May 1, 1962 H. PETERSEN ET AL 3,032,328

TORCH HEIGHT CONTROL

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Fig. 1

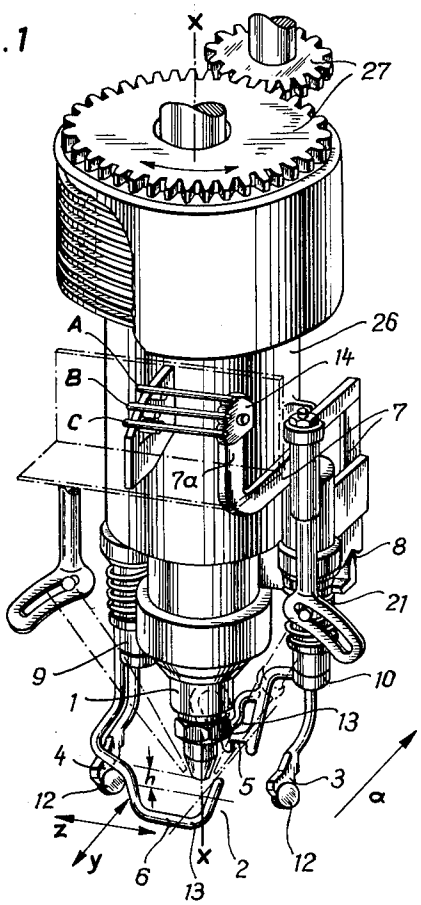
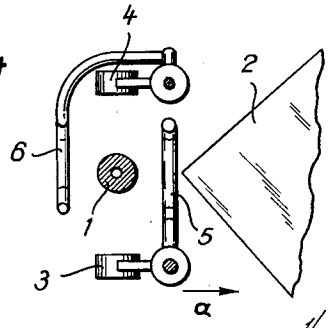


