

Sept. 24, 1946.

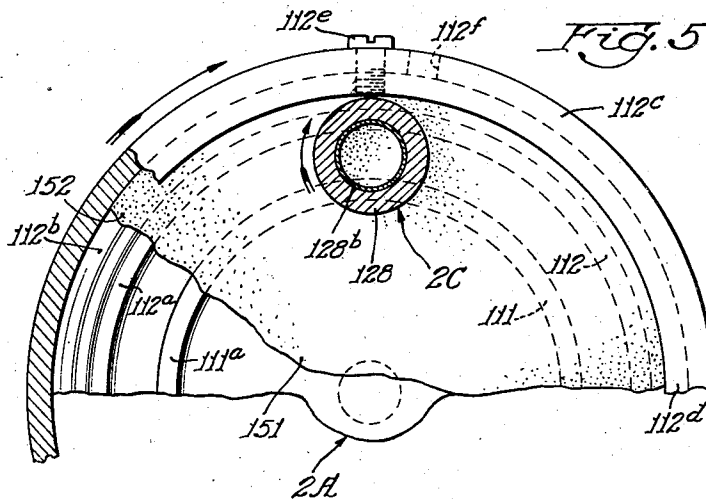
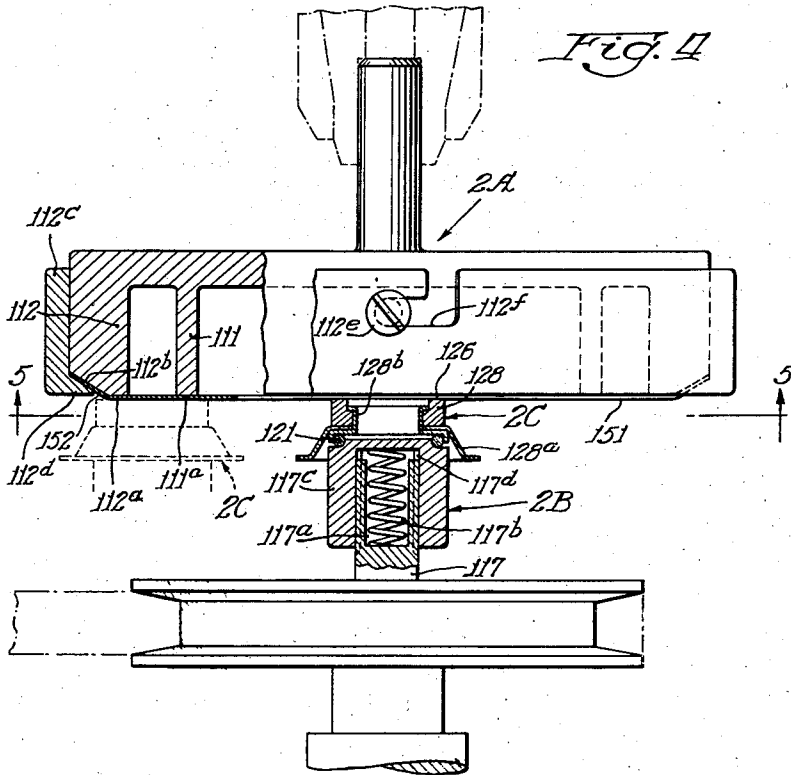
D. S. OLIVER

2,408,334

LAPPING METHOD AND MACHINE

Filed July 31, 1944

2 Sheets-Sheet 2



Inventor:
Delbert S. Oliver
By: *Emerson C. Putzbaugh*

Att

UNITED STATES PATENT OFFICE

2,408,334

LAPPING METHOD AND MACHINE

Delbert S. Oliver, Euclid, Ohio, assignor to Pesco Products Co., Cleveland, Ohio, a corporation of Ohio

Application July 31, 1944, Serial No. 547,389

6 Claims. (Cl. 51-131)

1

This invention relates to arrangements for highly and accurately finishing rotative bearing and sealing surfaces particularly those having an annular or ring shape.

Prior to this invention it has been found extremely difficult to properly finish a radially extending bearing and seal surface on a drive shaft. Equal difficulty has been encountered in an effort to accurately finish the bearing and seal surface on the ring portion of a diaphragm seal assembly.

