Sept. 28, 1943. P. VOLK 2,330,647

TRACER CONTROL FOR MATERIAL WORKING MACHINES

Filed May 15, 1940

Fig. 1.

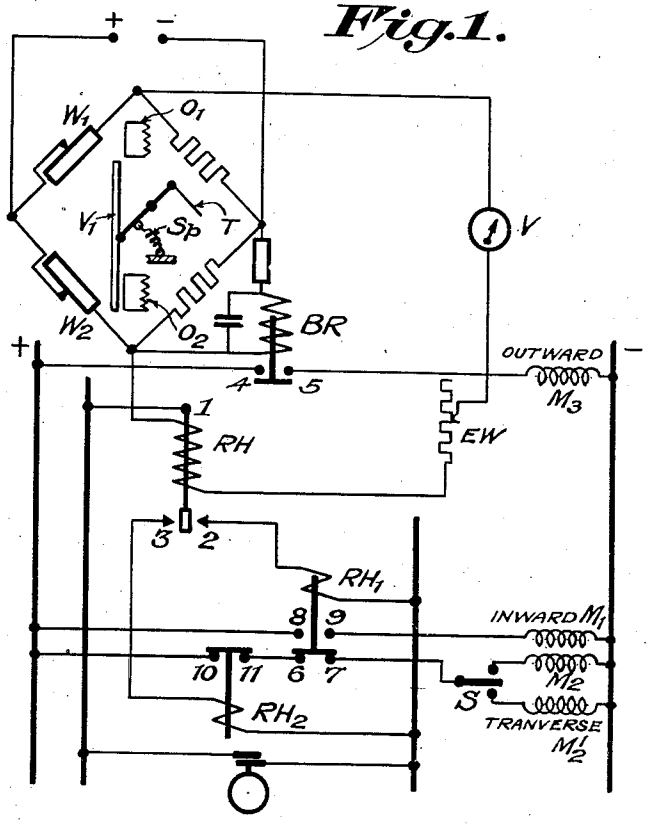
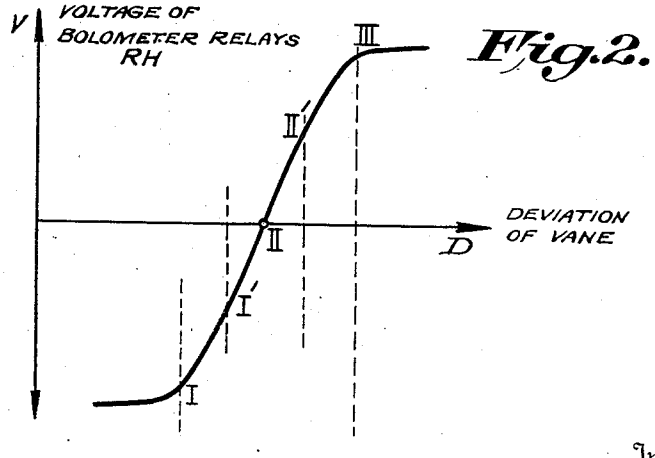


Fig. 2.



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TRACER CONTROL FOR MATERIAL WORKING MACHINES

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10 Claims. (Cl. 90—13.5)

The invention relates to a tracer control for machine tools, and especially for material removing machine tools. More particularly, the invention relates to a tracer control provided with a nozzle bolometer as disclosed in the U. S. Patent 2,046,013 to Rudolf Bingel et al., and to an improvement therein. The tracer of a control device of this type is combined with a nozzle bolometer for controlling the operation of the nozzle vane thereof and distinguishes from that disclosed in U. S. Patent 1,683,851 to Shaw in which the tracer effects the operation of control contacts by mechanical means.

The feeding movements are controlled intermittently, for example, through magnetic clutches, resulting in a step-like working path in which the height of the individual steps and the accuracy of working are dependent on the separation of the contacts controlled by the tracer. The greater the accuracy required, the smaller should be the distance between the contacts. The possibility of performing this method is, however, limited inasmuch as the smaller the distance is between the contacts, the larger will be the frequency of the controlling movements and the demand on the control relays. The actual working time also decreases by the operating time of the control relays. The ratio between the working time and the controlling time becomes the more unsatisfactory the more the frequency of the controlling movements increases. Also, at a certain minimum distance between the contacts, hunting occurs in the operating movements when the travel excess of the driven parts of the machine is larger than the distance between the contacts of the tracer. On the other hand, the tooling periods may occur in which small distances between the contacts are undesirable, for example, in rough-planing where at a lesser degree of accuracy large amounts of material are to be removed as quickly as possible. In passing over from rough-planing to smooth-planing it was previously necessary to exchange the tracers since the readjustment of the contact space required too much time and also the services of an experienced mechanic which are not always available.

