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F. GLASSFORD

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GRINDING TOOL

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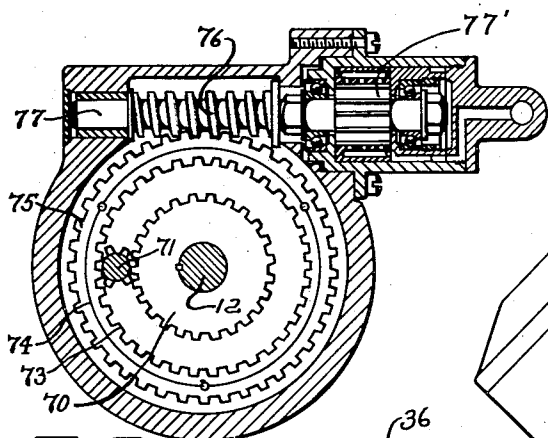


Fig. II.

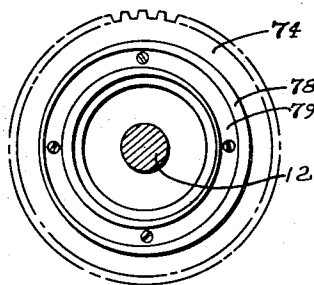


Fig. V.

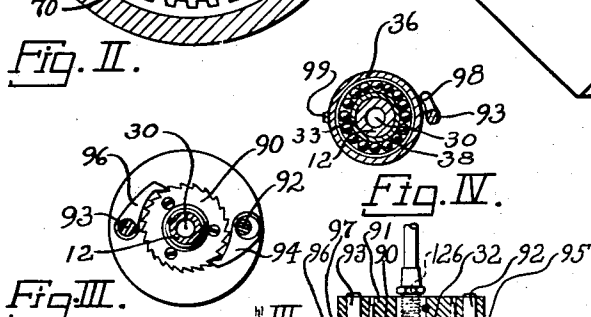


Fig. IV.

Fig. III.

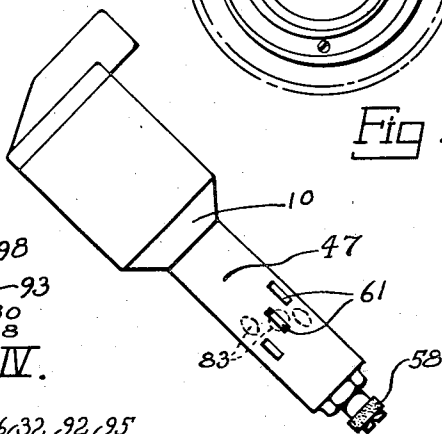


Fig. VI.

