Oct. 19, 1948. E. BUGATTI 2,451,658

MOUNTING OF GRINDING WHEELS, ESPECIALLY ON GRINDING MACHINES

Filed Sept. 11, 1945 2 Sheets-Sheet 1

Fig. 1

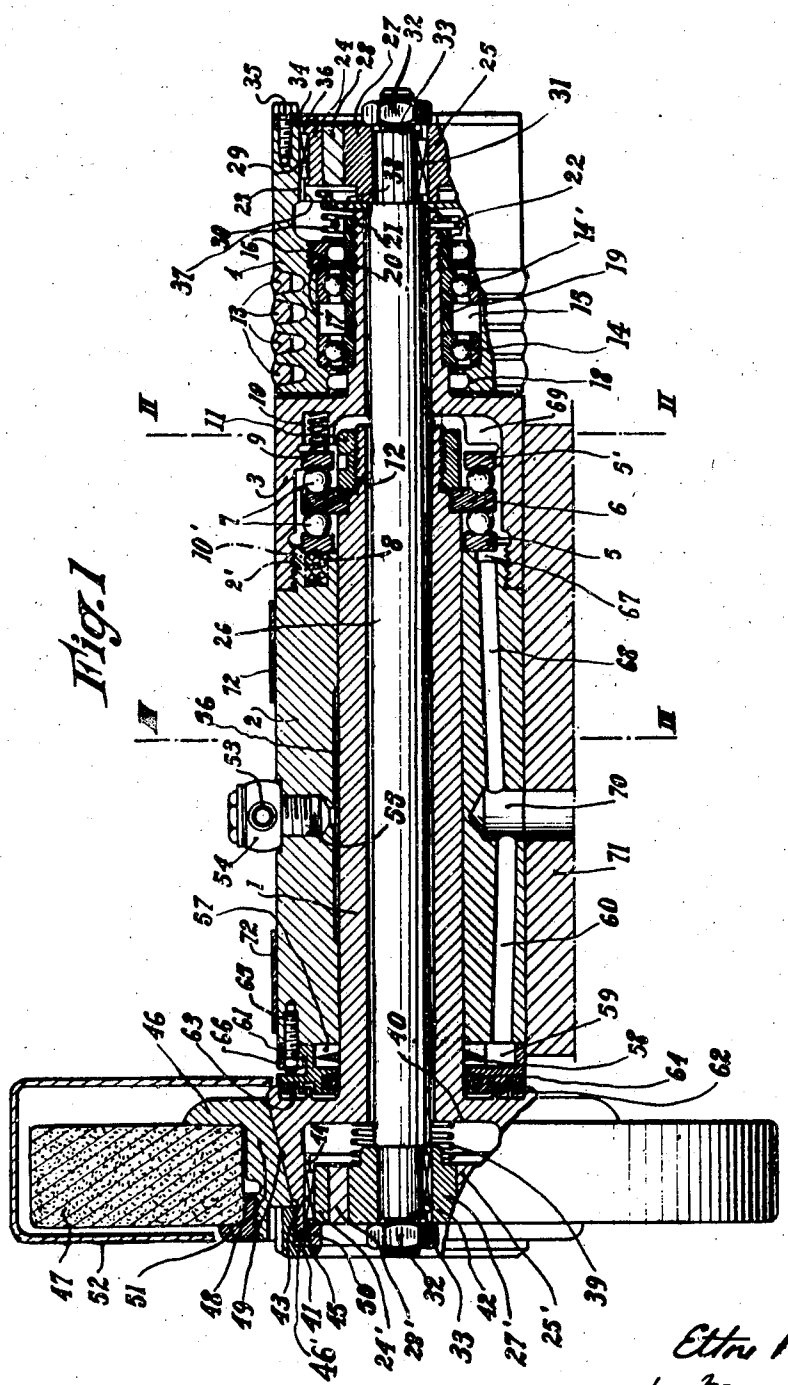

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Fig. 3

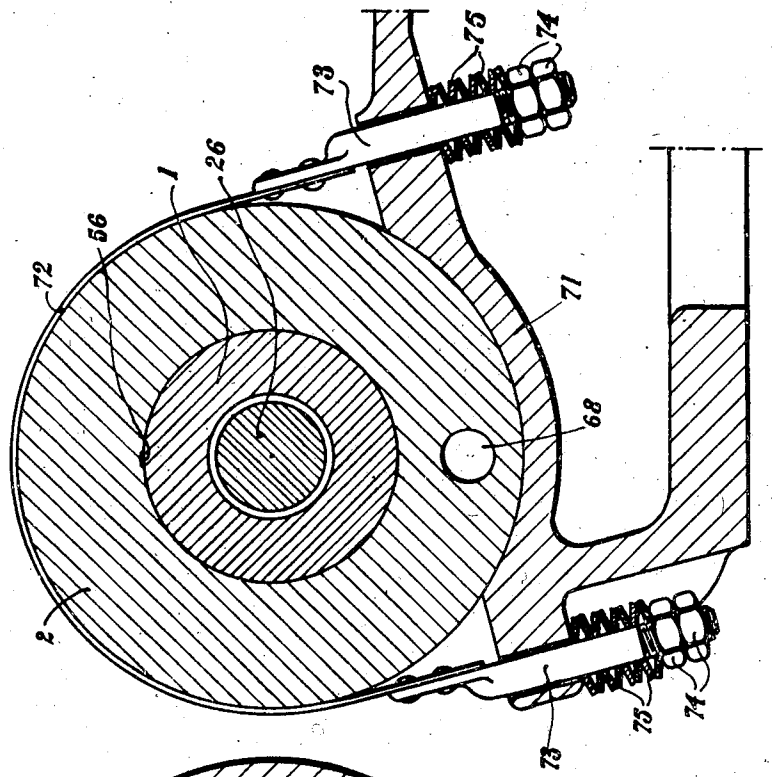
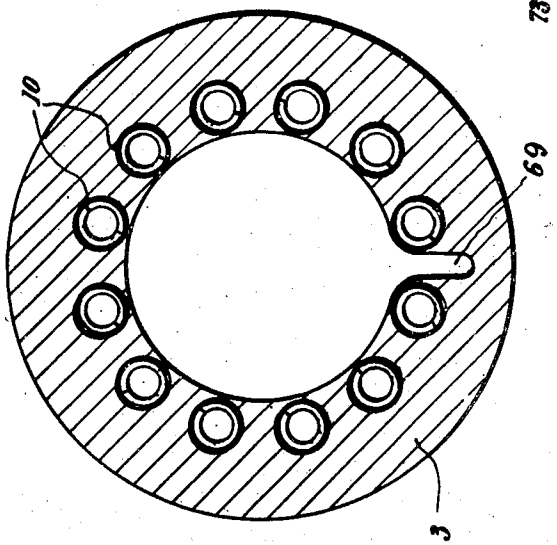


Fig. 2



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2,451,658

MOUNTING OF GRINDING WHEELS, ESPECIALLY ON GRINDING MACHINES

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It is known that the grinding wheel spindle in a grinding machine is one of the most delicate parts of machines of this kind. As a matter of fact they must, on the one hand, allow fast rotation of grinding wheels sometimes very heavy and difficult to equilibrate, on the other hand, receive motion from one or several pulleys, counterbalancing of which is also defective.

Expansion phenomena complicate the designing thereof owing to the fact that they compel to provide particular compensating devices, the use of which does not always suffice to avoid play when the spindle and its bearings are cold.

These various considerations have led constructors to take many precautions with a view to securing a constant accuracy consonant with that of the whole machine, and as far as possible to eliminating vibrations which are detrimental to finish of machined work. Originally, grinding wheels are equilibrated together with the spindles bearing them, pulleys and even belts but in operation these precautions are not always observed when one or several members such as grinding wheel or belts are replaced, thus making illusive the advantages to be expected from the original mounting of spindles.

