(Model.) 3 Sheets—Sheet 1.

G. H. SMITH.

ATTACHMENT FOR GRINDING MACHINES.

No. 359,943. Patented Mar. 22, 1887.

Fig. 1.

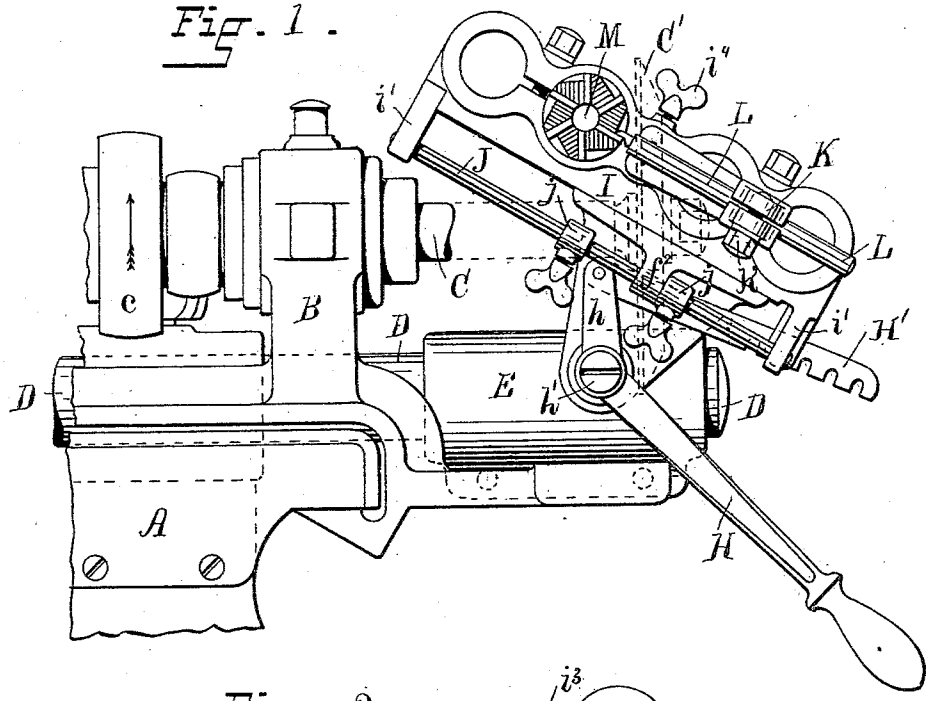
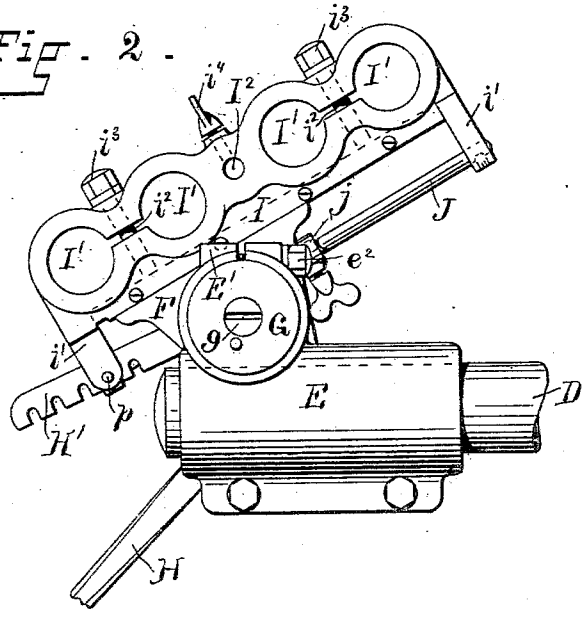


Fig. 2.



WITNESSES.

Chas. H. Luther Jr

Jno. L. Condron

INVENTOR.

George H. Smyth

by Joseph A. Miller & Co

Attys

(Model.) 3 Sheets—Sheet 2.

G. H. SMITH.

ATTACHMENT FOR GRINDING MACHINES.

No. 359,943. Patented Mar. 22, 1887.

Fig. 3.

