Oct. 10, 1933. H. L. BLOOD 1,929,967

SIZE DETERMINING MECHANISM FOR AUTOMATIC MACHINES

Filed Dec. 29, 1931 2 Sheets-Sheet 1

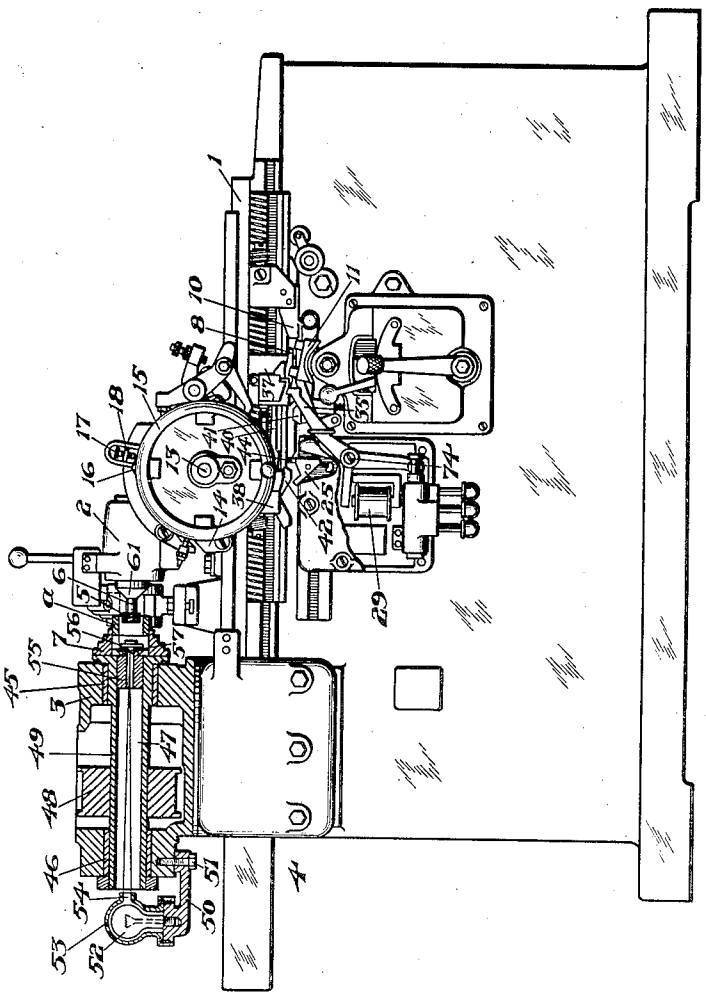


Fig. 1

Inventor
Harold L. Blood

By Geo. D. Kennedy Jr.
Attorney

Oct. 10, 1933. H. L. BLOOD 1,929,967

SIZE DETERMINING MECHANISM FOR AUTOMATIC MACHINES

Filed Dec. 29, 1931 2 Sheets-Sheet 2

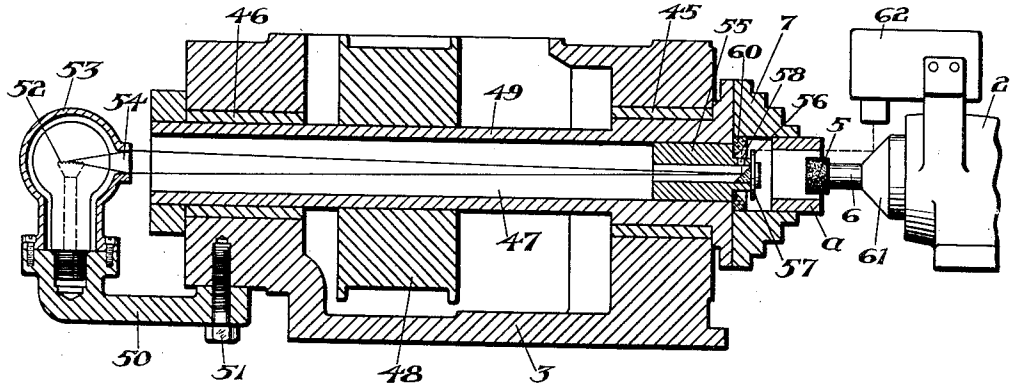


Fig. 2

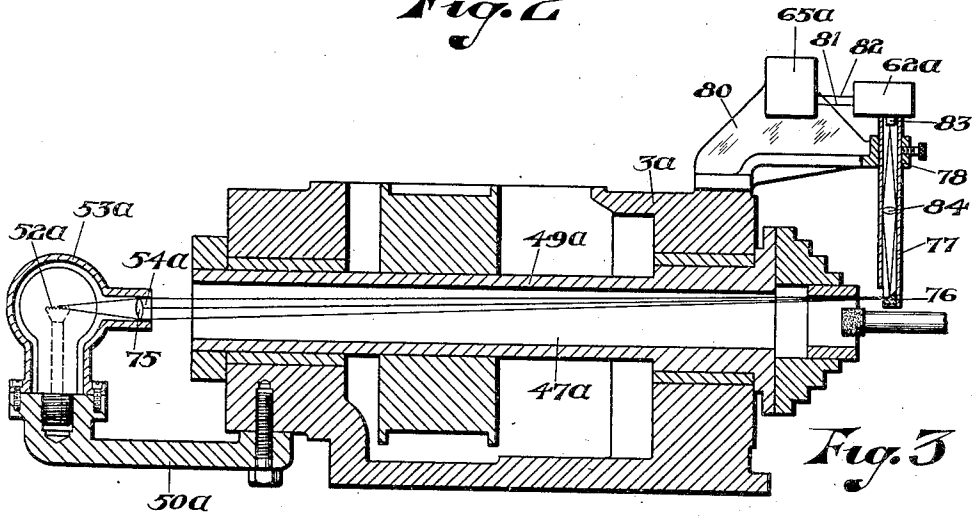


Fig. 3

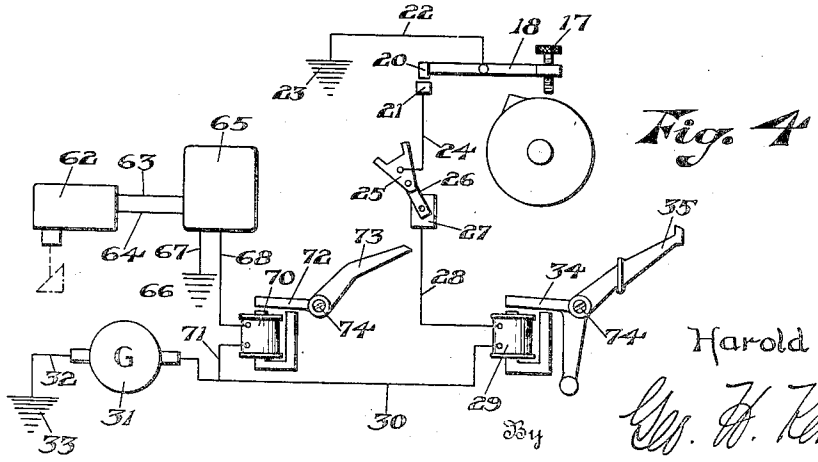


Fig. 4

Inventor
Harold L. Blood
By Geo. H. Kennedy Jr
Attorney

Patented Oct. 10, 1933 1,929,967

UNITED STATES PATENT OFFICE

1,929,967

SIZE DETERMINING MECHANISM FOR AUTOMATIC MACHINES

Harold L. Blood, Worcester, Mass., assignor to The Heald Machine Company, Worcester, Mass., a corporation of Massachusetts

Application December 29, 1931
Serial No. 583,643

17 Claims. (Cl. 51—50)

The present invention relates to automatic machines for the reduction of workpieces to a predetermined size. Although in certain of its aspects it is applicable to various types of machines, its particular utility is in connection with machines for treating, as by a cutting operation, the internal surfaces of sleeves, gears, bushings and the like articles.

In prior constructions of automatic machines of this character, the size of the workpiece being treated is determined either by a gage mechanism of the type shown in the McDonough Reissue Patent No. 16,141, issued August 11, 1925, a later construction of the same type being shown in the Kempton and Gallimore Patent No. 1,731,719, granted October 15, 1929, or by the movement of the crossfeed mechanism which causes the cutting tool to cut progressively deeper and deeper into the surface of the workpiece, as shown in the Guild Patent No. 1,682,672, granted August 28, 1928.