A primary object of this invention is to do away with the drawbacks above mentioned. In a preferred embodiment, my invention comprises one or several of the following features:

1. The grinding wheel is carried by a hollow shaft of a very big diameter, revolving in a very long smooth bearing.

2. The shaft is secured against axial thrusts by means of a double-acting ball thrust bearing or the like, one of the stationary rings of which rests against the shaft bearing or a member fast with the latter, through a set of coil-springs arranged on one or several concentrical rows. This manner of mounting allows of axial expansion of the grinding wheel shaft and precludes any axial play of the grinding wheel shaft in its bearing.

3. Drive is conveyed to the grinding wheel by means of a spindle having a weak inertia and turning inside the grinding wheel shaft. Said driving spindle is actuated, at an end, by means of a pulley, through a resilient coupling and at the other end, it drives the grinding wheel shaft through another resilient coupling.

4. The driving pulley, above mentioned under 3, is provided with ball-bearings or with cylindrical or conical roller bearings which are locked through their inner rings, on a stationary member appended to the bearing of the grinding wheel shaft.

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5. The resilient couplings connected to the inner driving spindle may slide, one in a bore of the driving pulley, the other in a similar housing arranged in that part of the grinding wheel shaft which faces the grinding wheel. Moreover, these resilient couplings are fast with the driving spindle in axial direction. Two equal coil-springs or two sets of equal, concentrically arranged springs hold the driving spindle and its couplings in axial direction and allow of length variations of the grinding wheel shaft and driving pulley.

6. The bearing for the grinding wheel shaft may be lubricated with pressure lubricant. Feeding of lubricant is made preferably through the upper part of the bearing, and oil escaping from the ends of the latter is collected in cavities arranged for this purpose and provided, if need be, with deflectors, from where it comes back to a main container in the frame, through a series of suitable passages in the lower part of the bearing.

7. In order to prevent access of dust and fillings to the bearing a set of baffles is provided on the side of the grinding wheel, stationary members of said baffles belonging to the bearing while the rotating members belong to the grinding wheel shaft; furthermore one or several felt packings are arranged to rub on the grinding wheel shaft. For protecting the ball or roller bearings of the driving pulley, deflectors fast with said pulley are provided.

8. The bearing of the grinding wheel shaft has, preferably, a cylindrical shape as also its extension which supports the driving pulley. This pulley and that part of the extension located between said pulley and bearing may be slightly smaller than the bearing, so that the latter may be placed on a cradle of any length.

9. The bearing of the grinding wheel shaft is, preferably, secured in its cradle by means of straps, the threaded lugs of which are long enough to enable locking of nuts with interposition of a set of Belleville washers or coil-springs.

From examination of the features above recited, it results that grinding wheel shafts constructed according to my invention secure the following advantages:

1. The grinding wheel shaft is sheltered against any consequence arising from a possible defect of counterbalancing of the driving pulley and hence is not subjected to trepidations and vibrations from said pulley and its belts. Said grinding wheel shaft may be separately balanced, with the grinding wheel on it, without taking into consideration the other turning masses.

2. Torsional vibrations arising from the disturbances above mentioned are absorbed by the

resilient couplings of the driving spindle and, to a certain extent, the driving spindle itself, which has a rather weak section relatively to its length.

3. No axial play of the grinding wheel shaft in its bearing can occur; the springs, housed in the bearing between the latter and one of the rings of the double-acting ball thrust bearing, continually press the three rings of the latter against the stationary part. Any adjustment of axial play of this ball thrust bearing, such an adjustment being always very difficult to perform, is therefore avoided. On the other hand, in the case where the grinding wheel unexpectedly comes into contact with the work or a foreign body, said springs act as a damper and allow in some degree, of avoiding deterioration of the grinding wheel or its shaft.