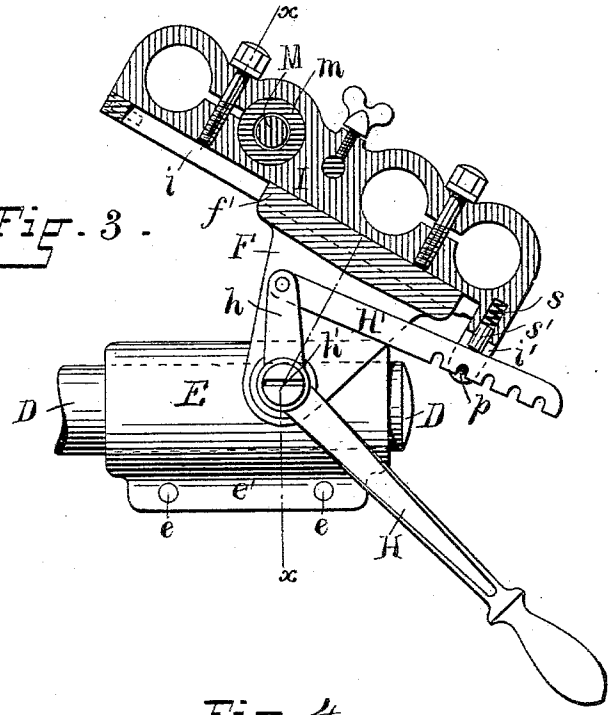
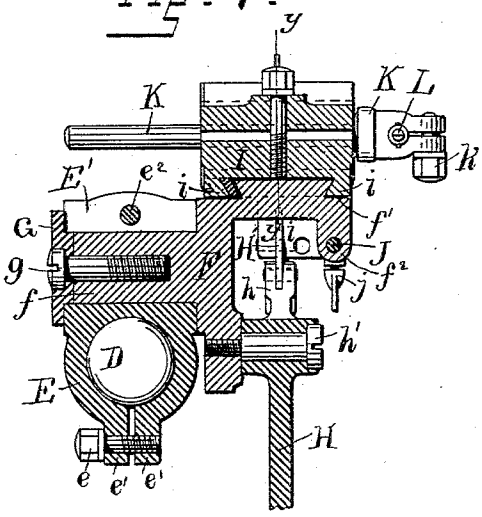


Fig. 4.



WITNESSES:

Chas. H. Luther Jr.

Jno. L. Condron

INVENTOR:

George H. Smith

by Joseph H. Miller & Co

Attys

(Model.) 3 Sheets—Sheet 3.

G. H. SMITH.

ATTACHMENT FOR GRINDING MACHINES.

No. 359,943. Patented Mar. 22, 1887.

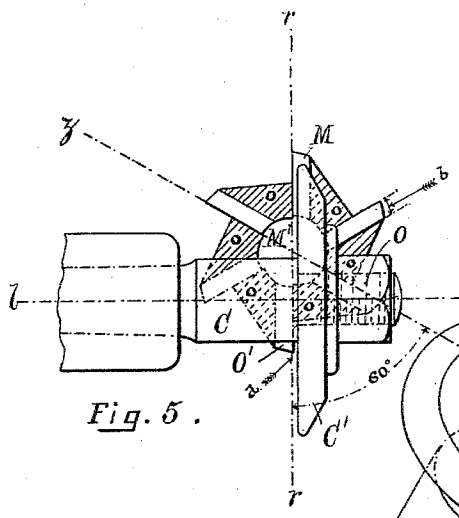


Fig. 5.

