H. WALTHER.

ADJUSTABLE REAMER.

APPLICATION FILED FEB. 11, 1908.

1,002,612.

Patented Sept. 5, 1911.

3 SHEETS—SHEET 1.

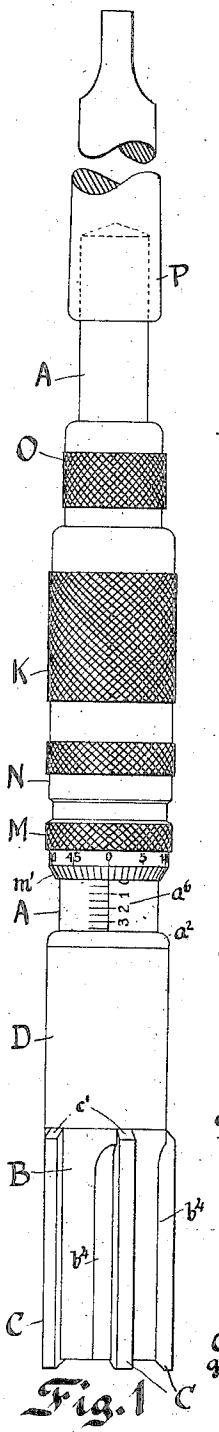

Fig. 1

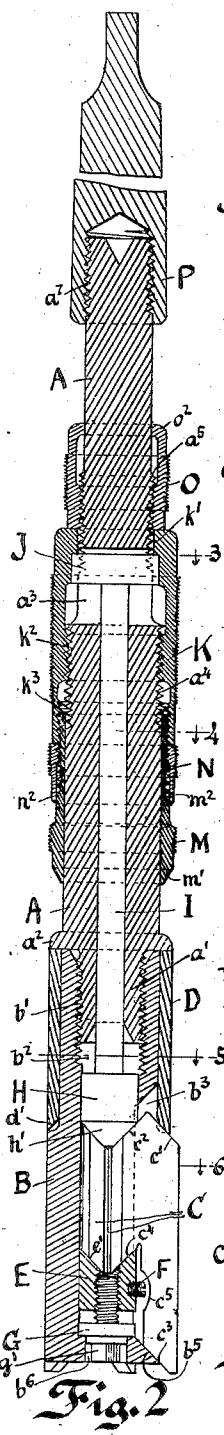

Fig. 2

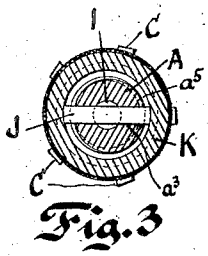

Fig. 3

Fig. 4

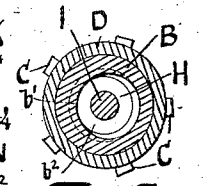

Fig. 5

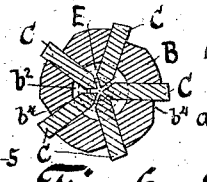

Fig. 6

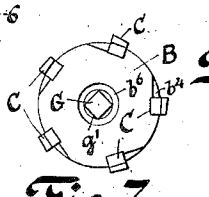

Fig. 7

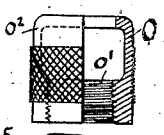

Fig. 8

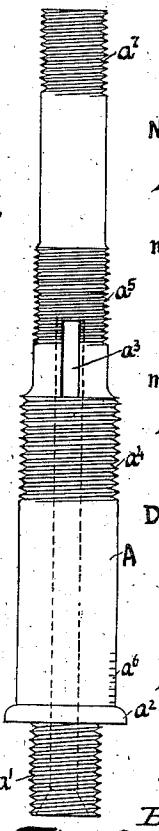

Fig. 9

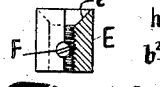

Fig. 10

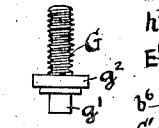

Fig. 11

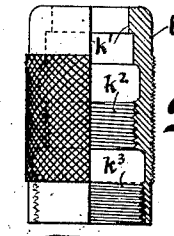

Fig. 12

Fig. 13

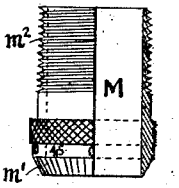

Fig. 14

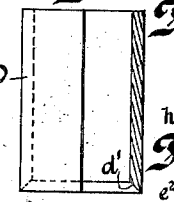

Fig. 15

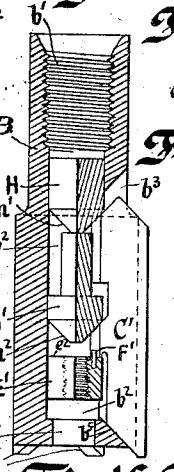

Fig. 16

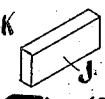

Fig. 17

Fig. 18

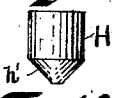

Fig. 19

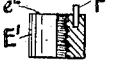

Fig. 20

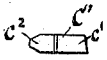

Fig. 21

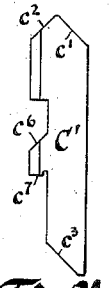

Fig. 22

Witnesses:

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Minnie D. Schuerbein

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By George Whitmore Collins Attorney

H. WALTHER.

ADJUSTABLE REAMER.

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1,002,612.

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3 SHEETS—SHEET 2.