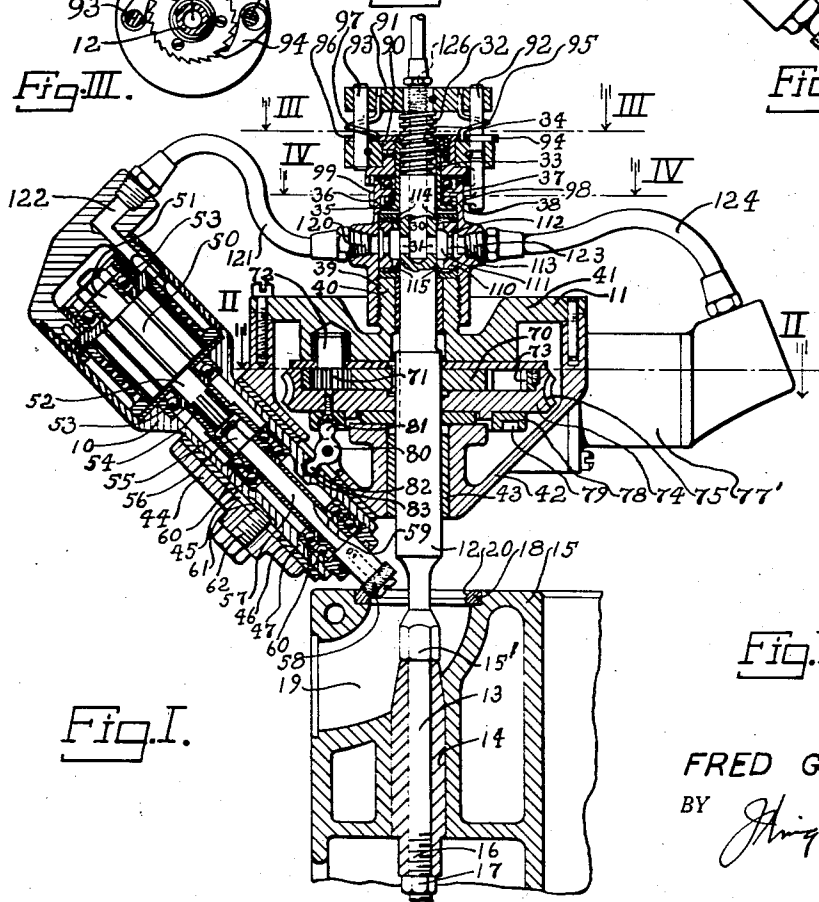


Fig. I.

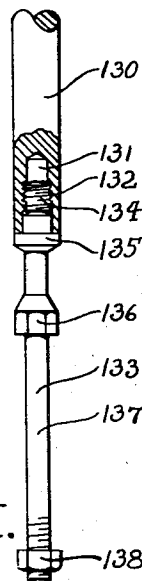


Fig. VII.

INVENTOR.
FRED GLASSFORD.

BY *Harry Harness*
ATTORNEYS.

UNITED STATES PATENT OFFICE

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GRINDING TOOL

Fred Glassford, Royal Oak, Mich., assignor to
Chrysler Corporation, Detroit, Mich., a corpo-
ration of Delaware

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20 Claims. (Cl. 51—241)

My invention relates to rotary grinding tools and it has particular relation to tools adapted to grind valve seats of internal combustion engines.

More specifically, my invention relates to a tool for grinding annular valve seats wherein a high speed grinding element is revolved about the axis of the valve seat to grind the seat.

One object of my invention consists in providing a suitable means for supporting a high speed rotary grinding element and bodily revolving said element, while in engagement with the seat to be ground, about the axis of the valve seat.

Another object of my invention comprises providing a grinding tool of the character indicated in which the grinding element is automatically fed axially of the seat to be ground and is simultaneously reciprocated laterally thereof.

A further object of my invention is to provide a valve grinding tool which will grind a uniformly smooth valve seat at a predetermined angle which is truly concentric with the valve stem guide opening regardless of its original relation and condition and regardless of the degree of wear on the grinding wheel, which is completely automatic, and which is simple and inexpensive to manufacture.

For a better understanding of my invention reference may now be had to the accompanying drawing, of which:

Fig. 1 is a vertical cross-sectional view of a rotary grinding tool constructed in accordance with my invention and is shown mounted in an operative position on an internal combustion engine, a portion of which is illustrated in cross section.

Fig. 2 is a cross-sectional view of the structure illustrated in Fig. 1, the section being taken along the line II—II thereof.

Fig. 3 is a cross-sectional view of the indexing feed mechanism incorporated in the structure illustrated in Fig. 1, the view being taken along the line III—III thereof.

Fig. 4 is a cross-sectional view of another portion of the indexing feed mechanism, the section being taken along the line IV—IV of Fig. 1.

Fig. 5 is a cross-sectional view of a portion of the grinding tool supporting member illustrating a portion of the grinding tool reciprocating means, the view being taken directly below the cam actuator of Fig. 1.

Fig. 6 is a side elevational view illustrating the grinding element housing.

Fig. 7 is a view, partially in section and partially

in elevation, illustrating another form of the vertical standard illustrated in Fig. 1.

Referring to Fig. 1, I have shown a high speed rotary grinding element 10 mounted upon a rotatable support 11 which in turn is mounted upon a vertical stationary hub or standard 12, the lower end 13 of which is adapted to fit into an opening in a valve stem guide 14 in a cylinder block 15 of an internal combustion engine. The lower portion 13 of the stationary standard 12 is provided at its upper end with a shoulder 15' which rests upon the top of the valve stem guide 14 and is provided at its lower end with a threaded portion 16 on which a nut 17 is screwed in threaded engagement to secure the standard 12 in alignment with respect to the valve stem opening and the valve seat to be ground. As illustrated, a valve insert member 18 is rigidly secured in a valve port 19 and is provided with an inclined seat or face 20 which must be accurately ground in order to prevent a leakage between the valve (not shown) and the seat during operation of the internal combustion engine.