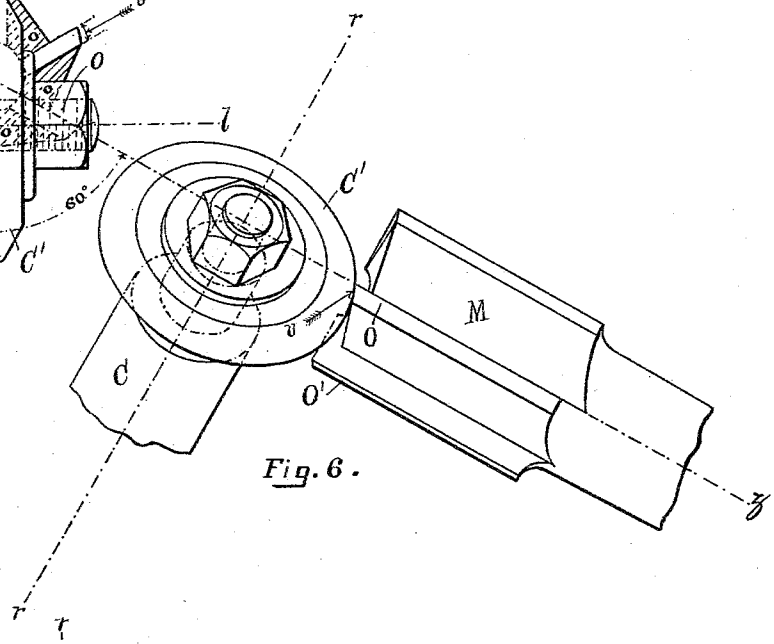


Fig. 6.

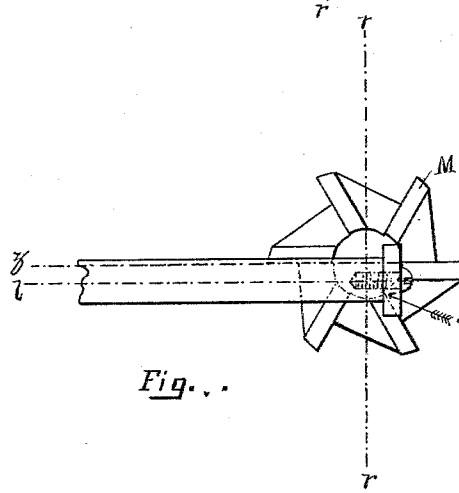


Fig. 7.

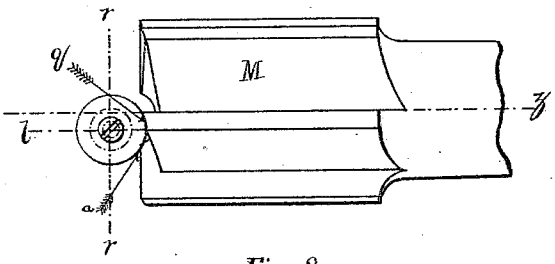


Fig. 8.

WITNESSES:
Chas. H. Luther Jr.
Willis Fowler.

INVENTOR
George H. Smith
BY
Joseph A. Miller & Co
ATTORNEYS

UNITED STATES PATENT OFFICE.

GEORGE H. SMITH, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR TO THE BROWN & SHARPE MANUFACTURING COMPANY, OF SAME PLACE.

ATTACHMENT FOR GRINDING-MACHINES.

SPECIFICATION forming part of Letters Patent No. 359,943, dated March 22, 1887.

Application filed April 9, 1885. Serial No. 161,646. (Model.)

To all whom it may concern:

Be it known that I, GEORGE H. SMITH, of the city and county of Providence, and State of Rhode Island, have invented a new and useful Attachment for Grinding-Machines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to the grinding by an emery-wheel of cutter-teeth on cutting-tools, and especially to the cutter-teeth on the ends and faces of that class of tools known as "end-mills" and "face-mills."

The objects of my invention are to sharpen and grind in a peculiar manner the cutter-teeth, as hereinafter fully described, and also to remove stock from between the teeth equal to recutting or removing stock by rotary cutters previous to hardening or tempering the tool.

To the above purposes my invention consists in certain novel constructions and arrangements of the parts of the attachment, as hereinafter fully described and claimed.

