April 6, 1937. F. D. VAN NORMAN 2,076,508

OSCILLATING GRINDER

Filed April 9, 1936

Fig. 1.

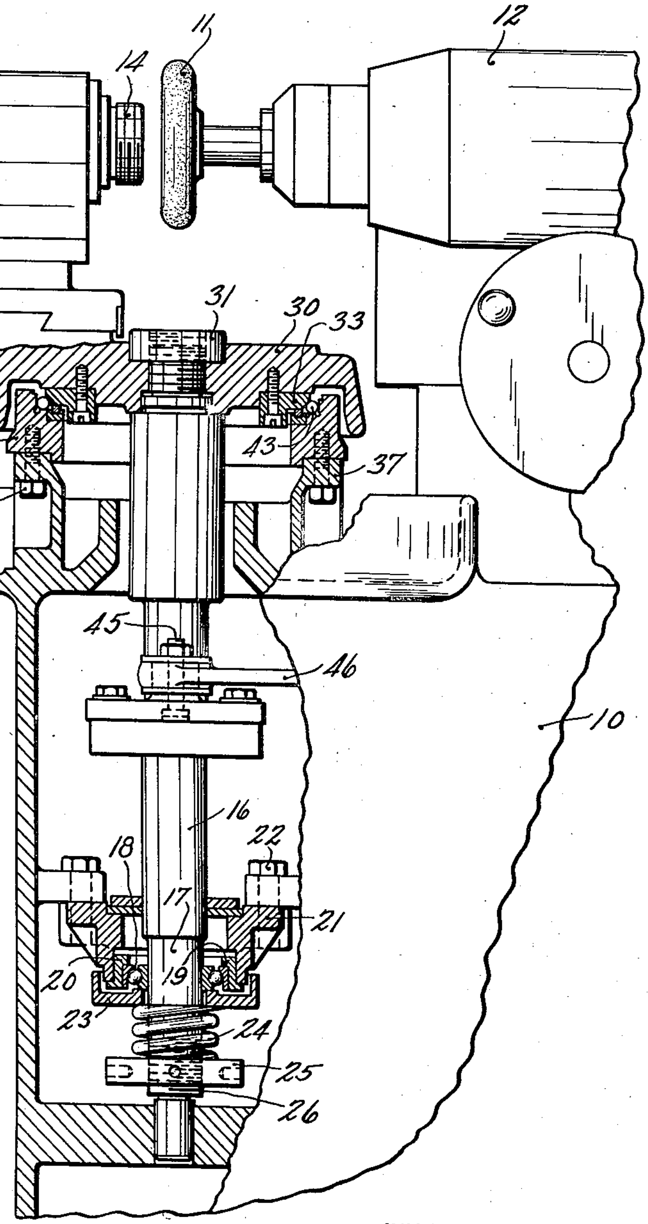
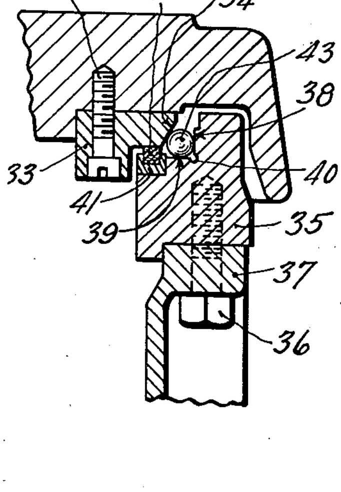


Fig. 2.



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OSCILLATING GRINDER

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7 Claims. (Cl. 51—97)

This invention relates to an improvement in the mounting for the oscillating spindle of oscillating grinders of the precision type. In previously proposed grinding machines of this type it has been proposed to support the upper end of the oscillating shaft by a radial or radial-thrust ball bearing of the usual type, generally combined with a conical plain bearing, and to support the bottom of the shaft in a similar bearing. Such an arrangement has proved satisfactory for the grinding of ball races of ordinary types, but will not permit the grinding of races for roller bearings of the spheroidal type having relatively wide roller grooves possessing a large radius of lateral curvature. When such races were ground on prior machines the load on the wide-faced wheel used to grind them was so great as to cause lateral displacement of the oscillating spindle and chattering of the work against the grinding wheel. Even to get a moderately smooth finish on the race the feed of the work had to be reduced to such a low point as to make the operation wholly impracticable. As a commercial matter races of this type could not be ground at a cost which would make them available for general use.

