

(No Model.)

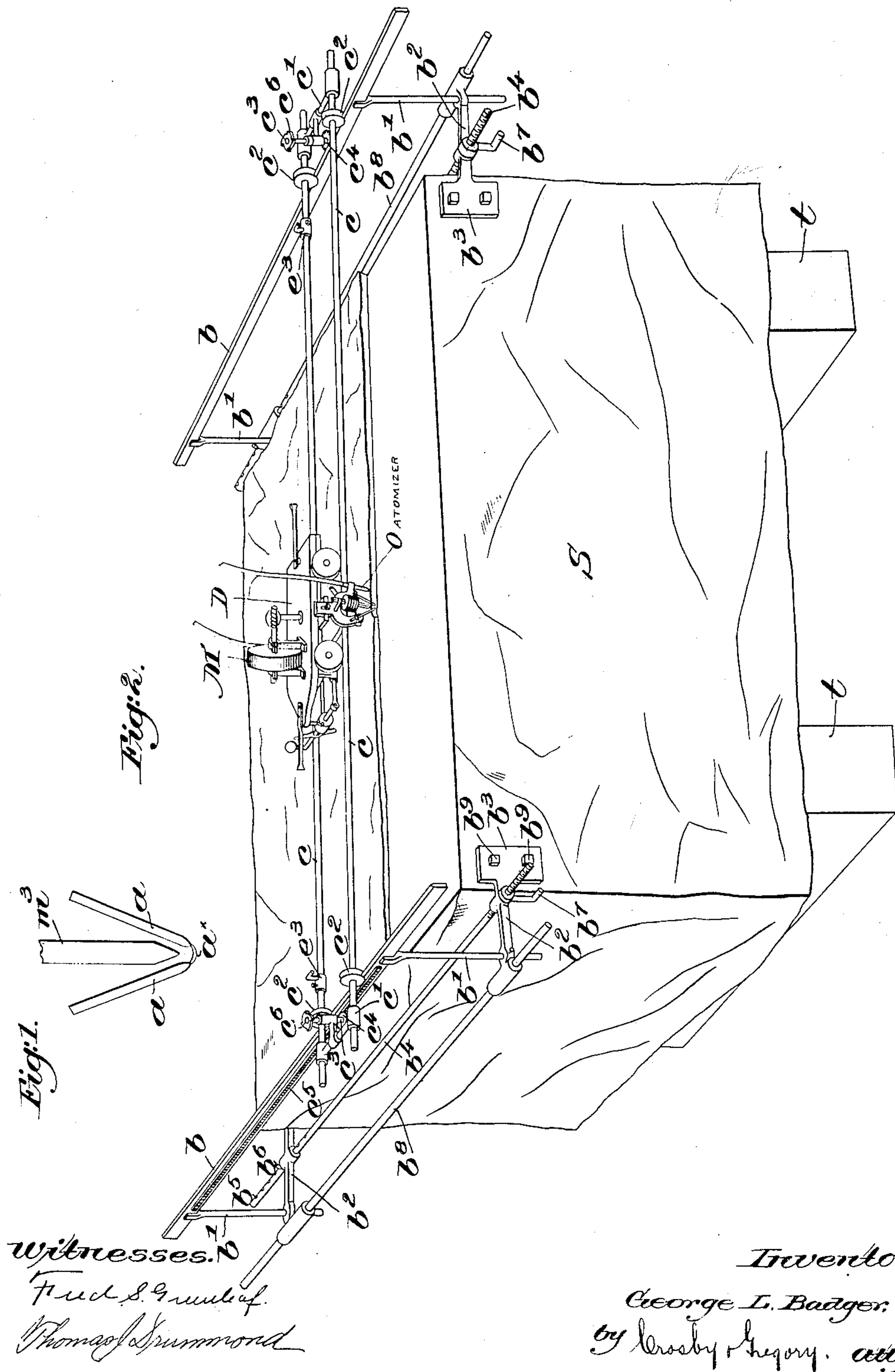
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G. L. BADGER.

METHOD OF AND APPARATUS FOR DRESSING STONE.

No. 561,367.

Patented June 2, 1896.



(No Model.)

