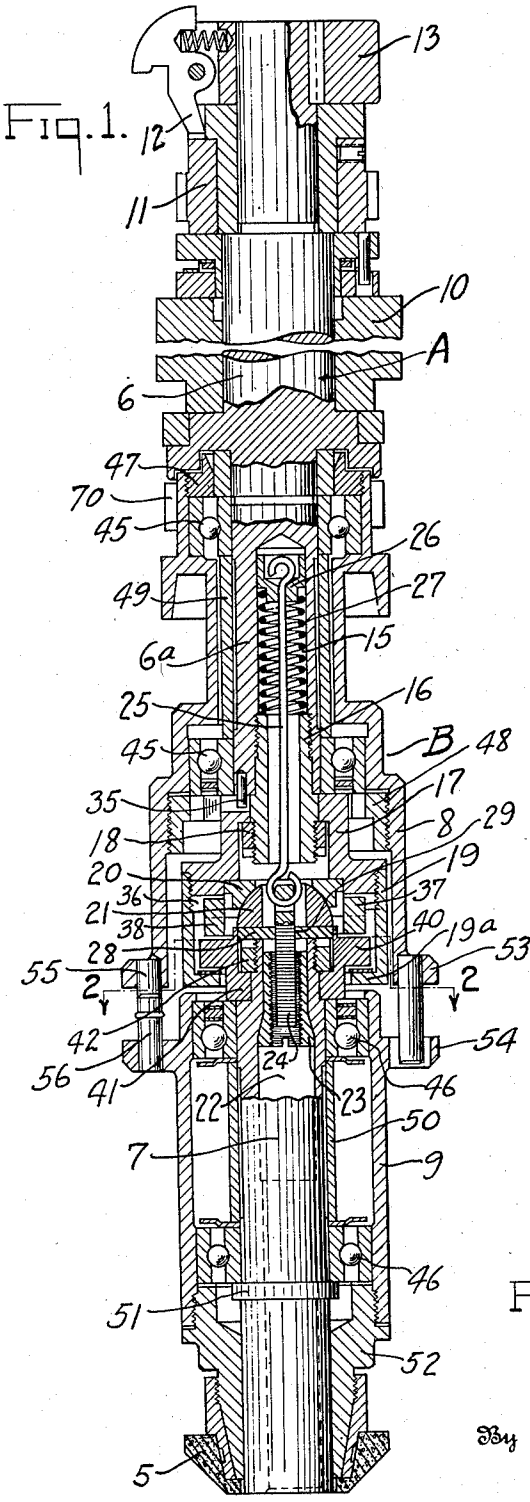
May 10, 1938. E. A. HALL 2,116,498

GRINDING MACHINE

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Fig. 1.



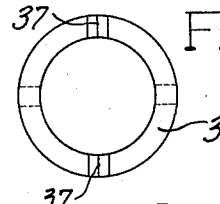


Fig. 4.

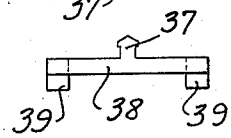


Fig. 5.

Fig. 2.

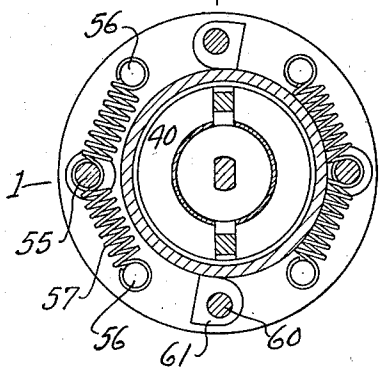
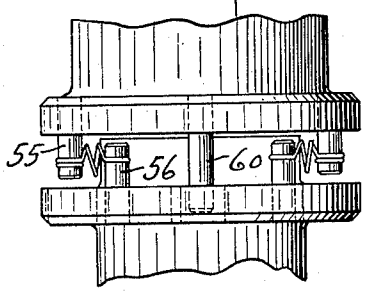


Fig. 3.