The vertical standard 12 is provided at its upper end with a longitudinally extending passageway 30 which communicates with transversely extending passageways 31. A portion of the upper end of the member 12 is externally threaded, as indicated at 32. A sleeve member 33 surrounds the upper portion of the standard 12 and is provided with internal threads 34 in threaded engagement with the threaded portion 32 of the vertical standard 12. The sleeve 33 is provided with an annular flange 35 which supports a second sleeve member 36. The sleeve 36 is provided adjacent its upper end with an inwardly extending annular flange 37 which rests on the flange 35 through the agency of ball bearings 38. The sleeve 36 is provided at its lower end with an internally threaded portion 39 which is secured in threaded engagement with a sleeve 40 projecting upwardly from a housing 41 of the support 11.

Secured to the housing 41 is a second housing 42 which is likewise centrally and rotatably supported on the stationary standard 12 by means of a bearing sleeve 43. The housing member 42 is provided on one side with an outwardly projecting housing 44 within which is a recess 45, the axis of which is disposed at an angle to and intersects the vertical axis of the standard 12 about which the support 11 rotates. Disposed within the recess 45 is a rigidly mounted bearing sleeve 46 which in turn encloses a casing or housing 47 which houses and supports the rotary portions of the grinding element 10.

The grinding element 10 consists of a high speed air driven turbine 50, the construction of which constitutes no portion of the present invention. The rotor of the turbine 50 is provided with a shaft 51 at its upper end and a shaft 52 at its lower end, both of which are rotatably mounted in ball bearings 53. The shaft 52 is splined and has slidably and non-rotatably secured thereto a sleeve 54, the enlarged lower end 55 of which is provided on its inner surface with flattened portions adapted to engage the sides of a nut 56 which is secured in threaded engagement with the end of a shaft 57 on the lower end of which is mounted a grinding element 58. The shaft 57 is surrounded by a plurality of sleeves 59 which are converted into a rigid hollow spacing member when the nut 56 is tightened. The sleeves 59 constitute the inner race of ball bearings 60 disposed at each end of the shaft 57, the outer races of which are rigidly secured in the casing 47. The casing 47 is provided with a plurality of longitudinally extending slots 61, as best shown in Fig. 6, into one of which the end of a movement limiting screw 62 projects. The screw 62 permits movement of the casing 47 within the sleeve 46 corresponding to the length of the slots 61. The casing 47 may be manually adjusted longitudinally of its axis by moving the casing and placing the screw 62 in the desired slot 61, thus varying the distance between the grinding element 58 and the vertical standard 12 for grinding various diameters of valve seats.

In order to rotate the support 11, a gear wheel 70 is rigidly keyed to the stationary standard 12. A relatively small pinion 71 is provided with an integral stud or pin 72 which projects into and is rotatably secured within the upper portion 41 of the housing 11. This pinion 71 in turn meshes with an internally threaded portion 73 rigidly secured to an annular member 74 to provide a planetary gear system. The annular member 74 is provided with an externally threaded portion 75 which constitutes a worm wheel and which meshes with a worm 76, as best shown in Fig. 2. The worm 76 is mounted on a shaft 77 journaled in the housing 42 and adapted to be driven by an air driven turbine 77'.

Secured to the bottom surface of the annular member 74 is a second annular member 78, provided in its lower surface with a cam slot 79. Pivotaly mounted on the lower housing 42 of the support 11 is a bell crank lever 80 having an upwardly extending portion 81 which rides within and is moved by contacting with the sides of the cam slot 79. A downwardly extending arm 82 projects into one of a series of recesses 83 in the grinding element casing. Each of the recesses 83 is arranged diametrically opposite one of the slots 61. As the annular member 74 rotates with respect to the housing member 42 the bell crank lever 81 will impart to the grinding casing element 47 a reciprocatory motion which serves the double purpose of keeping the grinding wheel properly trimmed at all times and also provides a uniformly ground valve seat regardless of any slight imperfections in the grinding wheel.