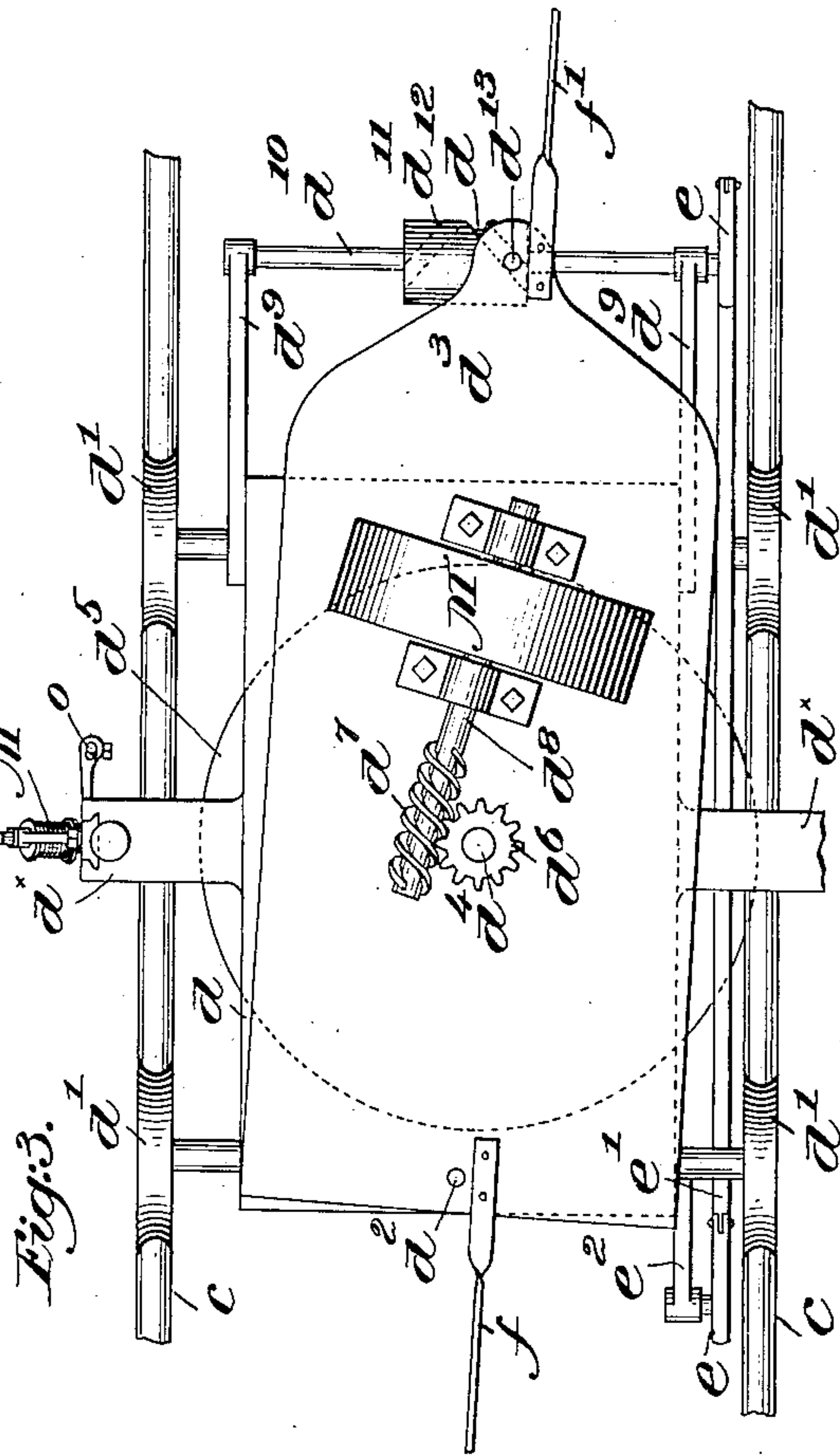
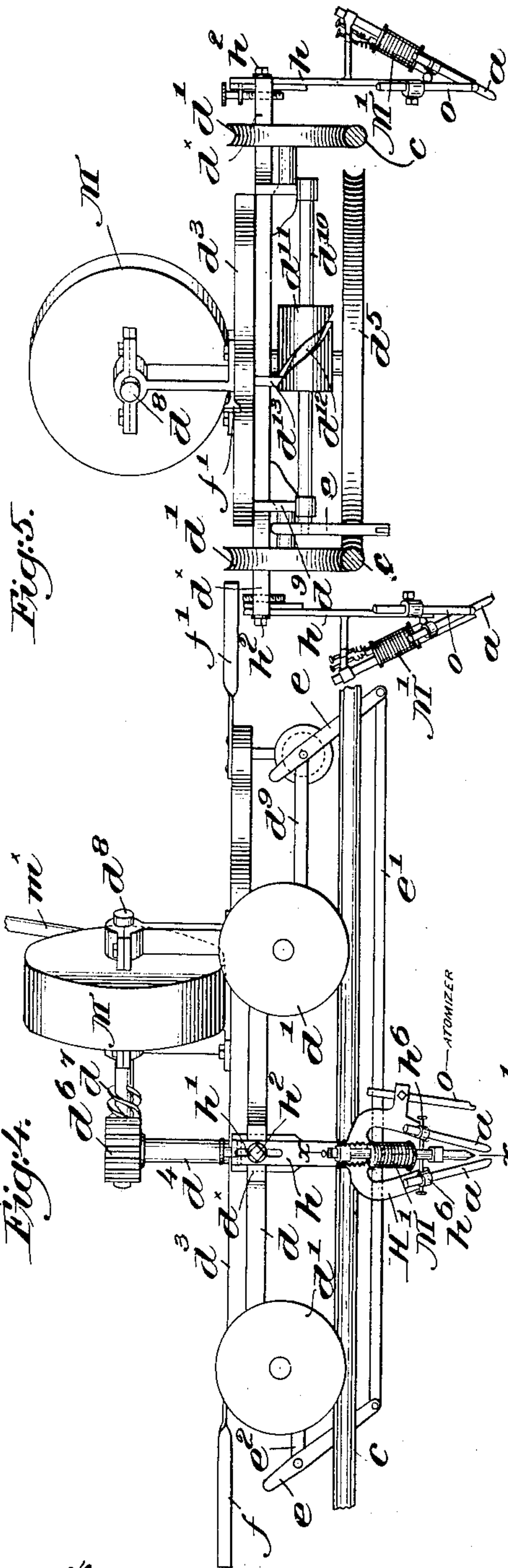
4 Sheets—Sheet 2.

G. L. BADGER.

METHOD OF AND APPARATUS FOR DRESSING STONE.

No. 561,367.