In the McDonough and Kempton and Gallimore grinding machine constructions, the gage member is reciprocated relative to the workpiece, and the grinding operation is interrupted when the workpiece is ground to such a size that the gage may enter the bore therein. The constant hammering action of the gage against the end of successive workpieces before the workpiece reaches the predetermined size in addition to the wear on the gages as they enter within the bore of the workpiece soon destroys the accurate gaging surfaces of the gage, necessitating frequent inspection and replacement of the gage in order to procure successive workpieces which are reduced consistently to the predetermined size.

In a construction of the type disclosed in the Guild patent, the size of the workpieces is controlled by the movement of the crossfeed mechanism which operates to terminate the grinding operation when the cutting surface of the grinding wheel reaches a predetermined vertical plane during the crossfeed movement; the location of this plane is determined by a dressing tool which operates during each grinding operation to maintain the surface of the grinding wheel smooth and in the desired position relative to said plane, said dressing operation resulting in a reduction in diameter of the grinding wheel, which is compensated for by a transverse compensatory movement of the grinding wheel relative to the work-holding member to cause said wheel, during successive grinding operations, to move into the above noted predetermined vertical plane before the grinding operation is terminated. Although machines of this construction are entirely satisfactory in operation, the inequalities inherent in grinding wheels and the necessarily involved construction and operation of the machine are such that frequent inspections and adjustments must be made in order that successive workpieces shall all be reduced to the same desired size. It is accordingly the principal object of the present invention to provide a novel construction for determining the size of a workpiece which incorporates the advantages of the above constructions without incorporating any of the disadvantages thereof.

According to the present invention, the size of the workpiece is determined by a beam of light, which operates in conjunction with a photo-electric cell or other suitable light-responsive mechanism in such a manner that the grinding operation on a workpiece is interrupted when the proper intensity of light activates the photo-electric cell, said cell being energized just as the workpiece reaches predetermined size. In one construction, a gage mechanism is provided so that as the workpiece reaches the size of the gage, which latter is always maintained out of contact with the work, the grinding operation will be interrupted in response to activation of a suitable light-responsive element by a beam of light passing over said gage and the surface of the workpiece. In the other construction the light passes directly over the workpiece for actuation of the light responsive mechanism.

Other objects and advantages will appear from the following detailed description taken in connection with the accompanying drawings in which:—

Fig. 1 is a front elevation of an internal grinding machine embodying the invention.

Fig. 2 is an enlarged sectional view of a workhead and a grinding wheelhead showing in detail one embodiment of the invention.

Fig. 3 is an enlarged sectional view of a workhead showing in detail a modified embodiment of the invention.

Fig. 4 is a wiring diagram for the machine.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, the machine provides the usual reciprocatory table 1 provided in an internal grinding machine; either the grinding wheel or the work to be ground may be carried on said table, the reciprocations of the latter operating in either case to produce a relative movement between said grinding wheel and workpiece. In the construction shown, the table 1

supports and carries a wheelhead 2, and the work to be operated upon is held in a workhead 3, the latter being carried by a bridge 4 which spans the slideways, not shown, provided by the machine frame, for the back and forth movement of the table 1. A grinding wheel 5 is mounted an a spindle 6 journaled in the wheelhead 2 and a workpiece *a* is mounted in a suitable workholding chuck or other clamping device 7 journaled in the workhead.

The back and forth movement of the table 1 to cause the wheel 5 to make the required traverse of the workpiece *a* may be procured in any well known manner, as by the use of the fluid pressure controlling and reversing mechanism, forming the subject matter of the Herald and Guild Patent No. 1,582,468, granted April 27, 1926. Such mechanism forms no part of the present invention; it is sufficient to note that the driving means employed procures the reversal of the table at each end of its normal grinding stroke by the use of spaced adjustable dogs 8 and 10 carried by the table 1 and adapted alternately to engage and to move a reversing member 11. The latter during the grinding operation, when the grinding wheel 5 is moving back and forth within the workpiece *a* is situated between said dogs 8 and 10 in position to be alternately struck by said dogs and, by its consequent movement, effects the reversals of the table 1. The grinding wheel is rotated at a high speed in any suitable manner and the workholding member is also rotated at a somewhat slower speed by a belt drive from a countershaft as will hereinafter appear.