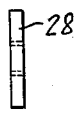


Fig. 6.

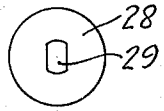


Fig. 7.

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Fig. 8.

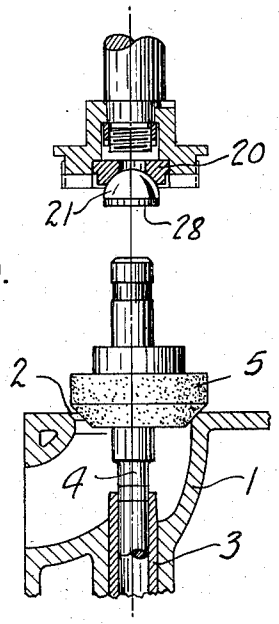


Fig. 9.

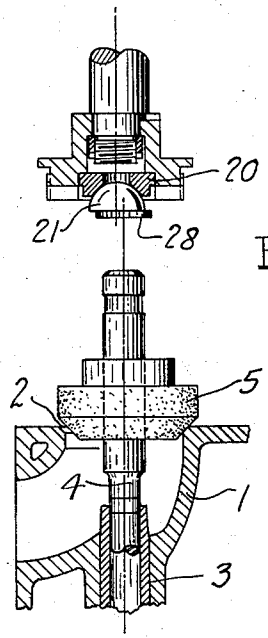


Fig. 10.

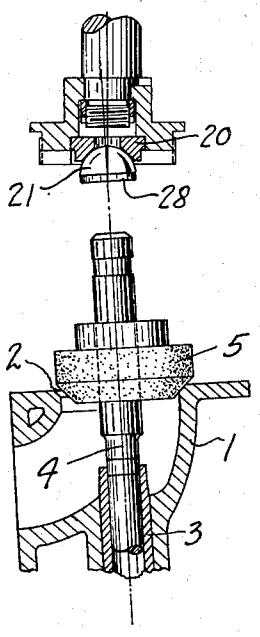
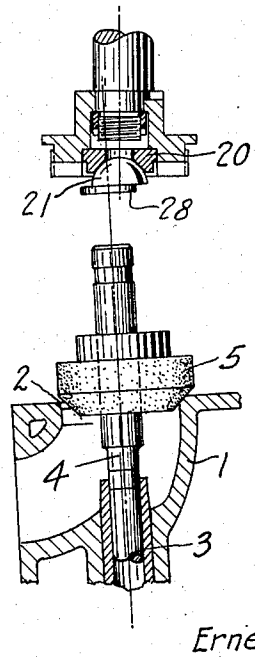


Fig. 11.



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UNITED STATES PATENT OFFICE

2,116,498

GRINDING MACHINE

Ernest A. Hall, Toledo, Ohio, assignor to The Hall Manufacturing Company, Toledo, Ohio, a corporation of Ohio

Application October 14, 1936, Serial No. 105,505

16 Claims. (Cl. 51—241)

This invention relates primarily to valve seat grinders, and particularly to one of the multiple spindle type but is not restricted to such use.

In the use of grinders of this character, the grinding of two or more valve seats of an engine cylinder block is accomplished at the same time with a single down feeding operation of the grinding spindles, the cylinder block being presumably mounted to space the centers of the valve guides, in which pilots are mounted, in true alignment with the centers of the respective grinding spindles. This is only theoretically possible, for in practice the factories cannot prevent some slight variance in the centers either of the grinder spindles or valve guides and pilots in parallel relation or of the spindles and guides in respective axial alignment. In practice, these centers will vary from .003" to as much as .020."

An object of this invention is the provision of a multiple spindle grinder, the grinding spindles of which are adapted to automatically accommodate themselves individually to any reasonable variance of said centers, thus preventing springing, binding and unsatisfactory working of the grinder and imperfect grinding of the valve seats due to such variances. A further object of the invention is the provision of a single grinder spindle having provision to automatically adapt itself to a variance in the true center of the pilot it is intended to engage.

