Sept. 26, 1967 C. S. HARRIS 3,343,390

TOOLS FOR FINISHING SURFACES

Filed Feb. 1, 1965 2 Sheets-Sheet 1

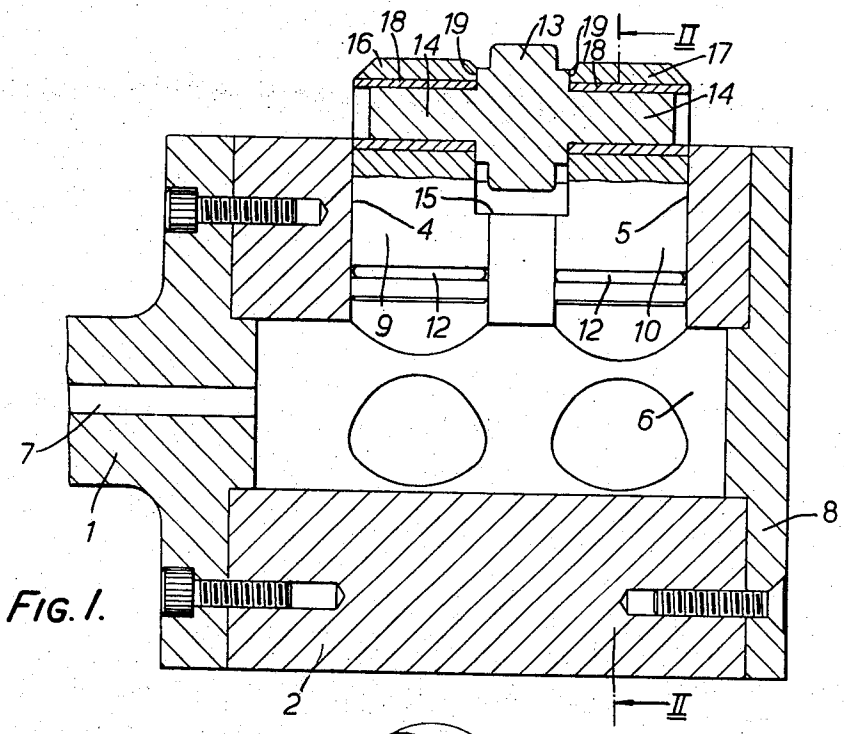


FIG. 1.

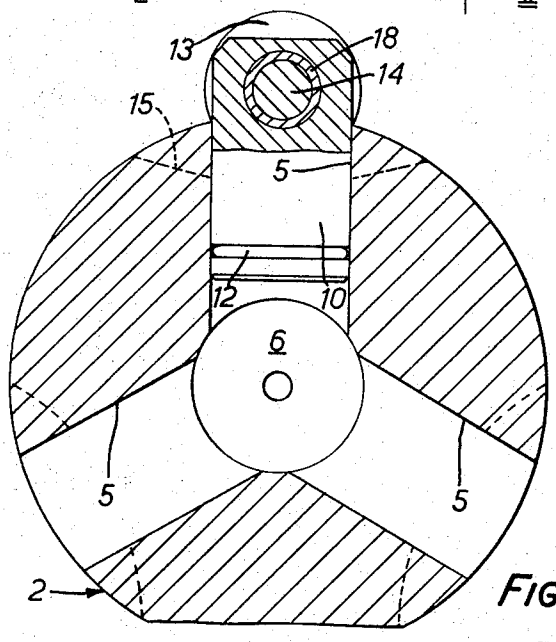


FIG. 2.