The wheelhead 2 of the machine is mounted on a cross-slide which is arranged to have a transverse movement on suitable ways, not shown, on the reciprocatory table, movement of said cross-slide being procured by rotation of a threaded crossfeed shaft 13, the latter engaging an internally threaded member, not shown, which is secured in any suitable way to the cross-slide. The crossfeed shaft 13 is rotated in a step-by-step movement by mechanism of the type disclosed in the above noted Guild Patent No. 1,682,672 to procure a feeding movement of the grinding wheel to cause said wheel to cut progressively deeper and deeper into the workpiece; for the purpose of the present invention, it is sufficient to note that a ratchet wheel, not shown, is engaged by a pawl 14 which is actuated in response to the reciprocations of the carriage 1, thereby procuring rotation of said crossfeed shaft carrying the grinding wheel transversely against the surface of the workpiece.

The grinding operation is preferably interrupted before the workpiece reaches predetermined finished size, said interruption occurring in response to the movement of the crossfeed mechanism as disclosed in the above cited Guild patent. Referring to Fig. 4, the crossfeed shaft 13 carries a hand wheel 15 on which a cam 16 is mounted, said cam being carried, in response to the rotation of said shaft, into engagement with an adjusting screw 17 in one end of a pivotally mounted lever 18. Actuation of said screw by the cam 16 rocks said lever 18 and is arranged to procure a separation of the grinding wheel from the workpiece in order that a dressing or other desired operation may be performed thereon.

Separation of the grinding wheel from the work is procured through an electrical circuit. Referring to Fig. 4, the lever 18 on its end remote from the screw 17 has a contact point 20 which, in response to movement of the lever, engages a stationary contact 21 to close the above circuit. The contact point 20 is connected by a lead line 22 to a ground 23 and the contact 21 is connected by a lead 24 to the movable member 25 of a switch 26, said switch being normally in the position shown in Fig. 4 in which the movable member 25 is in engagement with a stationary contact 27, the latter being connected by a lead 28 to one terminal of an electromagnet 29, the other terminal of said magnet being connected by a lead 30 to one terminal of the generator 31. Since the other terminal of said generator is connected by a lead 32 to a ground 33, rocking movement of the lever 18 closes the circuit through the electromagnet 29 and energizing said magnet, thereby causing attraction of a pivotally mounted armature 34 and causing elevation of an upwardly extending lever arm 35 integral with said armature.

The elevation of the lever arm 35 responsive to the engagement of the cam 16 with the screw 17 functions to interrupt automatically the grinding operation on the workpiece for the above noted dressing and truing of the grinding wheel in advance of the final and finishing cuts. This involves withdrawal of the grinding wheel from the workpiece and the disposal, in the temporarily amplified path of movement of said wheel, of a dressing device, not shown, in the manner fully described in the above noted Guild Patent No. 1,682,672; it is sufficient to note for the purposes of the present application that the left hand table dog 8 which limits the right hand movement of table 1 is carried by a block 37 which is capable of free sliding movement longitudinally of the table. Under normal conditions, the block 37 is held in spaced relation to a stationary block 38 on the table by a latch lever 40 having its free end in engagement with the block 37 to maintain said block at a predetermined position on the table. When the lever arm 35 is elevated, as above pointed out, the latch connection is released and the subsequent right hand travel of the table 1 involves relative sliding movement between said table and the block 37, owing to the obstruction which the reversing member 11 imposes against the dog 8; finally the block 37 brings up against the block 38 whereby the dog 8 is immovably supported for shifting of the reversing member 11, thereby procuring reversal of the table 1. The reversing dog 8 is restored to normal position during the left hand movement of the table by a resiliently supported lug 41 on the front of the carriage which engages the block 37 and, as the table moves to the left, procures relative movement between the block and the table until the latch lever 40 again engages said block 37.