It is one of the objects of the present invention to overcome the disadvantages of the prior art as pointed out above, and to provide a bolometer control which fulfills the requirements as to the speed and accuracy of working at any time.

It is another object of the invention to provide a mechanism for adjusting the controlling movements of the machine by varying the electrical values of the bolometer control.

Further objects, features and advantages of the invention will appear in detail from the following description and the accompanying drawing, in which

Fig. 1 shows a diagram of connections of an embodiment of the invention, and

Fig. 2 a working diagram of the mechanism according to Fig. 1.

As shown diagrammatically in Fig. 1, a tracer T of the bolometer (disclosed in detail in the U. S. Patent 2,046,013) is provided with a vane V1 of, for example, trapezoidal shape which is moved over two air outlet ports or nozzles O1 and O2 so as to close one or the other of them to effect a continuous control of the bolometer relay by cooling the two heated resistance branches W1 and W2 of a Wheatstone bridge differently from one another. Due to the action of a spring Sp, as long as the tracer T is not in contact with the template or pattern, the air outlet port O2 for the heated bolometer resistance W2 is covered by the vane V1, while the air outlet port O1 for the resistance W1 is still open. If a pressure now bears upon the tracer T, the vane is thereby moved so that the resistance W1 is covered to a lesser degree and the resistance W2 to a higher degree. In the extreme case, the air outlet port O1 for the resistance W1 will be covered completely and the port O2 for the resistance W2 will be fully open. Thus, when the bolometer vane is moved in either direction, the polarized relay RH of the bolometer is supplied with a voltage the size of which varies in accordance with the movement of the bolometer vane, as illustrated in Fig. 2, in which the abscissa D indicates the deviation of the vane and the ordinate V indicates the voltage supplied to the polarized bolometer relay RH. The operating voltage of the bolometer relay RH may be adjusted by the variable resistance EW so as to operate at the points I and III of the curve, whereas the relay BR is intended to operate at the point II of the curve, that is, with a fixed operating voltage determined by the bridge connection.

The operation of the tracer in inward and outward direction, i. e., toward and away from the pattern, is controlled by a further relay RH1 and the contacts 4 and 5 of the relay BR, whereas the movement of the tracer in a transverse direction is controlled by the open circuit contact of the relay RH1. The magnetic clutches and the details of their connection are only diagrammat-

ically illustrated in the drawing since such controls are generally known and disclosed, for example, in the U. S. Patent 1,683,581 to Shaw.

The operation of the system is as follows:

As long as the tracer T is not in contact with the pattern, the air outlet port 01 of the bolometer cooperating with the resistance W1 remains uncovered by the bolometer vane. A bridge current of such a direction and size is therefore produced that at the point I of the curve shown in Fig. 2, the contact 2 of the polarized bolometer relay RH will be closed. The auxiliary relay RH1 is then energized so that the winding M1 of the magnetic clutch for actuating the "inward travel," that is, the travel of the tracer toward the pattern, is likewise energized. As soon as the tracer comes in contact with the pattern, the bolometer vane deviates from its previous position. The value of the resistance W1 is then increased and that of the resistance W2 is decreased, and therefore also the value of the voltage supplied to the polarized bolometer relay RH is decreased, so that this relay and also the relay RH1 are released, the contacts 8 and 9 are disconnected and the winding M1 of the magnetic clutch for the inward travel of the tracer is deenergized. The contacts 6 and 7 of the relay RH1 are then closed and, depending on the position of the manually operated switch S, either the winding M2 or the winding M2' of the respective magnetic clutch will be energized so as to start the transverse travel of the tracer and the tool coupled therewith in one or the other direction. When the pressure acting on the tracer again decreases, the system returns to its original position so that the clutch M1 for the inward travel of the tracer is again operated until the tracer comes in contact with the pattern.

If in the transverse travel, there is a still further increase of pressure on the tracer, the bridge relay BR will be energized at the point II of the curve so that, aside from the transverse travel through the actuation of the clutch M2, the winding M3 of another magnetic clutch will be energized by the connection of the contacts 4 and 5 so as to start the travel of the tracer also in a direction away from the pattern. A still further increase of pressure on the tracer causes at the point III of the curve the polarized bolometer relay RH again to be energized, the contact 3 thereof to be closed and the relay RH2 to be energized. Since the contacts 10 and 11 of this relay are thus disconnected, the transverse travel of the tracer will be interrupted so that the latter only continues in its outward movement by the actuation of the magnetic clutch M3.

