SURFACE GRINDING APPARATUS

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ABSTRACT
A surface grinding apparatus for grinding a flat surface of a workpiece comprising a tool head slidably mounted on horizontal hydrostatic slide surfaces of a bed for rotary movement in a horizontal circular path. A grinding wheel shaft provided with a cup-shaped grinding wheel is rotatably supported on a ram which is vertically slidably mounted in the tool head. The grinding wheel shaft may be angularly adjusted relative to the grinding surface of the workpiece in a vertical plane and the ram may be moved vertically relative to the workpiece to render infeed movement to the grinding wheel.

4 Claims, 3 Drawing Figures
SURFACE GRINDING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates generally to a surface grinding apparatus and more particularly to an improved surface grinding apparatus having a cup shaped grinding wheel.

2. Description of the Prior Art
A conventional surface grinding apparatus has used a circumferential peripheral surface of a round grinding wheel for grinding a flat surface of a workpiece and has been somewhat successful. However, a surface grinding apparatus having a cup shaped grinding wheel has not been constructed because of several problems such as the lack of high efficiency and the fear of the grinding surface of a workpiece being overheated.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved surface grinding apparatus having a cup shaped grinding wheel capable of performing a grinding operation with high efficiency and high precision.

Another object of the present invention is to provide an improved surface grinding apparatus having a cup shaped grinding wheel wherein the grinding wheel is rotated about its own axis and in a horizontal circular path by rotary movement of a tool head.

Another object of the present invention is to provide an improved surface grinding apparatus having a cup shaped grinding wheel wherein a grinding wheel shaft is angularly adjustable in a vertical plane.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description of the preferred embodiment, when considered in connection with the accompanying drawings in which:

FIG. 1 is a front view of a preferred embodiment of the present invention;
FIG. 2 is a plan view of the present invention illustrated in FIG. 1; and
FIG. 3 is an enlarged view of the principal elements of the present invention shown in FIGS. 1 and 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference characters refer to identical or corresponding parts throughout the several views, there is shown in FIG. 1 a bed at the center of which a conventional linear-type transfer device is provided for transferring workpieces W to a predetermined position thereon. On opposite ends of the bed 1 outside a machining position, hydrostatic slide surfaces 1a and 1b are respectively provided on which a tool head 3 having hydrostatic pockets 3a and 3b, respectively, on the lower surface thereof is mounted slidably in a horizontal plane. A synchronous shaft 5, seen in FIG. 2, is rotatably supported by bearing blocks 4 mounted on the tool head 3. The synchronous shaft 5 is rotated by a motor 6 fixed to the right side of the tool head 3. On opposite ends of the tool head 3, supporting blocks 7 and 8 are mounted, which rotatably support respective rotary shafts 9 and 10. Sprocket wheels 11 and 12 are respectively secured to one ends of the rotary shafts 9 and 10 and are drivingly connected to the synchronous shaft 5 through respective chains 15 and 16.

As shown in FIG. 3, vertical drive shafts 17 and 18 are rotatably supported in the supporting blocks 7 and 8, and are respectively drivingly connected to the other ends of the rotary shafts 9 and 10 through worm and worm wheel mechanisms, not shown. The lower ends of the respective drive shafts 17 and 18 pass through the lower surface of the tool head 3 and have respective circular plates 19 and 20 which are coaxially and integrally formed therewith. The circular plates 19 and 20 carry respective eccentric shafts 21 and 22 which are eccentric therewith at predetermined distances. The eccentric shafts 21 and 22 project into the slide surfaces 1a and 1b, respectively, and are rotatably supported therein. Therefore, when the motor 6 is energized, the circular plates 19 and 20 are respectively rotated about the eccentric shafts 21 and 22 whereby the tool head 3 is rotated in a horizontal circular path.

A grinding wheel head 23 is mounted on the tool head 3 being substantially centrally disposed between the slide surfaces 1a and 1b. A ram 25 is vertically movably supported in the wheel head 23 and is guided by guide shafts 24 which are slidably supported in the wheel head 23.

As shown in FIG. 2, the ram 25 is moved vertically through a worm 26 driven by a motor, not shown, a worm wheel and a pinion 28 provided in the wheel head 23 for rendering an infeed or downward movement to a cup-shaped grinding wheel 34, described hereinafter, to perform a fine grinding operation on the workpiece W.