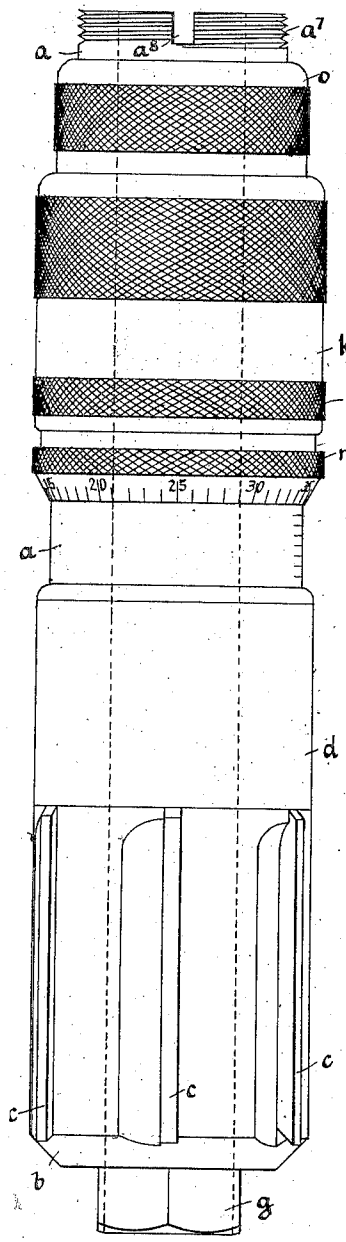

Fig. 23

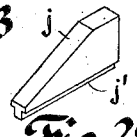

Fig. 29

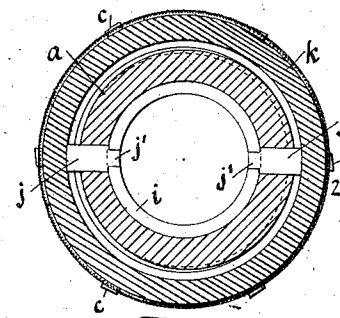

Fig. 25

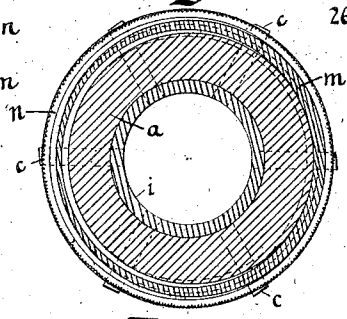

Fig. 26

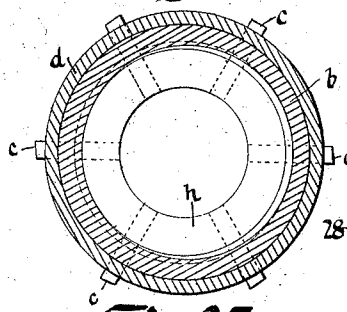

Fig. 27

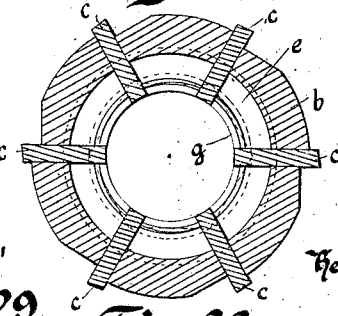

Fig. 28

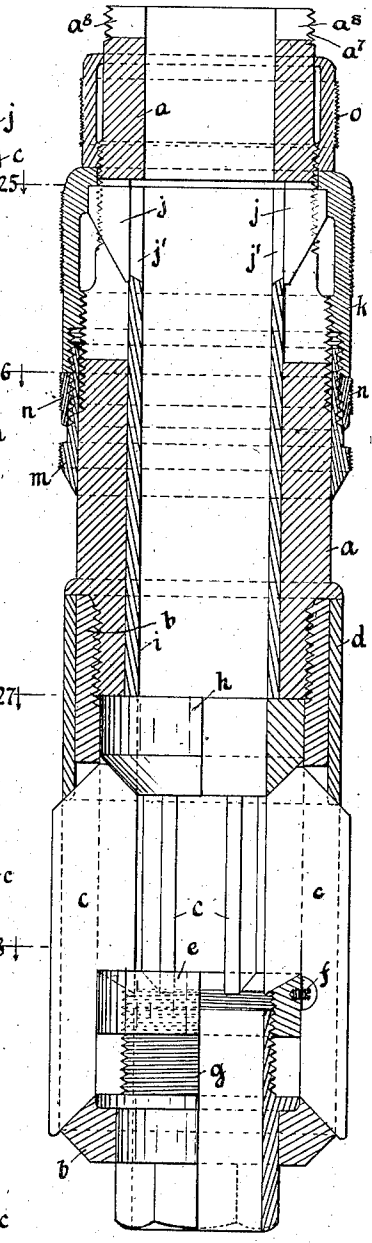

Fig. 24

Henry Walther, Inventor

Witnesses

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Attorney

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ADJUSTABLE REAMER.

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3 SHEETS—SHEET 3.

