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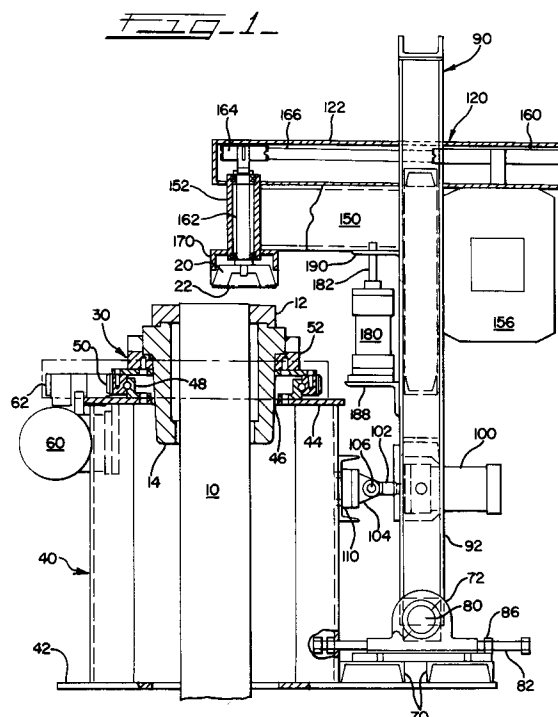
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London WC2B 6UZ(GB)(54) **Method and apparatus for grinding the end of a tubular workpiece.**

(57) In a grinding apparatus, an end of a tubular workpiece (10) is finished, preferably with a chamfer, by grinding while the workpiece is positioned in a holder (14) and rotated about the workpiece axis. A rotatable grinder (22) is carried by a carriage (90) that pivots the grinder in a plane that is radial to the axis whereby the grinder is moved between operative and inoperative positions. In a preferred arrangement, the grinder (22) is lowered into engagement with the workpiece by an actuator (180) acting against a constant upward biasing force.

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This invention relates to an improved method and apparatus for finishing the end of a tubular workpiece, and more particularly to a method and apparatus wherein a finishing tool is pivotable outwardly to permit insertion of a tubular workpiece into a rotatable holder.

There is a known technique for casting articles from molten metal, commonly referred to as bottom pressure casting, wherein molten metal in an enclosed ladle is pressurized and forced upwardly through a refractory pouring tube and into the bottom of a mold. When the mold is filled it is closed with a stopper and removed from the pouring tube. The pouring tube itself must be frequently replaced but is normally usable to successively supply a large number of molds. The upper end of the pouring tube must closely fit the mold bottom to prevent leakage of molten metal at that juncture and is preferably chamfered. Also it is necessary to encircle the upper end of the pouring tube with a cylindrical backing (known as a tube holding casting) and an annular reinforcement (known in the trade as a tube parting ring) that also must abut the mold bottom. Consequently, the pouring tube end must be carefully finished by grinding or the like, after the annular reinforcement and cylindrical backing are mounted thereon; and the outer edge of the tube end must be accurately finished to be flush with the upper face of the parting ring reinforcement.

Furthermore, such pouring tubes are sizeable pieces of equipment. For instance in an installation for casting railcar wheels the pouring tubes are 6 1/2 inches in diameter and several feet long. Heretofore the tube ends have been finished by hand held grinders. Thus it will be understood that it has been difficult to position such a workpiece for end finishing; and it has also been difficult to properly posture and maintain a finishing tool to obtain an accurate chamfered end on the workpiece.

Accordingly, it is an object of the present invention to provide an improved method and apparatus for positioning a tubular workpiece and accurately finishing an end thereof.

Briefly stated the present invention involves the inserting of a tubular workpiece in an axial direction into an annular holder, pivoting a finishing tool, in a direction preferably radial to the holder, and workpiece to a posture over the workpiece, extending the finishing tool in a generally longitudinal direction against the workpiece end while rotating the workpiece about its longitudinal axis and thereafter withdrawing and pivoting the tool in an opposite direction to permit extraction of the workpiece in an axial direction from the annular holder. A preferred apparatus to perform the foregoing steps comprises an upstanding base with an annular workpiece holder rotatably mounted on the base, a

carriage pivotally mounted to one side of the base for pivotal movement substantially radially of the annular holder, tool means reciprocally mounted on the carriage, and power means connected between the base and carriage to pivot the latter.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

FIGURE 1 is a side elevation view of a preferred embodiment of the invention with certain parts in section for clarity; and

FIGURE 2 is an end elevation view of the apparatus of FIGURE 1.