In order that the valve seat shall be properly and uniformly ground it is necessary that the grinding element, during its revolutions on the support 11, be lowered longitudinally of the vertical support 12. In order to accomplish this result I have provided a ratchet wheel 90 rigidly mounted on the upper end of the sleeve 35. Rigidly mounted on the vertical standard 12 is a cross arm 91 on which are mounted two vertically

extending pins 92 and 93. On the pin 92 is mounted a pawl 94 which is maintained in constant engagement with the ratchet wheel 90 by means of a spring 95 and prevents reverse rotation of the ratchet wheel. On the pin 93 is mounted a pawl 96 and surrounding the pin is a spring 97 which serves to maintain the pawl in engagement with the ratchet wheel. On the lower end of the pin 92 is an arm 98 which is adapted to be engaged by a lug 99 mounted on the upper end of the sleeve 36, as best shown in Fig. 4, which in turn rotates with the support 11. As the support 11 rotates, the lug 99 engages with the arm 98 once during each revolution and causes a rotation of the pawl 94 on the pin 92. As the pawl 94 is mounted off center on the pin 92, as illustrated in Fig. 3, it serves to impart a slight rotary motion to the ratchet wheel 90 which in turn moves the sleeve 35 on the threaded end of the vertical standard 12, thus lowering the support 11 with respect to the standard 12 and thus lowering the grinding element with respect to the valve seat to be ground.

Mounted within the sleeve 36 is an annular member 110 provided with a recess 111 which is disposed in open communication with the transverse openings 31 in the vertical standard 12. The member 110 is also provided with an exterior annular chamber 112 which communicates with the chamber 111 by means of air passages 113. The annular member 110 is adapted to rotate with the sleeve 36 which in turn rotates with the support 11. Leakage of air between the relatively rotatable parts, that is, between the vertical standard 12 and the surrounding rotatable annular member 110, is prevented by means of flexible gaskets 114 secured to the member 110 and adapted to slidably engage the vertical standard 12. These gaskets are provided with inwardly extending flexible lips 115, so arranged that the air pressure within the chamber 111 is exerted thereon, thus causing the sealing action to vary proportionately with the air pressure within the chamber 111.

The sleeve 36 is provided with a threaded opening 120 into which is secured a pipe or air conduit 121, the opposite end of which is connected in threaded engagement with an air inlet duct 122 of the air driven turbine 50. On the opposite side of the sleeve 36 is disposed a threaded opening 123 into which is secured an air conduit 124 which is connected to a similar air inlet opening of the air driven turbine 77'. The upper end of the vertical standard 12 is threaded, as indicated at 126, to receive an air conduit, the opposite end of which will be connected to some suitable source of air pressure or air reservoir.

Having described the structural features of my invention, its operation is as follows: When it is desired to grind a particular valve seat the grinding tool is mounted in the proper position, with respect to the seat, by inserting the lower end 13 of the vertical standard 12 within the opening in the valve stem guide 14 and the nut 17 is tightened, thus rigidly securing the vertical standard 12 in alignment with the valve stem opening. The support 11 is then lowered by rotating the ratchet wheel 90 manually until the grinding wheel 58 is disposed in proximity to the surface to be ground. Air is then admitted to the conduit 30 in the upper end of the vertical standard 12. This air will pass through the conduit 30, through the transverse openings 31 through the chamber 111, opening 113, and chamber 112, into the conduit 121. The air is carried by the conduit 75

121 into the air driven turbine 50 and rotates the same at a high rate of speed.

At the same time air passes from the opening 31 through the chamber 111, passageway 113, and chamber 112, into the air conduit 124, by which it is carried to the air driven turbine 77'.