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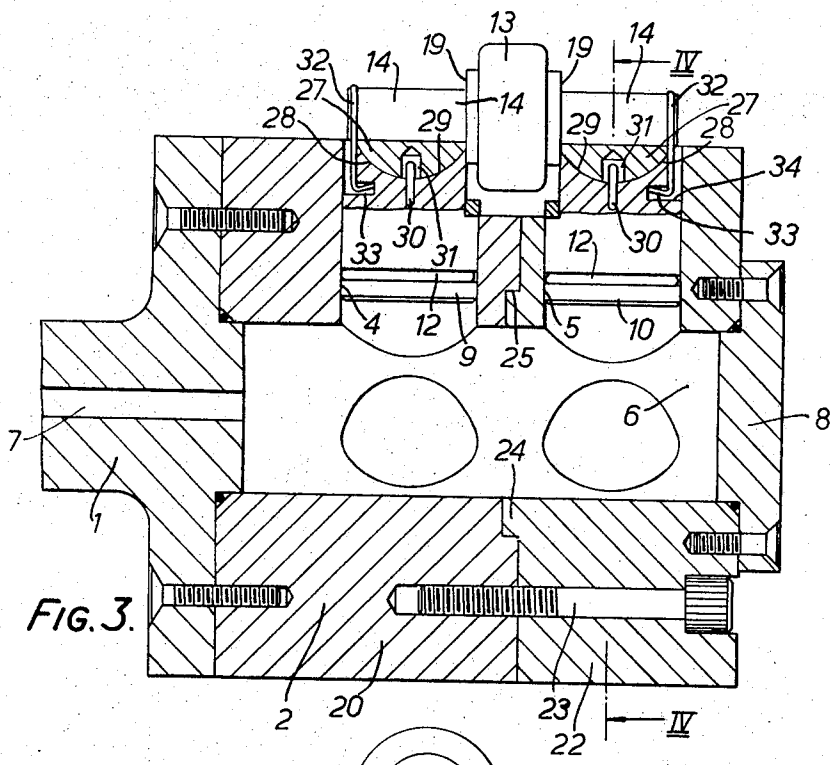


FIG. 3.

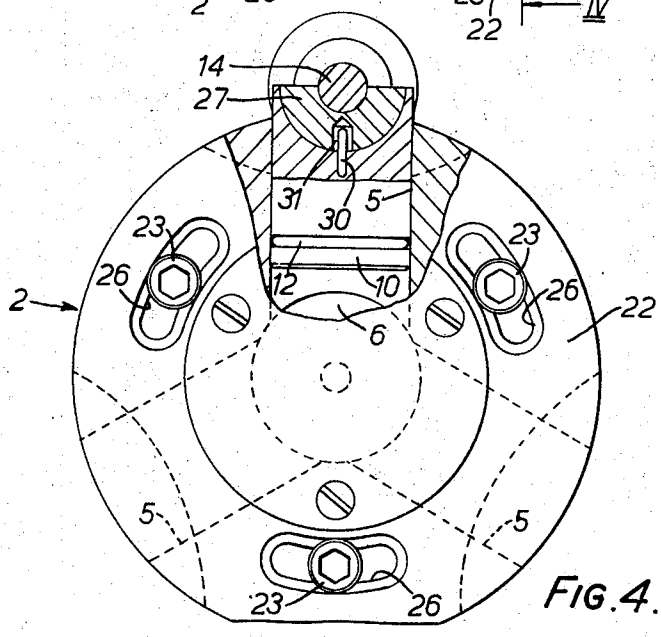


FIG. 4.

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TOOLS FOR FINISHING SURFACES

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8 Claims. (Cl. 72—122)

ABSTRACT OF THE DISCLOSURE

A rolling head having a body part and three rollers equiangularly spaced around the periphery of the head, each roller being mounted for independent floating movement radially of the head between two hydraulic pistons slidable in separate but adjacent bores in the body. The longitudinal axes of the bores associated with each roller are parallel but relatively offset with respect to the direction of the rotational axis of the head so that each roller is skewed to provide a "lead-in" which causes progressive feeding action of the head into a bore being finished.

This invention relates to rolling heads used for finishing the internal surfaces of cylindrical bores to provide an extremely high polish or micro-finish as is required, for example, in high pressure hydraulic cylinders intended to be used as hydraulic ram components.

