which is supported for rotation at its upper end by the anti-friction bearing **23**. The key **21** also has a spline connection with the oblique cylindrical member **24** which fits in an oblique bore **17'** of member **17** whereby axial movement of the member **24** will shift the member **17** laterally. The member **24** has a shifter groove **25** in which is fitted a shifter pin **26** eccentrically located on a disc **27** that is journaled on a shaft **28** fitted in a bushing **29** mounted in the wall **30** of the tracer mechanism housing, indicated generally by the reference numeral **31**. An operating handle **32** attached to the disc **33** pinned to the outer end of shaft **28** makes it possible to rotate the eccentric pin **26** and thereby, through the connecting mechanism, shift the eccentric members **15** and **16** off center with respect to the fixed axis of rotation of the member **22**, and thereby determine the initial port opening effected by the valve plungers **12** and **13** and thus establish the feed rate at which the cutting operation will be performed by the cutting tool of the machine.

As the gear **20** rotates the eccentrics, one valve plunger will be moved toward a port closing position, and the other valve plunger will be moved to effect a greater port opening, and thus the feed rates effected by the two valves will be inversely changed, thus effecting a change in the resultant direction of feed, with the result that a complete rotation of the eccentrics is capable of changing the direction of resultant movement throughout a range of 360 degrees, or in other words, the tracer can completely circumscribe a pattern.

As in the patent, gear **20** is rotated by a hydraulic motor, which is indicated by the reference numeral **34** in Figure 3, of the drawings, and this motor is connected by gearing **35**, **36** to the gear **20**, all mounted within the tracer housing **31**.

By means of this invention a tracer valve is provided for controlling the rotation of the hydraulic motor **34**, and the arrangement of this tracer valve and its connection to the tracer forms part of the present invention.

Referring to Figure 5, the tracer valve plunger is indicated by the reference numeral **37**, and this valve plunger is slidable in a sleeve **38** mounted in a bore **39** which, as shown in Figure 1, is formed in the lower rotatable mem-

ber 40 of the tracer head which is attached to the upper member 22 by suitable fastenings, such as the screws 41. It will now be noted that the axis of the bore 39 is at right angles to the axis of rotation of the tracer head. The sleeve 38 provides a pair of pressure ports 42, due to the valve being divided, which are connected to a source of pressure, a pair of motor ports 43 and 44 which are hydraulically connected to the hydraulic motor 34 and a pair of exhaust ports 45 and 46. In effect, the valve is a reversing control valve, which has been shown diagrammatically in Figure 9, in which the valve plunger 37 has a pressure port 42, a pair of motor ports 43 and 44 which are connected by suitable channels 47 and 48 to the hydraulic motor 34 and a pair of exhaust ports 45 and 46. In this view the pressure port 42 is connected by a suitable channel 49 to a supply pump 50 having a relief valve 51. It will now be obvious that when the tracer valve plunger 37 is in a central position that the motor 34 is stationary, so that any movement of the valve to one side or the other of its center position will cause corresponding rotation of the hydraulic motor in one direction or the other.

Shifting of the tracer valve plunger 37 is effected by a crank arm 52 which, as shown in Figure 5, is keyed at 53 to a vertically extending shaft 54 which, as shown in Figure 1, has connected to its lower end a second crank arm 55 to which is attached the tracer supporting mechanism shown in Figures 7 and 8. The lower crank arm 55 is shown in Figure 6, from which it will be seen that a spring 56 exerts a continuous urge on the arm 55, and thus, in turn, through the shaft 54 and upper crank arm 52 would normally position the tracer valve 37 in an off-center position. The parts are so oriented that this spring is the one that maintains a continuous urge on the tracer finger to maintain the tracer in contact with the pattern.

The crank arm 55 has the lower portion of it bifurcated by a cross slot, as indicated by the dotted lines 57 and 58 in Figure 6, thereby forming two dependent arms indicated by the reference numerals 59 and 60 in Figure 7. A tracer finger support 61 is mounted in the cross slot and permanently connected to a crosswise extending pintle pin 62 which is bearinged at opposite ends in the arms 59 and 60 respectively. The pintle pin forms an oscillatable support for the tracer support and also is capable of axial sliding movement. In other words, the pin is urged in one direction by a spring 63, and an adjustable stop screw 64 supported by the arm 60 engages a ball 65 mounted in a socket 66 formed in the end of the pin 62 to limit the extent of axial movement. This adjustment is for the purpose of compensating for any difference in size between the diameter of the cutter and the diameter of the tracer finger. As shown more particularly in Figure 8, the tracer support 61 has a dependent socket member 67 in which interchangeable tracer fingers 68 are inserted and secured as by the set screw 69 shown in Figure 1.