Fig. 4



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Fig. 2

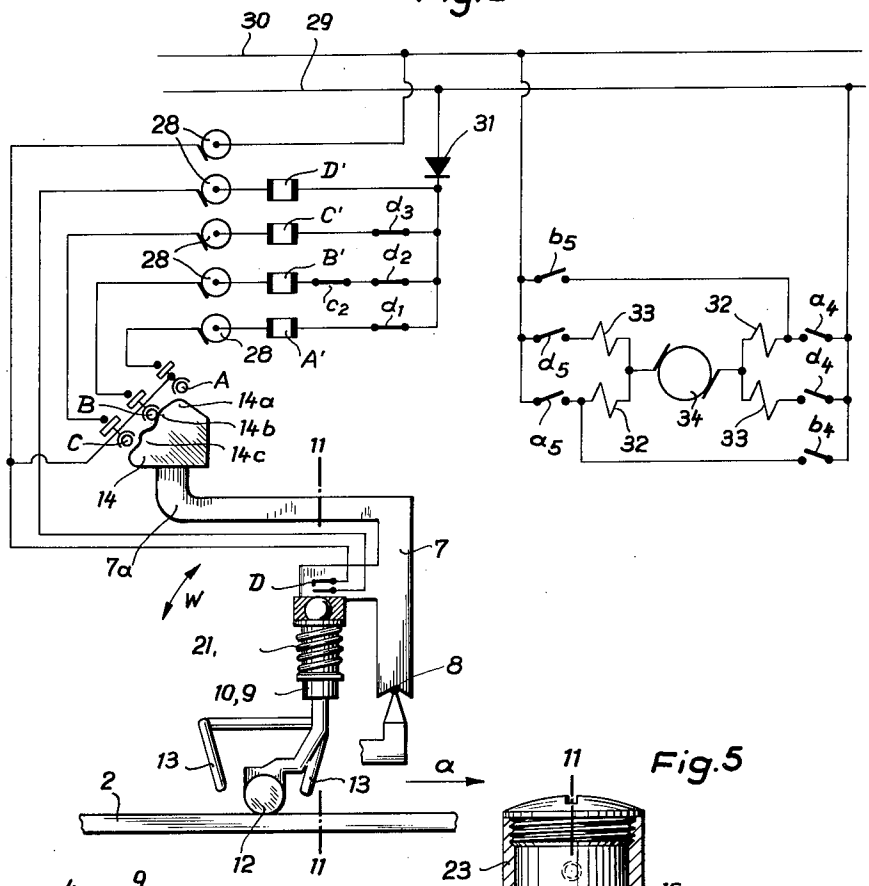


Fig. 3

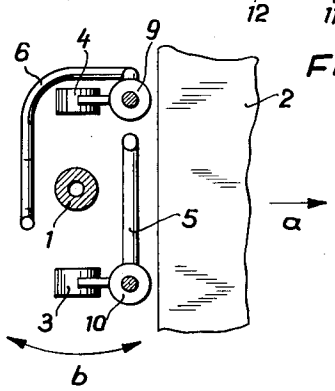
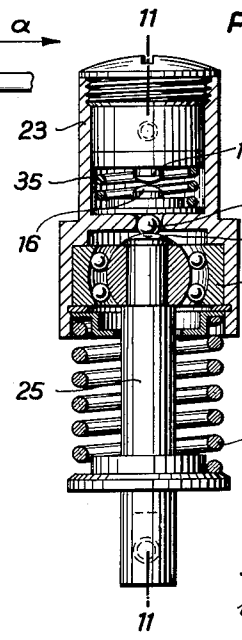


Fig. 5



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TORCH HEIGHT CONTROL

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The present invention concerns an arrangement for controlling tools in connection with tracing or copying machine tools, more especially of cutter burner or welding tools, for constant vertical clearances from the workpiece by means of feelers.

Various types of feelers are known which are supported on the surface of the workpiece and in the event of any unevenesses thereof control by way of electric contacts an arrangement for the height adjustment of the tool. These however do not conform to the requirements in connection with a fully automatic cutter burner or welding machine. The problem in this case, besides the normal vertical feeling, which has to follow any given curve course, is also to provide an effective protection against the tool striking larger obstacles, without interrupting the feeling operation.

According to the present invention one or more feelers are disposed on a rocker mounted pivotal about a horizontal axis. The feelers, for example, are comprised of rollers which due to the actual weight of the rocker or by spring pressure are urged against the workpiece. A control cam located on the rocker actuates contacts as control means for the correction in height. If the roller of the feeler is moved downwardly out of the central inoperative position, then a drive not described in detail causes a downward movement, if the roller is urged upwardly, it causes the tool to execute an upwards movement. A downwards movement exceeding a certain degree of the roller, for example, when passing over local cavities, interrupts the downward movement.

Since in the case of cutter burner and welding machines due to the constant cutting or welding speed the feed cannot be stopped when striking against obstacles, there are provided around the tool stirrup-like feelers which can yield in all directions. In order to allow sufficient time for the corresponding vertical movement of the tool to overcome the obstacles, these feelers have to move in advance of the tool. In order not to falsify the vertical feeling they are fixed at a certain distance above the workpiece. The roller feelers are also adapted to be hinged outwardly in all directions. each outward hinging movement of one or more feelers cause the tool to move upwardly at increased speed. As soon as the roller feelers again drop into their central position there is carried out a short downward movement and the normal vertical feeling comes into effect again.

The pivot of the rocker is preferably disposed at a certain distance in front of the point of locus of the feelers with the workpiece. By this so-called dragging rocker there is prevented an excessive control by the feeler arm rearing.

In a known copying machine tool, disclosed in German patent specification No. 925,565, it is possible for the rotation of the control member corresponding to the control cam to be utilized for the purpose of turning the tool or rotatable part thereof into the same angular position as the control member by means of a mechanical drive or an electric shaft. In accordance with the invention, the whole feeling member is mounted on or together with the tool rotatable about the vertical axis thereof. The rotation is so controlled in accordance with the above described apparatus that the feelers are always disposed as a certain angle relative to the direction of feed of the tool. Thus, for example, it is possible for a roller feeler

each to be arranged to the right and the left of the tool at an angle of 90° relative to the direction of feed and a feeling stirrup each in front and behind the tool.