By my improvement the oscillating spindle is given such rigidity as to remove chatter marks entirely from the races. The accuracy of the grinding operation has also been greatly improved and the speed of grinding has been increased more than one hundred percent. This has been done by simple means which in addition to the results stated above have actually reduced the cost of the oscillating shaft mounting.

The manner in which these advantages are attained will now be described with reference to the accompanying drawing, in which:

Fig. 1 is a detail section through the oscillating shaft of an oscillating grinder; and

Fig. 2 is a detail section on a larger scale of a portion of the upper shaft mounting shown in Fig. 1.

The frame of the machine is shown at **10**, this having been broken away to show only those parts concerned with the present invention. As is customary, a grinding wheel **11** is carried by a tool head **12** which may be of any usual type including means for causing lateral feeding movement of the wheel against the work. The work is carried by a suitable chuck (not shown) mounted for rotation on a spindle **14** rotatably mounted in a work carrying head **15**. The latter head is fixed to the upper end of an oscillating shaft or spindle **16** preferably made of rigid construction as is usual in devices of this character.

At its lower end this spindle has an accurately ground portion **17** slidably fitting into the inner race of a ball bearing **18** of standard radial-thrust type. The outer race of this bearing abuts a shoulder **19** of an annular member **20** carried by an annular bracket **21** held to the frame as by bolts **22**. The inner race of the bearing **18** rests against a collar **23** which is free upon the shaft. A compression spring **24** bears against this collar and against an adjusting collar or nut **25** screwed onto the threaded lower end **26** of the shaft. By turning the nut **25** the shaft can thus be drawn downwardly with any desired degree of tension for a purpose which will be described below.

At its upper end the shaft is reduced and threaded to receive a cap or head **30** held in place as by a nut **31** and supporting the work-carrying head **15**. To this cap is secured, as by screws **32**, the inner race **33** of a ball bearing of unusual and important design. The construction of this bearing is shown in detail in Fig. 2. The body of the inner race is made relatively heavy so as to give as much rigidity as possible, and the bearing surface **34** is formed at an angle of 45°. The outer race **35** is likewise made of heavy and rigid construction, and is held as by screws **36** to a portion **37** of the frame surrounding the shaft. This outer race is formed with two substantially flat ball contacting surfaces **38** and **39** at right angles to each other and at 45° to the bearing surface **34** of the inner race. A groove **40** is formed between the surfaces **38** and **39** to permit them to be accurately ground. The member **35** is preferably shouldered to receive a ring **41** extending somewhat above the level of the surface **39** so as to retain the balls in place during assembling, and grooved to carry a grease retaining felt **42**. A series of balls **43** is placed between the two ball races, preferably without any separator, the balls being as close together as is practicable without binding. A proper spacing of the balls will be secured by filling the outer ball race completely and then removing one ball.

The shaft **16** is oscillated in any convenient way, an adjustable crank pin **45** being shown conventionally for purposes of illustration. This pin is coupled by a connecting rod **46** to any suitable crank or other oscillating means.

It will be observed that the inner ball race is drawn downwardly by the spring **24** so that the balls 43 are at all times held tightly in place against any tendency of the head 30 to tip under the load exerted upon it by the unbalanced weight of the work head 15, the downward pull of its driving belt, the pull of the connecting rod 46, or the grinding pressure of the wheel on the work. This secures a pre-loading of the ball bearing so great that any tendency towards distortion or displacement of the oscillating shaft by any of these factors is unimportant by comparison. While pre-loaded ball bearings have been previously known, the extent to which the pre-loading is carried in this case produces effects not hitherto attained. I prefer to use a load on the compression spring 24 of an order of magnitude of more than two thousand pounds. If desired, the spring 24 may be omitted and its place taken by a rigid collar which can be tightened up to any desired degree. The rigidity of the bearing construction and the small load per ball make such a construction possible, the tension of the shaft taking the place of the spring.