In the accompanying drawings, illustrating my invention, Figure 1 represents a back view, in elevation, of my attachment carrying a cutting-tool, and mounted upon a rigid bar of the grinding-machine frame, (shown in part,) and with the grinding-wheel (shown in broken lines) fixed upon its arbor, lying to the rear of said attachment. The tool-holder is here adjusted and set so that its line of motion lies in a plane parallel to the axial line of the grinding-wheel, and makes an angle with the side of said wheel equal to the degrees in a circle divided by the number of teeth in the tool M. Fig. 2 represents a front view of the attachment shown in Fig. 1, and as mounted upon a portion of the rigid bar of the machine-frame. Fig. 3 represents a central longitudinal sectional view of the attachment as shown in Fig. 2, and as taken on line *y y*, Fig. 4. Fig. 4 represents a transverse sectional view of the attachment, taken on line *x x*, Fig. 3, the holder being in horizontal position. Fig. 5 represents an enlarged end view of tool M detached and as coacting with the grinding-wheel, the relative proportion of the wheel to the tool being here reduced compared with Fig. 1. Fig. 6 represents a perspective view of Fig. 5. Fig. 7 represents an end view of a detached tool being ground by a small emery-wheel, and illustrating the old manner. Fig. 8 represents a side view of Fig. 7.

In the said drawings like letters designate corresponding parts throughout.

In the said drawings, A designates the machine-bed; B, the frame, and C the arbor for the grinding-wheel of a grinding-machine.

c designates the pulley for driving the arbor C, and C′ designates the emery or grinding wheel, (shown in broken lines,) which is mounted upon the arbor C and to the rear of the attachment.

It is to be understood that the attachment embodying my invention is not confined to application upon any particular form of grinding-machine, and hence I have deemed it necessary only to show the contiguous parts of a grinding mechanism.

D designates the rigid bar upon which my attachment is secured, and by which it is set in suitable position upon the machine.

E designates a split collar or clamp which surrounds the bar D, and which is firmly clamped thereon by screws *e*, passing laterally through lips *e′*, formed on the under side of the clamp. This clamp is also formed on its upper side with a split projection, E′, which surrounds the hub *f* of bed F, hereinafter described, and is clamped firmly around said hub by a screw, e^2. The hub *f* is also secured in the split projection E′ by a screw, *g*, passing longitudinally into the outer end of the hub and through a cap, G, covering the hub. The adjustable head F is of approximately inverted-L shape in cross-section, and upon the upper side of its extension is formed a dove-tail guide, *f′*.

H designates a hand-lever, which is pivoted upon the lower part of the bed F by a screw, *h′*, and which is formed at its upper end with an extension, *h*, projecting at an angle from the lever H. To the upper end of extension *h* is pivoted one end of an arm, H′, the opposite end of which is formed on its under side with a series of notches, as shown in Figs. 1, 2, and 3.

I designates the tool-holder, the under side of which is formed with two parallel extensions, *i*, projecting downward, and having inwardly-inclined inner sides to embrace the sides of guide *f'*. At each end the tool-holder I is formed with a downwardly-extending projection, *i'*, through a slit in one of which works the free end of arm H', a pin, *p*, being set across the slit in such manner as to be engaged by the notches of arm H'. A spring, *s*, is set in a socket formed in this projection *i* directly over the slit, and serves to hold a stud, *s'*, down upon the free end of arm H', so as to hold its notches in engagement with pin *p*.

The tool-holder I is constructed to travel freely on its bearings on the adjustable bed F. By virtue of the arrangement of the collar E being adjustable on its bearing it may be swung around in a plane normal to the axial line of bar D. By virtue of the arrangement of the projection E' on collar E, having its journal-box at right angles thereto, and the bed F being journaled therein by means of hub *f*, the bed F may be swung around on hub *f* in a plane parallel with said axial line of bar D. These combined constructions admit of the bed F being adjusted relatively to the two said planes, so that the holder I, traveling thereon, may be predeterminately set and fixed to reciprocate in a line of motion anywhere in a plane parallel with the axial line of the grinding-wheel. The binding-screws *e* and *e²* serve to determinately set the bed F at the desired angle.

J designates a bar, which extends longitudinally beneath the extension of the bed F and the holder I. This bar passes through an eye in a lug, *f²*, extending downwardly from the outer end of bed F, and the ends of said bar are fixed rigidly in the extensions *i'* of the holder I. This bar also carries two adjustable stops, *j j*, having each a binding-screw for holding it in any desired position upon the bar, so that as the holder is operated by the lever H the stops will alternately engage with the lug *f²*, and thus limit the traverse of the holder.