One roller feeler and a feeler stirrup each are preferably joined to form a member adapted to be hinged outwardly from the perpendicular axis in all directions. The hinging out is rendered possible in that the feeler carrier is mounted in a swivel ball bearing having a perpendicular axis and retained in its central position by means of a centrally mounted spring. On the upper end of the feeler carrier there is a ball in a socket, which when the carrier is hinged out actuates a contact.

The roller feelers may however also be arranged at any desired position. Thus, it is convenient in circumstances to use only the roller feeler on the workpiece side for the vertical feeling in order not to affect same by the distortions on the scrap side.

It may also be convenient to obtain a favourable vertical movement of the feeler or feelers respectively to replace the rocker by a perpendicular guide, coupled in accordance with the invention with the possibility of being hinged outwardly in all directions of the feeler or feelers respectively by using a ball joint mounting.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a burner cutter or welding tool of a copying machine tool provided with a control device in accordance with the invention;

FIG. 2 is a diagrammatic side elevation of the control device in accordance with the invention;

FIGS. 3 and 4 are both diagrammatic plan views of the feeler arrangement in the control device in accordance with the invention;

FIG. 5 is a section showing a switching contact responding to the pendulum movements of the feelers.

The numeral **1** in the drawings designates the tool of a copying machine tool, which following its scanned or determined curve acts on the workpiece **2** to be machined, the tool **1** shown only partly in the example, for example, is adapted as a cutter burner or welding tool. On the fixed part of the vertically adjustable tool **1** there is mounted a housing **26** for vertical feeling rotatably mounted but relative to the machine fixedly disposed in the vertical direction, which by means of a wheel pair **27** is automatically swung in the direction B about the working axis X—X of the tool **1** by means of an electric shaft, for example, according to the rotary-field system. The transmitter of the electric shaft is coupled with a ball component separating device as disclosed in the German Patent No. 925,565, in such a way that the angular position of the transmitter corresponds to the tangent of the traced pattern curve. By this, the four feelers **3**, **4**, **5** and **6**, for example, are mutually and automatically adjusted to assume predetermined angles relative to the given direction of movement *a* of the tool **1**. The feelers **3** and **4** thus abut against workpiece **2** with their lower free ends due to their own weight and retain the tool **1** continually at a constant distance *h* or with operational clearance from the workpiece **2**.

For feeling normal unevennesses of the workpiece **2** all feelers **3**, **4**, **5** and **6** are mutually mounted by way of a bell-crank lever **7** on the housing **26** adapted to rock about the horizontal axis **8** defined, for example, by knife-edge bearings. The axis **8** is always kept at right angles to the momentary direction of movement *a* of the tool **1** by the swivel drive via the wheel pair **27** and with regard to this direction of movement *a* is disposed in front of the working axis *x*—*x* of the tool **1**. When striking obstacles it is possible for the feelers to carry out pendulum movements in pairs, **3** with **5** and **4** with **6** in the holders **9**, **10**, relative to perpendicular or substantially

perpendicular axis 11—11 in any directions relative to the arrows *y* and *z*.

The bell-crank lever 7 carrying the feelers 3, 4, 5 and 6 and adapted to be rocked about the axis 8 determined by the knife-edge bearing is provided at its free lever end 7*a* (FIG. 2) with a control cam 14, which is adapted to cooperate via separate cam sections 14*a*, 14*b*, 14*c* with several, for example three, switching contacts A, B, C, which are firmly arranged on the housing 26. On each of the holders 9, 10, by way of which the feelers 3, 4, 5 and 6 are in operational connection with the bell-crank lever 7, as evident from FIG. 2, there is provided a switching contact D, which is actuated when the feeler executes a pendulum movement.