The invention is fully described in the following specification, and one embodiment thereof illustrated in the accompanying drawings, in which—

Figure 1 is a central vertical section of a grinding spindle of the eccentric type embodying the invention, with parts in full and parts broken away; Fig. 2 is cross-section on the line 2—2 in Fig. 1; Fig. 3 is a side elevation of the portion of the spindle adjacent to the point where the section of Fig. 2 is taken; Figs. 4 and 5 are plan and edge views, respectively, of a joint member of the Oldham type used in the spindle; Figs. 6 and 7 are edge and plan elevations, respectively, of the slide plate member used in connection with a joint of the spindle; Figs. 8 and 9 are diagrammatical views illustrating, respectively, the aligned and out-of-aligned parallel relation of the guide pilot and spindle axes, and Figs. 10 and 11 are similar views illustrating the aligned and out-of-aligned angular relation of the guide pilot and grinding spindle axes.

Referring to the drawings (Figs. 8 to 11), 1 designates a section of an engine cylinder block, 2 a valve seat in said block, 3 a valve stem guide, 4 a pilot mounted in said guide and projecting at its upper end through and above the seat, and 5 a grinding wheel in grinding relation to the valve seat.

The grinder means embodying the invention (Figs. 1 to 7) includes a center shaft or body member A, which comprises an upper section 6 and a lower section 7, and also includes a grinding wheel driving spindle B mounted on said shaft and which likewise comprises an upper section 8 and a lower section 9. The shaft and spindle sections are connected together to have respective driving coaction and at the same time to permit the lower sections 7, 9 to have both universal angular or tilting and lateral sliding movements with respect to the upper sections, whereby to permit a grinding means to accommodate itself to an out-of-true variance within limits of a valve seat to be ground and associated guide pilot.

The upper section 6 of the shaft A is journaled in any suitable stationary part 10 of the associated grinding machine, and in the present instance above such part has a spur gear 11 loosely mounted thereon and in driving connection with the shaft through a trip-dog 12 and collar 13 keyed on the shaft. If the grinder is of the eccentric type, as illustrated in the present embodiment of the invention, the shaft section 6 below the bearing part 10 is made eccentric, as shown by the portion 6a. The lower end of the eccentric portion 6a of the shaft is provided with a longitudinally extending bore 15 which has its axis coincident with that of the shaft axis, so that it is offset with respect to the center of the part 6a.

A tubular plug 16 is threaded into the lower end of the bore 15 and carries at its lower end a coupling member 17 of tubular form, the upper end of which is inwardly flanged over a holding nut 18 on said plug, while its lower end is outwardly flanged and threaded to the upper end of a sleeve 19, the lower end of which extends a distance below the member 17 and is provided with an inwardly extending annular flange 19a. A ring 20, forming a concaved spherical joint seat, is fitted into a recess in the lower end of the member 17 and is engaged by the spherical surface of a half round joint member 21, which is disposed within the central portion of the sleeve 19 below the ring seat 20. It is thus apparent that a universal pivotal connection is provided between the two shaft sections.

The lower shaft section 7 has a longitudinally extending opening 22 therethrough which is in

offset relation to the center of such section to the same extent as bore 15 in the upper shaft section. The bore 22 at its lower end is adapted to fit down over the upper extended end of a guide pilot 4 during a grinding operation of a valve seat, and its upper end has a nut 23 rotatably mounted therein and longitudinally threaded to adjustably receive a threaded stem 24. The nut 23 is shouldered in the upper end of the bore to limit its upward movement therein. This stem is flattened on opposite sides for a purpose hereinafter described and extends beyond the upper end of the shaft section 7 and into an opening provided axially through the semi-spherical joint member 21.