The preferred embodiment of the invention was devised to finish the end of a six and one half inch (6 1/2") diameter molten metal pouring tube 10, made of a refractory material, and thereby provide an accurate planar inner end edge with a slight chamfer downward from the inside tube surface to the outside surface. It will be seen in FIGURE 1 that the end of the tube 10 is, prior to the finishing operation, encircled by a reinforcing tube parting ring 12 and tube holding casting 14; and it is required that the finishing operation place the outer edge of the end chamfer even with the axial face of the parting ring. The finishing tool is a carborundum grinding disk generally 20 having a flat circular abrasive face 22 that is spun at high speed about the disk axis.

The devised method begins with positioning the pouring tube 10 by inserting it into an annular holder generally 30 and then rotating the tube 10 about its axis. After inserting the tube 10 the finishing tool is operatively located by moving it inwardly from an inoperative posture, to one side of the tube 10, in a direction radial to the tube axis to an operative posture with the finishing tool opposing but spaced from the tube end; while simultaneously exerting a biasing force to move the tool away from the tube end. Preferably the tool is moved radially into the operative posture by swinging or pivoting it about a point to one side of the tube 10 and in a plane containing the axis of the tube so as to maintain the axis of the grinding disk 20 in that plane and thereby assure that the abrasive face 22 is maintained perpendicular to a plane containing the tube axis. The swinging or pivoting movement of the tool also enables limiting the inward movement and thereby placing the axis of the tool at a slight angle to the axis of the tube 10 at the operative posture, which angle will establish the chamfer placed on the finished tube end. The procedure is then continued by extending the tool into contact with the tube end while both rotating the tube 10 and spinning the grinding disk 20.

Preferably the tool is extended by applying fluid pressure sufficient to overcome the aforementioned biasing force and to urge the tool against

the tube end. As the tube rotates unevenness at the workpiece end will cause fluctuation of the reaction against the tool and hence cause unevenness in the fluid pressure. The rotating of the tube and spinning of the tool are continued at least until the pressure becomes constant thereby indicating that an even finish of the workpiece end has been achieved. At that point the procedure is concluded by terminating the fluid pressure overcoming the biasing force, thereby withdrawing the tool away from the tube end, then returning the tool to the inoperative posture by swinging or pivoting it in the axial plane, and finally extracting the tube 10 in an axial direction from the annular holder 30.

A preferred apparatus for carrying out the method includes an upstanding fixed frame generally 40 supported on a floor 42 or the like. The frame has a top 44 with a circular opening 46. Concentric with the opening 46 are an annular bearing raceway 48 and an annular ring gear 50 supported therein. The annular holder generally 30 is secured to the ring gear 50 and includes a chuck 52 to center and secure the pouring tube generally 10, including parting ring 12 and holding casting 14, therein. The floor beneath the fixed frame 40 may also have an opening directly beneath circular opening 46 in frame top 44 to permit the processing of long workpieces.

An electric motor 60 is fastened to the frame 40 and a gear reducer 62 connects the motor shaft to the annular ring gear 50 to cause the latter to rotate in the raceway 48 and thereby rotate any workpiece centered in the chuck 52 about the workpiece axis.

A flat base or pedestal 70 rests on the floor 42 immediately to one side of the fixed frame 40. A pair of spaced trunnions 72, 74 are slidably supported on the base 70 for adjustment toward and away from the fixed frame 40; and a pivot shaft or axle 80 is rotatably held in the trunnions 72, 74 to be perpendicular to the axis of rotation of both the ring gear 50 and workpiece, and also perpendicular to a radius of the workpiece that bisects the shaft 80. Threaded bolts 82, 84 extend through the respective trunnions 72, 74 and into the fixed frame 40. A plurality of adjustable nuts 86 on the bolts 82, 84 provide for accurately positioning and securing the trunnions, 72 74 with respect to the frame 40.

A pivotable carriage generally 90, comprising a pair of upstanding channel members 92, 94 and one or more cross members 90 fixed to the channels, is supported on the shaft 80 so as to be pivotable toward and away from the fixed frame 40. Each respective channel member 92, 94 is connected to the shaft 90 closely adjacent a trunnion 72, 74; and a power cylinder 100 is fastened centrally to a cross member 96 with its reciprocal rod 102 extending toward the fixed frame 40 where it is

connected by a clevis 104 and pin 106. The clevis 104 is detachably fastened to the frame 40 so that a selectable shim 110 is insertable therebetween. It will be understood that operation of the power cylinder 100 will cause the carriage generally 90 to swing inwardly and outwardly of the fixed frame 40; and, assuming full throw of the rod 102, the relative positions of the clevis pin 106 and pivot shaft 80 will fix the inward and outward angular positions of the carriage 90.