I have found that one of the principal reasons for the difficulty encountered results from the differences in the relative linear velocity between the particles of the abrasive and the surface being finished. In order to produce a substantially perfect bearing and seal surface this condition had to be corrected and some arrangement worked out whereby substantially uniform abrading action could be accomplished throughout the bearing and seal surface notwithstanding the fact that this surface was annular or circular in shape.

It is a principal object of this invention to provide a finishing arrangement for annular or ring-shaped bearing surfaces wherein the abrading means is given a linear relative velocity relative to the bearing surface throughout the radial extent thereof that is substantially uniform.

It is a further object to provide in a finishing arrangement of the present type an improved holding means for the abrading material and holding means for the work piece having a bearing surface thereon to be finished, the work holding means being effective to present the bearing surface with reference to the abrading material and support therefor in such a manner that rotation of the work holder and of the abrading material holder in the same direction at selected relative speeds produces relative linear velocity of substantially the same order between all of the particles of the abrasive and the portions of the bearing surfaces contacted thereby.

A further and more detailed object is the provision in an arrangement of the present type of a novel and particularly effective holding and tensioning arrangement for abrasive sheet material such as emery cloth or sandpaper and functioning to give the requisite backing support to the sheet when engaged by the bearing surface to be finished thereby.

Other and more detailed objects, advantages and uses of my invention will become apparent from a reading of the following specification taken in connection with the accompanying

2

drawings forming a part thereof and wherein:

Fig. 1 is a view in elevation indicating schematically an arrangement incorporating a preferred embodiment of my invention;

Fig. 2 is a broken away sectional view taken substantially on the line 2-2 of Fig. 1;

Fig. 3 is a broken away sectional view taken substantially on the line 3-3 of Fig. 1;

Fig. 4 is a broken away sectional view of an alternative, modified embodiment of my invention; and

Fig. 5 is a broken away sectional view taken substantially on the line 5-5 of Fig. 4.

Referring now in greater detail to the figures of the drawings and first to the preferred embodiment shown in Figs. 1 to 3, the arrangement incorporating my invention is composed generally of an abrading or lapping tool assembly A, a work piece holding assembly B adapted to hold a work piece C in proper relation to the lapping tool, a turning power transmission assembly indicated generally at D and a source of power E.

The present invention is directed particularly to the construction and mode of coaction of abrading or lapping tool assembly A and work holding assembly B whereby to provide a more perfect annular or circular seal and bearing surface on work piece C.

Abrading or lapping tool assembly A comprises a base 10 rotatably supporting the finishing tool assembly for turning about a vertical axis. A pair of concentric coaxially extending radially spaced walls or lands 11 and 12 terminate in a corresponding pair of finishing material supporting surfaces 11a and 12a, each of these terminal surfaces being disposed in a plane perpendicular to the axis of rotation of the finishing tool assembly A.

The intervening space between walls 11 and 12 is preferably enlarged to provide a chamber 13 for the reception of any enlargement that may be present on the work piece C being finished as will appear. The space 14 between the finishing material or abrasive supporting material surfaces 11a and 12a forms a very important part in the mode of coaction necessary to the accomplishment of the substantially perfect bearing and seal surface on the work piece as will appear. To facilitate the introduction of any enlargement that may be present on the work piece C there is provided an enlarged opening 16. It will be further noted that wall terminal surfaces 11a and 12a each have a radial dimension that is only a fraction of the total radial dimension of the work piece and that the bearing seal surface

of the work piece to be finished overlaps wall terminal surface 12a radially outwardly and wall terminal surface 11a radially inwardly.

Abrasive supporting surfaces 11a and 12a preferably perform their function by having loose abrasive powder applied thereto. However, as will appear from a description of the modified form of my invention presented in Figs. 4 and 5, this abrasive or finishing function may be accomplished by positioning a suitable bonded abrasive sheet such as emery cloth or sandpaper in supporting contact with surfaces 11a and 12a.

The work holding assembly B preferably comprises a rotatable holding member proper 17 formed with a coaxial bore 18 having splines 19 protruding radially inwardly from the wall thereof for cooperation with complementarily formed splines 27 on the work piece C for effecting the driving thereof. The terminal of bore 18 is provided with a resilient cushioning ring 21 functioning to allow for the necessary angular adjustments between the holder and the work piece C and for holding the same firmly but resiliently against the abrading or lapping tool A.