A link 25 is engaged at its lower end to the upper end of the stem 24 and extends up through the plug 16 to the upper end portion of the bore 15 in the shaft section 6, being attached at such end to a plunger 26 in said bore. A coiled expansion spring 27 is disposed in the bore 15 between the upper end of the plug 16 and the plunger 26 and tends to exert an upward pressure on the link 25 and stem 24 to hold the lower shaft section 7 up in proper relation to the shaft section 6. The upper end of the shaft section 7 has its thrust against the lower flat side of the joint member 21 through a flat washer-like plate 28 which has a central opening 29 with flattened sides to fit the stem 24 and has its upper side in sliding engagement with the coacting side of the joint member 21. It is thus apparent that while the plate 28 is fixed against lateral movement with respect to the lower shaft section 7, it is permitted to have a limited lateral sliding movement with such section relative to the joint member 21, and that at the same time the shaft section 7 and plate 28 are permitted to have tilting or angular movements with the spherical joint member 21 relative to the shaft section 6. The flat surface of the plate 28 in sliding contact with the bottom flat surface of the joint member 21 is diametric to its center from which its curved surface is struck. The seating pressure of the joint member 21 against the complemental ring seat 20 is determined by the tension of the spring 27 and this is adjustable by an adjusting of the nut member 23 on the stem 24, which may be accomplished by the insertion of a suitable tool for such purpose into the shaft bore 22.

The driving of the shaft section 7 from the section 6 is as follows: A pin 35 projects from the lower end of the shaft section 6 and engages a registering recess in the upper end of the coupling member 17, and the lower end of said member is provided within the sleeve 19 at opposite sides of the ring seat 20 with radial recesses 36 for receiving respective lugs 37 on a joint ring 38 of the Oldham type (Figs. 4 and 5), which ring has lugs 39 projecting from its lower face in 90° spaced relation to the lugs 37 and adapted to engage respective radially disposed recesses 40 in the outwardly flanged upper end portion of a driven coupling member 41, which is clamped to the upper reduced end of the lower shaft section 7 by a nut 42. The member 41 has substantially a clearance of .040 of an inch all around within the sleeve 19, so that such sleeve does not interfere with the permissible adjusting movements of the lower shaft section 7 relative to the upper section 6.

It is apparent with the above construction of shaft and manner of connecting its sections that when the lower section is on a pilot and the shaft is rotated, the sections 6a and 7 will be caused to have a revoluble movement about the pilot axis due to the eccentricity of the opening 22 with respect to the section 7, and also that the shaft section 7 will adjust itself to any out-of-center relationship of the pilot to the axis of the shaft 6 due to the combined spherical and lateral sliding mounting of the shaft section 7 with respect to the section 6. It is also apparent that if the grinding means is of the concentric as distinguished from the eccentric type, the axis of the shaft section 7 will not have a revoluble movement about the pilot axis, but the tilting and lateral sliding adjustments of such section with respect to the upper section will be the same as above described in order to accommodate the shaft to any out-of-variance of the pilot axis therewith without setting up any strain on the parts.

The upper and lower sections 8 and 9 of the spindle B are mounted for rotation on the off-set shaft sections 6a and 7 concentric thereto but off-set with respect to their axes of rotation, upper and lower sets of anti-friction bearings 45 being provided between the shaft section 6a and spindle section 8, while a similar set of upper and lower bearings 46 are provided between the lower shaft section 7 and spindle section 9.

The upper end of the spindle section 8 has a collar 47 threaded therein and shouldered over the outer race member of the bearing 45, while the lower end portion of the section 8, which is enlarged to receive the driving and joint means of the shaft sections 6a and 7 has a collar member 48 threaded therein above said means and shouldering against the outer race member of the lower bearing set 45. A spacer sleeve 49 is provided between the inner race members of the bearing sets 45.

The bearing means 46 within the lower spindle section are spaced by a spacer sleeve 50, the upper bearing set being shouldered, in the present instance, against the drive joint member 41 and an inturned flange at the upper end of the spindle section 9, while the lower bearing means set 46 is shouldered against a flange or rib 41 on the shaft section 7. The lower end of the spindle section 9 projects below the bearing means 46 and is adapted to have the upper extended end of the hub member 52 of the grinding wheel 5 threaded, or otherwise suitably mounted therein. The hub 52 is rotatably mounted on the lower end of the shaft section 7.