The tracer support is capable of oscillatable adjustment, and this is accomplished by providing a spring 70 which tends to rock the tracer support in one direction about the pintle pin and the extent of this movement is limited by a set screw 71 which, as more particularly shown in Figure 8, is threaded through the end of the tracer support 61 for engagement with a fixed cross pin 71' which is secured at opposite ends in the arms 59 and 60 as more particularly shown in Figure 7.

The purpose of this adjustment is to advance the tracer finger 68 slightly ahead of its normal vertical position in the direction of feed to provide a slight anticipation of the tracer over the cutter in following the profile to be copied and compensate for the slight time delay between reaction of the pattern on the tracer and the completion of a correction movement in the cutter. These effects will be better understood now by a general discussion of the tracing operation, because the rotatable adjustment of the tracer head bears a definite relation to the resultant direction of relative feeding movement between the work and the cutter.

As previously mentioned, the two slide control valves 10 and 11 have central positions which have been indicated diagrammatically by the lines 72 and 73 in Figure 3. If the valve 10 is moved off center in the direction of the arrow 74, it will produce a movement in the corresponding direction of its connected slide. Similarly, if the valve 11 is moved off center in the direction of the arrow 75, it will produce a movement in the corresponding direction of its connected slide. The resultant of these two movements will produce a resultant direction of feeding movement with respect to the center of the tracer head in the direction of arrow 76. The directional arrow 76 is transferred to Figure 6 whereby it will be seen that the direction of feeding movement is at an angle to the axis of the crank arm 55, which axis is indicated by the line 77. The directional arrow line 76 may be considered a tangent to the pattern at the point of tracing and therefore the crank arm 55 makes an angle of about 45 degrees to the tangent. This gives about the best tracing condition, especially when the tracer encounters a 90 degree angle in the pattern. It will be noted, however, that the cross slot in the crank arm 55, indicated by the dotted lines 57 and 58, is parallel to the direction of feeding as indicated by the arrow 76. Referring now to the diagram in Figure 10, the feeding direction arrow 76 is shown with respect to the surface 78 of a pattern to be traced. When the tracer finger 68 is adjusted coaxial to the axis of the tracer head, the axis of rotation of the tracer head would pass through the axis of the tracer finger 68, and this position is indicated by the circle 79 in Figure 10.

As previously explained with respect to the adjustment effected by the set screw 71, the tracer finger support can be angularly adjusted about its pintle pin to set the end of the tracer finger 68 slightly ahead of its normal position, corresponding to the relative position of the cutter with respect to the work, and if this is done the end of the tracer in contact with the pattern would then occupy the position indicated by the circle 80 in the diagrammatic view in Figure 10, and the distance between the two center lines, as indicated by the reference numeral 81, would indicate how much the tracer was set ahead of the cutter for anticipation purposes. The amount is greatly enlarged in diagram for explanation purposes, and as a matter of fact it is only a few thousandths of an inch.

In Figure 6, the normal central position of the tracer finger is indicated by the reference numeral 82, and the axial center of the pivot shaft 54 is indicated by the reference numeral 83. The center 82 transferred to the diagram in Figure 10 constitutes the center of the circle 79 and the center 83 constitutes the center of a circle 84 which corresponds to the center of the pivot shaft 54. It will now be seen that any reaction on the tracer circle 80 in Figure 10 toward or from the pattern will cause a swinging movement about the center 83 and thereby rotation of the shaft 54 in Figure 1 which, in turn, will cause movement of the tracer valve 37 by the mechanism shown in Figure 5. This will cause rotation of the hydraulic motor and thereby of the tracer head and through the eccentrics cause a readjustment of the valves 10 and 11 and thereby gradually change the direction of resultant feeding movement of the cutter. It will be noted that rotation of the tracer head will move the rock shaft circumferentially about the axis of the tracer head, and since the tracer finger on the lower crank arm 55 is held by the pattern during rotation of the head there is produced a relative rotation between the crank shaft and head which will cause a return shifting movement to the valve plunger to centralize it and thus stop rotation of the motor. From this explanation it will be noted that the tracer finger 68 is not supported for universal oscillatable movement but for lateral swinging movement in one plane with respect to the arm 55 and parallel to the surface of the pattern. Normal to the pattern, the tracer finger is unyieldable and there-

fore is moved by undulations in the pattern to rock the arm **55**.