The turbine 77' rotates the worm 76 which in turn rotates the annular member 74. The annular member 74 drives the internal gear 73, secured thereon, which causes the rotation of the pinion 71. As the gear 70 is stationary the pinion 71 tends to roll about the periphery of the gear 70. The pinion 71, being supported on the housing 42 of the support 11, the supporting member 11 is thereby rotated at a relatively low rate of speed. I prefer that the turbine 77' shall operate at approximately 10,000 revolutions per minute and that the worm 76 drives the gear 75 at approximately 100 revolutions per minute. By a suitable ratio of the number of teeth of the internal gear 73 the stationary gear 70 and the pinion 71, I secure a speed of rotation of the support 11 of approximately 72 revolutions per minute which is within the range of desirable speeds for this member. The rotation of the support 11 causes the grinding wheel 58, being driven at a high rate of speed, to move in an annular path and to grind the uppermost portions of the valve seat. Rotation of the support 11 causes, once during each revolution, a movement of the sleeve 38 on the threaded portion of the vertical standard 12, thus lowering the grinding wheel 58 parallel to the vertical standard 12. I have found that this degree of movement should be on the order of several thousandths of an inch for each revolution of the support 11. This downward movement of the support 11 causes the grinding wheel 58 to grind deeper into the valve seat until the desired seat has been secured.

The reciprocation of the grinding element 58 by means of the bell crank lever 80, previously described, causes the movement of that wheel longitudinally of its shaft. This movement results in maintaining the surface of the wheel 38 trimmed parallel to the axis of the grinding element and prevents the formation of any imperfections or irregularities in the grinding wheel 58 and likewise prevents any corresponding imperfections in the valve seat to be ground. The vertical movement of the support 11 on the vertical standard 12 permits of securing uniform results regardless of the degree of wear or diameter of the grinding wheel 58. As the annular member 74 on which the cam slot containing member 78 is rotated at approximately 100 revolutions per minute and as the support 11 upon which the bell crank lever 80 is mounted rotates at approximately 72 revolutions per minute, it will be apparent that the grinding element will be so reciprocated that various portions of the length of the grinding wheel surface will be presented to a specific portion of the valve face to be ground on successive revolutions of the support 11, thus preventing any fixed movement of reciprocation of the grinding wheel with respect to the rotation of the member of the support 11, thus preventing any irregularity in the seat to be ground which might occur if the grinding element were not of uniform diameter throughout its length and if the same portion of the grinding wheel were always presented to the same portion of the seat to be ground during each revolution of the support 11.

In Fig. 7 is illustrated another form which the vertical stationary standard 12 may assume. In

this form the standard consists of an upper portion 130 provided at its lower end with a centrally disposed recess 131. The walls of this recess are threaded as shown at 132. The upper end of the upper portion 130 is identical with that shown in Fig. 1. A detachable lower portion 133 of the standard is provided with an externally threaded portion 134 which fits into the recess 131 and threadedly engages the portion 132. A shoulder 135 engages the bottom of the portion 130 so that the upper and lower portions 130 and 133 may be secured together to constitute a rigid unitary standard. The lower portion 133 is provided with a shoulder 136 and a longitudinally extending portion 137, the lower end of which is threaded to receive a clamping nut 138, to mount the standard properly on the valve stem guide, as previously described.

The structure shown in Fig. 7 is particularly adapted for use on equipment employed in garages or other establishments in which it is desired to employ the same grinding machine on various sizes of internal combustion engines in which the openings in the valve stem guides are of different diameters. As the lower end of the standard should fit the opening in the valve stem guide rather closely, in order to produce a uniformly ground valve seat, each machine used for this purpose should be provided with several of the detachable lower portions 137 to fit accurately the various sizes of valve stem openings.

It will be apparent from the foregoing description that a structure of the character described would be completely automatic so that it can be secured in position and started and thereafter permitted to operate without attention until the valve seat is properly ground. By constructing the various casings, housings, and the like, of suitable light weight materials, such as aluminum, the total weight of the entire structure may be reduced to a minimum, at present around 10 pounds, and by arranging the various non-concentric elements on opposite sides of the vertical standard 12 the weights thereof may be substantially balanced, thus preventing any tendency for lateral flexing of the vertical standard 12 during operation of this device.