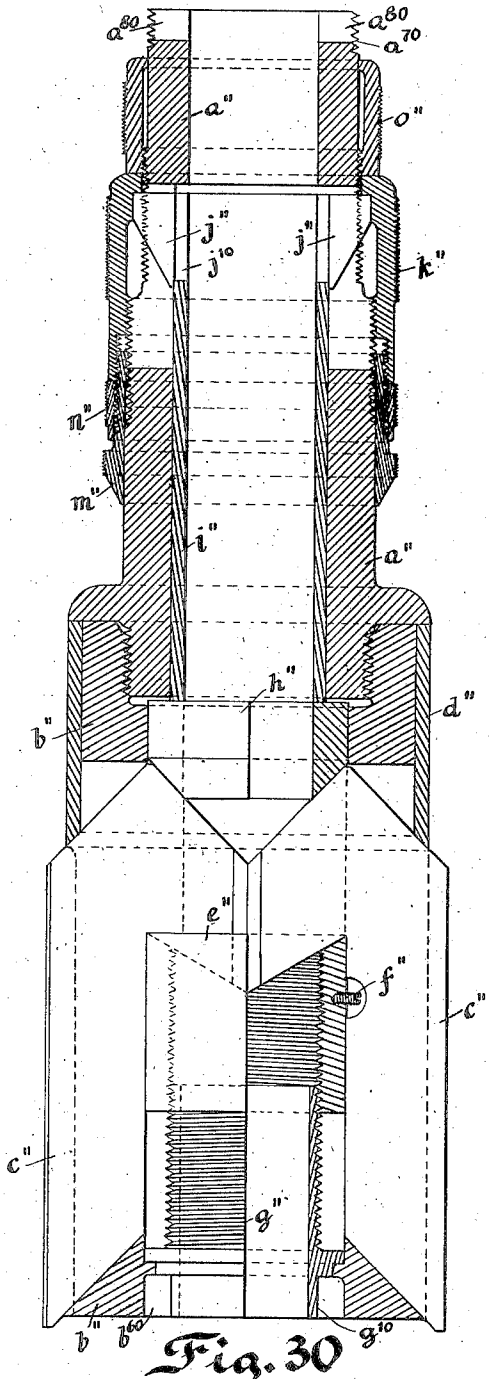

Fig. 30

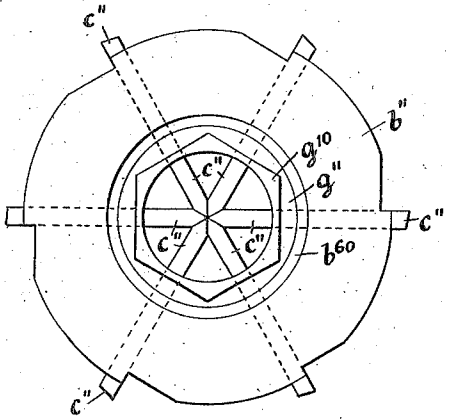

Fig. 31

Witnesses

A. P. Van Loghem

Minnie D. Schienlein

Henry Walther, Inventor

By George Whitmore Collier

Attorney

UNITED STATES PATENT OFFICE.

HENRY WALTHER, OF MILWAUKEE, WISCONSIN.

ADJUSTABLE REAMER.

1,002,612. Specification of Letters Patent. Patented Sept. 5, 1911.

Application filed February 11, 1908. Serial No. 415,306.

To all whom it may concern:

Be it known that I, HENRY WALTHER, of Milwaukee, Wisconsin, have invented an Adjustable Reamer, of which the following is a specification.

The object of my invention is to provide an adjustable expansion reamer of superior simplicity, greater rigidity and much greater accuracy and ease of adjustment than anything heretofore existing.

More particularly I aim to produce a reamer with means for adjusting the effective cutting diameter to any desired bore and with a fine degree of adjustment in an improved manner.

In adjusting the cutting diameter of ordinary expansion reamers, it is necessary to go through a cut-and-try operation, the reamer being expanded or contracted to approximately the right diameter, than calipered or gaged, and if found still too large or too small again expanded or contracted slightly and again calipered, and so on until exactly the right diameter is obtained, after which this diameter is locked up. Such an operation is a tedious one and one which requires the tool to be taken to the tool-room or shop to be changed, and moreover, requires so much time that the value of the adjustable feature is largely nullified. Furthermore it cannot be carried out on reamers having an uneven number of blades. In my invention, this trial and error method is completely eliminated, as is also the calipering. Briefly, I provide a means whereby the reamer can be set at once to the desired diameter and with micrometric accuracy, in the same way as a micrometer gage or caliper is set, that is, by means of a graduated screw. In order to avoid any difficulty in having the graduations fit the blades, I provide means for resetting the graduation marks to zero as the cutters are worn down and require to be reground, to center the blades in the reamer, or when new blades are inserted therein. My arrangement is also such that it admits of absolute rigidity of the cutter-blades with a minimum of strain upon the adjusting parts, which strain has been a disadvantageous feature of many reamers.

A special form of my reamer has been devised and is here shown which is capable of being used in the manner of a shell-reamer, to wit, being tubular and adapted to be placed upon a mandrel for use; but it differs entirely from the so-called shell-reamers in the fact that it is capable of a much greater range of expansion than the latter—that is, one measured in inches rather than thousanths of an inch; that the ends of the cutting-blades at all times extend beyond the end of the cutter-head, whereby the latter does not interfere with the former reaching the bottom of a hole, and that at the same time the cutting-blades are at all times supported by resting firmly upon the solid end of the cutter-head.

A novel construction embodied in my reamer consists in making the cutter-head and stock in two pieces united by a separable joint midway of the reamer, and inserting the central core-piece or pieces through the openings at the united ends of these features, whereby it becomes possible to make the head-end of the cutter-head solid and to secure certain further peculiarities of construction which will be hereinafter described.

My reamer has the peculiarity distinguishing it from others, that the construction is such as to permit of the cutter-blades extending all the way to the axis, there being no core or other piece interfering with this disposition; and thereby I am enabled to give my reamer a great range of expansion, thus enabling one tool to take the place of three or four. For example, no reamer now constructed so far as I am aware is capable of expansion for exceeding one-eighth of an inch; therefore a range of bore of from two to four inches, say, requires not less than 16 different sizes of reamers; whereas with my reamer I get a range of expansion of fully one-half inch, so that the same range can be secured by only four reamers.

The nature and construction of my invention may best be understood from the accompanying drawings and the following description thereof.

In these drawings, Sheet 1 illustrates a small-sized reamer constructed according to my invention, and Sheet 2 shows a large-sized hollow or tubular reamer embodying the same principle. Figure 1 is an elevation and Fig. 2 a longitudinal section of the aforesaid small-sized reamer; Figs. 3, 4, 5 and 6 are transverse sections of the same taken on the plane of the lines 3, 4, 5 and 6 respectively; Fig. 7 is an end view from the lower end thereof; Fig. 8 is part eleva-

tion and part section of the adjusting lock-nut; Fig. 9 is a side-elevation of the stock shown separately, and in a plane at right-angles to that of Fig. 2; Fig. 10 is part elevation and part section of the clamping-nut, in a plane at right-angles to that of Fig. 2; Fig. 11 is a side-elevation of the clamping-screw; Figs. 12 to 15 inclusive are half side-elevations and half sections of the adjusting-nut, calibrating lock-nut, calibrating-sleeve and abutment-sleeve respectively; Fig. 16 is a longitudinal section of the cutter-head showing alternative forms of the cutters, core-block and clamping-nut; Fig. 17 is a perspective view of the cross-bar for the core-rod; Figs. 18 and 19 are side elevations of the core-rod and core-block respectively; Fig. 20 is in part side-elevation and part section of the alternative form of clamping-nut shown in Fig. 16; Figs. 21 and 22 are respectively an end and side elevation of the alternative form of cutter-blades shown in Fig. 16. In Sheet 2, the figures showing the larger sized reamer are as follows: Fig. 23 is a side elevation and Fig. 24 a longitudinal section, the core-block, clamping-nut and clamping-screw in this latter being shown in part elevation; Figs. 25, 26, 27 and 28 are transverse sections on the planes represented by the lines 25, 26, 27 and 28 respectively; Fig. 29 is a perspective view of one of the wing-pieces for the core, showing a slightly modified form; Fig. 30 is a longitudinal section of a still larger sized reamer, and Fig. 31 is an end view thereof.

