Sept. 29, 1953 C. A. ELLIS 2,653,427

MEANS FOR CONTROLLING EDGING MACHINES

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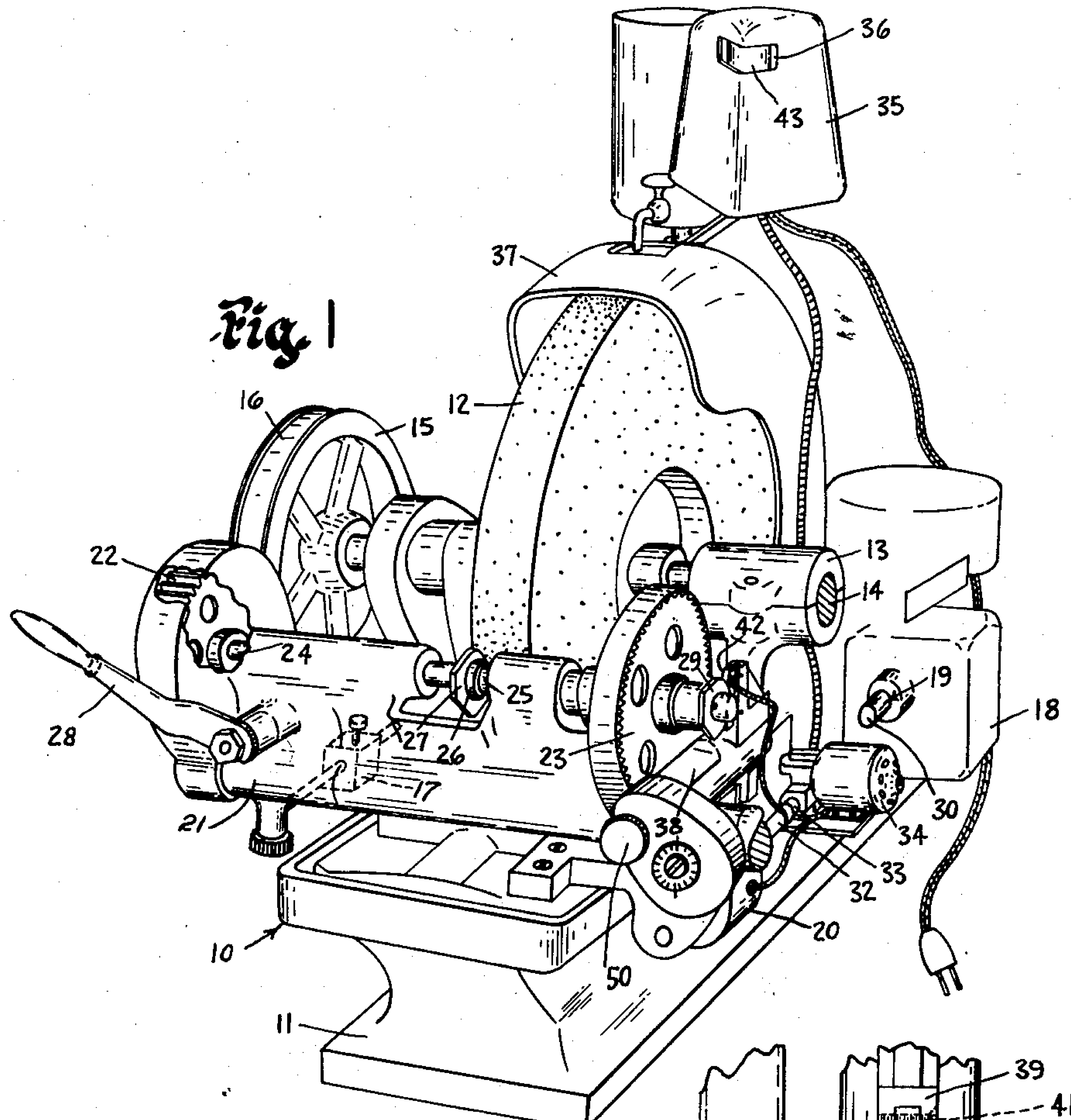