On the above noted amplified right hand dressing stroke of the table 1, in order to prevent a repetition of said dressing stroke, an arm 42, Fig. 1, pivoted on the block 38 on the table strikes a lug 44 of the movable switch member 25, thereby rocking said switch member away from the stationary contact 27 to break the circuit through the electromagnet 29 and to release the upwardly extending lever arm 35.

The above described mechanism is all old and well known in the art and of itself forms no part of the present invention. The latter involves the attainment in connection with such or similar grinding machine instrumentalities of the novel and useful results hereinbefore set forth. According to the present invention, the grinding operation is continued, after the above noted dressing operation has been performed on the

grinding wheel, until the workpiece is ground to a predetermined finished size at which time the grinding operation is brought to a close by a separation of the grinding wheel from the workpiece in response to energization of a light-responsive element. Referring to Figs. 1 and 2, a spindle 49 carrying the workholding chuck 7 on the right hand end thereof is journaled in bearings 45 and 46 provided by the workhead 3 and is provided with a longitudinal bore 47 extending throughout its length. A pulley 48 is fixed on the spindle between the bearings 45 and 46 to provide for the rotation of the workholding chuck from a countershaft, not shown.

A bracket 50 is fastened to the workhead 3 by a bolt 51 and supports a light bulb 52 or other suitable source of light; and an opaque shell 53 extending over said light has an opening 54 therein in alignment with the longitudinal bore of the spindle, thereby directing the light from said source longitudinally through said spindle. The inner or right hand end of the spindle carries a sleeve 55 secured therein, said sleeve supporting on one end thereof a gage member 56 which is substantially equal in diameter to the predetermined finished diameter of the workpiece. A beam or ray of light from the source of light 52 is directed longitudinally through the bore of the spindle by the opening 54 in the shell 53, as indicated by the converging lines in the bore 47, Fig. 2, against a prism or other reflecting surface 57 secured in the sleeve 55, said beam of light being thereby angularly reflected through a transverse bore 58 in said sleeve against a conical reflecting surface 60 which directs the beam of light past the periphery of the gage member, the angularity of the reflecting surfaces 57 and 60 causing the beam of light past said gage to be horizontal, as indicated by the dotted line of Fig. 2. The beam of light from the surface 60 is directed toward a conical reflecting surface 61 formed on the wheelhead 2 which surface reflects the beam toward an opening in an opaque shell 62 within which is mounted a photo-electric cell, not shown.

While the workpiece *a* is smaller in diameter than the gage 56 before said workpiece is ground to its desired size, the beam of light passing horizontally over the periphery of said gage will be interrupted by the inner flat surface of the workpiece, said beam being allowed to pass through said workpiece along the ground surface thereof only when said workpiece corresponds to the diameter as determined by said gage. When the workpiece reaches the predetermined finished size, as determined by the gage, the beam of light passes through said workpiece and is reflected by the reflecting surface 61 onto the photo-electric cell and activating said cell to procure separation of the grinding wheel from the workpiece.

Referring now to the wiring diagram of Fig. 4, the terminals of the photo-electric cell, which is of any suitable construction are connected by leads 63 and 64 to the terminals of a relay mechanism 65 of any suitable type, which is made operative in response to the activation of the photo-electric cell by the beam of light directed against said cell, to energize a circuit, as by closing a switch, not shown, thereby to procure the runout of the table carrying the grinding wheel to rest position. One terminal of said switch is connected to a ground 66 by a lead 67 and the other terminal is connected by a lead 68 to one terminal of an electromagnet 70, the other terminal of said electromagnet being connected by a lead 71 to the lead 30 which connects to one terminal of the generator 31, the other side of said generator, as above noted, being grounded. Closing of the above noted switch by the relay mechanism 65 thus energizes the electromagnet 70, thereby causing attraction of the armature 72 and procuring elevation of the lever arm 73 integral with said armature, said armature and lever arm being pivotally mounted on the same shaft 74 that provides the pivotal mounting for the armature 34 on the front of the machine. Elevation of the lever arm 73 moves the end of said lever arm into the path of the left hand table dog 8 which is pivotally mounted on its carrying block 37 so that it is free to ride on the upper surface of said lever arm, and is thereby carried clear of the reversing member 11 during the right hand movement of said table after elevation of said arm 73, whereby the table 1 is not reversed but continues its movement to the right carrying the grinding wheel out of the workpiece, the table being brought to a full stop by any suitable means such as shown in the aforesaid Heald and Guild Patent No. 1,582,468.