In these drawings the same reference letter and numeral refers always to the same part.

Referring first to Sheet 1 of the drawing, the small sized-reamer comprises as shown nineteen parts, to wit, a main body or stock A (Fig. 9); a cutter-head B (Fig. 16); five cutter-blades C; abutment-sleeve D (Fig. 15); clamping-nut E (Fig. 10), carrying a pin or screw F in the side thereof; clamping-screw G (Fig. 11); core-block H (Fig. 19); core-rod I (Fig. 18); cross-bar J (Fig. 17); adjusting-nut K (Fig. 12); calibrating-sleeve M (Fig. 14); calibrating lock-nut N (Fig. 13); adjusting lock-nut O (Fig. 8); and a turning-head P. All the other parts are mounted on or in the stock A and cutter-head B, and it will be observed that these two are connected together at an intermediate point of the length of the reamer by a separable screw-joint formed by a threaded boss a' on the stock and the interior threads b' formed in the end of the bore b^2 of the cutter-head. In the bore b^2 are slidably mounted the core-block H and the clamping-nut E, which oppose each other to clamp the blades C in adjusted position. These blades are set in radial slots b^3 in the cutter-head as shown, being recessed at b^4 as usual in front of the blade. The form of the blades C is to be particularly noted, as it is of the essence of the invention. Each blade, as will be seen, is provided with four oblique surfaces designated respectively c', c^2, c^3, and c^4. The oblique edges c' and c^3 are parallel, the former abutting upon and guided by the conically faced edge d' of the sleeve D, which is fitted over and upon the upper end of the cutter-head, both abutting against the shoulder a^2 formed for the purpose on the stock A; while the oblique edge c^3 abuts upon the oblique end-face b^5 of the slot b^3 which is, or ought to be, parallel to the edge c^3. The oblique face c^2 abuts upon the conical face h' of the core-block H, which is or should be formed with the same angle. The oblique edge c^4 is undercut and abuts upon the undercut conical face e' of the clamping-nut E, which is moved up to engage the same by means of the clamping-screw G mounted in the end of the bore b^2 and having a square or polygonal head g' projecting through a hole b^6 in the cutter-head, and having a circular flange g^2 abutting against the end of the bore. The clamping-nut E is kept from rotating by means of the pin or screw F, which lies in one of the slots b^3, the inner edge of one cutter-blade C being cut away as shown at c^5 to leave room for it. The precise angle of obliquity of the edge c^4 and the coned face e' is not of consequence, and it may even be ninety degrees, as illustrated in Figs. 16, 20 and 22, which will be described hereinafter. Upon the core-block H abuts the end of the core-rod I, which is fitted to slide longitudinally in the central bore of the stock A. Upon the upper end of this in turn rests the cross-bar J, which slides longitudinally in a transverse slot a^3 in the stock. The diameter of the stock at this point is made slightly smaller than lower down, to enable the ends of the bar J to project so as to engage the internal annular shoulder k' of the adjusting-nut K, which has a set of threads k^2 engaging corresponding threads a^4 on the larger diameter of the stock. It will be seen therefore that the nut K serves to adjust the position of the blades C by advancing the core-block H through the medium of the rod I and the cross-bar J, and in connection with the clamping-nut E and clamping-screw G to secure the blades in their adjusted position. The nut K is itself secured in its adjusted position by means of a lock-nut O which engages threads a^5 on the smaller diameter of the stock A, which threads are preferably of a slightly different pitch from the threads a^4 whereby a stronger locking-action is produced. In Fig. 8 the lock-nut O is shown with reverse or left-handed threads o', which may be used in

some cases if preferred. The lock-nut O is made with an annular extension or apron o^2, which covers and conceals the threads and prevents them from injury. Longitudinally on the stock A are inscribed a set of graduations a^6 having intervals corresponding to the pitch of the thread a^4 on which the adjusting-nut turns. With these graduations coöperate a series of circular graduations m' on the beveled edge of the calibrating sleeve M. According to my construction this sleeve is formed separately from the adjusting-nut K and adjustably secured thereto by engaging threads k^3, m^2 on the two members; while to hold the calibrating-nut M in any fixed position on the nut K I provide the lock-nut N, the internal threads n' of which engage the threads m^2 (Fig. 2). I prefer also to provide the nut N with an annular extension or apron n^2 which covers and protects the thread m^2 of the sleeve M. By means of the calibrating-sleeve and lock-nut the reamer can be set at zero or any desired cutting diameter. This is particularly advantageous in enabling the reamer to be adjusted and readjusted repeatedly to compensate the wear of the cutter-blades, so that the reading of the micrometer-graduations shall always be correct. It entirely eliminates corrections for graduations, calculations and approximations in setting. After the blades are set in place and ground up to even diameter, the sleeve M will be set to zero and locked up, and this will be ordinarily done in the stock-room of the machine-shop and the reamer is then ready for use by the machinists, who set it by means of the graduation to any desired cutting-diameter. The machinist therefore will confine his adjustment to the nut K, while the toolkeeper will confine his adjustment to the sleeve M. The turning-head P is in this instance shown as a conical head to fit a drill-chuck, attached to the end of the stock A by means of screw-threads a^7. Any other form of turning-head may be substituted. It is in this instance made separate from the stock A because of the small diameter of the reamer, and to enable the several nuts and sleeves to be assembled in place. It will be noted that among other advantages this construction enables the lower end of the cutter-head to be made substantially solid, there being only a small hole at the center to admit the head of the screw G. This gives a rigid and unyielding support or backing for the ends of the cutter-blades, which is of great importance, because otherwise the bottom of the hole cannot be reamed true and square.