Fig. 1

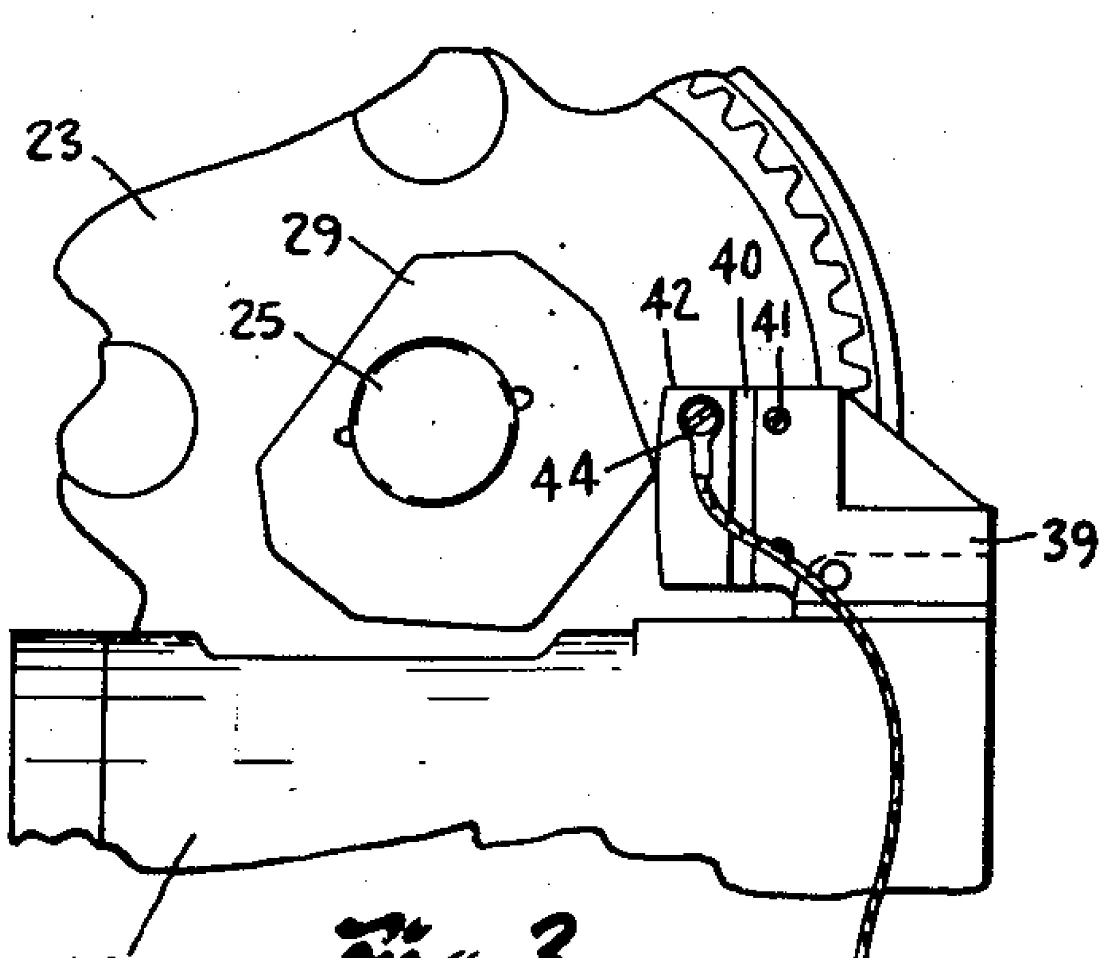

Fig. 3

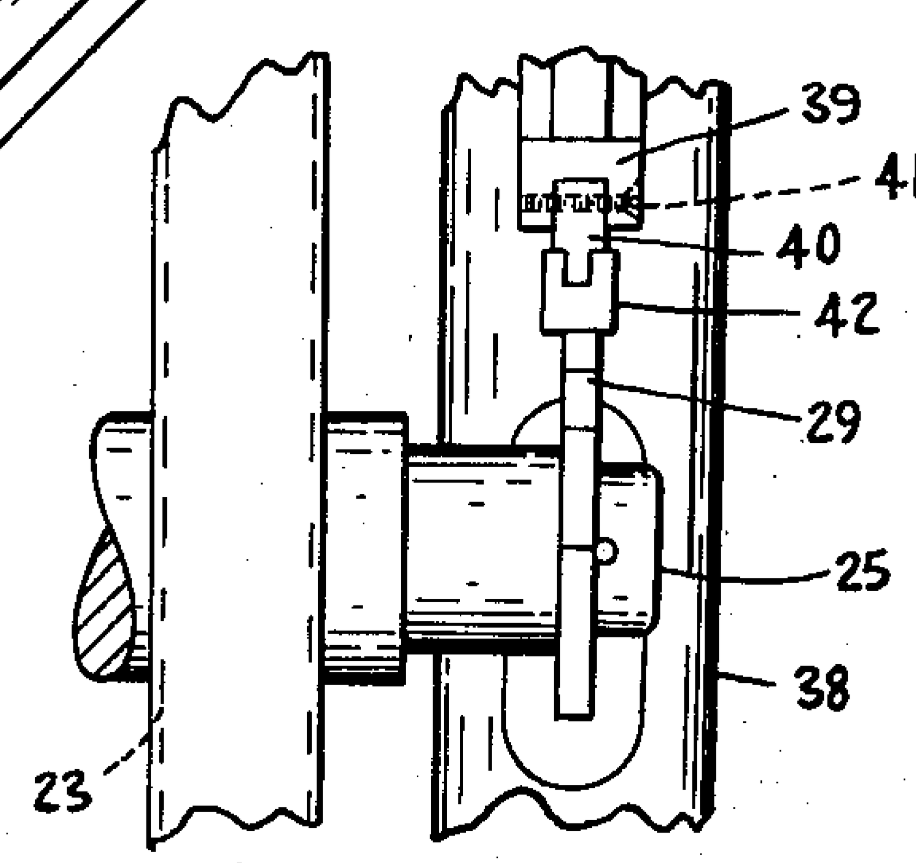

Fig. 4

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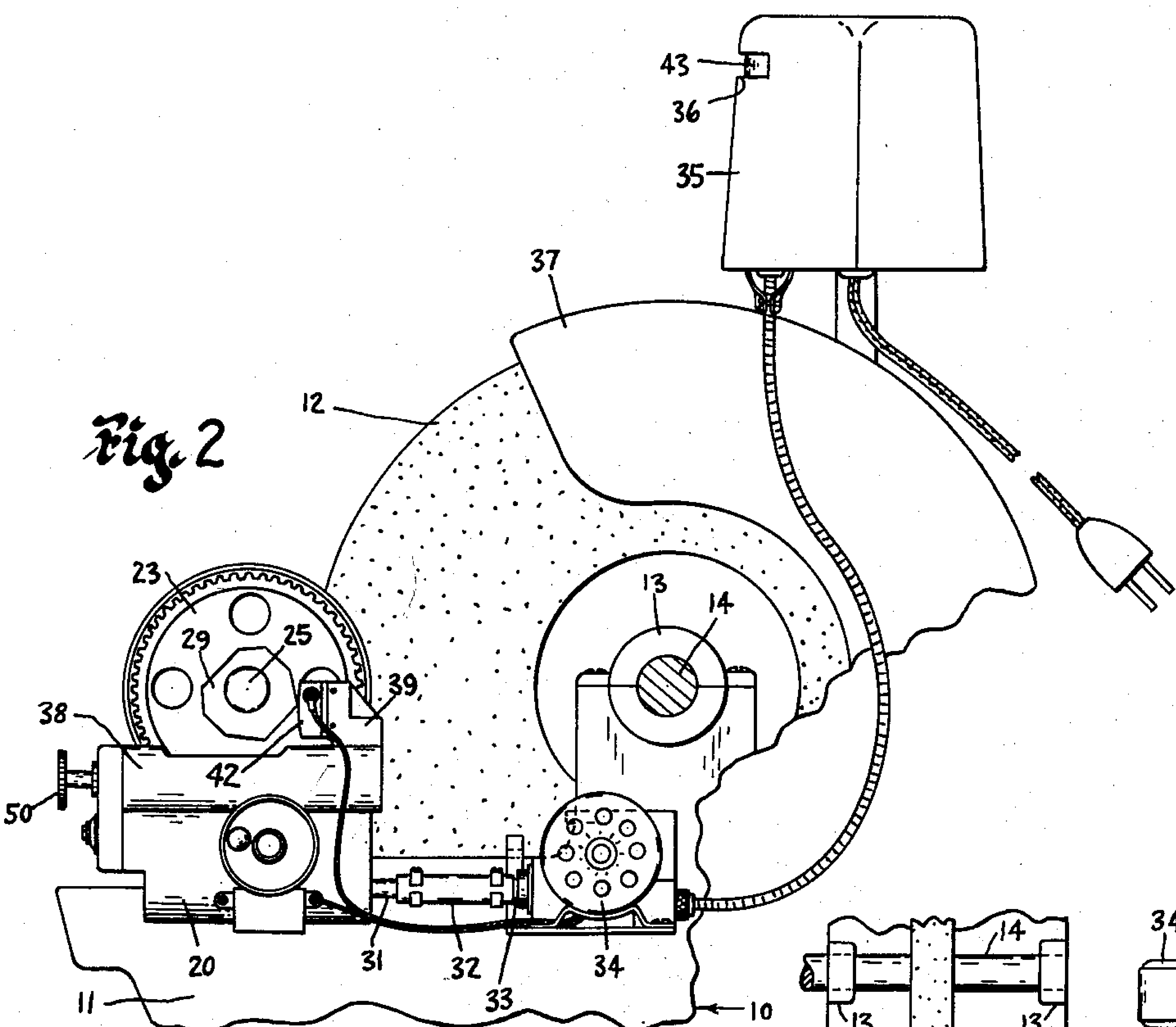
Fig. 2



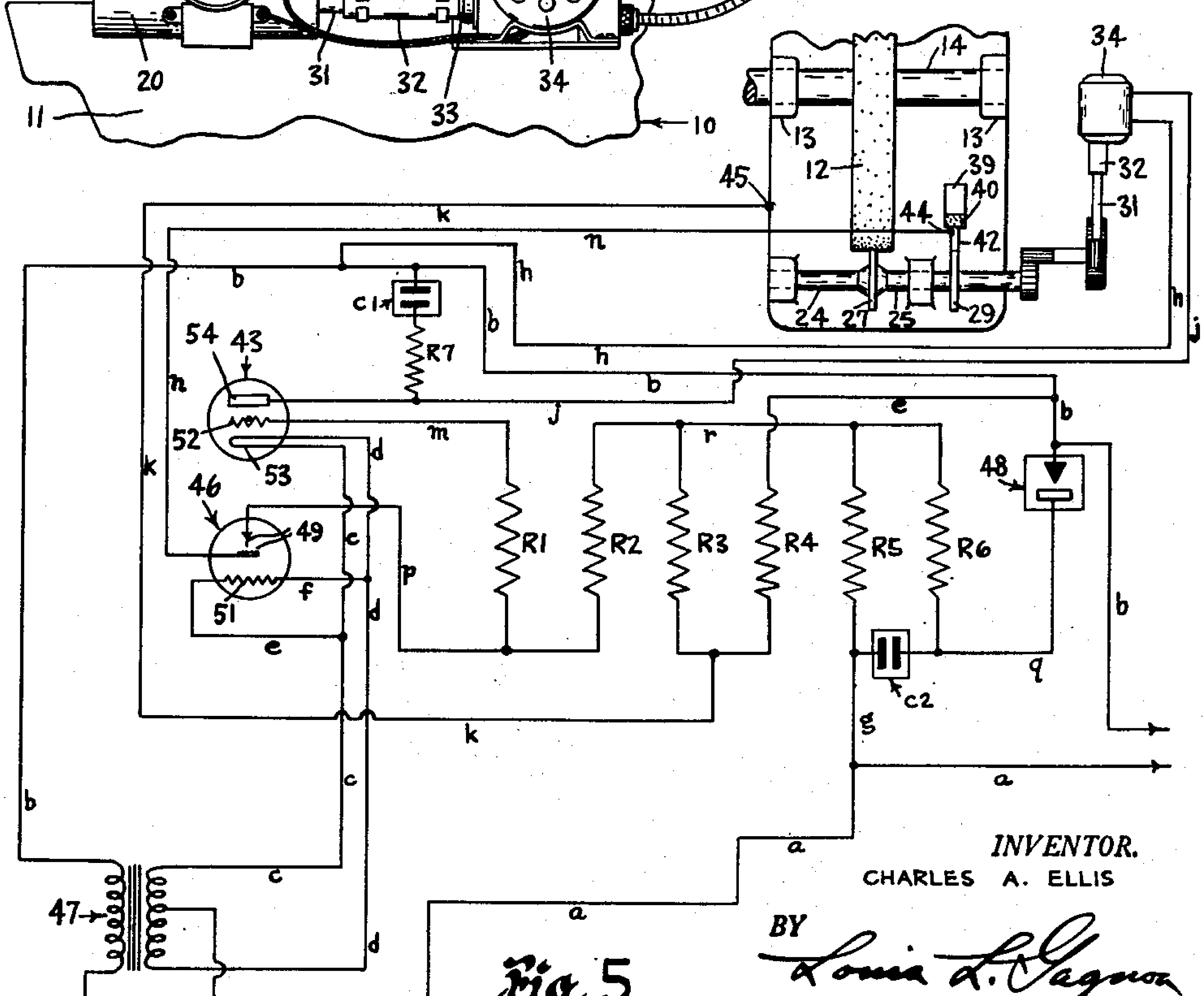


Fig. 5

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Patented Sept. 29, 1953 2,653,427

UNITED STATES PATENT OFFICE

2,653,427

MEANS FOR CONTROLLING EDGING MACHINES

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Application November 13, 1947, Serial No. 785,590

3 Claims. (Cl. 51—101)

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This invention relates to new and improved means for forming and controlling the contour shapes of articles and relates more particularly to electronic means for controlling the operation of edge grinding machines used for this purpose.