Patented June 2, 1896.



Witnesses.

Fred S. Grunkaf.

Thomas J. Grummord.

Inventor:

George L. Badger.  
by Crosby & Gregory, attys.

(No Model.)

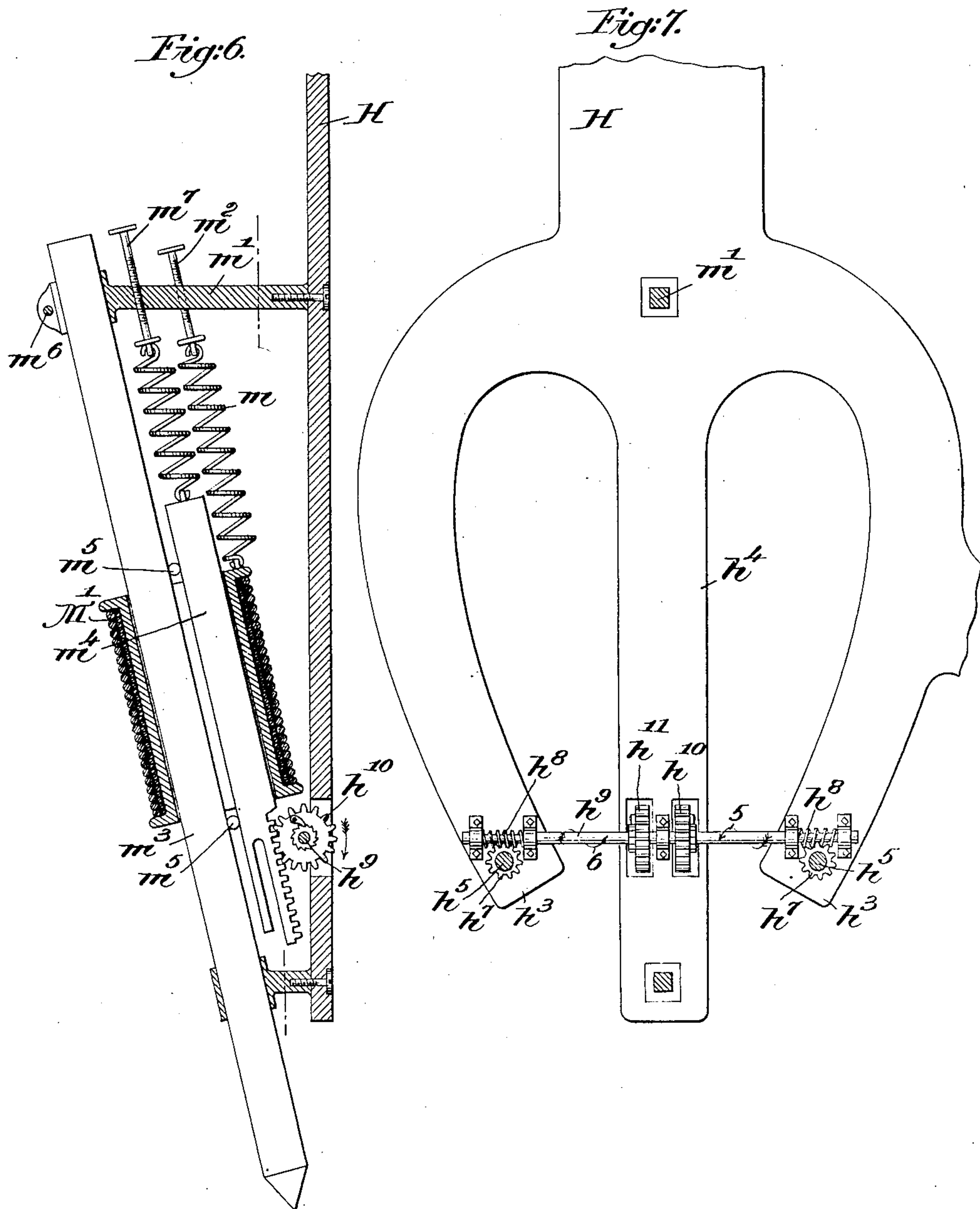
4 Sheets—Sheet 3.

G. L. BADGER.

METHOD OF AND APPARATUS FOR DRESSING STONE.

No. 561,367.

Patented June 2, 1896.



Witnesses.

A. C. Harmon  
Fred. S. Greenleaf

Inventor:  
George L. Badger.  
by Crosby & Gregory  
attys.



(No Model.)