The adjacent end portions of the upper and lower spindle sections 8, 9 are formed with outwardly projecting annular flanges or enlargements 53 and 54, respectively, and the flange 53, in the present instance, has two drive pins 55 projecting therefrom towards the flange 54, one at each side of its axis. Rigidly projecting from the flange 54 towards the flange 53 at each side of each pin 55, in spaced relation thereto circumferentially of the flange, is a driven pin 56 (Figs. 2 and 3), and each of the pins 56 is yieldingly connected to the adjacent pin 55 by a respective coiled contractile spring 57. The tension of the springs 57 being substantially the same, the pins 55 are normally held in centered relation with respect to the associated pins 56 and a yielding driving of the spindle section from the spindle section 8 is effected through such pins and springs, as is apparent. This manner of connecting the two spindle sections permits such sections to have the same relative tilting and lateral sliding adjusting movements as the shaft sections 6a and 7.

In addition to the yielding driving connection

between the spindle sections just described, the section 8 has drive pins 60 projecting from its flange 53 at each side of its axis and entering respective sockets 61 in the flange 54, such sockets being larger in cross-section than the pins 60, so that driving action does not take place until the pins have moved a distance sufficient to take up the lost motion space between them and the recessed wall, the pins being normally held in neutral position within the sockets by the action of the springs 57. It is thus apparent that while a positive driving action may take place between the pins 60 and lower spindle section 9, the shock of the initial engagement of the pins with the socket walls is absorbed or lessened to a considerable extent by the springs 57 and the drive is through such springs unless considerable resistance is encountered.

The spindle B is intended to be driven at high speed, for instance 10,500 R. P. M., such speed being communicated to the spindle, in the present instance through a spur gear 70, on its upper end from any suitable drive means (not shown). If the grinding means is of the eccentric type, wherein the grinding wheel axis is offset with respect to the valve seat so that the wheel has grinding engagement with the seat only at one side of its axis, as in the form illustrated in Fig. 1, the spindle carrying shaft A is driven at a relatively slow speed, for instance 32 R. P. M., which causes the point of contact of the grinding wheel with the valve seat to progressively travel around the seat due to the eccentric mounting of the shaft on the pilot, as well understood in the art. For such purpose, suitable means (not shown) is provided for driving the shaft through the medium of the gear 11.

In the use of a grinding means embodying the invention, the machine head carrying such means is lowered to place the grinding wheel 5 in grinding relation to a subjacent valve seat, and to cause the bore 22 of the lower shaft section 7 to engage over the upper end of the pilot 4 projecting up from the valve stem guide of such seat, as shown in Figs. 8 to 11. The pilot fits the bore 22 so that the axes of the lower shaft section 7 and spindle section 9 are caused to stand in true parallel relation to the pilot axis. If the grinding means is of the eccentric type, as illustrated in Fig. 1, the grinding wheel axis is slightly offset with respect to that of the valve seat, so that the wheel has contact with the valve seat only at one side of its axis and such contacting point is caused to slowly traverse the entire seat by reason of the eccentricity of the axis of the shaft section 7 with respect to that of the pilot and the slow rotational movement which is imparted to the shaft relative to the spindle. If the pilot axis is on dead center with the axis of the upper spindle section 8, as shown in Fig. 8, it is apparent that there will be no relative adjusting movement between either the upper and lower sections of the spindle B or the upper and lower sections of the shaft A and in such case the grinding means operates the same as though the spindle and its carrying shaft each comprised a single member. In the event the axis is parallel with the axis of the upper spindle section 8, but is offset laterally therefrom, as shown in Fig. 9, the grinding means will accommodate itself to such offset center position of the parts and will be permitted to function properly without any binding action due to the permissible lateral sliding of the lower spindle section 9 and its shaft section 7 relative to the respective upper sections.