4. In the same order of ideas, the resilient fastening of the bearing on the machine frame completes the various provisions made to diminish the consequences of any possible wrong operation.

5. Lubrication under pressure, which may easily be adapted to the bearing of the grinding wheel shaft, allows of continually driving out dusts and filings which tend to infiltrate through tightness felts. The baffles provided near the grinding wheel hub co-operate to this sheltering.

6. As the driving pulley is wholly independent of the grinding wheel shaft, it can be equilibrated separately once for all, this being much easier than equilibrating a combination comprising the grinding wheel, shaft and pulley. Further, it will be remarked that when the grinding wheel is changed its shaft alone is concerned; the driving part proper (pulley and belts) keeps its own balancing.

The following description with reference to the appended drawings given solely by way of example will show how this invention may be carried out.

Fig. 1 shows, in longitudinal section, a grinding wheel shaft carried out according to this invention.

Fig. 2 is a cross-section taken along line II—II on Fig. 1.

Fig. 3 is another cross-section taken along line III—III on Fig. 1.

The grinding wheel shaft 1 revolves in a bearing 2. The latter has a threaded part 2' on which a bearing 3 for a grooved pulley is locked. A double-acting ball thrust bearing, consisting of stationary rings 5 and 5', a rotatable ring 6 and balls 7, rests against a side 8 of bearing 2. The stationary ring 5 is centered in a recess of side 8, while the other stationary ring 5' may slide in a bore 9 in bearing 3. A set of coil-springs 10 located in holes provided in that portion of bearing 3 which extends radially and inwardly so as to provide in effect an abutment member, keep the various members of the ball thrust bearing in mutual contact. This set of springs 10 may be completed by a set of less strong springs 10', acting in opposition and having merely for its function to hold against one another, the member 7 and 8 of the ball thrust bearing. The rotary ring 6 is pressed against a shoulder on the grinding wheel shaft 1 by means of a nut 11 screwed on a threaded part 12 of the shaft 1, which extends beyond said shoulder.

The driving pulley 4, actuated by means of belts 13 which convey drive from an electric motor or any shaft dependent on the machine, turns on ball-bearings 14 and 14'. As above explained, the application of roller or like bearings is also possible.

Ball-bearings 14 and 14' are located in a bore 15 of the pulley 4, which is open so as to allow of piling up ball bearings 14 and 14'. A threaded ring 16 which acts at the same time as an oil deflector, holds, by resting on a shoulder 17 of the pulley 4, the outer ring of ball-bearing 14' on the right of Fig. 1, while the other ball-bearing 14, has its outer ring in abutment on the bottom of bore 15.

In this zone, pulley 4 has an oil deflector 18, which, for the best, is integral with said pulley 4. The inner rings of ball-bearings 14 and 14' are pressed against a shoulder of bearing 3, with an intervening spacer 19, by a nut 20 screwed on a threaded part 21 of bearing 3. Nut 20 is locked by a steel wire brake 22.

Pulley 4 has further a housing 23 in which is mounted with an easy fit the outer ring 24 of a resilient coupling 25 which conveys drive to a spindle 26 through its inner ring 27 and a plastic mass 28. The resilient coupling 25 may be made in any known manner, and driven for instance, either through alternating projections on its outer and inner rings 24 and 27, said projections being located in cavities of plastic mass 28, or owing to adherence of plastic mass 28 to rings 24 and 27, said adherence being obtained by vulcanization or any other manner.

The outer ring 24 is provided with one or several keys 29 slidably engaging suitable grooves 30 in pulley 4. The inner ring 27 has also one or several keys 31 slidably mounted therein and which are embedded in spindle 26; ring 27 is abutted against a shoulder on spindle 26 by a nut 32 screwed on a threaded part 33 of spindle 26.

An annular plate 34, secured on pulley 4 by means of a set of screws 35, limits axial displacements of spindle 26 and its coupling 25. A plastic ring 36 may be inserted between ring 27 of coupling 25 and annular plate 34, so as to make up for clearance between these members and avoid ingress of dust into bore 23.