Such rolling heads normally comprise a body part carrying a number of small diameter rollers which are spaced around the periphery of the head and arranged to engage the surface of the bore of the workpiece. On rotation of the head relatively to the bore with accompanying feed of the head progressively along the bore the rollers, which are arranged to exert a substantial outward pressure on the bore surface while rolling over the latter, produce the required high surface finish.

It is an object of the invention to provide a rolling head which will be adaptable to small changes in dimensions of a bore being finished, for example the small degree of ovality which is acceptable in hydraulic cylinders, and which will also facilitate axial feed of the rolling head along the bore.

According to the invention a rolling head has a body part and a plurality of rollers which are spaced around the periphery of the head and are mounted on the body part so that they can float independently of each other radially of the head while exerting an outward rolling pressure, the rotational axis of each roller being skewed through a small angle relatively to the rotational axis of the head to provide a "lead-in" which causes or assists the rolling head to move progressively along a bore being finished.

The head may for example have three rollers equiangulary spaced around the periphery, and preferably each roller of the head is able to float independently of the other rollers and of the body part. To this end each roller is conveniently mounted on the outer end of a hydraulic piston which is slidable in a corresponding radial bore in the body part. The arrangement is such that hydraulic fluid can be admitted to the bore and acts on the inner end of each piston to provide the rolling pressure urging the rollers radially outwards.

In order to define the lead angle, i.e. the angle through which the roller axes are skewed relatively to the rotational axis of the head, each roller may be mounted between two adjacent hydraulic pistons which are slidable in separate but adjacent bores in the body part. These bores are parallel but relatively offset with respect to the direction of the rotational axis of the head in order to provide the desired lead angle.

Preferably the lead angle of each roller is adjustable as it has been found that the desired degree of lead varies in accordance with the size of the bore to be rolled and the speed of working, and other factors, and hence when the lead angle of the roller axes is fixed the usefulness of any particular rolling head is limited. When each roller is mounted on two parallel pistons the desired adjustment can be achieved if the body part comprises two sections which are relatively rotatable through a small angle about the rotational axis of the head and in each of which is disposed a series of bores for reception of one piston of each roller. Thus the two pistons of each roller are respectively slidable in bores of the two body sections which can be locked in the desired adjusted position to provide the desired offset of those two bores and hence the desired lead angle for the roller. Adjustment of the relative angular position of the two body sections provides simultaneous and identical adjustment of the lead angle of all the rollers.

Preferably each roller is attached to shaft portions or stub shafts which are integral with or fixed in the roller and mounted in journal bearings at the outer ends of the corresponding hydraulic pistons. Conveniently the arrangement is such that the journal bearings can be assembled on the roller before the pistons are inserted in their respective cylinders, so that when the two pistons are in position in the cylinders the roller is automatically located endwise between the two journal bearings. When the lead angle of the roller is adjustable by arranging the cylinder bores in relatively rotatable sections of the body part the journal bearings are conveniently of a self-aligning nature so that they automatically accommodate adjustment of the two body sections.

The invention will now be further described with reference to the accompanying drawings which illustrate, by way of example, two embodiments in accordance with the invention. In the drawings:

FIGURE 1 is an axial sectional view of one of the embodiments,

FIGURE 2 is a sectional view on the line II—II of FIGURE 1, and

FIGURES 3 and 4 are respectively sectional and part-sectional views corresponding to the views of FIGURES 1 and 2 but of the other embodiment.

In each embodiment the rolling head comprises a shank **1** by which the head in use is driven and which is attached at one end to a body part **2** which is formed with six radial cylinder bores arranged in three pairs of adjacent bores **4**, **5**. The three pairs of bores **4**, **5** are equiangularly spaced about the main rotational axis of the shank **1**. All six bores are connected at their inner ends to a central hydraulic chamber **6** which at one end is connected to a hydraulic supply conduit **7** passing centrally through the shank **1** and at the other end is sealed by an end plate **8** of the body part **2**.