The work piece C may take a number of different forms the essential structure of each of which includes an annular or ring shaped bearing and seal surface 26 extending in a radial plane perpendicular to the normal axis of rotation of the work piece C. The work piece C must be arranged in driving relation to the holder B and in the present instance this is accomplished by the splines 27 on the work piece cooperating with the complementary splines 19 on the holder. The particular work piece C shown in Fig. 3 further includes a reduced cross section coaxial stem 28 terminating in a second enlargement 29 which may also have splines thereon. The present abrading tool assembly A is particularly effective for cooperation with this type of work piece since the reduced cross section stem 28 readily passes between spaced walls 11 and 12 and the enlarged chamber 13 provides for enlargement 29 carried on the terminal portion of the work piece.

Turning power transmission assembly D may take various forms the essential characteristic required thereof being that abrading or lapping tool assembly A must be rotated in the same direction as work holding assembly and work piece C. Furthermore the respective turning rate must be properly correlated with reference to one another in order to approximate as near as practicable the ideal abrading conditions. It is desired that the relative linear velocity between any radial point on the ring or annular shaped bearing and seal surface 26 and the abrading particles contacting the same be substantially the same throughout both for the inner abrading material supporting surface 11a and the outer surface 12a. It is believed that the present arrangement more nearly approximates this ideal condition than any other heretofore available. By the optimum choice of the relative dimensions of surfaces 11a of the tool assembly and the bearing seal surface 26 of the work piece and by choosing the optimum relative rate of rotation of the tool assembly and the work piece the above ideal mode of coaction is approximately realized.

I have found that particularly effective results are obtained by having the radii of walls 11 and 12 several times as large as the radius of the annular surface to be finished. In addition it is important that the radial width of the respective abrasive material supporting surfaces 11a and 12a

be no greater than the radial width of the surface 26 to be finished and preferably slightly smaller. It is of still further importance that the annular surfaces 26 overlap wall terminal surface 11a radially inwardly as indicated at 25a and likewise overlap outer terminal wall surface 12a radially outwardly as indicated at 25b. I have found that particularly effective results are obtained if the mean radius r_{12} of outer terminal wall surfaces 12a is made to be of the order of about six times the value of the mean radius r_{26} of surface 26 to be finished. By having the mean radius r_{11} of inner wall surface 11a and the mean radius r_{12} of outer wall surface 12a arranged as described, employing a width of surfaces 11a and 12a not greater than the width of annular surface 26 there results an overlapping between the several surfaces both radially inwardly and radially outwardly. It will now appear that when the work piece C is rotated in the same direction as the tool assembly A the relative velocity between the outer lapping face 12a and annular surface 26 will be the difference between the linear velocity of the surface 12a and the linear velocity of the surface 26. The relative velocity between the inner lapping surface 11a and the annular surface 26 will be the sum of the velocity of the inner lapping surface 11a and the velocity of the surface 26. While it will be apparent that, strictly speaking, this is only true as regards an average taken with reference to the median radii r_{11} , r_{12} , and r_{26} , it is important to note that for all practical purposes this arrangement and mode of coaction produces a substantially perfectly flat surface. In other words, by means of this arrangement it is possible for all practical purposes, to compensate for the fact that the outer lapping surface 12a is moving faster than the inner surface 11a and to thus obtain the same relative velocity between the abrading particles and the work surface 26 on both sides of the work piece C. It is found that the lapping surfaces 11a and 12a remain true for a long period of continuous operation and require resurfacing only after several hundred pieces have been finished.

For the purpose of applying rotative power to abrading tool assembly A and work piece holder assembly B, transmission assembly D is provided which may comprise a pulley 31 receiving power from any suitable source indicated generally at E as being in the form of a drive belt. Pulley 31 may drive work holder assembly B directly and through means of a second pulley 32 and belt 33 drives a third pulley 34. Through a connecting drive shaft 36 pulley 34 drives a fourth pulley 37 in turn connected by a belt 38 to a pulley 39 directly associated with abrading tool assembly A. By the proper choice of the respective sizes of the several pulleys the desired optimum relative speed of rotation can be readily effected between abrading tool assembly A and work piece C. I prefer to turn abrading tool assembly A three revolutions while turning work piece C two revolutions. This has been found to give very satisfactory results.