It has been the general practice in the past when forming the contour edges of articles such as ophthalmic lenses to use a pattern or former, whereby a lens blank located in a grinding machine adjacent the grinding wheel will be rotated in a head so that the contour edge of the lens upon completion of the grinding operation will be shaped in conformity with the contour edge of the former. Many different types of means have been employed to control the operation of grinding machines to produce the best results. However, past attempts have generally terminated in slight improvements in final results gained at the expense of sacrificing other desired features. To illustrate this, in using prior art type electrical means for controlling the operation of the grinding mechanism, the additional speed gained by such a control method is more than offset by the shorter life of the machine and continuous servicing made necessary by the burning of the electrical contacts due to the high current necessary to properly operate the device, and an additional very undesirable feature is the danger to the machine operator always presented by parts of the machine carrying high voltage.

Therefore, it is one of the principal objects of this invention to provide electronic means for controlling the operation of machines of the above character, which means will overcome all of the difficulties of the prior art and, in addition thereto, will introduce many new and novel features.

Another object of the invention is the provision of improved means for controlling the operation of edge grinding machines to employ the principle of "plunge grinding" to considerably shorten the time required for the operation.

Another object is the provision of an improved device for forming the contour edge of an article such as an ophthalmic lens satisfactorily in substantially one complete revolution.

Another object is the provision of an edge grinding machine having visual means for indicating the operative condition of the means for controlling the rotation of the article being ground.

Another object is the provision of electronic control apparatus for edge grinders having time delay safety means associated therewith to insure longer life of the electronic control apparatus.

Another object is the provision of electronic control means for edge grinders adapted to automatically advance the article to be formed only as fast as the article is ground to desired size and shape.

Another object is the provision of electronic

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control means adapted to be easily attached as a unit to existing edge grinding machines of the character set forth.

Further objects of the invention are to provide, as hereinafter set forth, an electronic control device for edge grinding machines which is simple in its construction and arrangement, durable, thoroughly efficient in its use, readily attachable, and comparatively economical to manufacture.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of an edge grinding machine with an electronic control device attached thereto;

Fig. 2 is a fragmentary side elevation of the mechanism disclosed in Fig. 1;

Fig. 3 is a fragmentary side elevation of the circuit making and breaking means controlled by the pattern attached to the grinding machine;

Fig. 4 is a fragmentary plan view of the disclosure illustrated in Fig. 3; and

Fig. 5 is a schematic wiring diagram of the circuit showing diagrammatically the electronic control for associated parts of the edge grinding machine.

It is the general practice in the manufacture of articles such as ophthalmic lenses to provide edge grinding machines to intermittently or continuously rotate a lens being ground with such rotary movement being imparted to the lens upon the removal of the glass down to a size governed by the pattern or former.

In machines employing means for continuously rotating an article to be edged such as an ophthalmic lens, the lens is generally rotated at a constant speed throughout the entire edging operation and it is well known that under these circumstances some portions of the periphery of the lens being edged will become shaped to the proper size before other portions due to the fact that most lenses being shaped will be of uneven contour, thereby requiring more material to be removed in some portions than in others. Also, hard spots may be encountered in certain portions of the glass which will require more time for grinding these portions. Thus it will be seen that if the lens is rotated at a constant speed throughout the edging operation, considerable time may be lost while the portions of the lens requiring less grinding must be slowly rotated to bring other unground portions into position for grinding.

Although many attempts in the past have been made to provide efficient means and methods for intermittently rotating the article to be edged, these devices have not been entirely satisfactory. Various types of mechanical and hydraulic controls have been devised for this purpose but they have generally proved to be slow and inefficient and, therefore, not practical for modern high-speed production methods. Electrically controlled devices for this purpose have been the nearest approach to the desired control mechanism but have had some undesirable features, among them being the necessary expense and loss of time involved in repair of parts such as electrical contacts which, due to the high current passing through them, usually become pitted, burned, charred or otherwise damaged, thus necessitating shut-down of the machine and repair of replacement of the damaged parts. Also, there may exist in some controls of this type constant arcing between the contacts located on or in connection with some of the moving machine parts. This arcing also will cause the contacts to become pitted or burned because of the high voltage passing between the contacts. These conditions are very undesirable especially when occurring in the manufacture of such articles as ophthalmic lenses since the lenses may be finally formed inaccurately as to desired finished sizes and shapes and the texture of the edge surfaces impractical for use. In addition, many times the parts of electrically controlled machines carrying high voltage are disposed in such positions that they may be accidentally contacted by the machine operator.

The present invention is adapted to overcome these and other difficulties found in prior art machines by electronically controlling the intermittent rotation of the article relative to the grinding wheel in accordance with the amount of material to be removed from the portion of the article in direct engagement with the grinding wheel. Such electronic control, as hereinafter disclosed, has proved to be not only faster but much more positive in action with no breakdown caused by arcing and burning of the contacts and the like and is comparatively simple in its construction and entirely automatic in its operation.

In the present device, electronic means are used to control the intermittent rotation of the article to be abraded wherein high resistance low current circuits substantialy free from inductive effects are used to control the operation of the abrading machine. Also, with the present device, it is possible to use the principle of the "plunge" cut whereby in forming the contour shape of the article being abraded, the first as well as each of the succeeding cuts or grinding operations may be made to the finished dimension, thereby requiring only a single complete revolution of the article to complete the contour thereof to its final size and shape. In addition, there is also provided the novel feature of signaling means whereby the machine operator will receive visual indication informing him when the device is being operated to rotate the lens, the signaling means also indicating the completion of the revolution of the article and consequently the completion of the edging operation.