In the modification shown in Fig. 3, the grinding operation is brought to a close when the workpiece reaches the predetermined finished size without the use of a gage mechanism. Referring to this figure, it will be seen that the workhead construction is substantially the same as shown in Fig. 2, said workhead 3*a* providing a support for the rotating spindle 49*a* which has a longitudinal bore 47*a* extending therethrough. A bracket 50*a* which is secured to the workhead, supports a light bulb or other suitable source of light 52*a* which is covered by a shell 53*a*, the latter having an opening 54*a* therein in alignment with the longitudinal bore 47*a* in the spindle. A lens 75 is adjustably mounted in the opening 54*a* in the shell, said lens being arranged so that a beam of light from said source is directed toward the right hand or outer edge of the workpiece *a* and is arranged to pass the edge of said workpiece only when the latter has reached the predetermined finished size to impinge, after passing said workpiece, on a reflecting surface 76 carried in the lower end of a tube 77. Said tube 77 is adjustably supported in a vertical bore 78 of a bracket 80 carried by the workhead, said bracket 80 also providing a support for the relay mechanism 65*a*, the terminals of which are connected by leads 81 and 82 to the terminals of the photo-electric cell, not shown, within the shell 62*a*. The photo-electric cell is carried on the upper end of the tube 77, and the shell 62*a* has an opening 83 in alignment with the upper end of said tube, so that, as the workpiece reaches the predetermined finished size, the beam of light from the source 52*a* passes through said workpiece and is reflected by the reflecting surface 76 into the tube 77. A lens 84 is adjustably mounted within said tube and directs the beam of light from the source into the opening 83 in the shell 62*a* for the photo-electric cell to activate the same. The activation of the photo-electric cell in this modification operates through the relay mechanism 65*a*, in the manner above pointed out, to procure separation of the grinding wheel from the workpiece.

From the foregoing, it will be noted that the grinding operation is interrupted or brought to a close when the workpiece is brought to a predetermined size in response to the energization or activation of a light responsive element by a beam of light passing over the ground surface of the workpiece, said energization functioning

through suitable mechanism to procure separation of the grinding wheel from the workpiece. In one embodiment, the beam of light for energization of the light responsive element is directed past a gage mechanism which acts as a comparator for the diameter of the workpiece, said gage being mounted out of contact with the surface of said workpiece; in another embodiment, the beam of light passes directly from the source past the ground surface of the workpiece to activate the light-sensitive element.

I claim,

1. In a machine of the class described, a cutting tool and a work-supporting member, a light-sensitive element, means for directing a beam of light toward said element, said beam of light being normally interrupted by a workpiece in said workholding member until said workpiece reaches a predetermined size, and means under the control of said light-sensitive element to procure a change in the cutting operation, said element being energized by said beam when said workpiece reaches the predetermined size.

2. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, means to direct a beam of light against the surface of said workpiece, and means toward which said beam is directed and actuated by said beam of light to interrupt the cutting operation, said beam engaging and actuating said last means when said workpiece reaches a predetermined size.

3. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, a gage spaced from said workpiece, means to compare the diameter of said workpiece to the diameter of said gage without contacting said workpiece with said gage, and means operating to interrupt the cutting operation when said workpiece reaches the size determined by said gage.

4. In a machine of the class described, a cutting tool, means to procure a cutting action between said tool and a workpiece, a gage spaced from said workpiece, means to pass a beam of light over the surface of said gage and into contact with said workpiece, and means energized by said beam of light to interrupt said cutting operation when the workpiece reaches the size determined by said gage, the latter being maintained out of contact with said workpiece.