The centre lines of the three bores **4** lie in a common diametral plane with respect to the rotational axis, and the centre lines of the bores **5** lie in a further common diametral plane. The centre lines of each pair of cylinders **4**, **5** lie approximately in a common plane containing the rotational axis of the shank **1**, but they are offset slightly from one another in a direction perpendicular to that plane for a purpose described hereinafter.

Within each cylinder **4** or **5** is slidably mounted a hydraulic piston **9** or **10** formed with an annular groove in which is received an O ring seal **12** which engages the wall of the respective cylinder bore. A roller **13** having integral end or stub shaft portions **14** is rotatably supported between each pair of pistons **9**, **10**, the stub shafts being rotatable in journal bearings mounted at the outer ends of the pistons. Thus each roller **13** is rotatably supported

between the corresponding pair of piston 9, 10 and the body part is cut away as at 15 to accommodate the roller. At the inner ends of the stub shafts 14 each roller 13 is formed with locating shoulders 19 which act to provide endwise location for the roller between the journal bearings. For clarity two of the pairs of pistons and the associated rollers are omitted from the views of FIGURES 2 and 4.

In the embodiment of FIGURES 1 and 2 the pistons 9, 10 are respectively formed at the outer end with a projecting lug 16 or 17 bored to accommodate plain bearing bushes 18 which provide the aforesaid journal bearings and in which the stub shafts 14 are received. As the centre lines of each pair of cylinders 9, 10 are slightly offset one with respect to the other in the axial direction of the head the result is that the rotational axis of each roller does not lie parallel to the rotational axis of the head but is slightly skewed relatively thereto. This provides a lead for the rollers so that as the head is turned within a bore being finished the lead angle of each roller results in a feeding action along the bore, each roller tending to follow a helical path corresponding to the particular lead angle.

The embodiment of FIGURES 3 and 4 differs in that the lead angle of the three rollers 13 is adjustable, a single and simple adjustment being provided common to all three rollers. To this end the body part is formed with two cylindrical sections 20 and 22; the section 20 is attached to the shank 1 and the section 22 has bolted thereto the end plate 8. The sections 20 and 22 are clamped together in an adjusted position by means of three equiangularly spaced bolts 23, with a central spigot 24 on the section 22 engaging a corresponding recess 25 in the section 20. The bolts 23 are threaded into the section 20 and pass through three arcuate slots 26 in the section 22, so that the two sections can be clamped together in any desired position of angular adjustment within the range permitted by the length of the slots 26.

The three cylinder bores 4 are formed in the body section 20 and the three cylinder bores 5 in the body section 22, the central hydraulic chamber 6 being common to both sections and hence to all six bores. It will be appreciated that if the clamp bolts 23 are slackened off the relative angular position of the sections 20 and 22 can be adjusted to vary the relative offset of the centre lines of the cylinder bores 4 and 5 with respect to the axial direction, thus providing similar adjustment of the lead angle of each roller 13. When the desired adjustment of this angle has been obtained the sections 20 and 22 are clamped firmly together by tightening the bolts 23.

The stub shafts 14 are in this embodiment supported on half bearing shells 27 in which the shafts 14 seat and which have a hemispherical outer surface 28. The shells 27 seat in complementary hemispherical bearing seatings 29 in the crowns of the pistons 9 and 10 and they are located by central dowel pins 30. The purpose of the dowel pins 30 is merely to prevent the shells 27 turning with the stub shafts 14; they are firmly fixed in the pistons 9, 10 but engage with clearance in recesses 31 in the shells 27. Thus the dowel pins do not restrain or inhibit self-aligning bearing movement.

Each rollers 13 is held captive on the corresponding pair of pistons 9, 10 by means of spring clips 32 which engage around end grooves in the stub shafts 14 and have inturned bottom ends 33 which hook into corresponding recesses 34 in the pistons. The recesses 34 provide clearance between the clips 32 and the walls of the bores 4 and 5.