FIG. 5 shows an example of a holder 9, 10, with the switching contact D, the contact members of which are designated by 15, 16 between which contact members the spring 35 acts. In a housing 23 firmly connected with the bell-crank lever 7 there is held, for example, by means of a swivel ball bearing 24, a bolt 25 adapted to be pivoted relative to the axis 11—11 in all directions. By means of a compression spring 21 the bolt 25 after each pendulum movement is returned into the central position. On the lower end of the bolt 25 the feelers are mounted vertically adjustable 3 with 5 or 4 with 6 respectively, whilst the upper end 17 carries a ball 19 in a socket. This ball 19 is guided in a groove in the intermediate wall of the housing 23 and with the pendulum movement of the bolt 25 is forced out of the socket upwardly and causes the lower contact member 16 of the contact D to contact the upper contact member 15.

FIG. 2 shows by way of example a wiring diagram, which illustrates the possibility of transmitting the commands of the feelers, 3, 4, 5, and 6 to the mechanical height adjustment, not shown.

The switching contacts A, B, C and D are connected with relays A', B', C' and D' by way of collector ring contacts 28, thus allowing the feeling apparatus to be swung any number of times through 360°. The relays are supplied from a source of alternating current 29, 30 through a rectifier 31. A reversible electric motor 34 drives the vertical adjustment. The motor 34 is controlled as follows by the relays A', B', C' and D'.

The feeler device is shown on the drawings in the inoperative position, all the relays are dead and motor 34 is at a standstill. If the bell-crank lever 7 is swung upwards then the contact A is depressed and the relay A' operates. The contacts *a*4 and *a*5 close and results in a magneto-motive force in the windings 32 of the electric motor 34 corresponding to the direction of rotation, which causes the upward movement of the tool 1. If the bell-crank lever 7 is swung in a downward direction then contact B is depressed and the relay B' operates. A magneto-motive force in the opposite direction is caused in the windings 32 by way of the contacts *b*4 and *b*5, thus reversing the direction of rotation of the motor 34 and the tool 1 moves upwards. If the bell-crank lever 7 swings to a certain degree downwards (for example, if the feeler slips off the workpiece 2), then the contact C is depressed and the relay C' operates. The contact *c*2 opens so that the relay B' is released and the motor 34 stops. The downwards movement is interrupted by this.

If due to a pendulum movement the contact D closes then the relay D' operates. By opening the contacts *d*1, *d*2 and *d*3 each other relay goes dead. By way of the closing contacts *d*4 and *d*5 a magneto-motive force is set up in windings 33, which in correspondence with an accelerated upwards movement of the tool 1 cause the acceleration of revolutions of the motor 34.

The control arrangement in accordance with the invention is thus so designed that with any desired three-dimensional control movement of only a single feeler 3, 4, 5, 6, there is caused a vertical correction of the tool 1 by way of the appropriate switching contact.

With reference to the example it is evident from FIGS. 1 to 4 that the four feelers 3, 4, 5 and 6 are arranged distributed around the working axis X—X of the tool 1, for example, at predetermined angles of 90° relative to one another, whereby two feelers 3, 4 are arranged on either side of the tool on an imagined line, which extends through the centre of the tool and vertically to the direction of movement *a*, whilst the feelers 5 are in advance of and the feelers 6 retarded relative to the direction of movement *a* of the tool 1. The arrangement and design according to the invention of the feelers 3, 4, 5 and 6 provides for a feeling space extending ring-shaped around the tool 1, whereby all changes of shape occurring in this feeling space or obstacles which the workpiece surface to be treated exhibits, are scanned.

According to FIGS. 1 and 2 the main feelers 3, 4 are provided on their ends acting on the workpiece 2 with rollers 12, whilst the additional feelers 5, 6 on their ends have feeling stirrups 13 pointing at right angles to the direction of movement *a* of the tool 1.