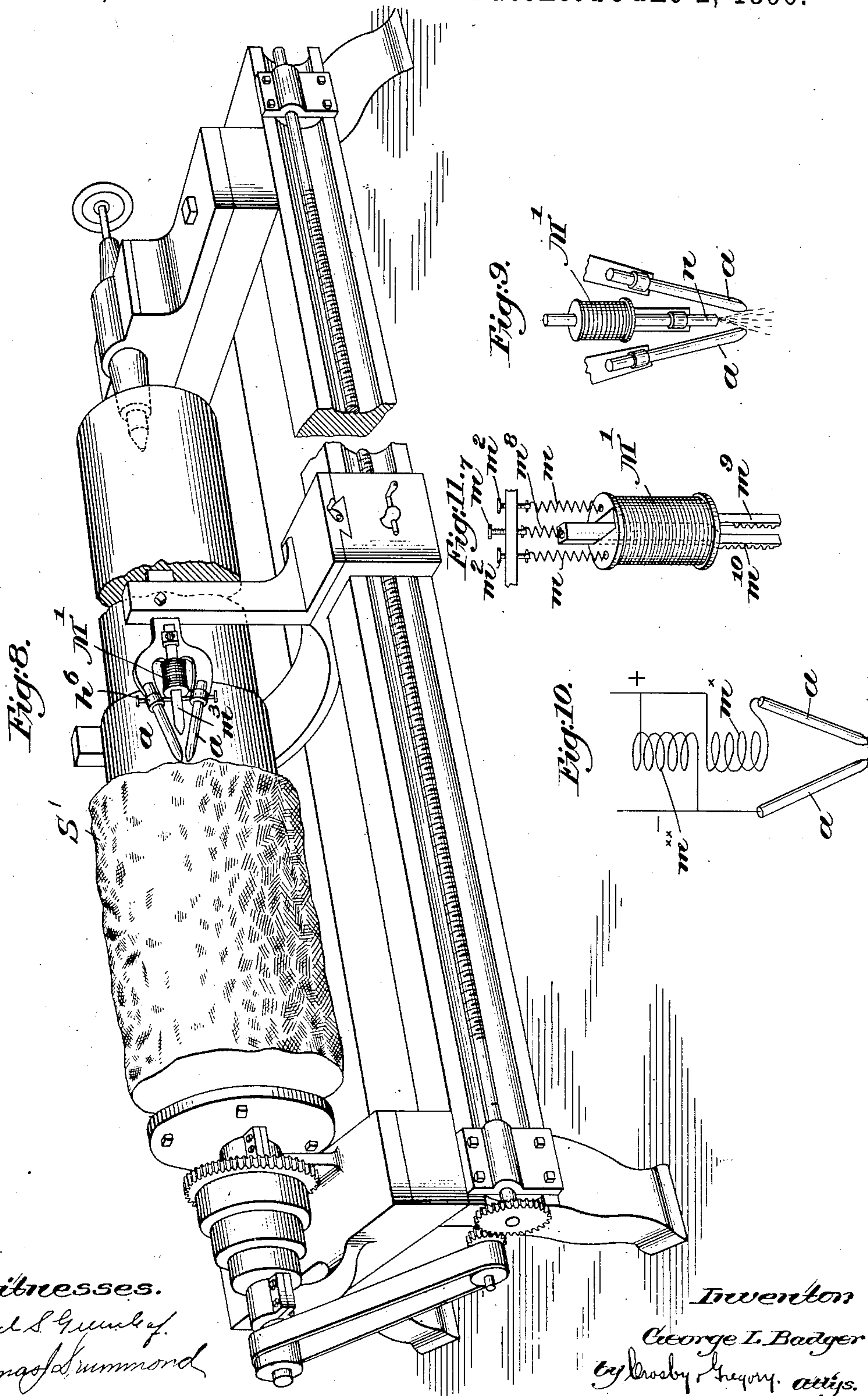
4 Sheets—Sheet 4.

G. L. BADGER.

METHOD OF AND APPARATUS FOR DRESSING STONE.

No. 561,367.

Patented June 2, 1896.



Witnesses.  
Fred S. Gregory.  
Thomas J. Hammond

Inventor  
George L. Badger  
by Crosby Gregory, attys.



# UNITED STATES PATENT OFFICE.

GEORGE L. BADGER, OF QUINCY, MASSACHUSETTS.

## METHOD OF AND APPARATUS FOR DRESSING STONE.

SPECIFICATION forming part of Letters Patent No. 561,367, dated June 2, 1896.

Application filed November 26, 1894. Serial No. 529,980. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE L. BADGER, of Quincy, county of Norfolk, State of Massachusetts, have invented an Improvement in Methods of and Apparatus for Dressing Stone, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

Stone in blocks or other forms when received from the quarry usually approximate in size and shape the desired finished stone or article; but the surface of the quarry-stone is rough and uneven and must be first dressed down to within, say, one-quarter inch of the desired finish-surface before the final finishing-tools, usually bush-hammers, can be applied for producing the final or finish surface.

Practical machines for finally finishing the stone-surface after the dressing operation referred to are now on the market; but such machines are incapable of use until the rougher quarry-surface has been dressed down to a fairly even surface, and nearly to that of the desired finish-surface, as described. I have conducted experiments to discover some means for expeditiously and economically working or dressing down the first or rough quarry surface in order that finishing-machines, such as are now on the market, may be used practically for producing the finish-surface. The results of my experiments have demonstrated that an electric arc, when moved or manipulated in suitable novel manner, may be used to dress down the rough surface both expeditiously and economically and fit the stone for the finishing-machine; but the heat from an electric arc is so intense that if permitted to act for any length of time upon one spot it will heat the stone to such a depth as will discolor and crumble or calcine it below the desired finish-line. To overcome this difficulty, I provide for moving the arc rapidly across the surface of the stone, whereby its intense heat is caused to act upon the stone-surface and crack off small quantities, the speed of movement being such that the arc will pass from point to point with such rapidity as will prevent the heat penetrating to a depth sufficient to discolor, crumble, or calcine the stone below the finish-line.

In carrying out my invention I employ two electrodes supplied with a current to form an arc which furnishes the desired heat, these electrodes being preferably mounted upon a suitable holder adapted to be manipulated by hand or by automatic machinery to cause the arc to travel laterally or across the surface of the stone at the required speed. Suitable devices are also employed to deflect the arc upon the stone-surface. I have found that the arc acts more effectively to remove the material if the latter is first dampened or cooled, and that the discoloration or crumbling of the stone is more effectually prevented if the stone be cooled at once after the passage of the arc over it, and therefore my invention further comprehends dampening or cooling the working surface, preferably by an atomizer close to and preferably at each side of the moving arc.