The form given to the races of the upper ball bearing is of particular importance. In the usual type of ball bearing the bearing surfaces have a substantial transverse curvature which inevitably permits a shifting of the races relatively to each other when an unbalanced load is applied. Such an unbalanced load occurs during the grinding operation, giving a tendency of the head to shift laterally from its precise operating location. In prior constructions the occurrence of such a load has caused a shift in the positions of the races of the upper ball bearing and has led to a chattering of the tool which is directly reflected in the accuracy of the ground surface of the work. With the present construction tilting of the head, even to the microscopic degree which caused the trouble in prior devices, cannot occur. The bearing surfaces of the ball races are all substantially straight, and even when an unbalanced load is brought to bear on the head there is no tendency for the two races to become displaced. This stability is increased by the provision of entirely separate surfaces in one of the races to take the radial and the thrust loads. An unbalanced load in the present case merely causes an increase in the pressure on the balls at one side which is inconsiderable in comparison with the pre-loading of the bearing, and no deflection takes place.

Attention should also be directed to the large size of the ball races and the relatively small size of the balls. In the preferred case the balls are approximately 3/8″ in diameter, and the ball races are about eight or nine inches in diameter, containing about seventy to ninety balls. Several results are secured by relative proportions of this general order of magnitude. The larger the diameter of the bearing, other things being equal, the greater will be the rigidity of the construction and the greater will be the freedom from chatter. In ball bearings of the usual type, however, a larger size of bearing necessitates larger balls, and the tendency towards deflection due to the curvature of the ball race is not reduced in the manner described above. Furthermore, large balls will not roll as much for a given rotation of the oscillating shaft as the small balls which are possible in the present construction, and for that reason tend to give uneven wear. Still further, the large number of balls in conjunction with the large size of the races effects a smoother oscillatory motion, and also permits the load on each ball to be kept so far below the ordinary working load of balls of this size that no measurable deformation can take place.

A substantial advantage in rigidity is also given by the mounting of the upper ball bearing directly on the head 30 rather than on the oscillating spindle. The head is held tightly in place by the pre-loading force exerted by the spring 24 and any tendency to lateral flexure which may be given to the spindle 16 by the connecting rod 46 is confined to the spindle and is not transmitted to the head. Such tendency to flexure is also reduced by the pre-loading tension imposed on the spindle. It is desirable to have the diameter of the ball circle sufficiently large so that it is spaced well out from the axis of the spindle. Since the bearing is entirely dissociated from the spindle it is feasible to make the ball circle as large as may be desired. I have found that a ball circle roughly three times the diameter of the shaft gives excellent results in insuring complete rigidity.

In actual use machines constructed in accordance with the present invention have proved to have a productive rate more than twice that of machines constructed along conventional lines, besides giving a higher degree of accuracy to the work. It has also been possible to grind work of sizes and characters which could not be economically produced previously.

What I claim is:

1. An oscillating grinder comprising an oscillating and a non-oscillating head, a bearing for the oscillating head comprising a lower race having two flat bearing surfaces substantially at right angles to each other, a frame for supporting the lower race in fixed position, an upper race fixed to the oscillating head and having a flat bearing surface at an angle of substantially 45° to each of the bearing surfaces of the lower race, a substantially complete series of balls between the two races, a spindle fixed to the oscillating head, means for oscillating the spindle, a radial and thrust bearing in the frame for supporting the spindle below the oscillating means, and means operating between the spindle and the frame through the later bearing for exerting a pre-loading force on the spindle and the head supporting bearing of a substantially greater order of magnitude than that of any other forces exerted on the head during the grinding operation.