Another very desirable feature is the incorporation in the present invention of a time delay type of safety means to prevent possible failure of the electronic device used to control the rotation of the article being abraded, thereby lessening the possibility of breakdowns within the electronic control.

Such an electronic control device as presented by the following description and shown in the accompanying drawings may be attachable as separable units to abrading machines already made and in use or they may be built into the machines when the machines are being constructed.

Referring more particularly to the drawings wherein like characters of reference designate like parts throughout the several views, the device embodying the invention as illustrated in Fig. 1 comprises broadly an edge grinding machine **10** having a base **11** on which a grinding stone or wheel **12** is rotatably supported in bearings **13** by means of arbor **14**.

Power is transmitted to the arbor **14** through a pulley **15** mounted thereon and a belt **16** transversing the pulley, the belt being connected to any suitable constant source of power not shown.

A drive shaft **19** in the ordinary edge grinding machine is operatively connected at its forward end to gear and worm mechanism located within a gear box **20**, which mechanism operates in response to the rotary movement of shaft **19** to rotate a horizontal shaft journaled in the head **21** and about which the said head swings and which in turn operates through additional gearing to synchronously rotate gears **22** and **23**. A pair of longitudinally spaced head and tail spindles **24** and **25** are journaled in the upper portion of the head **21**, spindle **24** carrying at its outer end gear **22**, with gear **23** being fixedly mounted about midway on spindle **25**. The inner adjacent ends of the spindles **24** and **25** are provided with pads **26** between which is carried the article **27** which is to be shaped. The article may be formed of glass, metal or any other desired material which is to be provided with a shape controlled by a pattern or former. It may be a blank for a pattern, a watch crystal, lens blank or other similar article but for ease of description it is referred to throughout as being a lens blank. A handle **28** located on the front of the head **21** may be manually operated to spread the spindles **24** and **25** to release the lens blank as well as to draw the inner ends of the spindles toward one another to clamp the blank in position through means commonly known in the art. The lens blank **27** when in place between the pads **26** on the ends of spindles **24** and **25**, will thus be rotated continuously through the mechanism described above, with the edge of the blank being in abutting relation with the abrading surface of the grinding wheel **12** which through its rotation will tend to remove material from the abutting contour edge of the blank.

The head **21** is pivotally attached to the base **11** as set forth above and may be swung toward or away from the grinding wheel **12**. It is normally urged toward the grinding wheel by a weight **17**. The movement of the head **21** and consequently the lens blank **27** relative to the abrading surface of the grinding wheel **12** is controlled by a pattern or former **29** which is attached to the outer end of spindle **25** by any suitable means. The pattern **29** is of the shape of the lens to be ground. Upon operation of the gear mechanism the pattern, in being rotated against a contact shoe **42** having a suitable hard, rigid surface, will cause the head **21** to swing forwardly or rearwardly in accordance with the irregularities in the contour of the pattern. It will be seen that in a device of the character wherein the pattern and the blank are continuously rotated at a predetermined speed the high spots of the blank will require more rotations of the blank in grinding them off than will the low spots. Therefore, the time when the finished low spots rotate past the area adjacent the grinding wheel to bring the high spots repeatedly into grinding position is entirely wasted.

Several revolutions may be required before a high spot finally is ground to the finished dimension.

It is to be understood that the foregoing description is primarily based on a standard machine and hence forms no part of this invention except insofar as the drive mechanism for the grinding wheel is concerned with respect to its operation with related mechanism now to be set forth.

There is provided in the present construction electronic means for controlling the rotation of the blank to permit the contour edge of the blank to be reduced substantially to size in a single cycle of movement. With reference to Figs. 1 and 2, the rotatable drive shaft 19 has its central portion cut away which, in attaching one of these electronic controls to a standard machine, will leave one portion 30 of the shaft 19 unused and merely projecting slightly from the gear box 18 depending upon the length of the portion eliminated. The opposite forward portion 31 of the shaft 19 projects rearwardly from the gear box 20 and is connected by a coupling 32 to a motor drive shaft 33 operated by a motor 34, the motor being mounted by suitable means upon the machine base 11 and operatively controlled by electronic means enclosed within a housing 35 secured in some advantageous position on the machine whereby the said electronic means will also function as a signaling device and will be readily visible to the machine operator within the housing 35 through the opening 36. In the present illustration the housing 35 containing the electronic control means is shown secured to the top of the safety guard 37 of the grinding wheel 12 and thereby within the direct vision of the operator.

It can readily be understood that, with this construction, operation of the motor 34 will cause rotation of coupling 32 and forward portion 31 of the shaft 19 to rotate the lens blank 27 and pattern 29 through means recited hereinbefore, and that when the operation of the motor 34 is discontinued this will consequently stop rotation of the lens blank 27 and pattern 29 and allow that portion of the lens blank held in engagement with the abrading surface of the grinding wheel 12 by the weight 17 to be ground at said abutting area. The extent of said grinding is controlled by the engaging of the pattern 29 with the contact shoe 42.

A laterally disposed shoe supporting member 38 is fixedly mounted on the machine base 11 below the pattern supporting end of shaft 25 and above gear box 20 and carries at its rearward end an upwardly extending adjustable bracket 39. The bracket 39 is shaped to present a forwardly projecting vertical surface spaced slightly above the supporting member 38 having a longitudinal groove therein adapted to carry the rear edge of an insulating member 40 firmly located therein by means of pins 41 or the like. The contact shoe 42 is mounted over the forward edge of the insulating member 40 and held immovably in position by a press fit connection. As can be seen by reference to Figs. 3 and 4, the edge of the pattern or former 29 is adapted to engage the shoe 42 to control the operation of the invention as will be made clear in the description of the operation of the machine which follows.

Mounted within the housing 35 is the electronic means for controlling the rotation of the lens blank and which includes a thermionic tube containing mercury vapor, argon or other noble gas, and which is indicated in the drawings by reference numeral 43.