A coil-spring 37 confined between the threaded ring 16 turning with pulley 4 and a dished plate 38 which rests against the ring 27 of coupling 25, axially pushes the spindle 26 in opposition to pressure of a spring 39 which acts on the other end of spindle 26.

Said spring 39 rests on a side 40 of the grinding wheel shaft 1 and on the inner ring 21' of a resilient coupling 25' which conveys drive from spindle 26 to grinding wheel shaft 1. The resilient coupling 25' is mounted in like manner to coupling 25. Its outer ring 24' is adapted to slide in a recess 41 of grinding wheel shaft 1 the aforesaid side 40 constituting the bottom of said recess. Two keys 42 and 43, the first one 42 engaging shaft 26 and ring 27', while the other 43 engages ring 24' and slides in a groove 44 of recess 41, cooperate to drive transmission between shaft 26 and grinding wheel shaft 1.

The hub 46 of grinding wheel 47 is locked by a threaded ring 45, and is for the best, provided with a female cone 48 engaged by the male cone 49 on grinding wheel shaft 1. A plastic ring 50 acts as a dust excluder, like ring 36 provided at the other end of the shaft between annular plate 34 and ring 24. Nevertheless, the dimensions of the plastic ring 50 have been calculated more broadly than those of ring 36, in order to afford a greater capacity for compression and, therefore, to fill in more certainly the gap between nut 45 and ring 24'.

In order to complete the description, I shall mention a nut 51 screwed on a threaded part 46' of the hub 46, and a grinding wheel casing 52 attached in any manner on the bearing 2 of the grinding wheel shaft.

Lubricating oil from a pump is supplied to bearing 2 through a piping 53 ended by a union 54 screwing into a tapered hole 55 in bearing 2. The hole 55 opens through its lower part into a longitudinal or helical groove 56 in the bore of bearing 2, for the purpose of distributing oil. The excess oil which goes out of the bearing on the side of the grinding wheel is projected towards the periphery of a space 57 by a deflector 58 which is shrunk on grinding wheel shaft 1 or is integral therewith. The space 57 has, at its lower part, a well 59 in which opens a bore 60 drilled in the body of bearing 2. A cover 61, made of two parts with a view to allowing mounting, provide walls for the space 57; this cover cooperates by ribs 62 with shaft 1 also provided with similar ribs 63, so as to form baffling means between the stationary and turning members. A felt packing 64, located in a groove of cover 61, precludes oil infiltrations which might happen when stopping. Cover 61 is secured on bearing 2 by a set of studs 65 and nuts 66.

On the side remote from the grinding wheel, a space 67 provided in shaft 1 and in which opens a bore 68, and likewise a space 69 in bearing 3 secure return of oil towards a lower opening 70 which communicates with the oil container of the machine through a suitable piping.

Fig. 2 shows the arrangement of springs 10 and oil return space 69, and Fig. 3 the fastening device of bearing 2 on its crade 71. A strap 72 is united by riveting with lugs 73 which have a smooth part, long enough to allow of a set of Belleville washers 75 by means of nuts 74. Instead of Belleville washers very strong springs, or even rubber blocks or blocks of any other plastic material may be used.

It will be obvious that minor alterations may be brought about in the foregoing embodiments without departing from the spirit of the appended claims.

What I claim is:

1. In a grinding machine, a grinding wheel supporting and driving unit having a cylindrical outer shape substantially throughout its length, which comprises three successive cylinder sections, one of which is a bearing having a bore, the following one is a tubular extension which has a co-axial bore of larger cross section than the bore of the bearing and the third is a pulley; a bearing for said pulley, fast with the tubular extension, located inside said pulley and having a bore therethrough; a grinding wheel shaft rotatably borne in the bearing which forms the first cylinder section; and means passing through the bore in the bearing for the pulley and the bore of the tubular extension, for coupling the pulley with the shaft.