The body of the holder is formed with four transverse clamp-sockets, I', disposed in two pairs, and the sockets of each pair being connected by a slit, *i²*. A screw, *i³*, passes into the holder from above and through the slit, there being two such screws, one for each pair of sockets, and it will be seen that by tightening the screw *i³* the upper part of the clamp will be depressed upon the lower part, so as to clamp any tool placed in either of the sockets I'. Between the two pairs of sockets is formed a transverse socket, I², open at both ends, and designed to receive the round stem of the index-finger holder K, and provided with a screw, *i⁴*, entering from above, so as to secure the holder in the socket.

The index-finger holder K consists of a body having a straight portion provided at one end with a round stem, extending at right angles thereto and affording a bearing to rest in the socket I², and in which it is turnable on its long axis. At the other end of said straight body is an oppositely-disposed flat head constructed with a cylindrical eye, *t*, the center line of which is normal to the long axis of said stem. The slit *v* communicates with eye *t* through its length, and across it is set the binding-screw *k*, which serves to contract or dilate the eye *t*, in order to bind or release the index-finger L, set therein. The clamp-sockets I' and I² are disposed with their long axes in range on the same plane, so that the worked tool and the stem of holder K are always maintained with their axes in a plane parallel with the line of motion of the holder I on the bed F.

The index-finger L consists of a rod, the engaging end of which is provided with a pawl normally forced outward. It is evident that the stem of holder K may be turned on its long axis in socket I², so that the central line of finger L may lie in the line of motion of holder I; or it may have its engaging end adjusted above or below the same. In Fig. 1 it is shown as lying in said line of motion.

M designates a six-toothed end-mill, the shank of which is inserted into a tubular casing, *m*, Fig. 3, while the latter is clamped in one of the sockets I' by means of binding-screws *i²* in proper relation to the grinding-wheel C', as hereinafter described.

By the term "side of the grinding-wheel," herein used in the description and claims, is meant a broadside of the grinding-wheel always maintained in a plane normal to the axial line of said wheel.

As is well known to those familiar with the art of cutting or grinding the teeth on milling-cutters or cutting-tools, if the tool to be cut or ground be carried onto the periphery of the grinding or emery wheel in a line of motion parallel to the axial line of said wheel, the cut made will be in an arc identical with the curve of said periphery. If the tool be carried onto said periphery in a line at right angles to the above-described line of motion, the cut produced will be a straight one. Now, considering these two lines of motion just described as lying in the same plane and always normal to each other, if the tool be carried onto the periphery of the grinding-wheel in any other line of motion in said plane—*i. e.*, angularly to said lines—the cut produced will be in every case of an elliptical curve. The difference between the curves of the cuts produced by the two described lines of motion in same plane and normal to each other and the cuts produced by a line of motion angularly to said lines may be readily understood by imagining the grinding-wheel as a cutting-circle whose periphery cuts the worked tool. It will be obvious that in the cases of the two normal lines of motion, if the cutting-circle be projected on a plane normal to said lines of motion, in the former case the projection will be a perfect circle and the latter will be a perfect

line, and in the cases of the angular lines of motion the cutting-circle projected on a plane normal to said lines will produce ellipses.

It will be seen that since the bar D is parallel with the axial line of grinding-wheel C′, and the journals of the collar E and projection E′ are at right angles to each other, my attachment may be readily adjusted so that the line of motion of the tool-holder may be at any angle to the side of said wheel and in a plane parallel to the axial line of said wheel. Thus I am enabled to gain any desired elliptical cut.