In initiating a complete lens grinding operation the operator of the edge grinding machine will initially cause a suitable source of power to be directed to the grinding machine to impart rotation of the grinding wheel 12 through belt 16, pulley 15 and arbor 14, causing the grinding wheel to revolve continuously until said source of power is rendered inoperative by the machine operator.

A lens former or pattern 29 of the desired shape of the finished lens to be ground is then mounted on the outer end of tail spindle 25 which is journaled in the head 21, the head during these initial setting up operations being stationary and swung and held in a position away from the grinding wheel 12. At this point the handle 28 may be manipulated by the operator to open the space between the pads 26 on the ends of the head and tail spindles 24 and 25 for insertion of a lens blank 27 to be ground between said lens supporting pads 26, the handle 28 being returned to its initial position to close the space between the pads and to clamp the lens blank firmly in position in the conventional manner.

Since the head 21 is pivotally supported upon the base 11, this head is capable of oscillation toward and away from the grinding wheel 12. Although it normally is inoperatively positioned in a substantially vertical position, in operation it is constantly urged toward the grinding wheel by the weight 17 mentioned above and will position and hold the contour edge of the lens blank 27 against the abrading surface of the revolving grinding wheel. Other suitable means may, if desired, be incorporated to provide additional adjustments with respect to the pressure required to maintain the head in position so that the lens blank will constantly engage the wheel. The resultant size of lens is controlled by the initial adjstment of the contact shoe 42 inwardly or outwardly relative to the abrading surface of the grinding wheel through suitable adjusting mechanism housed in the supporting member 38 and operated by the thumb wheel 50 in the conventional manner.

In the actual lens grinding operation, the lens blank 27, which has been fabricated as to the optical surfaces formed thereon as prescribed by an optician, is allowed to rest in edge contact against the abrading surface of the grinding wheel under the action of the weight 17 described above. When the lens blank 27 first engages the wheel 12 the former or pattern 29, because of the initial size of the blank, will be held spaced from the shoe 42. However, as the edge of the lens is ground by the revolving grinding wheel, the pattern 29 will approach closer to shoe 42 until it finally actually makes contact with the shoe to prevent the head from swinging further toward the grinding wheel and thus preventing additional material from being ground off the edge of the lens blank at said location. This completes the initial cut or what is known as a "plunge" cut; that is, the lens edge at said location has been reduced to its final depth in one cut.

The contacting of the pattern 29 with the shoe 42 at the completion of the initial "plunge" cut causes the motor 34 to be energized and thereby causes the lens blank to be rotated an amount sufficient to present an adjacent uncut portion of the blank to be abraded in a similar manner. When the progressive adjacent uncut portion of the lens blank is advanced through the energizing of the motor the rotation thereof will simultaneously cause the pattern to become disengaged from the contact shoe and will automatically de-energize the motor whereupon the lens blank will remain stationary for a period of time sufficient to allow the abrading wheel to grind the newly presented portion of the blank to a depth wherein the pattern will again contact the shoe to cause a repetitive function to take place. These successive "plunge" cuts are formed intermittently throughout the entire contour of the lens blank and will thereby reduce the blank to the shape of the pattern.

The energizing and de-energizing of the motor results from the provision of an electrical system embodying an electron tube 43 of the thermionic type. This tube embodies a filament 53, a grid 52 and a plate 54 and has its interior filled with a gas such as mercury vapor, argon or other noble gas as previously stated. This electron tube functions to open and close the circuit to the motor and its operation is controlled by a relatively low voltage as compared with the voltage required for energizing the motor 34.

The primary coil of a transformer 47 is connected through circuit *a*—*b* to the incoming source of electrical energy, the secondary coil of the transformer being connected through circuit *c*—*d* to the filament 53 of said electron tube 43. The circuit also embodies a time delay relay tube 46 having a heater unit 51 therein and make-and-break contacts 49. The heating unit 51 is connected by the lead *e* to the conductor *c* and by the lead *f* to the conductor *d* in parallel with the filament of the electron tube 43. One of the contacts 49 is connected by the conductor *n* to the contact shoe 42 through the terminal 44. The other of said contacts 49 is connected by the lead wire *p* to a resistor circuit controlling the operation of the grid 52 in the electron tube 43. These resistors are indicated by R1, R2, R3, R4, R5, and R6. In this instance, the lead *p* is connected directly with the resistor R1 which in turn is connected through the lead *m* to the grid 52 of the electron tube.

The contacts 49 of the delay relay tube 46 are normally in open relation and are in series with the control circuit to the shoe 42 and pattern 29. Heating of the delay tube heater 51 closes the contacts 49 after a given time interval such as, for example, forty seconds. During this interval, the filament of the electron tube 43 has had ample time to reach its operating temperature. This is necessary only when first starting the machine so that the operator will not encounter difficulties caused by not waiting a sufficient interval for the electron tube to become properly heated. The plate 54 of the electron tube 43 is connected through the conductor *j* directly to one side of the motor 34 and the opposite side of said motor is connected through the conductors *h*—*b* to one side of the alternating current supply. The other side *a* of the alternaing current supply is conductively connected to the tube filament through *c* and/or *d*, the electron stream between the filament and plate completing the motor circuit under operative conditions.

The grid 52 of the electron tube 43 is normally negative and the negative voltage is supplied by a bias circuit including a half-wave rectifier 48, located in the circuit on the lead *q* between conductor *b* and a pair of dropping resistors R5 and R6, the rectifier 48 serving to convert the alternating current supplied by leads *a*—*b* to direct current. Thus, negative or minus voltage is supplied from the rectifier 48 and resistors R5 and R6 through conductor *r*, resistors R2 and R1 and conductor *m* to the grid 52. However, since it is desired to conduct true direct current to the grid rather than pulsating current as supplied by the half-wave rectifier 48, a condenser C2 is inserted between resistors R5 and R6, the condenser acting to store energy in this circuit and to discharge energy between the waves discharged by the half-wave rectifier 48, thus providing essentially direct current through resistor R5 and on to the grid 52. The resistor R1 is inserted in the circuit for protection of the grid to limit current flowing to the grid.