Figure 1 is a diagram illustrating the principle of my invention. Fig. 2 in perspective illustrates one form of apparatus for working stone in accordance with this invention, the electrodes being shown as mounted upon a movable carriage which is reciprocated over the surface to be worked, the arc acting in the nature of a planing-tool to plane or work the surface. Figs. 3, 4, and 5 are a plan view and side and end elevations, respectively, of the carriage shown in Fig. 2. Fig. 6 is a vertical section on the dotted line  $x x$ , Fig. 4, showing the preferred manner of arranging the magnet for deflecting the electric arc; Fig. 7, a plan view of the preferred form of holder on which the electrodes are mounted. Fig. 8 shows my invention embodied in the form of a lathe; Fig. 9, a detail illustrating a modification, and Fig. 10 a diagram illustrating the arrangement of circuits. Fig. 11 is a perspective view of the solenoid and its immediate appurtenances.

Referring to the diagram, Fig. 1,  $a a$  typify two electrodes through which a current of electricity is passed, the current, in jumping from one electrode to the other, forming an arc, (indicated at  $a^x$ ), the said arc being diverted from its normal path by the lines of force surrounding the end of a magnet  $m^3$ ; or in lieu of this mechanism I may employ any device which will divert the arc, as de-



scribed. If, now, the electrodes be moved along the unworked surface of the stone or stone-like material, the intense heat of the arc acts to break or crack from the body of the material small quantities of the latter, precisely as they would be chipped off by a mechanical tool, and by providing suitable apparatus for manipulating the electrodes relatively to the surface to be worked I am enabled to work stone expeditiously and economically.

In the drawings, Figs. 2 to 7, inclusive, I have illustrated one form of apparatus for effecting this relative movement of the electrodes and the surface to be worked. Referring to said figures, S represents a block of granite or other stone, the top surface of which is to be worked to a plane. Upon the opposite ends of the block S, I clamp, in suitable manner, guide-rods  $b$ , the same, in the present instance of my invention, being mounted upon standards  $b'$ , made vertically adjustable in the arms  $b^2$ , having their ends flattened at  $b^3$  and clamped upon the opposite sides of the block at its corners by means of clamping-rods  $b^4$ , shown as passed through suitable eyes in the arms  $b^2$ , and provided at one of their ends with a series of perforations  $b^5$ , through which pins  $b^6$  may be inserted, the said rods at their opposite ends being threaded to receive the clamping-nut  $b^7$ . Approximate adjustment is effected by means of the pins  $b^6$  and the holes  $b^5$ , final adjustment being effected by means of the clamping-nuts  $b^7$ , which, when turned, clamp the flattened ends  $b^3$  of the said arms  $b^2$  tightly upon the block. The arms  $b^2$  at their outer ends are shown provided with enlarged heads, bored longitudinally to form guideways for the rods  $b^8$ , which hold the said arms  $b^2$  in parallelism during adjustment.

In the preferred embodiment of my invention the flattened ends  $b^3$  of the arms  $b^2$  are provided with a plurality of adjusting-screws  $b^9$ , which may be adjusted to accommodate inequalities in the surface of the block at the points at which it is desired to clamp the arms in position.

Upon the guide-rods  $b$  is mounted a rolling frame, shown as comprising the two track-rods  $c$ , joined at their opposite ends by suitable heads  $c'$ , the said rolling frame being mounted upon suitable wheels or sheaves  $c^2$ , adapted to roll upon the guide-rods  $b$ .

Upon the track-rods  $c$  is mounted a carriage D, shown as comprising a frame  $d$ , (see Figs. 3, 4, and 5,) mounted upon wheels  $d'$ , which travel upon the track-rods.

The frame  $d$ , as herein shown, has pivoted to it at  $d^2$  a swinging plate  $d^3$ , carrying the vertically-arranged shaft  $d^4$ , journaled in suitable bearings and provided at its lower end with a feeding-wheel  $d^5$ , grooved at its periphery to engage the inner face of one or the other of the track-rods  $c$ , according as the plate  $d^3$  is swung to the right or to the left.

The vertical shaft  $d^4$ , at its upper end, is shown provided with a pinion  $d^6$ , driven by a worm  $d^7$  on the shaft  $d^8$  on a suitable motor M. This motor may be of any suitable or desired kind or construction, I having herein shown one actuated in a suitable manner by air under pressure admitted through the supply-pipe  $m^x$ .

The frame  $d$ , at its end opposite the pivot  $d^2$ , is shown as provided with two longitudinally-extended arms  $d^9$ , in the ends of which is journaled the shaft  $d^{10}$ , carrying at its middle the cylindrical enlargement or hub  $d^{11}$ , in which is cut a path-cam  $d^{12}$  for the stud  $d^{13}$ , depending from the adjacent end of the swinging plate  $d^3$ . Rotation of the shaft  $d^{10}$  and its cam-hub will vibrate the swinging plate  $d^3$ , swinging it to the right or to the left, according to the direction of rotation of the shaft of the cam, to thereby swing the grooved feeding-wheel  $d^5$  into frictional engagement with one or the other of the track-rods  $c$ , so that rotation of the said feeding-wheel by the motor M will act to move the carriage D in one or the other direction, according as the feeding-wheel is in engagement with one or the other of the said track-rods.