5. In a grinding machine, a grinding wheel, means to procure a grinding operation between said wheel and a workpiece, a light-sensitive element, means to direct a beam of light against the surface of said workpiece and toward said element, the latter being in a position to be energized by said beam when said workpiece reaches a predetermined size, and means responsive to energization of said light-sensitive element to procure a separation between said grinding wheel and workpiece.

6. In a machine of the class described, a cutting tool, means to procure a cutting action between said tool and a workpiece, a gage spaced from said workpiece, means to pass a beam of light over the surface of said gage and into contact with said workpiece, and means energized by said beam of light to control the progress of the cutting operation, said gage being maintained out of contact with the workpiece.

7. In a grinding machine, a grinding wheel, means to procure a grinding operation between said wheel and a workpiece, a light-sensitive means, means to direct a beam of light against the surface of said workpiece in a position to impinge said light-sensitive means when said workpiece reaches a desired size, and means actuated by said light-sensitive means when impinged by said beam of light to interrupt the grinding operation when said workpiece reaches the desired size.

8. In a grinding machine, a grinding wheel, means to procure a grinding operation between said wheel and a workpiece, a light-sensitive element, means to direct a beam of light against the surface of said workpiece in a position to engage said element at a predetermined point in the grinding operation, said element being energized by said beam when the latter engages said element, and means responsive to energization of said light-sensitive element to procure cessation of the grinding operation.

9. In a grinding machine, a grinding wheel, means to procure a grinding cycle on a workpiece, a light-sensitive element, means to direct a beam of light against the surface of the workpiece and in a direction to pass over the surface of said workpiece and engage said light-sensitive element when said workpiece is reduced to a predetermined size, and means operated by said light-sensitive element to control the progress of the grinding cycle.

10. In a machine of the class described, a cutting tool, means to procure a cutting action between said tool and a workpiece, a gage spaced from said workpiece, means to pass a beam of light over the surface of said gage and into contact with said workpiece, and means energized by said beam of light to procure a change in the cutting operation, said gage being maintained out of contact with the workpiece.

11. In a machine of the class described, a cutting tool, means to procure a cutting action between said tool and a workpiece, a gage spaced from said workpieee, means to pass a beam of light over the surface of said gage and into contact with said workpiece, and means energized by said beam of light to procure cessation of the cutting operation, said gage being maintained out of contact with the workpiece.

12. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, light-sensitive means, means to direct a beam of light against the surface of said workpiece in a position to impinge said light-sensitive means when said workpiece reaches a desired size, and means actuated by said light-sensitive means when impinged by said beam of light to procure a change in the cutting operation.

13. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, light-sensitive means, means to direct a beam of light against the surface of said workpiece in a position to impinge said light-sensitive means when said workpiece reaches a desired size, and means actuated by said light-sensitive means when impinged by said beam of light to procure cessation of the cutting operation.

14. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, light-sensitive means, a source of light, and means governed by the size of the workpiece to procure a change in the intensity of the light impinging on said light-sensitive means from said source when said workpiece reaches a predetermined size, and means

controlled by said light-sensitive means and responsive to said change in the intensity of the light to procure a change in the cutting operation.

15. In a machine of the class described, a cutting tool, means to procure a cutting operation between said tool and a workpiece, a light-sensitive element, means to direct a beam of light against the surface of said workpiece in a position to engage said element at a predetermined point in the cutting operation, said element being energized by said beam when the latter impinges thereon, and means responsive to a change in the intensity of the light impinging on said element to procure a change in the cutting operation.

16. In a grinding machine, a grinding wheel, means to procure a grinding operation between said wheel and a workpiece, a light-sensitive element, means to direct a beam of light against the surface of said workpiece in a position to engage said element at a predetermined point in the grinding operation, said element being engaged by said beam when the latter impinges thereon, and means responsive to a change in the intensity of the light impinging on said element to procure a change in the grinding operation.

17. In a grinding machine, a grinding wheel, means to procure a grinding operation between said wheel and a workpiece, a light-sensitive element, means to direct a beam of light against the surface of said workpiece in a position to engage said element at a predetermined point in the grinding operation, said element being energized by said beam when the latter engages said element, and means responsive to energization of said light-sensitive element to procure a change in the grinding operation.

HAROLD L. BLOOD.