Resistors R4, R3 and R5 are in series and provide an alternating current network, circuit *b*—*e*—R4—R3—*r*—R5—*g*—*a*, the values of the resistors being selected so that voltage across R5 is not enough to allow conductor *r* to be positive with respect to the filament 53 of the electron tube. However, upon contact being made between the pattern 29 and shoe 42 resistors R2 and R3 are placed in parallel. This circuit is effected as shown in Fig. 5 by lead line *n* connected at 44 to shoe 42 and through contacts 49 and lead line *p*. Lead line *k* has one end connected at 45 to the machine and thus the circuit is completed through the machine to the pattern 29. The opposed end of said lead line *k* is connected between resistors R3 and R4. When contact is made between the shoe 42 and former 29 the resistance of the R3—R4—R5 circuit is reduced to a point where the voltage across resistor R5 will rise to such a degree as to permit positive pulses to be supplied to the grid 52 of the electron tube 43, through conductor *r*, resistors R2 and R1 and conductor *m*.

It is understood that a characteristic of the electron tube 43 is that it will permit current to flow as long as the grid and plate are positive with respect to the filament but changing the condition of the grid while current is flowing is not effective to either control or stop the plate current. However, when the grid becomes positive with respect to the filament as described above, this will start the flow of electrons to the plate 54 which also is positive and thence through conductor *j* to the motor 34. Thus, the motor is supplied with pulsating current through circuits *a*—*c* or *a*—*d* to the tube 43 and lead *j*, thence through conductors *h* and *b* to complete the circuit thereto.

A condenser C1 is connected in parallel with the motor, leads *b* and *j*, to improve the operation of the motor by furnishing impulses during the time the electron tube is non-conductive. This is accomplished by the condenser becoming charged during the conducting cycle of the tube and by its discharging through the motor in the non-conducting cycle. Resistor R7 in series with the condenser C1 is provided fir the purpose of limiting the peak of inrush current to the condenser to reduce the possibility of its failure.

Immediately upon being energized, the motor 34 will operate to rotate the lens blank 27 and pattern 29 to bring an uncut portion of the lens blank into abrading position as described above. This will cause the head 21 to swing in a direction away from the grinding wheel 12 thus causing the pattern 29 to become disengaged from the contact shoe 42, thereby breaking the circuit to the resistor network, converting the voltage to the grid 52 of electron tube 43 to negative polarity. Due to the characteristic of this electron tube this will effectively cause the stopping of the flow of electrons from filament 53 to the plate 54 as soon as the plate voltage passes through zero to thus break the circuit to the motor 34, de-energizing the motor and stopping the rotation of the lens blank and pattern.

The motor will not operate to rotate the lens blank again until the portion of the blank in abutting relation with the grinding wheel 12 has been cut to the depth desired as controlled by the pattern 28, at which time the pattern will again make contact with the shoe 42 to again energize the motor 34 as described and the cycle is repeated until the entire contour edge of the lens blank has been ground to the size and shape of the pattern, after which it may be removed from the machine and a new lens blank to be ground may be substituted in its place.

It is important here to note that the electron tube 43 is mounted within the control housing 35 in such a position that it can be visible through the opening 36. The gas within the tube is of such a type that it will become luminous when current is passing between the filament and the plate of the tube, thereby indicating visually to the operator when the motor is being energized to rotate the lens blank. It is also important to note that the blank is rotated by the motor 34 only a very small amount since the contact between the pattern and shoe is almost immediately broken. Only a small amount of material is removed from the blank during each grinding operation or between each interval of contact of the blank with the grinding wheel and the interval of contact of the pattern 29 with the shoe 42. That is, the lens is ground during the period that contact is broken between the pattern 29 and shoe 42 and until contact is again established between these members. Therefore, there will be numerous engagements and disengagements between the shoe and the pattern in grinding each edge surface of the lens blank, or such surfaces as correspond to the surfaces of the pattern 29. The entire edge surface is not removed at each engagement between the lens blank and the grinding wheel, but instead only a small portion, or so much of the blank as can be presented to the abrading surface of the grinding wheel. As a result there will be numerous engagements between the pattern and shoe for intermittently rotating the lens blank, because the lens blank will be out of pressure contact with the wheel when the pattern 29 engages the shoe 42.

One complete turn or revolution of the lens blank is sufficient generally to remove the necessary material to bring the blank down to proper size and shape. However, as the last amount of material is removed, the pattern and shoe will again make contact and the circuit to the motor 34 will be established to permit the lens blank to again be rotated. This second rotation of the lens blank, if desired, will be made at a high rate of speed and, together with the rotation of the grinding wheel, insures the removal of any superfluous material and cleans up the tiny "scallops" on the edge of the blank. One revolution of the blank under this condition is sufficient to perform this cleaning up operation although the blanks are satisfactory for general use without the added operation. The continuous rotating of the lens blank and therefore the continuous illumination of the tube indicates to the operator that the lens is completed.

With this method of removing the material and the forming of a lens, production time is reduced considerably compared with the general methods employed for this purpose, together with the added advantage of greater safety provided through the use of a high resistance circuit in areas most likely to be contacted by the operator.

It can be clearly seen from the foregoing that an abrading machine of the character described hereinbefore is an improvement over prior art machines by providing efficient and simple electronic control for operation thereof, said electronic control including the employment of the principle of "plunge grinding" which considerably shortens the time required for a grinding operation of an article to shape the contour edge of the article satisfactorily in most cases in one complete revolution of the article, with a second revolution of the article being made if desired, the electronic control for the machine also having visual means for indicating the operative condition thereof and safety means associated therewith to insure longer life of the apparatus, in contrast to the short life of prior art devices. Electronic controls for abrading machines of the character described may be easily attached as units to existing edge grinding machines of the character set forth.