In Fig. 10, the axis of the pilot is shown as angularly disposed with respect to that of the upper spindle section with the two axes intersecting at the center of curvature of the ball joint member 21. In Fig. 11, the pilot is shown with its axis in the same angular relation to the axis of the upper spindle section as in Fig. 10, except that one is laterally offset from the other a slight distance so that they intersect at a point below the curvature center of the ball joint member 21. In this latter case, there is a compound variance in the relationship of the axes of the pilot and upper spindle section which it is necessary to overcome in order to effect a true grinding action and to eliminate binding strain on the parts, such compound variance including not only the angular but also the lateral offset relation to the axes of the pilot and upper spindle section. Therefore, in this latter case, the spindle and shaft parts must not only be connected by a universal pivotal joint but also by a lateral sliding joint so that the wheel spindle may be driven without setting up sufficient side friction to cause the pilots to bend or to hold the grinding wheel spindle over too much to one side which would cause an untrue grinding condition and set up vibration, especially when it is understood that the tolerances in valve seat grinding, in order to meet present-day requirements, are in tenths of thousandths of an inch.

With the present invention, the driving means for the lower spindle section is of yielding nature which allows perfect freedom of action without unnecessary side pressure being applied. For instance, if the pilot in the valve stem guide is off center .020" to the left the drive pin 55 at point *a* (Fig. 2) moves outwardly .020", while the opposite pin 55 at point *b* moves inwardly .020". Then, as the spindle travels around one-half a circle, the pin 55 which carries the spring center gradually moves toward the center until it gets around to the position *b*, thus causing it to move laterally a total of .040", which is also true of the other drive pin. Therefore, it can be seen that the springs 57 are traveling at their respective center points 55 a total of .040" inwardly and outwardly 10,500 times per minute, and do this without setting up vibration or undue strain on the pilot or spindle bearings.

In the case of the eccentric shaft, the Oldham joint made up of the members 17, 38, and 41, interposed between the shaft sections 6a and 7, drives one of such sections from the other and at the same time without interfering with the free compound adjusting movements of the lower shaft section with respect to the upper. It is apparent that the lateral sliding of the plate 28 on the diametrical face of the ball joint member 21 permits the lower shaft and spindle sections to move sideways and run in that position without the slightest rise or fall, whereas if a standard universal joint which fulcrums around a definite center were used, it would be necessary that the pilot bend to accommodate a condition which effects a lateral offset adjustment of the lower spindle and shaft section with respect to the other, as shown by Figs. 9 and 11, and there would also be present a rise and fall of the wheel as it travels eccentrically around the valve seat, thus causing an untrue grinding of the seat.

The spring 27 carries the entire weight of the lower spindle and shaft sections, together with the additional frictional pressure required be-

tween the slide plate 28 and the flat of the ball joint member 21 for successful operation. If the tension of the spring is too great it will cause stiffness in action of the grinding means and effect a slightly out-of-true grinding of the valve seat. This may be corrected by easing up on the spring adjustment.

It will, of course, be understood that if the valve seat grinding means is of the concentric type, the construction is the same, except that the portion of the shaft on which the spindle is mounted is not eccentric to the shaft body, thus making the bore of the shaft in which the pilot is received centrally disposed with respect to the lower shaft section which engages the pilot. It will also be understood that with the concentric type of valve grinding means, there is no necessity of driving the shaft so that the driving means therefor and the driving connection between the shaft sections may be eliminated.

It will also be understood that while a valve seat grinding means embodying the invention is capable of use in a single spindle machine where only one valve seat at a time is ground, it is particularly intended for use in a multiple spindle machine wherein the separate grinding means acts simultaneously on a plurality of valve seats and wherein, in practice, the condition is encountered of variance in centers between one or more grinding spindles of the machine and of the valve seats operated on. It will also be understood that while the invention has been particularly described in connection with a valve seat grinder, it is apparent that it may be used in connection with any tool drive, wherein the relative movements of the tool axis and a stationary part of the drive spindle axis herein described are desirable to suit the work to be performed.

I wish it understood that my invention is not limited to any specific construction, arrangement or form of the parts, as it is capable of numerous modifications and changes without departing from the spirit of the claims.