2. The combination of claim 1, which further comprises resilient means located in the bore of the tubular extension, interposed between the shaft and said extension for resisting axial movement of said shaft in the direction of the above-named sequence of cylinder sections.

3. The combination of claim 1, the bearing having a lubricant inlet port extending to its bore, a lubricant outlet port opening on the outer surface of the bearing, and intermediate lubricant return channels from the ends of said bearing to said outlet port, the combination further comprising means attached to said bearing at its end remote from the tubular extension providing a seal around said shaft.

4. The combination of claim 1, further comprising a frame having a recess in the form of a cylinder portion, adapted partially to accommodate said unit; and resilient flexible means providing a strap over the exposed portion of the unit positioned in said recess for holding said unit in the recess.

5. In a grinding machine, the combination of a bearing having a length which is considerable with respect to the diameter of the bore of said bearing; a grinding unit including a grinding wheel and a tubular wheel shaft which is located on one side of said grinding wheel, and which is fast with said wheel, and is revolubly borne in said bearing; wheel driving means rotatably supported from said bearing at the end thereof which is remote from said grinding wheel; a spindle accommodated in said tubular wheel shaft, extending from a point in the plane of the grinding wheel to a point in the plane of the wheel driving means; means in the plane of said grinding wheel for resiliently coupling said shaft with said grinding unit; and resilient means in the plane of said wheel driving means, for coupling said wheel driving means with said shaft.

6. In a grinding machine, the combination of a main bearing which has a considerable length as compared with the diameter of its bore, and comprises an inner peripheral recess in its bore and an outer peripheral recess, said recesses being in spaced apart relationship at an end of said bearing; a grinding unit including a grinding wheel and a tubular shaft fast with said wheel, located on one side thereof and revolubly borne in said main bearing, said grinding wheel being located at the end of said main bearing which is remote from the first-named end thereof; means in said inner peripheral recess, adapted and arranged to cooperate with said tubular shaft, providing a thrust bearing for said shaft; means revolubly borne on the main bearing in the outer peripheral recess thereof, for driving said grinding wheel; and means extending through said tubular shaft for transmitting drive from said driving means to said grinding unit.

7. The combination of claim 6, which further comprises resilient means in said inner peripheral recess, backed from said main bearing, for urging said thrust bearing towards the second-named end of the main bearing.

8. In a grinding machine, the combination of a main bearing which has a considerable length as compared with the diameter of its bore and has an outer peripheral recess and an inner peripheral recess having axially spaced apart, radial walls, each of which has at least one axially directed hole, said recesses being disposed in spaced apart relationship at an end of the main bearing; a grinding unit including a grinding wheel and a tubular shaft fast with said wheel, located on one side thereof and revolubly borne in said main bearing, said grinding wheel being located at the end of the main bearing which is remote from the first-named end thereof; an antifriction thrust bearing for said tubular shaft, adapted and arranged to cooperate therewith, supported and guided in said inner peripheral recess of the main bearing for axial movement therein, said thrust bearing having an axial extent less than the distance between the radial walls of said inner recess; a spring nested in each of said axially directed holes, adapted and arranged to be com-

pressed between said main bearing and said thrust bearing, the spring located on the side proximate to the first-named end of the main bearing being weaker than the spring on the other side; means revolubly borne on the main bearing in the outer peripheral recess thereof, for driving said grinding wheel; and means extending through said tubular shaft for transmitting drive from said driving means to said grinding unit.