Although I have illustrated but one form of my invention and have described in detail but a single application thereof, it will be apparent to those skilled in the art that my invention is not so limited but that various modifications and changes may be effected therein without departing from the spirit of my invention or from the scope of the appended claims.

What I claim is:

1. A grinding tool comprising a rotatable grinding element, a rotatable support therefor, the axis of said grinding element being inclined with respect to the axis of the support, said axes converging in the general direction of the work acted on by the grinding element, means adapted to automatically and intermittently move said support longitudinally of its axis as it rotates, and means for rotating said element and said support.

2. A grinding tool comprising a rotatable grinding element, a rotatable support therefor, the axis of said grinding element being inclined with respect to the axis of the support, said axes converging in the general direction of the work acted on by the grinding element, means adapted to reciprocate said element longitudinally of its axis during rotation of the element, means adapted to automatically move said support longitudinally of its axis during rotation of the support, means

for rotating the element at substantially uniform speed during said reciprocation thereof, means for rotating the support, and means adapted to rotate said element and said support at different rates of speed.

3. A grinding tool comprising a rotatable grinding element, a rotatable support therefor, stationary means for mounting said support, the axis of said grinding element being inclined with respect to the axis of the support, means actuated in response to movement of said rotatable support for automatically adjusting the position of the grinding element in the direction of the axis of said support, means responsive to movement of said rotatable support for moving the grinding element in the direction of the axis of the grinding element, and means adapted to rotate said element and said support.

4. A grinding device for a valve seat having a valve stem guide associated therewith, said device comprising a vertical stationary member centered in said valve stem guide, a supporting member rotatably mounted thereon, a rotatable grinding element mounted on said support and having its axis disposed at an angle to and intersecting the axis of the support, means responsive to operation of the grinding device for automatically adjusting said support on said stationary member, means for manually adjusting said support on said stationary member, means responsive to operation of the grinding device for adjusting said grinding element laterally with respect to the stationary member, means for manually adjusting said grinding wheel laterally of said stationary member, and means for rotating said element and said support.

5. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through a valve seat thereof, a support rotatably mounted on said stationary member, a housing slidably mounted on said support, a rotatable grinding element mounted in said housing and adapted to grind said valve seat, an annular member rotatably mounted on said support and provided with a cam member, means movably mounted on said support and in operative engagement with said housing and said cam member, and means adapted to rotate said grinding element, said support and said annular member.

6. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through a valve seat thereof, a support rotatably mounted on said stationary member, a housing slidably mounted on said support, a rotatable grinding element mounted in said housing and adapted to grind said valve seat, a cam member mounted on said support and rotatable with respect thereto, gearing interconnecting said cam member and said support and adapted to rotate them at relatively different speeds, a lever pivotally mounted on said support, one portion of said lever being disposed in operative engagement with said cam member and a second portion being operatively connected to said housing to cause reciprocating sliding thereof on said support, and means adapted to rotate said grinding element and said support.

7. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through

a valve seat thereof, said projecting portion having a portion of its length threaded, a normally stationary sleeve mounted on said stationary member in threaded engagement therewith, a supporting member rotatively mounted on said sleeve, a grinding element rotatively mounted on said supporting member and adapted to grind said valve seat, means associated with said supporting member adapted to intermittently operatively engage said sleeve to rotate it on the stationary member, and means adapted to rotate said grinding element and said supporting member.

8. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through a valve seat to be ground, said projecting portion having a portion of its length threaded, a normally stationary sleeve mounted on said stationary member in threaded engagement therewith, a supporting member rotatively mounted on said sleeve, a grinding element rotatively mounted on said supporting member and adapted to grind said valve seat, means adapted to rotate said sleeve on said stationary member comprising a ratchet wheel rigidly secured to said sleeve, a pawl disposed in operative engagement with said ratchet wheel and pivotally mounted on said stationary member, means mounted on said supporting member adapted to operatively engage said pawl to rotate said sleeve on said stationary member, and means adapted to rotate said grinding element and said supporting member.

9. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through a valve seat thereof, a support rotatably mounted on said stationary member, a grinding element rotatably mounted on said support and adapted to grind said valve seat, means for rotating said support comprising a gear wheel rigidly mounted on said stationary member, a pinion adapted to engage said gear wheel and rotatably mounted on said support, an annular member surrounding said gear wheel and provided with an internally threaded surface surrounding said gear wheel and adapted to mesh with said pinion, said annular member being provided with a second portion provided with gear teeth, and means disposed in driving engagement with said second portion and adapted to drive said annular member.

10. A valve seat grinding tool comprising a member adapted to be stationarily mounted in a valve stem guide of an internal combustion engine and to project upwardly therefrom through a valve seat thereof, a support rotatably mounted on said stationary member, a grinding element rotatably mounted on said support and adapted to grind said valve seat, and means for rotating said support comprising a gear wheel rigidly mounted on said stationary member, a pinion adapted to engage said gear wheel and rotatably mounted on said support, an annular member surrounding said gear wheel and provided with an internally threaded surface surrounding said gear wheel and adapted to mesh with said pinion, an externally threaded worm wheel secured to said annular member, a worm gear meshing with said worm wheel, and means mounted on said support operatively connected to said worm gear to rotate the same.

11. A valve seat grinding tool comprising a ro-

tatable support, means for centering said support with respect to a valve seat, a rotatable grinding element mounted on said support and adapted to engage said valve seat, the axis of said grinding element being disposed parallel to the seat at the point of engagement therewith, means for reciprocating said grinding element longitudinally of its axis during operation of the tool, means for rotating said grinding element at substantially uniform speed during said reciprocation, means for rotating said support, and means for automatically moving said support longitudinally of said centering means.

12. A valve seat grinding tool comprising a stationary standard adapted to be mounted centrally of the valve seat to be ground, a support rotatably mounted on said standard, an air driven turbine mounted on said support and adapted to rotate the support at a relative low speed, a grinding element rotatably mounted on said support, and a second air driven turbine mounted on said support and adapted to rotate said grinding element at a relatively high rate of speed.

13. A valve seat grinding tool comprising a stationary standard adapted to be mounted centrally of the valve seat to be ground, a support rotatably mounted on said standard, a grinding element rotatably mounted on said support, an air driven turbine mounted on said support and adapted to drive said grinding element, said standard being provided with a longitudinally extending air passageway at a point remote from said valve seat to be ground and a transversely extending passageway communicating therewith at a point adjacent said turbine, a member mounted on said support and provided with an air chamber in open communication with said transverse passageway, and means comprising an air duct interconnecting said chamber and said turbine.

14. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, and means for imparting rotation to said supporting structure and grinding element.

15. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, means engaging the inner end of the valve stem guide for clamping the hub thereto, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, and means for imparting rotation to said supporting structure and grinding element.

16. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging

generally toward the valve seat, means for imparting rotation to said supporting structure and grinding element, and means including a feed controlling element carried with said supporting structure for automatically advancing said grinding element toward the valve seat.

17. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, means for imparting rotation to said supporting structure and grinding element, and means intermediate said hub and supporting structure for automatically advancing said grinding element toward the valve seat.

18. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, and prime movers respectively driving said rotatable supporting structure and said grinding element, said prime movers being carried by said rotatable supporting structure and being spaced from said hub to provide rotary balance for said supporting structure.

19. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, and prime movers respectively driving said rotatable supporting structure and said grinding element, said prime movers being carried by said rotatable supporting structure and being spaced from said hub to provide rotary balance for said supporting structure, the prime mover driving said supporting structure extending substantially radially of said hub.

20. In a grinding device for valve seats having valve stem guides associated therewith, said device including a stationary hub fixed with respect to said valve stem guide and projecting therefrom through the valve seat associated therewith, a supporting structure rotatably mounted on said hub, a rotatable grinding element mounted on said support, the axes of rotation of said hub and grinding element converging generally toward the valve seat, and prime movers respectively driving said rotatable supporting structure and said grinding element, said prime movers being carried by said rotatable supporting structure and being spaced from said hub to provide rotary balance for said supporting structure, the prime mover driving said supporting structure extending substantially radially of said hub, and the prime mover driving said grinding element extending substantially longitudinally of the axis of rotation of said grinding element.