In the present instance of my invention the shaft  $d^{10}$  is provided with a lever  $e$ , connected by a link  $e'$  with a similar lever (also indicated by the letter  $e$ ) pivoted to a suitable support  $e^2$  at the opposite end of the carriage.

Upon one of the track-rods  $c$  I have mounted the adjustable stops  $e^3$ , which as the carriage approaches the end of its movement in either direction strike one or the other of the levers  $e$  and move the same to rotate the shaft  $d^{10}$  and its cam to shift the swinging plate  $d^3$  and its feeding-wheel to cause a return movement of the carriage, the latter being thus automatically given a reciprocating movement across the surface of the stone to be worked.

The heads  $c'$ , which unite the ends of the track-rods  $c$ , are shown as provided with vertical spindles  $c^3$ , carrying at their lower ends pinions  $c^4$ , in mesh with racks  $c^5$  on the sides of the guide-rods  $b$ , the said spindles  $c^3$  being provided at their upper ends with star-wheels or their equivalents  $c^6$ .

The carriage D has its swinging plate  $d^3$  provided with oppositely-extended fingers  $f$   $f'$ , which as the carriage approaches the ends of its reciprocations in either direction engage one or the other of the star-wheels  $c^6$  and rotate the same a distance equivalent to the movement of one tooth, causing the pinion  $c^4$ , acting upon the rack, to feed the frame  $d$  forward a predetermined distance, determined by the rotation of the said star-wheel and its pinion. By this means the carriage D is given not only a reciprocating movement across the surface to be worked, but is also gradually fed from one to the other side of the stone.

Referring now to Figs. 4 to 7, inclusive, the frame  $d$  of the carriage D is provided with oppositely-extended wings  $d^x$   $d^x$ , grooved to



receive the dovetailed shanks  $h$  of the electrode holders or carriers H H. The shanks  $h$ , as herein shown, are slotted at  $h'$  to receive the clamping-screws  $h^2$ , tapped in the said wings, and by means of which the vertical positions of the said holders may be changed at will.

Referring now to Figs. 6 and 7, each holder H, as herein shown, is horseshoe in shape, having two curved side arms  $h^3$  and a central finger or arm  $h^4$ . In the ends of the curved arms  $h^3$  are journaled short arbors  $h^5$ , which at one side of the holder are provided with sleeves  $h^6$ , rigidly secured thereto, as shown in Fig. 4, in which are clamped the two electrodes  $a$ , preferably of carbon. The arbors  $h^5$ , preferably at the side of the holder H opposite the electrodes, are shown provided with pinions  $h^7$ , in mesh with and rotated by the worms  $h^8$  on the worm-shaft  $h^9$ , journaled in suitable bearings on the said holder, and provided at its middle with two pinions  $h^{10}$   $h^{11}$ , shown as recessed into the central finger or arm  $h^4$  of the holder. These pinions, as herein shown, are not fast upon the worm-shaft  $h^9$ , but are connected therewith by suitable pawl-and-ratchet mechanisms. (Illustrated in Figs. 6 and 7.) The pawls upon the two pinions and their ratchets face in opposite directions to rotate the arbor, each in one direction, so that each pinion can rotate the arbor in one direction only and in an opposite direction from the other, for a purpose to be described.

M' is an electromagnet or solenoid suspended by springs  $m$  from a post  $m'$ , projecting from the holder H, said springs being attached to suitable adjusting-screws  $m^2$ , tapped in the said post.

The solenoid M' has a core-opening of sufficient size to receive the bar-magnet or fixed armature  $m^3$  and the movable armature-piece  $m^4$ , the same being separated, as herein shown, by antifriction-rollers  $m^5$  to permit a free movement, one with relation to the other. The bar-magnet  $m^3$  is shown as adjustably held in fixed position at  $m^6$  in the post  $m'$ , and in the said post is tapped an adjusting-screw  $m^7$ , to the end of which is connected a spring  $m^8$ , also joined to the end of the movable armature.

The solenoid and its movable armature-piece are provided, respectively, with racks  $m^9$   $m^{10}$ , (see Fig. 11,) which mesh with the two pinions  $h^{10}$   $h^{11}$ , loose on the regulating-arbor  $h^9$ , Figs. 6 and 7.

When trimming the device, the electrodes are placed in contact with each other, and when the coils of the solenoid are energized by the passage therethrough of an electric current the said solenoid (normally held by its springs in an elevated position or unbalanced relatively to the magnet or fixed armature  $m^3$ ) is at once drawn downward, or into a balanced position thereon, such downward movement acting, through its rack  $m^9$ , to ro-

tate the pinion  $h^{10}$  in the direction of the arrow 5, Fig. 7, and, through its pawl and ratchet, also rotate the arbor  $h^5$  in the same direction to turn the electrode-carriers slightly to separate the electrodes and establish an arc. The armature  $m^4$  is drawn down with and by the energized solenoid, and held down as long as the current is maintained at its full strength, downward movement of the armature having no effect upon the arbor, for the reason that its pawl-and-ratchet face is in an opposite direction from the pawl and ratchet of the pinion  $h^{10}$ , so that while both racks come down together the rack  $m^9$  alone moves the arbor, the other pawl simply clicking over the teeth of its ratchet without engaging the latter.