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

1. In a grinding machine, a spindle having an inner drive section and an outer driven section in end to end relation, adjustable tension means yieldingly connecting said sections to retain them in predetermined end to end relation and including a pivotal joint permitting relative angular universal movements of the sections, a sliding joint at the outer side of said first joint to permit transverse shifting movements of the outer section relative to said joint, and means connecting said sections to drive one from the other and permitting said relative angular and transverse movements of the sections.

2. In a grinding machine, a body shaft having inner and outer end to end sections, connection between said sections permitting predetermined relative transverse movements thereof, a spindle having a drive section rotatably mounted on said inner shaft section and an outer grinding medium carrying section mounted on said outer shaft section, and means connecting said spindle sections to drive one from the other without interfering with the relative movement of the shaft sections on which the spindle sections are mounted, and separate drive means for said inner body shaft section and said spindle drive section.

3. In a grinding machine, a body shaft having inner and outer longitudinally aligned sections, means connecting said sections and permitting relative angular universal movements thereof, a spindle having inner and outer drive and driven sections rotatably mounted respectively on the inner and outer shaft sections, and a driving connection between said spindle sections permitting angular movements of the outer spindle and shaft sections relative to said inner sections.

4. In a grinding machine, a body shaft having inner and outer longitudinally aligned sections, the outer section having a pilot receiving socket in its end, means connecting said sections in end to end relation and including a universal pivotal joint permitting relative angular universal movements of the sections, a spindle having an inner drive section and an outer driven section rotatably mounted respectively on said inner and outer shaft sections for relative angular movements with the shaft sections, and driving connection between the spindle sections permitting said relative angular movements.

5. In a grinding machine, a body shaft having inner and outer longitudinally aligned sections with the outer section socketed to receive a guide pilot, means connecting said sections in end to end relation, means suspending the outer section from the inner section, and means forming a pivotal connection between said sections to permit relative angular universal movements thereof, a spindle having an inner drive section and an outer driven section rotatably mounted respectively on said inner and outer shaft sections for relative angular movements therewith, and yielding driving connection between said spindle sections permitting said relative movements.

6. In a grinding machine, a body shaft having inner and outer longitudinally aligned sections, the outer section having a pilot receiving socket in its outer end, a pivotal joint between the adjacent ends of said sections permitting relative angular universal movements thereof, sliding joint means permitting transverse sliding adjustment of the outer section relative to said first joint with the sliding plane of said second joint intersecting the curvature axis of said first joint, means suspending said outer section from the inner section and retaining the abutting faces of said joints in assembled relation, a spindle having an inner drive section and an outer driven section rotatably mounted respectively on said inner and outer shaft sections for relative movements therewith, and means driving one spindle section from the other without affecting the relative movements of the shaft sections and of the spindle sections therewith.

7. In a grinding machine, a slow speed rotatable body shaft having an eccentric portion divided into separate inner and outer longitudinally aligned sections, the outer section having a pilot receiving socket in its outer end with its axis coincident with the shaft axis when the sections are axially aligned, means retaining the sections in end to end relationship and permitting relative angular universal movements thereof, means driving one shaft section from the other and permitting relative angular movements of the sections, a high speed spindle including an inner drive section and an outer driven section rotatably mounted respectively on said inner and outer eccentric shaft sections for relative angular movements therewith, the outer spindle section carrying a valve seat facing member, and means for driving said sections one from the other without

interfering with the relative angular movements thereof.

8. In a machine of the class described, a slow speed rotatable body shaft having an outer eccentric end portion divided into inner and outer longitudinally aligned sections, said outer section having a pilot receiving socket in its outer end with its axis aligned with the axis of the shaft when the shaft sections are centrally aligned, means connecting the shaft sections for predetermined relative compound movements, means retaining the sections in assembled relation and permitting said relative movements, means for driving one shaft section from the other without interfering with said relative movements, a high speed spindle having an inner drive section and an outer driven section rotatably mounted respectively on said inner and outer shaft sections for relative movements therewith, said outer section being adapted to carry a valve seat facing tool, and means for driving said spindle sections one from the other without interfering with the relative adjusting movements of the shaft section.