Turning now to the alternative modification of my invention shown in Figs. 4 and 5, it will be apparent that the same fundamental features are involved, this arrangement being particularly adapted for finishing a radially extending bearing and seal surface of the annular type on a work piece having no protuberance extending axially in the direction of the abrading surface thus making it practicable to employ a bonded

5

abrasive such as emery cloth or sandpaper. The abrading tool assembly 2A and the work holder assembly 2B are arranged to be driven in a similar manner to that described in the first modification, the latter functioning to hold and present the work piece 2C for finishing engagement with the abrading sheet forming part of the abrading tool assembly.

The abrading tool assembly 2A comprises concentric coaxially extending walls 111 and 112 corresponding to walls 11 and 12 of the first modification and terminating in abrasive sheet material supporting spaced-apart surfaces 111a and 112a. These surfaces 111a and 112a are likewise disposed in a plane perpendicular to the axis of rotation of tool assembly 2A. The radius, width, and other relationships of terminal wall surfaces 111a and 112a with reference to the work piece 2C to be finished are determined in accordance with the same fundamentals described in connection with the first modification. The periphery of outer wall surface 112a merges with a beveled surface portion 112b for cooperation with radial terminal portions of a sheet of abrasive cloth such as emery cloth or sandpaper in a manner as will appear. An embracing ring 112c is received about the outer periphery of wall 112 and is formed with a radially inwardly extending protuberance 112d complementarily formed on the inner side thereof for cooperation with beveled surface 112b and effective to firmly engage and apply the requisite tension to the abrasive cloth 151 by contact with the peripheral portion 152 thereof. This results in snug engagement between the abrasive cloth 151 and terminal surfaces 111a and 112a, these latter surfaces functioning as a backing support for the abrasive cloth and rendering the same effective in the desired critical areas in contact with the bearing and seal surface 126 of the work piece 2C being finished.

Clamping ring 112c is fastened in abrasive cloth engaging position by means of a radially extending locking pin 112e carried by the wall 112 and cooperating with a bayonet slot 112f formed in ring 112c.

Work holding assembly 2B comprises upstanding rotatable supporting shaft 117 formed with an internal bore 117a receiving a coil compression spring in engagement with the inner terminal thereof, the outer terminal of this spring engaging the closed end of a work supporting member or bonnet proper 117c. Shaft 117 is provided with coaxial splines cooperating with complementarily formed splines 117d formed on the inner periphery of work supporting bonnet 117c for effecting driving relation therebetween. Work supporting bonnet 117c is formed on the outer portion thereof with a recessed shoulder for the reception of a flexible ring 121 effective to resiliently and drivingly support the work piece 2C. The spring 117b is effective to supply the necessary axial pressure through the intervening flexible ring 121 to cause the desired abrading action on annular bearing and sealed ring surface 125, while at the same time this flexible ring insures the precise alignment required between bearing and seal surface 126 and the underlying surfaces 111a and 112a carry the abrading sheet in supported relation thereon.

The particular work piece 2C is characterized by the absence of any axially extending protuberance that would interfere with the proper functioning of the abrasive cloth and it may include, by way of example, a flexible diaphragm

6

supported seal and bearing ring. The arrangement shown comprises a seal and bearing ring proper 128 fastened about an opening through the radial inner portion of a flexible diaphragm support 128a by means of a fastening ring 128b the lower portion of which cooperates with flexible ring 121 for effecting the flexible driving relationship.

As in the case of the modification of Fig. 1, it will be seen that the features of critical importance include the provision of radially spaced backing surfaces 111a and 112a. In the more specific aspects of this modification it is also important that wall surfaces 111a and 112a be overlapped both radially outwardly and radially inwardly by the bearing and ring surface 126.

This second modification is of special value in connection with finishing bearing and seal surfaces on bronze bearing rings, it being quite important that the bearing surface be made substantially perfectly flat. It has been found necessary to hold these surfaces to a perfection within the limits of two light bands. Bronze or any soft material has a tendency to charge when being lapped by a loose abrasive. It is therefore desirable that a bonded abrasive such as emery cloth be used and this modification lends itself especially to the use of emery cloth. The novel features of the holding assembly are of particular advantage in maintaining the requisite tension of the emery cloth in firm engagement with the backing surfaces thus insuring greater perfection in the finish of the bearing and seal surface.