9. In a grinding machine, the combination of a bearing having a length which is considerable with respect to the diameter of the bore of said bearing; a grinding unit including a grinding wheel and a tubular wheel shaft fast with said wheel, located on one side thereof and revolubly borne in said bearing; wheel driving means rotatably supported from said bearing at the end thereof which is remote from said grinding wheel; a spindle in said tubular shaft, co-extensive with said shaft and said wheel driving means, said spindle being adapted and arranged at the end thereof adjacent to said grinding wheel for axially movable, driving engagement with the grinding unit, in the plane of the wheel, said spindle being also adapted and arranged at the end thereof remote from said grinding wheel for axially movable, driving engagement with said wheel driving means; and a pair of resilient means operatively interposed between said spindle and said grinding unit, and between said spindle and said wheel driving means respectively, adapted to urge the spindle in axially opposite directions, for biassing said spindle to operative engagement with said grinding unit and wheel driving means.

10. In a grinding machine, the combination of a frame including an elongated cradle portion and at least two longitudinally spaced apart lugs on each side of said cradle portion; a grinding unit including a long bearing for a grinding wheel shaft and for means to drive said shaft, said long bearing being so shaped as to seat in said cradle; at least two flexible straps, each of which extends from a lug on one side of said cradle to the opposite lug on the other side of said cradle; and means providing an adjustable, resilient connection between each lug and the corresponding strap.

11. In a grinding machine, the combination of a bearing; a grinding wheel shaft having a grinding wheel at an end thereof, rotatably borne in said bearing, said shaft having its opposite end which protrudes from the corresponding end of said bearing; a ring on said opposite end of said shaft, fast therewith so as to be rotatable with said shaft; a radially extending, abutment member around said opposite end of said shaft, axially spaced apart from said rotatable ring and positioned with respect to the latter on the side thereof remote from said bearing; rigid means for supporting said abutment member from said bearing; and resilient means operatively interposed between said rotatable ring and abutment member for resisting axial thrusts imposed on said shaft in the direction from the first-named end of said shaft to said opposite end thereof, said resilient means being predetermined to be operative only with abnormal axial thrusts.

12. In a grinding machine, the combination of a bearing; a grinding wheel shaft having a grinding wheel at an end thereof, rotatably borne in said bearing, said shaft having its opposite end which protrudes from the corresponding end of said bearing; a ball thrust bearing having one

of its two rings secured in radial position on said opposite end of said shaft, the remainder of said ball thrust bearing being located on the side of said ring remote from said shaft bearing; a radially extending, abutment member around said opposite end of said shaft, located on the same side as, but farther from said shaft bearing than, said ball thrust bearing; rigid means for supporting said abutment member from said bearing; and resilient means in prestressed condition interposed between said abutment member and the second ring of said ball thrust bearing, for urging said ball thrust bearing towards said first named end of said shaft bearing.

13. In a grinding machine, the combination of a bearing; a grinding wheel shaft having a grinding wheel at an end thereof, rotatably borne in said bearing, said shaft having its opposite end which protrudes from the corresponding end of said bearing; a tubular extension removably secured to said bearing at the opposite named end thereof, coaxially therewith, said tubular extension having such an inner diameter as to leave an annular, unobstructed space between said extension and said opposite end of said shaft; and means located in said annular, unobstructed space, operatively interposed between said shaft and said extension for resiliently limiting axial movement of said shaft upon occurrence of abnormal axial thrust on said shaft.

14. The combination of claim 13, which further comprises an annular driving member rotatably borne on said extension; and central means passing through said extension for transmitting driving torque from said member to the shaft.

15. In a grinding machine, the combination of a bearing; a shaft having an axial bore therethrough, rotatably borne in said bearing and having a grinding wheel at an end thereof; a thin driving spindle accommodated in said bore of said shaft, co-extensive therewith and further protruding from the end of said shaft opposite to the first named end thereof; a tubular extension secured to said bearing on the side of said opposite end of the shaft, coaxially therewith; an annular driving member rotatably borne on said extension; resilient means at the end of said annular driving member remote from said bearing, for supporting the corresponding end of said spindle from and co-axially with said driving annular member, said resilient means providing a resilient torque transmission coupling between said driving annular member and said spindle; and further resilient means at the end of said spindle adjacent to said grinding wheel, for supporting said spindle from said shaft and providing a resilient torque transmission coupling between the same.

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