9. In a machine of the class described, a slow speed rotatable body shaft having an eccentric portion with separate inner and outer longitudinally aligned sections, means yieldingly retaining the sections in assembled relation and providing both a pivotal joint and a transverse sliding joint therefor to permit relative angular universal movements of the sections as well as predetermined lateral shifting movements thereof in any direction in a plane transverse to the axis of the outer section, means connecting said sections to drive one from the other in any position of relative adjustment, a high speed spindle having an inner drive section and an outer tool carrying driven section rotatably mounted respectively on said inner and outer shaft sections for relative adjusting movements therewith, and a driving connection between said spindle sections permitting relative movements of the spindle sections with the shaft sections.

10. In a machine of the class described, a slow speed rotatable body shaft having an eccentric portion with separate inner and outer longitudinally aligned sections, means yieldingly retaining the sections in assembled relation and providing both a pivotal joint and a transverse sliding joint therefor to permit relative angular universal movements of the sections as well as predetermined lateral shifting movements thereof in any direction in a plane transverse to the axis of the outer section, means connecting said sections to drive one from the other in any position of relative adjustment, a high speed spindle having an inner drive section and an outer tool carrying driven section rotatably mounted respectively on said inner and outer shaft sections for relative adjusting movements therewith, and a yielding driving connection between said spindle sections permitting relative movements of the spindle sections with the shaft sections.

11. In a machine of the class described, a spindle having an inner driving section and an outer driven grinding medium carrying section in end to end relation, a thrust connection between the adjacent ends of said sections including a pivotal universal joint and a universal transverse sliding joint, the sliding plane of said latter joint being crosswise of the axis of said inner section and diametrical of said pivotal joint, means retaining said sections and the members of said joints in assembled relation and permitting said relative movements of the sections, and means for driving one section from the other without interfering with the said relative movements thereof.

12. In a machine of the class described, a spindle having an inner driving section and an outer driven grinding medium carrying section in end to end relation, a connection between said sections, including a ball and socket joint and a transverse sliding joint intersecting the pivotal center of said first joint, means for retaining assembled connection of said sections and joint members without preventing said relative movements, and means for driving one section from the other without interfering with said relative movements.

13. In a grinding machine, a spindle having an inner drive section and an outer driven grinding wheel carrying section in end to end relation, said outer section having a socket in its outer end for receiving a stationary guide member, a connection between the adjacent ends of said sections retaining them in assembled relation and including a universal pivotal and a universal transverse shifting joint enabling one section to be driven by the other irrespective of an out-of-line relationship of the axes of the inner and outer sections within predetermined limits, and means for driving one section from the other without interfering with the action of said connecting means.

14. In a grinding machine, a spindle having an inner driving section and an outer driven grinding wheel carrying section in end to end relation, said outer section having an outer end socket for receiving a stationary guide member, an end thrust double joint connection between said sections permitting universal pivotal and universal transverse shifting of one section relative to the other, and means for yieldingly driving one section from the other without interfering with said relative movements of the sections.

15. In a grinding machine, a shaft having an inner drive section with an eccentric outer end portion and a driven section normally aligned with said eccentric portion, means connecting said sections in end to end relation and including a universal pivotal and a universal transverse sliding joint, said outer section having a pilot receiving socket in its outer end eccentric to such section, a grinding wheel carried by said outer section, and driving connection between said sections permitting relative universal and pivotal movements of the sections.

16. In a grinding machine, a shaft having a drive section with an off-set end portion and a driven section in end to end relation with said off-set portion, said outer section having a pilot receiving socket in its outer end eccentric to such section, a connection between said sections including a universal pivotal and a universal transverse shifting joint, a driving connection between said sections permitting said universal movements, a sleeve mounted on said outer section for movements therewith and carrying a grinding medium, and means for driving said sleeve at a speed different from that of the outer shaft section without interfering with said relative universal movements of the sections.

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