The springs  $m$  sustaining the solenoid are of such strength that the solenoid is held in its lowermost position as long as any appreciable current flows through its coils.

The solenoid has a compound winding, its large coil  $m^x$  being in series with the electrodes, (see Fig. 10,) its smaller coil  $m^{xx}$  being oppositely wound and arranged in shunt in the said circuit.

When the arc is lengthened and the resistance correspondingly increased by the burning away of the electrodes, more or less of the current is diverted through the shunt-coils of the magnet to neutralize the latter to a certain extent and permit its armature to be retracted, according to the degree of neutralization of the solenoid, through its rack  $m^{10}$  rotating the pinion  $h^{11}$  in the direction of the arrow 6, which is opposite that of the arrow 5, to thereby, through its pawl and ratchet, rotate the arbor also in the direction of arrow 6 to feed the electrodes closer together to restore the normal arc. The current is then immediately restored to its full strength and the armature drawn down to its normal position, but without changing the position of the arbor, owing to its pawl-and-ratchet connection therewith.

By reference to Fig. 11 it will be seen that the upper end of the rack  $m^9$  is toothless, in order that the said rack, when the solenoid is drawn down, may not interfere with the operation of the arbor by the rack  $m^{10}$  and its pinion.

Assuming the guide-rods  $b$   $b$  to have been properly clamped upon the block of stone to be operated upon, the operation of the apparatus thus far described is as follows, viz: A current of electricity of suitable strength is conducted to and through the electrodes  $a$   $a$  by means of suitable connections, (not herein shown,) and at once draws down the solenoid M' and separates the electrodes, as described, to form an arc  $a^x$  (see Fig. 1) of intense heat. The electrodes having been previously adjusted with relation to the surface to be worked to move past the same, much as a planing-tool is moved on a planing-machine, the motor M is now set in oper-



ation to reciprocate the carriage D and cause the latter to travel back and forth across the surface of the block to cause the arc  $a^x$  between the electrodes to move over the surface of the stone and gradually chip or work off quantities of the stone. The bar-magnet  $m^3$ , which may be a permanent magnet or may be magnetized by the action of the current in the coils of the solenoid, has its end arranged between the electrodes and a short distance from the arc, the action of the lines of force radiating from the ends of said magnet deflecting the said arc outwardly, as illustrated in the diagram, Fig. 1, to better act upon the stone or material to be worked. This magnet may be adjusted, as desired, to meet the changing position of the arc due to the readjustment of the electrodes.

In lieu of the magnet  $m^3$  for deflecting the arc I may employ an air-jet, as illustrated in Fig. 9, wherein the air is projected from a nozzle  $n$ , arranged between the electrodes and connected by a flexible pipe with a suitable source.

In my experiments I have found that the intense heat of the electric arc will better act upon and chip or remove the material if the latter be cooled and wet or dampened either before or after the passage of the arc thereover, or both before and after, as desired, the cooling and dampening of the stone in advance of the arc, and, to a certain extent, following the arc, rendering it more brittle and therefore more easily crumbled, the subsequent cooling, either by the dampening fluid or otherwise, preventing the heat penetrating to any considerable depth into the stone to discolor or crumble it below the finish-line. I have accordingly arranged an atomizer (indicated at  $o$ ) at opposite sides of the electrode-carrier, which sprays water or cooling fluid upon the surface of the stone as the carriage is reciprocated thereupon.

While I prefer the use of an atomizer which projects both water and air upon the material, yet I may use either the air-jet or the water-jet independently and obtain excellent results.

In the apparatus illustrated in Figs. 2 to 7, inclusive, the work is stationary upon a suitable support, herein shown as of timber  $t$ , the electrodes and their holder or carrier having a movement across the surface to be worked. In Fig. 8, however, the work is moved in front of the electrodes, and, referring to said figure,  $S'$  represents the block of stone mounted in a lathe of suitable construction, the electrodes  $a$  being mounted in a suitable holder arranged upon the frame of the lathe and reciprocated along the latter by mechanism common to turning-lathes.

I prefer in any apparatus to employ two sets of electrodes, one set being arranged to follow and cut deeper than the first, as illustrated in the drawings.

While I have herein shown the electrodes

as used in connection with a machine for feeding the same relatively to the work, yet the holder H may be detached from the machine and provided with a suitable handle to enable it to be manipulated by hand.

As herein shown, the arc is moved in nearly horizontal position across the surface to be worked; but it is evident that the positions of the electrodes may be varied to change at will the angle at which the arc is presented to the work.

I am aware that the electric arc has been employed to heat to as great a depth as possible a stone-surface for quarrying purposes; but so far as I am aware before my invention an electric arc has never been passed rapidly across a stone-surface, so as to effect the chipping off of small quantities of the surface, the movement being so rapid as to prevent the heat penetrating to any considerable depth, deep penetration of the heat being essential in the former instance and unnecessary in the latter instance.

I claim—

1. The improvement in the art of dressing the surface of stone, which consists in generating an electric arc close to the stone-surface and in a movable holder, and moving the arc so held along such surface with sufficient speed to crack or chip off particles of the stone's surface without its heat penetrating to any appreciable depth, substantially as described.

2. The improvement in the art of dressing the surface of stone, which consists in generating an electric arc close to the stone-surface and in a movable holder and moving the arc so held along such surface with sufficient speed to crack or chip off particles of the stone's surface without its heat penetrating to any appreciable depth, and in the presence of a stone-cooling agent, substantially as described.