The size of the working steps obtained by the apparatus according to the invention is indicated by the distance between the points I and III of the diagram, that is, by the distance D which the bolometer vane travels within the range of control. If the variable resistance EW is reduced, the bolometer relay RH may then be operated with a lower voltage, for example, at the points I' and II', whereby the range of control of the vane is reduced accordingly. With a mechanical tracer according to the prior art, this would mean a reduction of the contact distance and an increase in the working accuracy. The formation of the working steps and the working accuracy may be indicated by means of a voltmeter V which is preferably calibrated in millivolts.

I claim:

1. In a tracer control device for tool machines or the like, the combination of a tracer bar disposed to follow a given template, with a nozzle bolometer relay for controlling the tool movement of the tool machine, said bolometer having a nozzle control vane for controlling the temperature of the bolometer wires, said vane being operatively connected with said tracer bar to partake in the movements of the latter for controlling the bolometer wire temperatures in accordance with said tracer movements, a polarized relay controlled by the bolometer for adjusting the tool movements of the tool machine, and means for varying the potential for energizing said polarized relay.

2. In a tracer control device for tool machines or the like, the combination of a tracer bar disposed to follow a given template, with a nozzle bolometer relay for controlling the tool movement of the tool machine, said bolometer having a nozzle control vane for controlling the temperature of the bolometer wires, said vane being operatively connected with said tracer bar to partake in the movements of the latter for controlling the bolometer wire temperature in accordance with said tracer movements, a polarized relay controlled by the bolometer for adjusting the tool movements of the tool machine, and means for varying the potential for energizing said polarized relay, said means comprising a variable resistance in the circuit of the polarized relay.

3. A control circuit for a machine tool equipped with a tracer and a bolometer controlled thereby, comprising a polarized relay connected as the bridge element of the bolometer bridge circuit and adapted to operate upon a predetermined degree of unbalance of the bridge in either direction, a marginal relay connected in parallel with one arm of said bridge circuit and adjusted to operate when the bridge is unbalanced in one direction, and feeding means controlled by said relays for moving the tool in coordinate directions.

4. A control circuit as set forth in claim 3, wherein means is provided for adjusting the sensitivity of the polarized relay to render the same operative responsive to a greater or lesser degree of unbalance of the bridge circuit.

5. A control circuit for a machine tool equipped with a tracer and a bolometer controlled thereby, comprising a polarized relay connected as the bridge element of the bolometer bridge circuit and adapted to operate upon a predetermined degree of unbalance of the bridge in either direction, a marginal relay connected in parallel with one arm of said bridge circuit and adjusted to operate when the bridge is unbalanced in one direction, inward and transverse feeding means controlled by said polarized relay, and outward feeding means controlled by said marginal relay.

6. A control circuit for a machine tool equipped with a tracer and bolometer controlled thereby, comprising a polarized relay connected as the bridge element of the bolometer bridge circuit and adjusted to operate upon a predetermined degree of unbalance in either direction, inward feeler feeding means operated by said relay responsive to an unbalance of said bridge circuit in one direction, a marginal relay connected in parallel with one arm of said bridge circuit and adapted to operate when the bridge is balanced or unbalanced in the opposite direction, out-

ward feeler feeding means operated by said marginal relay, and transverse feeding means controlled by said polarized relay and operative only when the degree of unbalance is insufficient to operatively energize said polarized relay.

7. A control circuit for a machine tool equipped with a tracer and bolometer controlled thereby, comprising a polarized relay connected as the bridge element of the bolometer bridge circuit and adjusted to operate upon a predetermined degree of unbalance in either direction, inward feeler feeding means operated by said relay responsive to an unbalance of said bridge circuit in one direction, a marginal relay connected in parallel with one arm of said bridge circuit and adapted to operate when the bridge is balanced or unbalanced in the opposite direction, outward feeler feeding means operated by said marginal relay, transverse feeding means and an operating circuit therefor, and means controlled by said polarized relay for opening said circuit responsive to energization of the polarized relay due to unbalance of the bridge circuit in either direction.

8. In a control circuit for a machine tool equipped with a tracer and a bolometer controlled thereby, a marginal relay connected in parallel with one of the arms of the bolometer bridge circuit and adjusted to operate responsive to a predetermined decrease in the resistance of another arm of said circuit, and tool feeding means controlled by said relay.

9. In a control circuit for a machine tool equipped with a tracer and a bolometer controlled thereby, a marginal relay connected in parallel with one of the arms of the bolometer bridge circuit and adjusted to operate responsive to a predetermined decrease in the resistance of another arm of said circuit, outward tool feeding means controlled by said relay, a polarized relay connected as the bridge element of said bridge circuit, and inward and transverse tool feeding means controlled by said polarized relay.

10. In a control circuit for a machine tool equipped with a tracer and a bolometer controlled thereby, a relay constituting at least a part of one arm of the bolometer bridge circuit, said relay being connected in series with another arm of the bridge which has its resistance varied by movement of the bolometer vane, and tool feeding means controlled by said relay.

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