As described small relative angular movement between the two body sections 20 and 22 causes relative tangential movement between the two pistons 9, 10 of each pair thereof and between each pair of spherical bearings 27. Since this movement is on an arc, and not linear, there is three dimensional relative movement and consequently pivotal movement on three orthogonal axes which are

absorbed by the spherical bearings combined with sliding movement of the stub shafts 14 in the bearing shells 27.

In use, with both embodiments the head is positioned at one end of the bore to be finished and hydraulic fluid under pressure supplied to the central chamber 6 through the supply conduit 7, thus urging the pistons and hence the rollers 13 independently into contact with the bore. The head is turned by means of the shank 1 and fed along the bore so that the complete surface thereof is rolled and thereby finished, the progressive feed of the head being caused or at least assisted by the lead angle of each roller 13. Each pair of pistons 9, 10 is able to float, with the associated roller 13, radially of the head independently of the other two pairs of pistons and the body part 2. Such floating movement accommodates any ovality or dimensional variations in the bore being finished without variation in the roller pressure which is dependent entirely on the hydraulic pressure in the chamber 6. Thus the rollers 13 float to accommodate ovality while maintaining the desired roller pressure and providing a corresponding finish.

I claim:

1. A rolling head having a rotatable body part, a plurality of rotatable rollers which are angularly spaced around an outer periphery of the body part and each of which is mounted on the body part for independent floating movement radially of the head, and two hydraulic pistons associated with each roller and slidable in separate parallel and adjacent bores in the body part, each roller being mounted between the corresponding two pistons, with rotational axes of the rollers being skewed through a small angle relatively to the rotational axis of the head to provide a "lead-in" which causes or assists the rolling head to move progresively along a bore being finished.

2. A rolling head according to claim 1, wherein each two parallel bores have axes relatively offset with respect to the direction of the rotational axis of the head, thereby providing said skewing of the rollers.

3. A rolling head according to claim 1, wherein each roller has two integrally formed stub shafts, and two journal bearings are respectively provided in the corresponding two pistons, each stub shaft being mounted in the corresponding journal bearing.

4. A rolling head having a rotatable body part, a plurality of rotatable rollers which are angularly spaced around an outer periphery of the body part and each of which is mounted on the body part for independent floating movement radially of the head, and two hydraulic pistons associated with each roller and slidable in separate parallel and adjacent bores in the body part, each roller being mounted between the corresponding two pistons, with rotational axes of the rollers being skewed through a small adjustable angle relatively to the rotational axis of the head to provide an adjustable "lead-in" which causes or assists the rolling head to move progressively along a bore being finished.

5. A rolling head according to claim 4, wherein the body part comprises two sections which are relatively rotatable, for the purpose of adjusting said small angle, about the rotational axis of the head and in each of which is slidable one piston associated with each roller.

6. A rolling head according to claim 4, wherein each roller has two integrally formed stub shafts, and two bearings are respectively provided in the corresponding two pistons, with each bearing comprising a half bearing shell in which the corresponding stub shaft seats, each shell having a hemispherical outer surface and each piston having a complementary seating in which the hemispherical outer surface of the corresponding shell seats.

7. A rolling head having a rotatable body part and a plurality of rotatable rollers which are angularly spaced around an outer periphery of the body part and each of which is mounted on the body part for independent floating movement radially of the head, rotational axes of

the rollers being skewed through a small adjustable angle relatively to the rotational axis of the head to provide an adjustable "lead-in" which causes or assists the rolling head to move progressively along a bore being finished.

8. A rolling head according to claim 7, wherein the body part comprises two sections which are relatively rotatable, for the purpose of adjusting said small angle, about the rotational axis of the head, and a plurality of pairs of pistons each pair of which carries one of said rollers with the two pistons of each pair thereof respectively slidable radially in said two body sections.

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