Referring again to FIG. 3, an adjusting sleeve 29 is mounted in the ram 25 and is restrained from rotation relative thereto. The lower portion of the adjusting sleeve 29 is journaled by a spherical bearing 30 so that the adjusting sleeve 29 is angularlyadjustably supported. A grinding wheel shaft 33 is rotatably supported in the adjusting sleeve 29 through metal bearings 31 and 32. The center of the spherical bearing 30 is located on the axis of the grinding wheel shaft 33. The wheel shaft 33 carries the cup-shaped grinding wheel 34 at the lower end thereof and the upper end thereof is connected through an elastic coupling 37 to a rotary shaft of a motor 36 mounted on a support 35 to which the upper ends of the guide shafts 24 are secured. A sleeve 38 is fixed to the upper end of the ram 25. A spherical sleeve 39 having a spherical surface on the outer peripheral surface thereof is rotatably journaled on the outer peripheral surface of the upper end of the adjusting sleeve 29. Four equiangularly spaced members 40 are vertically movably inserted between the outer peripheral surface of the spherical sleeve 39 and the inner peripheral surface of the sleeve 38. Each of the four members 40 is vertically adjusted by a differential screw 42 in a plate 41 fixed to the sleeve 38 so that the adjusting sleeve 29 and the grinding wheel shaft 33 may be adjusted in perpendicular relationship with the grinding surface of the workpiece.

Energization of the motor 36 rotates only the grinding wheel shaft 33, since the adjusting sleeve 29 is restrained from rotational movement to the ram 25. At this time, the tool head 3 together with grinding wheel 34 is rotated in a horizontal circular path by energization of the motor 6 so that an effective grinding opera-
tion can be performed. Under this situation, the whole end surface of the cup-shaped grinding wheel 34 contacts the workpiece W. However, there is no fear of the grinding surface of the workpiece being overheated because of lack of enough cooling, since the amount of infeed movement in the fine grinding operation is extremely small, so that a fine finished surface of the workpiece may be obtained with high precision.

In operation, by adjusting the differential screws 42, the axes of the adjusting sleeve 29 and the grinding wheel shaft 33 are adjusted to be perpendicular to the grinding surface of the workpiece. The motor 6 is then energized so that the circular plates 19 and 20 are rotated about the eccentric shafts 21 and 22, thereby to rotate the tool head 3 in a horizontal circular path. Since the tool head 3 is supported on the slide surfaces 1a and 1b outside a machining position, slight tilt of the tool head 3 because of variation in thickness of the lubrication oil film does not affect the finish accuracy of the workpiece in the machining position. Energization of the motor 36 causes rotation of the grinding wheel shaft 33. Under this situation, where the tool head 3 and the wheel shaft 33 are rotated in a horizontal circular path and at the same time wheel shaft 33 is rotated about its own axis, the ram 25 is moved vertically through the worm 26 rotated by energization of the motor so that the grinding wheel 34 is rendered an infeed movement to perform a fine grinding operation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A surface grinding apparatus for grinding a flat surface of a workpiece comprising:
   a bed for holding the workpiece in a machining position, said bed being provided with horizontal hydrostatic slide surfaces;
   a tool head slidably mounted on said horizontal hydrostatic slide surfaces of said bed for rotary movement in a horizontal circular path;
   driving means for moving said tool head in said horizontal circular path;
   a ram vertically slidably mounted on said tool head;
   a grinding wheel shaft rotatably supported in said ram and provided with a cup-shaped grinding wheel at the lower end thereof;
   means for angularly adjusting said grinding wheel shaft relative to the grinding surface of the workpiece in a vertical plane;
   driving means for rotating said wheel shaft; and
   means for vertically moving said ram relative to the workpiece to render infeed movement to said grinding wheel.

2. A surface grinding apparatus according to claim 1, wherein said driving means for moving said tool head comprises:
a synchronous shaft rotatably supported on said tool head;
supporting blocks mounted in said tool head;
a driving shaft rotatably supported in each of said supporting blocks and drivingly connected to said synchronous shaft to be rotated in a horizontal plane, said drive shaft passing through the lower surface of said tool head and carrying an eccentric shaft which is eccentric therewith at a predetermined distance;
and said eccentric shaft projecting into said slide surface and being rotatably supported therein.

3. A surface grinding apparatus according to claim 1 further comprising a grinding wheel head being mounted on said tool head, and wherein said ram is slidable in said wheel head and said driving means for said wheel shaft is mounted on said ram and is drivingly connected to said wheel shaft at the upper and thereof.

4. A surface grinding apparatus according to claim 3, wherein said means for angularly adjusting said grinding wheel shaft comprises:
an adjusting sleeve mounted in said ram and restrained from rotation relative thereto, said adjusting sleeve rotatably supporting said grinding wheel shaft and the lower portion thereof being journaled in said ram through a spherical bearing;
a spherical sleeve having a spherical surface on the outer peripheral surface thereof and being rotatably journaled on the outer peripheral surface of the upper end of said adjusting sleeve;
a plurality of spaced members vertically movably inserted between the outer peripheral surface of said spherical sleeve and the inner peripheral surface of said ram; and
means for vertically adjusting each of said spaced members.