3. In an apparatus for dressing stone by an electric arc, the combination with two electrodes through which a current is passed to form an arc, of a laterally-movable holder on which the said electrodes are mounted, and means to support such holder upon the stone and means to move such holder along the surface to be dressed so as successively to present the electric arc to various points of such surface, substantially as described.

4. In an apparatus for dressing stone by an electric arc, the combination with two electrodes through which a current is passed to form an arc, of a laterally-movable holder on which the said electrodes are mounted, a support for such holder by which it may be mounted upon the stone to be dressed, and means to change the positions of the said electrodes with relation to the stone being dressed and to impart a progressive movement to the said electrodes across the stone, substantially as described.

5. In an apparatus for dressing stone, a



stone-support, a movable holder, two electrodes mounted on said holder and arranged at an angle one with the other, and automatic adjusting mechanism on and movable with said holder for varying the angle of separation of the said electrodes, as they burn away at their arc ends, to thereby regulate the length of arc between the same, substantially as described.

6. In an apparatus for dressing stone, two pivotally - mounted electrodes, worm and worm-wheel mechanism for rotating the same upon their pivots to vary the separation of the same, a support having an electromagnet movable thereon, a spring tending to move said magnet in one direction, a fixed armature, a spring tending to move the latter in one direction, and rack-and-pinion connections between the said movable armature and magnet respectively, and the said worm and worm-wheel mechanism operating, substantially as described.

7. An apparatus for dressing stone containing the following instrumentalities, viz: two guide-rods, clamping devices by which to attach the same to a block of stone, a frame adapted to move on the said guide-rods and provided with one or more track-rods, a carriage movable on said track-rods, two or more electrodes on the said carriage, and a propelling-motor on the carriage to reciprocate the same, substantially as described.

8. An apparatus for dressing stone, containing the following instrumentalities, viz: two guide-rods, clamping devices by which to attach the same to a block of stone, a frame adapted to move on the said guide-rods and provided with two track-rods, a carriage movable on said track-rods, two or more electrodes on the said carriage, a feeding-motor on said carriage, a propelling-motor to rotate the same, and means to automatically move said feeding-motor into engagement with one or the other of said track-rods to move the carriage in one or the other direction, substantially as described.

9. In an apparatus for dressing stone, a holder, two electrodes mounted thereon, one of said electrodes having pivotal movement relative thereto, and worm and worm-wheel mechanism for rotating said electrode on its pivot to automatically vary the angle of separation of the said electrodes to thereby regulate the length of arc between the same and maintain the same approximately uniform as desired, substantially as described.

10. In an apparatus for dressing stone, a holder, two electrodes mounted thereon, one of said electrodes having pivotal movement relative thereto, worm and worm-wheel mechanism for rotating said electrode, a fixed armature or core adjustably supported on said holder, an electromagnet mounted on and longitudinally movable relatively to said fixed armature or core, a spring connecting said electromagnet to said holder and normally

tending to lift said magnet, a movable armature within said electromagnet and also connected to said holder by a spring normally retracting the same, said magnet and movable armature each having a rack to engage a pinion provided therefor and arranged to operate said worm and worm-wheel mechanism, substantially as described.

11. In an apparatus for dressing stone, the combination with two electrodes through which a current is passed to form an arc, a holder on which said electrodes are mounted, one electrode being mounted movable toward and from the other electrode, of electrically-actuated controlling mechanism automatically controlling the relative position of said electrodes, said mechanism comprising a fixed armature, an electromagnet loosely mounted thereon, and a movable armature, having a relative movement to both the said magnet and fixed armature, and means independent of the electric current, for regulating the current-actuated movement of said controlling mechanism, substantially as described.

12. In an apparatus for dressing stone by an electric arc, the combination with two electrodes through which a current is passed to produce an arc, a movable holder for the said electrodes, and a jet device also mounted upon the said holder adjacent said electrodes and through which cooling fluid is projected upon the stone-surface immediately before or after it is operated upon as the holder is moved along, substantially as described.

13. In an apparatus for dressing stone by an electric arc, the combination with two electrodes through which a current is passed to produce an arc, a movable holder for the said electrodes, and an atomizing-nozzle arranged upon the said holder and close to the said electrodes to move with the electrodes to project air and water upon the stone-surface operated upon, substantially as and for the purpose specified.

14. The improvement in the art or method of dressing stone, which consists in generating an electric arc, moving the latter along and in close proximity to the surface to be dressed, with sufficient speed to crack or chip off particles of the stone's surface without its heat penetrating to any appreciable depth, and thereafter quickly cooling said surface to prevent undue heating and injury to the stone, substantially as described.

15. The improvement in the art or method of dressing stone, which consists in moistening the surface to be dressed, and generating an electric arc and passing the same along and in close proximity to the moistened surface, substantially as described.

16. In the working of stone to a finished, natural surface, the herein - described improvement in the art of dressing the surface of the stone preparatory to the use of the finishing-tools, consisting of generating an electric arc close to the stone-surface and



then moving said are along such surface with  
a speed sufficient to crack or chip off parti-  
cles of the stone's surface without the heat  
therefrom penetrating to such depth as to dis-  
5 color or otherwise injure the natural appear-  
ance of the finished stone-surface, substan-  
tially as described.

In testimony whereof I have signed my  
name to this specification in the presence of  
two subscribing witnesses.

GEORGE L. BADGER.

Witnesses:

FREDERICK L. EMERY,  
AUGUSTA E. DEAN.