While my invention has been disclosed in connection with certain specific embodiments thereof it is to be understood that this is by way of example and not limitation, it being intended that my invention be defined by the appended claims.

I claim:

1. An apparatus for lapping a work piece having a headed stem and a flat radial seal flange spaced from the head, the seal surface having an annular contour arranged in a plane at a right angle to and concentric with the stem axis; said apparatus comprising a rotatable holder supporting the work piece; and a lapping assembly opposing said holder comprising a base rotatable on an axis parallel with and spaced from the holder axis; two coaxial parallel walls of substantial height having confronting abrasive supporting flanges at their ends and defining a relatively deep chamber the entrance to which is restricted by said flanges, the stem and head of the work piece being received in said chamber and entrance thereto; and radially aligned recesses in said flanges effecting the insertion of the work piece head into said chamber thereby to engage the seal flange with the abrasive supporting flanges of the lapping assembly.

2. An apparatus for lapping a work piece as defined in claim 1 wherein yieldable cushioning means are interposed between the holder and the seal flange to accommodate angular adjustment between the holder and work piece.

3. An apparatus for lapping a work piece having a headed stem and a flat radial seal flange; said apparatus comprising a rotatable holder supporting the work piece; and a lapping assembly opposing said holder comprising a base rotatable on an axis parallel with and spaced from the holder axis; and two coaxial parallel walls of substantial height having concentric confronting abrasive supporting flanges at their ends thus to define a relatively deep chamber the entrance

7

to which is restricted by said flanges, said flanges being spaced from each other a distance less than the diameter of the work piece head, the stem and head of the work piece being received in said chamber and entrance thereto, at least one of said flanges having an asymmetric region adapted to effect the insertion of the work piece head into said chamber thus to engage the seal flange with the abrasive supporting flanges of the lapping assembly.

4. An apparatus for lapping a work piece which has a headed stem and an annular seal flange, comprising a rotatable work supporting holder; and a lapping assembly opposing said holder comprising a base rotatable on an axis radially offset from the axis of said holder; spaced concentric walls of substantial height upstanding from said base; flanges on said walls projecting towards each other into the space between said walls and having abrasive supporting surfaces that oppose opposite regions of said seal flange, said walls defining an annular chamber the entrance to which is restricted by said wall flanges, the head and stem of said work piece being received in said chamber and the entrance thereto; and at least one of said wall flanges having an asymmetric region of sufficient dimensions to effect the ready insertion of the work piece head into said chamber thus to engage the seal flange with said abrasive supporting flanges.

5. An apparatus for lapping a work piece having a headed stem and a flat radial seal flange; said apparatus comprising a rotatable holder supporting the work piece; and a lapping assembly opposing said holder comprising a base rotatable on an axis parallel with and spaced from the holder axis; and two annular parallel walls of substantial height having concentric confronting flanges which provide abrasive supporting

8

surfaces, said walls and flanges defining a relatively deep chamber the entrance to which is restricted by said flanges, the distance between the confronting portions of said flanges being less than the diameter of the work piece head, the head and stem of the work piece being received respectively in said chamber and the entrance thereto, said restricted entrance having an enlarged region for permitting the introduction of the work piece head into said chamber past said flanges, thus providing for engagement of said seal flange with said abrasive receiving surfaces.

6. An apparatus for lapping a work piece having a headed stem and a flat radial seal flange spaced from the head, the seal surface having an annular contour arranged in a plane perpendicular to and concentric with the stem axis; said apparatus comprising a rotatable holder supporting the work piece; and a lapping assembly opposing said holder comprising a base rotatable on an axis parallel with and spaced from the holder axis; means on said base defining a relatively deep annular chamber having radially spaced overhanging concentrically arranged flange portions the outer surfaces of which are adapted to receive abrasive material, said flanges extending towards each other in overhanging relation to the outer portion of said chamber thereby providing a restricted entrance of less width than the diameter of the work piece head, the head and stem of the work piece being received respectively in said chamber and the entrance thereto; said restricted entrance having an enlarged region for permitting the introduction of the work piece head into said chamber past said flanges, thus providing for engagement of said seal flange with said abrasive supporting surfaces.

DELBERT S. OLIVER.