In starting the machine and in effecting initial engagement of the tracer with the pattern, the tracer must be moved in a direction substantially normal to the pattern surface to come into engagement with it, and in so doing the tracer finger would be oscillated or moved backward by the pattern upon contact therewith in a direction to effect compression of the spring **70**. The amount of this possible movement is very limited, and the operator would have to be very careful. To protect the tracer from being broken off and to stop the movement if under power controlled by the tracer valve, means have been provided in the form of a pin **84'** shown in Figure 1 which projects from the tracer finger support into engagement with a cam block **85** mounted on the hand wheel **86** which is attached to the rotatable head as shown in Figure 1. Thus, any backward movement of the tracer finger will cause downward movement of the free end of the pin **84'** and since the cam surface **87** is inclined, as shown in Figure 2, it will cause rotation of the crank arm **55** and thereby shift the tracer valve to cause rotation of the tracer head in a direction to relieve the pressure on the end of the tracer finger, preventing it from being broken off and placing its plane of oscillation more parallel or tangent to the pattern surface.

In starting the operation of the machine, the operator rotates the hand wheel **86** to position the direction arrow **76** on the spoke **88** of the hand wheel, as shown in Figure 6, to point in the direction of the pattern and then by shifting the eccentrics **15** and **16** off center by rotation of the control lever **32**, fluid pressure is connected through the control valves **10** and **11** to the respective slide cylinders, causing relative movement to take place between the tracer and pattern to move the tracer into engagement with the pattern. It will be noted that the spring **56** shown in Figure 6 is normally active to maintain the tracer valve in Figure 5 off center, which would cause continuous rotation of the motor **34** and thereby of the tracer head, but the operator at this time has the hydraulic pressure disconnected from the tracer valve through suitable valving well known in the art, or even by stopping the pump. When the tracer engages the pattern, fluid pressure is connected to the tracer valve, and it takes over and readjusts the position of the parts until the plane of oscillation of the tracer moves into parallelism with the pattern, after which the tracer will automatically follow around the profile.

Another feature of this invention is that since the tracer finger is held substantially rigid, it is possible to utilize it also to actuate a depth control valve at the same time it is following a profile. This is accomplished by mounting the rock shaft **54** for axial movement and frictional resistance is removed as far as possible by mounting the rock shaft in a tube **89** containing anti-friction balls **90**. A depth control valve plunger **91** is mounted in a valve sleeve **92** in the upper part of the tracer housing **31**, and as shown in the diagram in Figure 9, has a conventional pressure port **93**, motor ports **94** and **95** which are suitably connected to a hydraulic cylinder **96** having a piston **97** operatively connected for moving the tracer head toward and from a contoured surface substantially normal to the surface which the tracer finger **68** engages laterally. The valve also has a pair of exhaust ports **98** and **99** which are suitably connected to reservoir. Thus, any vertical movement of the valve plunger up or down from a central position will cause actuation of the piston **97**.

The valve plunger **91** is normally urged downward by a spring **100** into engagement with the end of a rod **101** which is slidable through the center of the rotatable member **22**. The lower end of the rod interfits in a radial slot **102** of an arm **103**, mounted for free rotation on the reduced end **104** of the rock shaft **54** in the sense that the arm **103** is held against rotation by the rod **101** so that the end of the shaft **104** rotates relative to the arm **103**. This permits the rock shaft **54** to oscillate without causing oscillation of the member **103**.

The spring **100** maintains the valve in engagement with the rod **101** and thereby through shoulders **105** on the lower end of the rod pushes against the member **103** and maintains it in engagement with the top side of the crank arm **52**. The crank arm **52** can move downward with the rock shaft **54** a small amount limited by the surface **106** on the underside of the crank pin engaging the top surface of the tube **89**.

A counterbalancing spring **107** is connected to the rock arm **55** by a pin **108** and the other end of the spring is connected to a pin **109** in the rotatable tracer head. This tends to counterbalance the weight of the parts and thereby relieves the pressure between the end of the tracer and the pattern. The tracer will be pushed up by the pattern sufficiently to centralize the valve plunger **91** and from then on any rise or fall in the contour being followed will effect a corresponding movement of the depth control valve which, in turn, will cause a corresponding vertical movement of the tracer head.