In the alternative forms of Figs. 16, 20, 21 and 22, the cutter-blade C′ is shown with two parallel oblique edges c^2 and c^6, the latter being formed midway for an additional core-block H′, which has a conical-face h^2 the same as the face h' of the block H, the block H′ being mounted end to end with the block H. This arrangement is however desirable only in long cutter-blades and is unnecessary in the smaller sizes. I have also here shown a clamping-nut E′ having a flat face e^2 instead of the internally coned face e' of the nut E. With this coacts the flat abutment-edge c^7, replacing the undercut edge c^4. The action of the clamping-nut in drawing the blades C together is accomplished, though not quite so effectively, by this flat-faced nut, because the pressure thereof upon the blades, acting in opposition to the cone-face d' of the sleeve D produces a couple tending to turn the lower end inwardly. I have also here shown, as a substitute for the side-pin F, a pin F′ inserted in the end of the nut (see Fig. 20) and lying between two cutter-blades. The same object could of course be accomplished in many other ways, of which two only are here shown.

The large-sized tubular reamer shown in Sheet 2 of the drawings is intended more particularly for reaming large bores, such as small gas-engine cylinders, as a substitute for the lathe-boring tools now in common use. As is well known it is very difficult or rather impossible to bore a cylinder exactly true with a boring-bar, because of the give or yield thereof. With this tool however it is possible to bore such a cylinder to practical exactness. This reamer is intended to be mounted on a mandrel, and therefore all the circular parts are made concentrically tubular, whereby the mandrel is adapted to pass through the center. With this exception the construction of all the parts *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *k*, *m*, *n*, and *o* is the same as that of the corresponding parts A, B, C, D, E, F, G, H, K, M, N and O. A separate description of the same is not therefore needed. The cross-bar J in the first form is however replaced by a special construction, to enable it to avoid interfering with the central mandrel, to wit, a pair of wing-pieces *j* which are mounted on the end of the tubular core I, extending radially therefrom so as to engage under the annular lug on the adjusting-nut *k*. According to the preferred construction the inner edge of each wing-piece *j* is provided with a tenon *j'* which is mortised into a corresponding longitudinal slot in the core *i* (see Figs. 24 and 25). The end of the tenon as shown in Fig. 24 is slightly undercut, but may more simply be cut off flat, as shown in Fig. 29. The wing-pieces will be put in with a driving fit, so that they cannot fall out of place even if the core should slip down below the top of the adjusting-nut. Of course I may use three or more of such wing-pieces (but this is unnecessary) and the device would work with but one only, but imperfectly. The stock is shown

as provided with screw-threads a^7 at its upper end the same as the stock A; and the upper end may also be provided with transverse slots a^8, which threads and slots are for the purpose of fixing the reamer non-rotatably to the mandrel, but as this feature is not herein claimed nor forms any essential part of my invention, it is not further illustrated. It will be understood of course that the cross-bar J shown in the solid form Fig. 1 may also be used in the tubular form provided the mandrel is suitably slotted to allow it to pass through.

The arrangement of the reamer shown in Figs. 30 and 31 is identical with Figs. 23 to 29, except in size and in having the lower end of the cutter-head b^{11} cut off flat within the projecting lower ends of the blades, and a recess at b^{60} to receive the polygonal head g^{10} of the screw g^{11}, and in having the inner ends of the blades c^{11} extend all the way to the axis; in these respects being identical with the reamer of Figs. 1 to 7. This reamer may be used either with a mandrel cut off short of the blades c^{11} or slotted out to receive them, according to the use which is to be made of the reamer, but I do not claim any special manner of using the reamer as a part of my invention.

From the above description it will be obvious to those skilled in the art that the principles of my improved reamer are of very various application and that the construction may be modified in various ways and some of the elements omitted, without departing from the scope of the invention. I do not therefore consider my invention further limited than is defined within the scope of my claims.

For the sake of definition, I refer to the end of the reamer shown as the lower end in the drawings as the lower or forward end, and the other as the upper or rear end, without intending any limitation as to the position in which the reamer is or may be used.

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

1. A metal-cutting tool comprising, in combination, a body having a central bore, said bore being terminated at the lower end by material which is an integral part of the cutter-head and has a hole of smaller size than the bore in it, a plurality of cutter-blades mounted in said body, a longitudinal moving core-piece slidably mounted in said bore and adapted to expand said blades when moved longitudinally, means for advancing said core-piece, and rotatable clamping-means turning in said hole at the end of said body and acting in opposition to said expanding means.

2. A metal-cutting tool comprising, in combination, a body divided intermediately into two pieces, to wit, a stock and cutter-head, said cutter-head having a bore open at the end united to said stock and terminating short of the other end, said cutter head having further a hole in said last-named end, a plurality of cutter-blades mounted in said cutter-head, a longitudinally moving core in said bore adapted to expand said cutter-blades, means carried by said stock for actuating said core, and means at the lower end of said cutter-blades acting in opposition to said core and actuated through the hole in the end of said cutter-head.

3. In a metal-cutting tool, a cutter-head having a central bore terminating short of the lower or forward end thereof, a plurality of cutter-blades set in said cutter-head and having oblique ends resting upon the portion of said cutter head lying beyond the end of said central bore, and a core-piece slidable longitudinally in said bore and adapted to expand said cutter-blades when moved longitudinally, said core-piece being inserted through the open upper or rear end of said cutter-head.

4. In a metal-cutting tool, a cutter-head having a central bore terminating short of the lower or forward end thereof, a plurality of cutter-blades set in said cutter-head, and a core piece slidable longitudinally in said bore and adapted to expand said cutter-blades when moved longitudinally, said core-piece being inserted through the open upper or rear end of said cutter-head, and said cutter-blades being bounded at their lower ends by oblique outwardly and downwardly extending edges, which rest on corresponding surfaces on the lower end of said cutter-head.

5. A metal-cutting tool of the class described comprising, in combination, a body made in two pieces, to wit, a stock and a cutter-head united together by a joint; each of said members having a bore therein open at the united ends and terminating short of the free end; the free end of the cutter head being closed except for an aperture of smaller diameter than said bore; a plurality of cutter-blades set in said cutter-head, an expanding-core movable longitudinally in the bore of said cutter-head and adapted to expand said blades; a member moving longitudinally in the bore of said stock and adapted to advance said core; and means mounted externally on said stock for actuating said last-named member.