The operation of the device is as follows: The tool to be ground having been properly clamped in the required socket, the attachment is moved upon the hub *f* till it sets at such an angle to the side of the grinding-wheel that the next face of the tooth under the one engaged by the pawl of the index-finger shall lie parallel with the side of the wheel. The stops *j* are so set upon the bar J as to limit the movement of the tool-holder in accordance with the length of surface to be ground, and the arm H′ is set at any angle convenient to the operator. Now, as the holder I is moved by means of the lever, the tool will be carried onto the periphery of the grinding-wheel on an angle equal to the number of degrees in a circle divided by the number of teeth in the tool. In the drawings the tool has six teeth, and consequently the angle of movement will be sixty degrees. By this means an elliptical cut is made by the grinding-wheel upon the tooth. During the grinding of the tooth the tool is held by the pawl of the index-finger L, and as soon as one tooth has been ground the next tooth is brought into position by turning the tool in the socket I′ in the direction permitted by the pawl. Both right and left hand mills may be ground with this attachment, the position of the tool-holder, the pawl, and grinding-wheel being reversed as compared with the drawings for left-hand mills. The position of the tool holder must be nearer vertical in accordance with increase in the number of teeth to the tool. During the grinding process the hand-lever H is moved by the left hand of the operator, who faces the front of the attachment, and thus reciprocates the tool-holder on its bearings, the traverse of the reciprocations being limited by the stops *j*, as before described. By the adjustment of the next tooth below the one being ground so that its face lies parallel with the side of the grinding-wheel, obviously the angularity of the line of motion to the side of said wheel will always be equal to the number of degrees in a circle divided by the number of teeth in the worked tool. However, this angularity may be varied to any desired angle lying in the plane parallel with the axial line of the grinding-wheel, as this is contemplated by my invention.

In Figs. 5, 6, 7, 8 the broken lines *z z* represent the lines of motion in which the worked tool M is carried onto the periphery of the grinding-wheel. The lines *l l* represent the axial line of the grinding-wheels. The lines *r r* represent a line in a plane normal to said axial line, or parallel to the side of said grinding-wheel.

In Figs. 5 and 6 is illustrated the position of the grinding-wheel C′ in relation to the end of mill M, a certain tooth, O′, of which is adjusted so that its face lies parallel to the side of the wheel C′, and the tooth O next to it is to be cut by wheel C′ on the line *z z*, which makes an angle of sixty degrees with the side of said wheel, or the number of degrees in a circle divided by the number of teeth in tool M. Fig. 6 represents a perspective of Fig. 5 projected on line of motion *z z*. This projection shows the periphery of grinding-wheel C′ elliptical and the curve of the cut produced on tooth O as elliptical, as indicated at the point of arrow *u*.

In Figs. 7 and 8 is illustrated the old method of grinding cutter-teeth with a small emery-wheel. This method is an inferior one, because the wheel in cutting or sharpening one tooth strikes against the next tooth lying below it and dulls or grinds off its cutting-edge, as shown at the point of arrows *a*. Again, because of the short radius of the grinding-wheel, the tooth is cut on a sudden curve, and this leaves a delicate backing for the cutting-edge thereof, as shown by point of arrow *q*. Again, it is obvious that, the wheel being much smaller in proportion than the worked tool, so as to get in between the teeth in grinding them, as the teeth increase in number the size of the wheel decreases accordingly, and generally the size of wheel demanded by the ordinary work in this process is so small that the peripheral speed of the wheel requires an impracticable speed of arbor and machine. Moreover, this small wheel has an uneven motion and a tendency to hack or chop the portion being ground. For these reasons this method of employing a small wheel is not used, and it is found better in sharpening or recutting cutter teeth to draw the temper of the tool, then recut them in a milling-machine and temper again. This method requires much time, is expensive, and injures the metal of which the tool is made. By virtue of the peculiar adjustable line of motion of my attachment I obtain the utmost clearance of the grinding-wheel in grinding the cutter-teeth, and may use the ordinary-sized wheel without harming the teeth or increasing the speed of the machine.

In cases where the cutter-tooth of the mill becomes so broad as to cause considerable heat in grinding a cutting-edge on the same, as shown by arrow *b*, Fig. 5, I can readily adjust my attachment by making the long axis of said mill oblique to a horizontal plane, and the mill-head either above or below said plane, so as to pass the surface *o* between the teeth onto the wheel, and thus rapidly remove stock from

there, and by gradually diminishing the breadth (shown at *b*) can make the mill as good as new.

In making milling-cutters with radial cutter-teeth it frequently happens that the teeth are ground non-radial, which renders the tool inferior, if not worthless. By the use of my attachment I can redeem such defective work by grinding the ill-shaped teeth radial, by placing the tool in the device so that the desired radial line will be parallel with the line of motion, and as the tooth will be cut on said line said tooth will be ground radial.