We claim:

1. In an apparatus of the type described having electrically controlled means for raising and lowering the torch in relation to a rotatably mounted torch sleeve during the lateral movement of said torch and torch sleeve relative to the workpiece, a workpiece contactor, means carrying said contactor on the torch sleeve for movement upwardly and downwardly relative thereto, a workpiece contacting member in said workpiece contactor, a support member for said contacting member and fixedly secured to said carrying means, means defining a universal joint connecting said contacting member with said support member to enable pendulum-like movement of said contacting member in any direction due to upstanding obstacles on the workpiece, means between said contacting member and support member yieldingly urging said contacting member towards a predetermined position relative to said support member with sufficient force to substantially prevent relative movement between said contacting member and support member due to normal unevenness of the workpiece, first electric switch means associated with said contactor carrying means and connected in electric circuit means of a reversible electric motor to cause raising, lowering, or immobilization of said carrying means relative to the torch sleeve, and second electric switch means associated with said universal joint and connected in an electric circuit of the electric motor to cause rapid raising of said torch upon pendulum movement of said contacting member in any direction.

2. An apparatus as set forth in claim 1, in which said means carrying the contactor comprises a bell crank, support means secured to said torch sleeve, and means on said bell crank in engagement with said support means to enable tilting movement of said bell crank on said support means on a horizontal axis transverse to the path of movement of the torch and spaced from the longitudinal axis of the torch, said first electric switch means being associated with said bell crank.

3. An apparatus as set forth in claim 1, in which said contacting member has two depending legs of different length.

4. An apparatus as set forth in claim 2, in which said tilting axis is disposed ahead of the torch in the direction of lateral movement of said torch.

5. In an apparatus of the type described having electrically controlled means for raising and lowering the torch in relation to a rotatably mounted torch sleeve during the lateral movement of said torch and torch sleeve relative to the workpiece, two workpiece contactors, a common means carrying said contactors on the torch sleeve for movement upwardly and downwardly relative thereto, a workpiece contacting member in each of said contactors, a support member for each of said contacting members, means defining a universal joint connecting each of said contacting members to its respective support member to enable pendulum movements of said contacting

members due to upstanding obstacles on said workpiece, means between each of said contacting members and the respective support member biasing each of said contacting members towards a predetermined position relative to its support member with sufficient force to substantially prevent relative movement between each of said contacting members and its support member due to normal unevenness of the workpiece, first electric switch means associated with said contactor carrying means and connected in electric circuit means of a reversible electric motor to cause raising, lowering, or immobilization of said carrying means relative to the torch sleeve, second electric switch means associated with said universal joints and connected in an electric circuit of the motor to cause rapid raising of said torch upon pendulum movement of any of said contacting members in any direction, and two dependent legs of different length on each of said contacting members, the two longer legs being disposed one at each side of the torch laterally of the direction of movement of said torch, and the two shorter legs being disposed one at each side of the torch in the direction of movement of said torch.

6. In an apparatus of the type described having electrically controlled means for raising and lowering the torch in relation to a rotatably mounted torch sleeve during the lateral movement of said torch and torch sleeve relative to the workpiece, a workpiece contactor, means supporting said contactor on the torch sleeve for tilting movement of the contactor on a horizontal axis perpendicular to the path of lateral movement of the torch and spaced from the vertical axis of the torch, said workpiece contactor comprising a support member and a workpiece contacting member, a universal joint between said support member and said workpiece contacting member, yielding means associated with said universal joint and adapted to bias said workpiece contacting member towards a predetermined position in relation to said support member, and means associated with said

contactor for energizing said electrically controlled means upon tilting movement of said support member from a predetermined position and upon deviation of said contacting member from its predetermined position in relation to said support member, said universal joint including a housing secured to said support member and having a substantially spherical cavity therein, a substantially spherical member secured to said workpiece contacting member, means retaining said substantially spherical member readily rotatable in all directions within said cavity, relatively movable electrical contact means in said housing, yielding means biasing said electrical contact means towards a relative position corresponding to de-energized condition of said electrically controlled means, and means interposed between said substantially spherical member and said electrical contact means and adapted to change the contact condition of said electrical contact means upon a predetermined degree of deviation of said workpiece contacting member from its aforementioned predetermined position relative to said support member.

7. The apparatus as set forth in claim 6, in which said electrical contact means is connected in a circuit of said electrically controlled means the closing of which causes rapid level adjustment of said torch in relation to said torch sleeve.

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