It will be apparent that many changes may be made in the details of construction and arrangement of parts shown and described without departing from the spirit of the invention as expressed in the accompanying claims. Therefore, it is to be understood that all matter set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A lens edging machine of the character described comprising a rotatable abrading wheel, a rotatable work holding device for supporting a lens in position to be edged by said abrading wheel, said work holding device being supported for movement in a controlled path toward and away from said abrading wheel, a pattern rotatable with said work holding device, a contact positioned to be engaged by said pattern to control the relative spacing of said work holding device to the abrading wheel, electrically operated drive means imparting simultaneous rotary movement to the work holding device and pattern when electrically energized, a circuit for connecting said drive means to an A. C. source, a three element type gas-filled electron tube embodying a cathode, plate and intermediately disposed control grid and having its cathode and plate connected in said circuit on one side of the drive means whereby there will be an A. C. potential on the plate when the drive means is connected by said circuit to an A. C. source, and a pair of bias circuits of fixed potential connected with said grid, one introducing D. C. voltage of negative polarity on the grid and the other simultaneously introducing voltage of positive polarity on said grid, said tube firing only when the grid is positive with respect to the cathode, and the bias circuit of negative polarity normally having a value slightly in excess of that of the positive polarity bias circuit to prevent firing of the tube, and means operable by engagement of the pattern and contact for increasing the potential of said positive polarity bias circuit to a value where it exceeds that of the bias of negative polarity to permit the tube to fire and allow the circuit to energize the drive means to rotate the work holding device and advance an adjacent un-

abraded portion of the lens to a position where the pattern and contact will disengage and cause the bias circuit of negative polarity to again become of greater potential so as to substantially instantaneously stop the said advance of the lens when the potential of the A. C. on the plate goes to zero and allow said portion of the lens edge to be ground, whereby in one complete revolution of the lens it may be edged to substantially the exact shape of the pattern.

2. A lens edging machine of the character described comprising a rotatable abrading wheel, a rotatable work holding device for supporting a lens in position to be edged by said abrading wheel, said work holding device being supported for movement in a controlled path toward and away from said abrading wheel, a pattern rotatable with said work holding device, a contact positioned to be engaged by said pattern to control the relative spacing of said work holding device to the brading wheel, electrically operated drive means imparting simultaneous rotary movement to the work holding device and pattern when electrically energized, a circuit for connecting said drive means to an A. C. source, a three element type gas-filled electron tube embodying a cathode, plate and intermediately disposed control grid, said tube having its cathode and plate connected in said circuit on one side of the drive means whereby there will be an A. C. potential on the plate when said circuit is connected to the A. C. source and said tube firing only when the grid is positive with respect to the cathode, and a pair of bias circuits connected with said control grid, each bias circuit including a plurality of resistors in series controlling the value of its potential, at least one of which resistors is common to both circuits and said circuits each further having at least one resistor separate from the other circuit, one of said bias circuits introducing voltage of positive polarity on the grid of predetermined normal value and the other bias circuit introducing D. C. voltage of negative polarity on the grid and having the value of its resistors such as to introduce negative voltage of a potential just over the normal value of the positive voltage of the first bias circuit to prevent firing of the tube, a make and break circuit connecting in parallel relation a resistor common to the two bias circuits and a resistor only in said positive polarity bias circuit, said latter circuit being completed by engagement of the pattern and contact to change the relation of the resistors in said positive polarity bias circuit from their normal series to said parallel relation to increase the potential of said circuit to a value where it exceeds the potential of the negative polarity bias circuit to permit the tube to fire and allow the circuit to energize the drive means to rotate the work holding device and advance an adjacent unabraded portion of the lens to a position where the pattern and contact will disengage to break said further circuit and cause the potential of the negative polarity bias circuit to again be of greater potential so as to substantially instantaneously stop the said advance of the lens when the potential of the A. C. on the plate goes to zero and allow said portion of the lens edge to be ground, whereby in one complete revolution of the lens it may be edged to substantially the exact shape of the pattern.

3. A lens edging machine of the character described comprising a rotatable abrading wheel, a rotatable work holding device for supporting a

lens in position to be edged by said abrading wheel, said work holding device being supported for movement in a controlled path toward and away from said abrading wheel, a pattern rotatable with said work holding device, a contact positioned to be engaged by said pattern to control the relative spacing of said work holding device to the abrading wheel, electrically operated drive means imparting simultaneous rotary movement to the work holding device and pattern when electrically energized, a circuit for connecting said drive means to an A. C. source, a three element type gas-filled electron tube embodying a cathode, plate and intermediately disposed control grid and having its cathode and plate connected in said circuit on one side of the drive means whereby there will be an A. C. potential on the plate when the circuit is connected to the A. C. source, said tube firing only when the grid is positive with respect to the cathode, and a pair of series resistor bank bias circuits connected with its grid, each circuit having at least one resistor common to the two circuits and a resistor separate therefrom, said bias circuits being connectable to the A. C. source, one bias circuit introducing alternating positive and negative pulses of voltage on the grid of a value determined by the resistors in its circuit, and the other bias circuit including a rectifier and having the values of its resistors such as to introduce negative D. C. voltage of a potential just over the normal value of the positive pulse of the first bias circuit to prevent firing of the tube, a make and break circuit connecting in parallel a resistor common to the two bias circuits and a resistor only in said positive potential introducing bias circuit, said latter circuit being completed by engagement of the pattern and contact to change the relation of said resistors from series to parallel relation to increase the potential of said circuit to a value where it exceeds the potential of the negative polarity bias circuit to permit the tube to fire and allow the circuit to energize the drive means to rotate the work holding device and advance an adjacent unabraded portion of the lens to a position where the pattern and contact will disengage and cause the bias circuit of negative polarity to be of greater potential so as to substantially instantaneously stop the said advance of the lens when the potential of the A. C. on the plate goes to zero and allow said portion of the lens edge to be ground whereby in one complete revolution the lens may be edged to substantially the exact shape of the pattern.

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