It is obvious, of course, that two directional control tracing may be desired at times without the depth control feature, which can be accomplished by divorcing the depth control feature while at the same time holding the piston **97**, shown in Figure 9, in fixed position. The circuit connections for accomplishing this are outside of the tracer mechanism of this invention, and are not part hereof, but such connections are old and well known in the art, and one way of making such connections are shown in Figure 7 of the patent to J. C. Campbell, No. 2,039,294, issued May 5, 1936.

There has thus been provided an improved tracer mechanism which utilizes a single tracer finger to control three directional movement between tool and work, and which is so constructed that the weight of the two directional valve is ineffective as a factor in determining the pressure between the tracer and the pattern whereby improved tracing conditions can be obtained.

What is claimed is:

1. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including a rock shaft eccentrically journaled in said head parallel to the axis of said head, a crank arm operatively connecting said rock shaft to said plunger, a second crank arm attached to said rock shaft, a tracer finger attached to said second crank arm in offset relation to the axis of the rock shaft whereby lateral movement of the tracer finger will rock said shaft to open said valve and cause rotation of the head.

2. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including a rock shaft eccentrically journaled in said head parallel to the axis of said head, a crank arm operatively connecting said rock shaft to said plunger, a second crank arm attached to said rock shaft, a tracer finger attached to said second crank arm in offset relation to the axis of the rock shaft, and resilient means operatively connected to said shaft for maintaining a rotational urge thereon to maintain engagement of the tracer finger with a pattern whereby lateral movement of the tracer finger will rock

said shaft to open said valve and cause rotation of the head.

3. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including a rock shaft eccentrically journaled in said head parallel to the axis thereof, a crank arm operatively connecting said rock shaft to said plunger, a second crank arm attached to said rock shaft, a tracer finger attached to said second crank arm and lying in said plane whereby lateral movement of the tracer finger will rock said shaft to open said valve and cause rotation of the head.

4. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including a rock shaft eccentrically journaled in said head parallel to the axis thereof, a crank arm operatively connecting said rock shaft to said plunger, a second crank arm attached to said rock shaft, a tracer finger attached to said second crank arm and positioned thereby co-axially with the tracer head axis when said valve plunger is in a neutral position whereby lateral movement of the tracer finger will rock said shaft to open said valve and cause rotation of the head.

5. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including a rock shaft journaled in said head parallel to the axis of the head, a crank arm operatively connecting said rock shaft to said plunger, a second crank arm attached to said rock shaft having an axis intersecting the axis of said head when said valve plunger is in a neutral position, a tracer finger, means on the axis of said crank arm at the point of said intersection to support said tracer finger on said rock shaft co-axial with the tracer head axis, said supporting means including a pivot providing angular adjustment of said tracer finger in a plane angularly related to a plane passing through the axis of the tracer head and rock shaft to advance the pattern contacting end of the tracer finger relative to the axis of said tracer head.

6. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, and pattern operable means to control the shifting of said plunger including an oscillatable shaft supported in the head parallel to the axis of said head, a crank arm operatively connecting said shaft to said plunger, a second crank arm attached to said shaft, a tracer finger, a support for said tracer finger mounted on said second crank arm by a pivot pin journaled therein, with its axis normal to said feeding direction, means to adjust the tracer finger support about said pivot pin to advance the pattern contacting end of the tracer finger ahead of said pivot pin, means acting on said shaft to maintain contact of the tracer with a pattern whereby lateral movement of the tracer will oscillate said shaft to open said valve and cause rotation of the head.

7. A tracer mechanism comprising a housing, a rotatable tracer head journaled in said housing, fluid operable means connected for rotation of said head, a tracer valve mounted in said head having a source of pressure connected thereto, said valve having a plunger movable from a neutral position to connect said source of pressure to said fluid operable means, a second valve mounted in said housing co-axial with the axis of said head, and means to control the shifting of said valves including a rock shaft journaled in said head parallel to the axis thereof for rotary and axial movement, a crank arm operatively connecting said rock shaft to said valve plunger for imparting movement thereto upon rotation of said shaft, a second member responsive to axial movement of the shaft for actuating said second-named valve, a second crank arm attached to said rock shaft, a tracer finger attached to said second crank arm in offset relation to the axis of the rock shaft whereby lateral movement of the tracer finger will operate the first-named valve and axial movement of the tracer finger will effect movement of the second-named value.

References Cited in the file of this patent

UNITED STATES PATENTS

2,332,533	Roehm	Oct. 26, 1943
2,448,675	Loewe	Sept. 7, 1948