Referring to Figs. 1 and 5, the tool M has the tooth below the one being ground with its face parallel with the side of the grinding-wheel, as clearly shown by arrow *d*, Fig. 5, where said face of tooth coincides with line *r r*. In these cases it is obvious that the grinding of the tooth will be uniform, since the face of the tooth being ground is also parallel with the line of motion. By depressing the peripheral end of said tooth below the line of motion the grinding will then be made crowning, and by elevating the same it will be made hollow.

I do not wish to be understood as broadly claiming the making of elliptical cuts on cutter-teeth, for I am aware that this has heretofore been accomplished by placing the arbor of the grinding-wheel at an angle with the work; and I also disclaim, broadly, the feature of the tool-holder bed or carriage being hinged and adjustable relative to the horizontal plane, since this construction is well known. This I do not do, for by the peculiar adjustable line of motion of my attachment I carry the work parallel to said wheel-arbor; or, in other words, I have a line of motion adjustable in a plane parallel with said arbor, as hereinbefore fully set out. I am thus enabled to accomplish these desirable results, and thereby gain the utmost clearance of the grinding-wheel and perform the work rapidly and efficiently, without having to draw the temper of the tool and retemper.

There may be various modifications made in the several features of my invention without departing from the spirit thereof.

As shown at M′ in Fig. 5, cutting-tools are often formed with a hollow center. In these cases I can readily remove stock from between the cutter-teeth as often as the tool becomes dull, and until the cavity M′ becomes cut away by frequent recuttings or repairings.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, with a bar and a collar turnable and adjustable thereon relative to the axis of the bar, of a bed hinged upon said collar and having the axial line of the hinge-joint normal to the axial line of the collar, and a reciprocating tool-holder sliding on said bed, and provided with means for reciprocating the holder, substantially as described, whereby the tool-holder may have a line of motion in a plane parallel to the axial line of the grinding-wheel.

2. The combination, with a bar and a collar turnable and adjustable thereon relative to the axis of the bar, of a bed hinged upon said collar, and having the axis of the hinge-joint normal to the axis of the collar, a reciprocating tool-holder sliding on said bed, and a hand-lever pivoted on said bed and provided with an adjustable hinge racked arm adapted to engage with the tool-holder, substantially as described.

3. The combination, with a bar and a collar turnable and adjustable thereon relative to the axis of the bar, of a bed hinged upon said collar, and having the axis of the hinge-joint normal to the axis of the collar, a reciprocating tool-holder sliding on said bed, a hand-lever pivoted on said bed and provided with an adjustable hinge racked arm, a projection on said bed provided with a slit, and a pin fixed across the slit, a spring-pressed stud working in a socket in said projection, said racked arm extending through said slit, and the rack engaging the pin and the stud engaging the arm, substantially as described.

4. In a grinding-machine attachment, the combination, with a tool-holder, of an index-clamp provided with an index-finger adapted to engage a tooth on the worked tool, substantially as described, said holder having a line of motion adjustable in a plane parallel to the axial line of the grinding-wheel, whereby said wheel and tooth may relatively approach on the line of motion.

5. In a grinding-wheel attachment, the combination, with a tool-holder having a line of motion adjustable in a plane parallel to the axial line of the grinding-wheel, of an index-clamp provided with an index-finger adapted to engage a tooth on the worked tool, substantially as described, and adjustable on its line of length in or out of said line of motion, and said engaged tooth accordingly adjusted, whereby said tooth may be cut by said wheel on said line of motion, substantially as set forth.

6. In a grinding-machine attachment, the combination, with a tool-holder having a line of motion adjustable in a plane parallel to the axial line of the grinding-wheel, of an index-finger mounted on said holder and adapted to engage a tooth on the worked tool and adjustable on its line of length in or out of said line of motion, and said engaged tooth accordingly adjusted, substantially as described, whereby the worked tool may be carried onto said wheel normal to the axial line of said wheel, and said tooth may be carried onto said wheel on a line of motion at an angle to the side of said wheel equal to the number of degrees in a circle divided by the number of teeth in said tool, substantially as described.