6. In a metal-cutting tool of the class described, a cutter-head having a central bore, a plurality of cutter-blades mounted radially in said cutter-head, the latter having an under-cut abutment for the upper or rear edges of said cutter-blades at its outer surface, and a clamping-device slidably mounted in said bore and adapted to press

endwise against said cutter-blades upon a point at or near their respective inner edges, thus acting in conjunction with said abutment of the cutter-head to draw the lower or forward ends of said cutter-blades inwardly.

7. In a metal-cutting tool of the class described, a cutter-head having a central bore, a plurality of cutter-blades mounted radially in said cutter-head, the latter having an abutment for the upper or rear edges of said cutter-blades at its outer surface, a core-piece slidably mounted in said core above said cutter-blades and acting in conjunction with said abutment-edge on said cutter-head to expand said cutter-blades, and a clamping-device slidably mounted in said bore and adapted to press endwise against said cutter-blades upon a point at or near their respective inner edges, thus acting in conjunction with said abutment on the cutter-head to draw the lower or forward ends of said cutter-blades inwardly.

8. In a metal-cutting tool of the class described, a cutter-head having a central bore, a plurality of cutter-blades set radially in slots in said cutter-head and having parallel obliquely outwardly and downwardly extending end-edges, the outer parts of the upper edges of said slots forming abutments for the upper end edges of said cutter-blades, the lower edges of said slots being parallel to the lower end-edges of said cutter-blades and forming rests therefor, a slidable core-piece mounted in the bore above said cutter-blades, and a clamping-device mounted slidably in said bore and adapted to press upon inwardly projecting parts of said cutter-blades thereby acting to draw the lower ends of said cutter-blades toward the center.

9. In a metal-cutting tool of the class described, a cutter-head having a central bore, a plurality of cutter-blades set radially in slots in said cutter-head and having parallel obliquely outwardly and downwardly extending end-edges, the outer parts of the upper edges of said slots forming abutments for the upper end-edges of said cutter-blades, the lower edges of said slots being parallel to the lower end-edges of said cutter-blades and forming rests therefor, a core-piece slidably mounted in said bore and acting in connection with said abutment-edges of said slots to expand said cutter-blades, and a clamping-device mounted slidably in said bore and adapted to press upon inwardly projecting parts of said cutter-blades thereby acting to draw the lower ends of said cutter-blades toward the center.

10. In a metal-cutting tool of the class described, a cutter-head having a central bore terminating short of the lower end thereof, a plurality of cutter-blades set in said cutter-head, a member for setting said cutter-blade and a clamping-member slidable longitudinally in said bore and adapted when advanced to draw said blades together and clamp them in any position in which they are set.

11. In a metal-cutting tool of the class described, a cutter-head having a central bore terminating short of the lower end thereof and having a second bore of smaller diameter extending from the end of said bore to the lower end, a plurality of cutter-blades set in said cutter-head, a clamping-member slidable longitudinally in said bore and adapted when advanced to clamp and draw said blades together, and means rotating in said second bore and abutting on said shoulder for advancing said clamping-member.

12. In a metal-cutting tool of the class described, a cutter-head having a central bore terminating short of the lower end thereof, a plurality of cutter-blades set radially therein, a clamping-nut slidable in said bore and adapted to engage said cutter-blades and draw them together, and a clamping-screw for operating said clamping-nut engaging the threads thereof and rotating in the end of said bore, said clamping-screw having a head extending through a hole in the lower end of said cutter-head forming means for rotating it.

13. In a metal-cutting tool of the class described, the combination of a cutter-head having a plurality of radial slots closed at both ends, radially movable cutter-blades set in said slots, said cutter-head having a central bore, a clamping-nut slidably mounted in said central bore and adapted to clamp said blades in position, a clamping-screw engaging said nut to move it longitudinally, and a member removably set in the side of said clamping-nut and having a projecting part which extends into one of said slots whereby it is prevented from rotating.

14. A metal-cutting tool of the class described, comprising in combination, a body having a central bore, a plurality of cutter-blades radially set in said body, a longitudinally moving core-piece in said bore adapted to expand said blades, an adjusting-nut turning on threads around the exterior of said body above said blades, one or more laterally projecting elements longitudinally movable in one or more transverse slots in said body acting on the end of said core-piece and engaging with said nut whereby the latter operates the blades, a longitudinal zero-line inscribed on said body below said nut and graduated in accordance with the pitch of the threads of said nut, a plurality of circular graduations into which the lower edge of said nut is divided and adapted to be read upon said zero line, and a lock-nut engaging with a second set of threads on said body above said adjusting-nut and adapted to lock the latter.

15. In a metal-cutting tool of the class described, the combination of a cutter-head having a plurality of radial slots therein, a plurality of cutter-blades mounted in said slots and having oblique downwardly and outwardly extending upper edges, a gage-sleeve having a conical undercut lower edge extending over the ends of said slots and forming an abutment and guide for said cutting-blades in their radial movement, and an immovably fixed abutment for the opposite end of said gage-sleeve.

16. In a metal-cutting tool of the class described, the combination of a stock, a cutter-head united thereto end to end by a joint, a shoulder formed on said stock at the joint, said cutter-head having a plurality of radial slots, a plurality of cutter-blades set in said slots, and having oblique downwardly and outwardly extending upper edges, and a sleeve surrounding the upper part of said cutter-head and abutting at one end upon said shoulder and at the other end overlying the ends of said slots and conically undercut to form a guide and abutment for said blades in their radial movement.

17. A metal-cutting tool comprising, in combination, a stock, a plurality of cutter-blades mounted therein, a core-piece and means carried thereby acting to expand said blades in an obliquely forward longitudinal direction when moved forward longitudinally, a threaded nut engaging threads on the surface of said stock, and means transmitting the endwise movement of said nut to said core-piece.

18. A metal-cutting tool comprising, in combination, a stock, a plurality of cutter-blades mounted therein, a core-piece and means carried thereby acting to expand said blades when moved longitudinally, a threaded nut engaging threads on the surface of said stock, and a transverse member passing through a slot in said stock and abutting on the end of said core-piece, said nut having an annular internal flange-lug which engages the end of said transverse member.