2. An oscillating grinder comprising an oscillating and a non-oscillating head, a bearing for the oscillating head comprising a lower race having two flat bearing surfaces substantially at right angles to each other, a frame for supporting the lower race in fixed position, an upper race fixed to the oscillating head and having a flat bearing surface at an angle to each of the bearing surfaces of the lower race, a substantially complete series of balls between the two races, a spindle fixed to the oscillating head, means for oscillating the spindle, a bearing in the frame for supporting the spindle below the oscillating means, and means operating between the spindle and the frame for exerting a pre-loading force on the spindle and the head supporting bearing of a substantially greater order of magnitude than that of any other forces exerted on the head during the grinding operation.

3. An oscillating grinder comprising an oscillating and a non-oscillating head, a bearing for the oscillating head comprising a lower race having two flat bearing surfaces substantially at right angles to each other, a frame for supporting

the lower race in fixed position, a spindle fixed to the oscillating head and passing centrally through the lower race, an upper race fixed directly to the oscillating head and having a flat bearing surface at an angle to each of the bearing surfaces of the lower race, a substantially complete series of balls between the two races, the balls being of sufficiently small size so that each ball makes a plurality of revolutions during the oscillation of the head and being sufficient in number so that the load on each ball will be substantially below the normal load for balls of that size, means for oscillating the spindle, a bearing in the frame for supporting the spindle below the oscillating means, and means operating between the spindle and the frame for exerting a pre-loading force on the spindle and the head supporting bearing of a substantially greater order of magnitude than that of any other force exerted on the head during the grinding operation.

4. An oscillating grinder comprising an oscillating head, a vertical shaft fixed to said head and depending therefrom, a bearing for the oscillating head comprising a lower race having two ball contacting surfaces respectively substantially parallel with and at an angle to the axis of the shaft, a frame for supporting the lower race in fixed position, an upper race fixed to the oscillating head and being outwardly remote from said shaft and having a ball contacting surface the contact line of which is substantially equidistant from the ball contacts in the lower race, a series of balls between the two races, a bearing in the frame for supporting the lower end of the shaft, means for oscillating the shaft, and means associated with said lower bearing and engaging the shaft for exerting a pre-loading downward pull on the oscillating head of a substantially greater magnitude than that of all other forces exerted on the shaft and head during the grinding operation.

5. An oscillating grinder comprising an oscillatable head, a vertical shaft fixed to said head and depending therefrom, a frame, a ball bearing race having two ball contacting surfaces, a second race having a ball contacting surface the contact line of which is substantially equidistant from the ball contacts in the first race, one of said races being secured to the head and the other to the frame, a set of balls between the races, a radial and thrust bearing in the frame to support the lower end of the shaft, means for oscillating the shaft, and compression means engaging the thrust bearing and including a nut threaded to the shaft to exert a downward pull on the oscillating head of a substantially greater magnitude than all other combined forces exerted on the shaft and head during the grinding operation.

6. An oscillating grinder comprising a frame, an oscillating head and a non-oscillating head separately supported on the frame, a bearing for the oscillating head comprising a lower race having two ball contacting surfaces and being supported in fixed position in said frame, said oscillating head including a downwardly extended portion or member, an upper race fixed directly to the oscillating head and having a ball contacting surface positioned angularly with respect to the two ball contacting surfaces in the lower race, a series of balls between the races, the balls being of sufficiently small size so that each ball makes a plurality of revolutions within the arc of oscillatory movement of the head, a bearing secured in the frame to axially guide said downwardly extended portion, pressure means connecting said bearing and extended portion to exert a heavy downward pull of the oscillating head against said lower race, to thereby positively limit both longitudinal and lateral movement of the balls within the utmost degree of precision, and means for oscillating the first named head.

7. An oscillating grinder comprising a frame, an oscillatable work support, said support including a downwardly extending portion or member of relatively reduced diameter, a ball bearing race fixed to the frame, a second ball bearing race fixed to the work support and being outwardly remote from said downwardly extending portion, a series of balls between the races and of sufficiently small diameter so that each ball rolls a plurality of revolutions in each direction within an arc of oscillatory movement of the work support on the order of 30 degrees, means for oscillating the work support, means supported in the frame for guiding the lower end of said portion, and pressure means associated with the frame and said extended portion to exert a downward pull on the work support of a greater magnitude than any other forces exerted thereon during the grinding operation.

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