7. In a grinding-machine attachment, the combination, with a tool-holder reciprocating

on an adjustable bed and having a line of motion thereon in a plane parallel with the axial line of the grinding-wheel, of a series of clamp-sockets in said holder, each adapted to hold a worked tool, a clamp carrying the index-finger and set in another of said sockets and adjustable therein, and adapted to swing said finger in or out of said line of motion, said finger adapted to engage a predetermined tooth on the worked tool, said bed predeterminately set, and means for reciprocating said holder thereon, whereby said tooth may be carried onto said wheel and cut, substantially as described.

8. In a grinding-machine attachment, the combination, with a tool-holder reciprocating upon an adjustable bed and having a line of motion thereon adjustable in a plane parallel to the axial line of the grinding-wheel and provided with a series of clamp-sockets in said holder disposed in range transversely to said line of motion, and each adapted to hold a worked tool, of an index-finger provided with a pawl on the engaging end thereof, an index-clamp carrying said index, and having an eccentric stem or bearing resting and turnable in another of said sockets and adapted to be swung in or out of said line of motion, said finger adapted to engage a predetermined tooth on said tool, said bed predeterminately set, and means for reciprocating said holder thereon, whereby said tooth may be carried onto said wheel in said line of motion and cut, substantially as described.

9. In a grinding-machine attachment, the combination, with a collar swiveled to a rigid bar, of a projection on said collar, and to which is swiveled an adjustable bed at right angles to said collar-swivel, binding means for said swivels, a tool-holder reciprocating on said bed, and means for reciprocating said holder, said holder provided with a series of clamp-sockets having their axes in the same plane and transverse to said line of reciprocation, and binding means for said sockets, substantially as described.

10. In a grinding-machine attachment, a tool-holder provided with four transverse clamp-sockets disposed in pairs, and each pair connected by a slit throughout their length, binding-screws disposed across said slits, and a fifth clamp-socket arranged between said pairs, and having its axis in the same plane with the axes of the other sockets and provided with a binding-screw, substantially as described.

11. In a grinding-machine attachment, the combination, with a swiveled adjustable bed provided with a longitudinal dovetail, of a tool-holder, substantially as described, having a bearing-surface conforming to said dovetail on said bed and sliding thereon, a guiding-lug extending from the opposite face of said bed having the dovetail, a sliding bar taking through said guiding-lug and rigidly connected at the ends to extensions on said holder, a pair of adjustable stops riding on said bar, one to each side of said lug, reciprocating means consisting of a projection at one end of said holder engaging an adjustable racked arm, and a pivoted lever connected to the said arm, whereby said holder may be reciprocated, substantially as described.

12. The combination, with the tool-holder, of an index-clamp consisting of a crank-shaped body, one arm of which is cylindrical to afford a bearing in a socket, the other arm of which is provided with a clamp socket extending normal to said bearing-arm, and binding means for said clamp-socket, and an index-finger set in said clamp, substantially as described.

13. In combination, the adjustable bed F, provided with the dovetail bearing f', and the tool-holder I, provided with the clamp-sockets I' I^2, having binding-screws i^2 i^4, said holder mounted on said bed and movable thereon, substantially as described.

14. In combination, the collar E, provided with screws e, the split projection E′, fixed upon said collar and provided with screw e^2, the adjustable bed F, having the hub f, resting in said projection E′, and provided with the guiding-lug f^2, the tool-holder I, provided with clamp-sockets I' I^2, having screws i^2 i^4, and reciprocating upon said bed F, said holder provided with the projections i', and the bar J, supported in said projections i' and provided with stops j, the lever H, provided with extension h, and the notched arm H′, said arm H′ taking in a slot in projection i' and engaging pin p, substantially as described.

15. The combination, with the tool-holder, of the index-clamp consisting of the body K, provided with a flat head having therein an eye, t, a communicating slit, v, and a binding-screw, k', and the index-finger L, substantially as described.

16. The combination, with the swiveled bed F, provided with the guiding-lug f^2, of the tool-holder I, provided with projections i i and bar J, the hand-lever H, pivoted to said bed and provided with the hinged racked arm H′, projection i of the tool-holder provided with the slit, and the pin and the spring-acted stud, substantially as described.

GEORGE H. SMITH.

Witnesses:
M. F. BLIGH,
J. A. MILLER, Jr.