19. A metal-cutting tool comprising, in combination, a stock, a plurality of cutter-blades mounted therein, a core-piece, means carried thereby acting to expand said blades when moved longitudinally, a threaded adjusting-nut engaging threads on the surface of said stock, a transverse member passing through a slot in said stock and abutting on the end of said core-piece, said nut having an annular internal flange-lug which engages the ends of said transverse member, and a lock-nut engaging a second series of threads on said stock and abutting against the end of said adjusting-nut.

20. In a metal-cutting tool, the combination of a stock having threads, a core-piece mounted centrally therein, and means for moving said core-piece longitudinally comprising an adjusting-nut having threads engaging the threads of said stock, a graduated line on the surface of said stock and parallel to the axis thereof, a circularly graduated sleeve having a screw-threaded connection with said adjusting-nut, and means for locking said sleeve fast to said nut.

21. In a metal-cutting tool, the combination of a stock having threads, a core-piece mounted centrally therein, and means for moving said core-piece longitudinally comprising an adjusting-nut having threads engaging the threads of said stock, a graduated line on the surface of said stock and parallel to the axis thereof, a circularly graduated sleeve having a screw-threaded connection with said adjusting-nut adapting it to longitudinal as well as circular setting with respect to said line, and a lock-nut engaging the threads on said sleeve and acting to lock said sleeve fast in position with respect to said adjusting-nut.

22. In a metal-cutting tool, the combination of a body, a plurality of cutter-blades mounted radially thereon and having each one or more oblique edges and also an undercut oblique edge, a core-piece having one or more conical surfaces engaging said oblique edges, means for advancing said core-piece, a clamping-piece having undercut surfaces engaging said undercut edges, and means for advancing said clamping-piece to draw said blades together.

23. In a metal-cutting tool, the combination of a stock, a slotted cutter-head, cutter-blades radially set in the slots of said head and having edges c' cut to a certain definite degree of obliquity and having further oppositely sloping oblique edges c^2 cut to a certain predetermined angle of obliquity, a core-piece having a conical face thereon having the same angle of obliquity as the edges c^2, means for moving said core-piece in an axial direction, and a sleeve fixed to said cutter-head in a definite position and having an edge adjusted to abut against the edge c' and limiting the length of the slots in which the cutter-blades move.

24. In a metal-cutting tool, the combination of a stock, a slotted cutter-head, cutter-blades radially set in the slots of said head and having edges c' cut to a certain definite degree of obliquity and having further oppositely sloping oblique edges c^2 cut to a certain predetermined angle of obliquity, a core-piece having a conical face thereon having the same angle of obliquity as the edges c^2, a sleeve fixed to said cutter-head in a definite position and having an edge adjusted to abut against the edge c' and limiting the length of the slots in which the cutter-blades move, a transverse member passing through a slot in said stock and

abutting against the end of said core-piece, and an adjusting-nut engaging with threads on said stock and having means engaging the ends of said transverse member.

25. In a metal-cutting tool, the combination of a stock, a slotted cutter-head, cutter-blades radially set in the slots of said head and having edges c' cut to a certain definite degree of obliquity and having further oppositely sloping oblique edges c^2 cut to a certain predetermined angle of obliquity, a core-piece having a conical face thereon having the same angle of obliquity as the edges c^2, means for moving said core-piece in an axial direction, and a sleeve fixed to said cutter-head in a definite position and having an edge adjusted to abut against the edge c' and limit the length of the slots in which the cutter-blades move, said cutter-blades having undercut oblique edges c^4, a clamping-nut having an undercut oblique surface e' engaging said edges c^4, and means for advancing said clamping-nut to clamp the blades in adjusted position.

26. In a metal-cutting tool, the combination of a stock, a slotted cutter-head, cutter-blades radially set in the slots of said head and having edges c' cut to a certain definite degree of obliquity and having further oppositely sloping oblique edges c^2 cut to a certain predetermined angle of obliquity, a core-piece having a conical face thereon having the same angle of obliquity as the edges c^2, means for moving said core-piece in an axial direction, a sleeve fixed to said cutter-head in a definite position and having an edge adjusted to abut against the edge c' and limit the length of the slots in which the cutter-blades move, said cutter-blades having undercut oblique edges c^4, a clamping-nut having an undercut oblique surface engaging said edges c^4, and a clamping-screw turning in a socket in the end of said cutter-head and engaging said clamping-nut.

27. A metal-cutting tool comprising, in combination, a stock having two sets of screw-threads on its exterior surface, a slotted cutter-head on the end of said stock, cutter-blades mounted in the slots of said cutter-head and having oblique inner edges c^2 and undercut oblique edges c^4, a core-piece having one or more conical faces acting against the edges c^2, a clamping-nut having an oblique undercut surface engaging the undercut edges c^4, a screw engaging said nut and rotating in the end of said cutter-head and prevented from endwise movement, an adjusting-nut engaging one set of threads on said stock, a lock-nut engaging the other set, and an operative connection between said adjusting-nut and core-piece whereby the latter is moved longitudinally.

28. A metal-cutting tool comprising, in combination, a stock having two sets of screw-threads on its exterior surface, a slotted cutter-head on one end of said stock, cutter-blades mounted in the slots of said cutter-head and having oblique inner edges c^2 and undercut oblique edges c^4, a core-piece having one or more conical faces acting against the edges c^2, a clamping-nut having an oblique undercut surface engaging the undercut edges c^4, a screw engaging said nut and rotating in the end of said cutter-head and prevented from endwise movement, an adjusting-nut engaging one set of threads on said stock, a lock-nut engaging the other set, an operative connection between said adjusting-nut and core-piece whereby the latter is moved longitudinally, a circularly graduated sleeve having an adjustable engagement with said adjusting-nut, and means for locking said sleeve in its adjusted position.

29. In an expansion metal-cutting tool, the combination of a radially slotted cutter-head, a plurality of cutting-blades set radially therein, each cutter-blade having its end-edges oblique downwardly and outwardly and parallel to each other, said cutter-head having surfaces coacting with and guiding said end-edges, the lower ends of said cutting-blades extending beyond the end of said cutter-head whereby to ream a hole square at the bottom, and means for expanding and contracting said cutter-blades in an obliquely longitudinal direction.

30. A metal-cutting tool of the class described comprising a tubular body having a central bore, a plurality of cutter-blades set therein, and a tubular core for expanding said blades the whole tool being tubular permitting the passage completely through it of a central mandrel.

31. A metal-cutting tool of the class described, comprising in combination a tubular body, a plurality of cutter-blades set therein, a tubular core mounted concentrically within said body and adapted to expand said blades, and tubular clamping-means for securing said blades in adjusted position.

32. A metal-cutting tool of the class described comprising, in combination, a tubular body, a plurality of cutter-blades set therein, a tubular core mounted concentrically within said body and adapted to expand said blades, and an adjusting-nut engaging threads on said body and acting on said core.

33. A metal-cutting tool of the class described comprising, in combination, a tubular body, a plurality of cutter-blades set therein, a tubular core mounted concentrically within said body and adapted to expand said blades, an adjusting-nut engaging threads on said body and adapted to actuate said core, and a tubular clamping-nut acting in opposition to said adjusting-nut, the tool as a whole being tubular.

34. A metal-cutting tool of the class described comprising, in combination, a completely tubular body, a plurality of cutter-blades radially set therein, and completely tubular means for adjusting said blades mounted concentrically within said body.

35. A metal-cutting tool of the class described comprising, in combination, a tubular body having a plurality of radial slots, a plurality of cutter-blades set in the respective slots, means within said body for adjusting the position of said blades and means within said body for clamping said blades in adjusted position; the whole tool being tubular to permit the mounting of the same upon a mandrel passing through the center.

36. In a metal-cutting tool of the class described, the combination of a tubular body having radial slots, a plurality of cutter-blades set in said slots, an adjusting-nut surrounding said body and engaging threads thereon, and means within said body adapted to expand said cutter-blades and actuated by said nut through one or more lateral orifices in said body; the tool as a whole being concentrically tubular permitting the mounting of the same upon a mandrel passing through the center.

37. A metal-cutting tool of the class described comprising, in combination, a tubular body having a plurality of radial slots, a plurality of cutter-blades set in said slots, said body having a central bore, a longitudinally movable tubular core-piece mounted in said bore and adapted to act upon said blades to expand them, an adjusting-nut surrounding said body and engaging threads thereon, and one or more laterally projecting elements connected with said core-piece and longitudinally movable therewith in one or more slots in said body, said projecting element or elements engaging with said nut thereby transmitting the longitudinal movement of said nut to said core-piece and said blades; the tool as a whole being tubular permitting the mounting of the same upon a mandrel passing through the center.

38. A metal-cutting tool of the class described, comprising, in combination, a tubular body having a central bore and a plurality of radial slots, a plurality of cutter-blades set in said slots, a longitudinally movable tubular core-piece mounted in said bore and adapted to act upon said blades to expand them, an adjusting-nut surrounding said body and engaging threads thereon, one or more laterally projecting elements connected with said core-piece and longitudinally movable therewith in one or more slots in said body, said projecting element or elements engaging with said nut thereby transmitting the longitudinal movement of said nut to said core-piece and said blades, and a tubular clamping-device mounted in said bore at the lower end of said blades and acting in opposition to said core-piece; the tool as a whole being tubular.

39. A metal-cutting tool of the class described comprising, in combination, a tubular body having a central bore and a plurality of radial slots, a plurality of cutter-blades set in said slots, a longitudinally movable tubular core-piece mounted in said bore and adapted to act upon said blades to expand them, an adjusting-nut surrounding said body and engaging threads thereon, one or more laterally projecting elements connected with said core-piece and longitudinally movable therewith in one or more slots in said body, said projecting element or elements engaging with said nut thereby transmitting the longitudinal movement of said nut to said core-piece and said blades, a longitudinally movable tubular clamping-nut in said bore at the lower end of said blades acting in opposition to said core-piece to clamp said blades, and a tubular clamping-screw in the end of said bore engaging the threads of said clamping-nut and having a head extending through the lower end of said body; the tool as a whole being tubular.

40. In a tool, the combination of a stock having external threads, a core-piece mounted centrally therein, and means for moving said core-piece longitudinally comprising an adjusting nut having a set of internal threads engaging the external threads on the stock and having one end bored out larger than the diameter of said threads and also threaded internally, a circularly graduated sleeve having a set of external threads on one end which extends within the recessed end of said adjusting nut and engages the internal threads thereof, and means for locking said sleeve fast to said nut.

41. In a tool, the combination of a stock having external threads, a core-piece mounted centrally therein, and means for moving said core-piece longitudinally comprising an adjusting nut having a set of internal threads engaging the external threads on the stock and having one end bored out larger than the diameter of said threads and also threaded internally, a circularly graduated sleeve having a set of external threads on one end which extends within the recessed end of said adjusting nut and engages the internal threads thereof, and a lock-nut comprising an internally threaded ring also engaging the threads of said sleeve and adapted to lock the same in position by jamming against the end of the recessed portion of said nut.

42. In a tool, in combination with a stock having external threads, a longitudinally adjustable part thereof and means for longitudinally adjusting said part comprising

an adjusting nut having an operative connection with said part and having a set of internal threads engaging said external threads on the stock, said nut having further one end recessed to a diameter larger than the diameter of said threads and also internally threaded, a longitudinal zero line on the surface of said stock, a sleeve one end of which is circularly graduated and adapted to be read by its position with respect to said line and the other end of which is reduced to extend within the recessed end of said nut and externally threaded to engage the threads of said recessed end, said sleeve being provided midway with a cylindrical periphery substantially equal to that of said nut, and a locknut consisting of a cylindrical annulus having an external periphery substantially equal to that of said nut and abutting against the recessed end thereof and having internal threads engaging that portion of the threads of said sleeve which extend beyond the recessed end of said nut.

In witness whereof, I have hereunto set my hand this 7th day of February, 1908.

HENRY WALTHER.

Witnesses:
E. C. BAYERLEIN,
W. G. TRUETTNER.