A movable platform generally 120 is carried between the channel members 92, 94 of carriage 90 at a level above the chuck 52 and workpiece therein. The platform 120 includes a cross arm 122 that extends between and is perpendicular to the channels 92, 94 and a depending plate 124 fastened to the underside of cross arm 122 and extending parallel to the channels. Four casters 128 bolted to the channels 92, 94 engage opposite edges of the plate 124 and confine its movement to parallel the channels. Compression springs 132, 134 are secured between brackets 138, 140 on each edge of the plate 124 and opposing brackets 142, 144 fastened to the respective channels 92, 94 and bias the platform 120 upwardly.

A beam 150 extends beneath cross arm 122 from the center of one side of the depending plate 124 to a cylindrical casing 152 at the end over the fixed frame 40. An electric tool driving motor 156 is mounted to the opposite side of the depending plate 124 with its drive shaft 158 and drive pulley 160 disposed upwardly. A tool drive shaft 162 extends through the casing 152 and a pulley 164 thereon is drivingly connected to the motor pulley 160 by a belt 166. It is important that the tool drive shaft 162 is aligned to be maintained in a plane that contains the workpiece axis. That is accomplished by centering shaft 162 with respect to the carriage 90 and positioning the trunnions 72, 74 equally spaced from the workpiece axis. The finishing tool such as grinding disk 20, is connected to the lower end of tool drive shaft 162 and is preferably partially enclosed by a shroud 170 held beneath the beam 150. A suitable exhaust manifold (not shown) may be connected to the shroud 170 to collect particulate material during a finishing operation.

The platform generally 120, with motor 156 and grinding disk 20 are moved parallel to the carriage channels 92, 94 by a fluid cylinder 180 and reciprocable piston rod 182 connected between an angle 188 fastened between channels 92, 94 on the carriage generally 90 and an angle 190 on the platform depending plate 124. The cylinder is connectable to a suitable pressurized fluid supply (not shown - preferably pneumatic) and is operable to pull the platform 120 downwardly with a controllable force overcoming the bias of the compression

springs 132, 134 and against the reaction of the workpiece (tube 10) against the flat grinding face 22 of grinding disk 20.

Thus in operating the aforescribed apparatus, starting with the carriage 90 being tilted away from the fixed frame 40 to an inoperative posture by actuating power cylinder 100 to extend its reciprocable rod 102, a pouring tube 10 is first inserted into the annular holder 30 and the chuck 52 is secured. The electric motor 60 is then energized to rotate the tube 10 about its axis. At the same time the power cylinder 100 is reversed to swing the carriage 90 inwardly toward the frame 40 and thereby to an operative posture with the grinding disk 20 located directly above the tube 10 and the abrasive face 20 thereof held at a slight angle, to chamfer the tube end, in accordance with the attitude of carriage 90 pre set by shim 110 and the adjustment bolts 82, 84. The tool driving motor 156 is energized and pressurized fluid is introduced to the upper end of cylinder 180 to lower the platform generally 120 thereby extending the spinning grinding disk 20 downwardly until the abrasive surface 22 engages the end of tube 10. When grinding is complete the fluid is released from cylinder 180 and compression springs 132, 134 will cause the platform 120 and grinding disk 20 to be withdrawn upwardly. The tool driving motor 156 may be deenergized and the power cylinder 100 is again activated to extend its rod 102 thereby swinging the carriage 90 outwardly to the inoperative position moving the grinding disk 20 completely clear of the annular holder generally 30 and the tube 10 held therein. At that point the tube is extracted upwardly and a new workpiece inserted downwardly.

The foregoing details have been provided to describe a preferred embodiment of the invention and further variations and modifications may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. A method for finishing an end of a tubular workpiece, said method comprising:
 - inserting a tubular workpiece in an axial direction into an annular holding means with one end of said workpiece disposed upwardly thereof;
 - pivoting a finishing tool, in a direction preferably radial of the workpiece axis, from a first inoperative posture at one side of said workpiece to a second operative posture opposite and spaced from said one end;
 - rotating said workpiece about its longitudinal axis;
 - extending said finishing tool from said op-

erative posture into engagement with said one end;

holding said finishing tool against the end of the rotating workpiece until an even end is finished thereon;

withdrawing said finishing tool from said workpiece to said operative posture;

pivoting said finishing tool, in a direction preferably radial to said workpiece axis, from said operative posture to said inoperative posture;

and extracting said workpiece axially from said holding means.

2. The method of claim 1 including exerting a constant biasing force on said finishing tool in a direction away from the workpiece and extending the finishing tool toward said workpiece by applying pressure sufficient to overcome said constant biasing force.
3. The method of claim 1 or 2 wherein an axis of said finishing tool and the axis of said workpiece are maintained in a common plane during all of the steps of the method.
4. A finishing apparatus for facing a tubular-like workpiece, said apparatus comprising:
 - an annular holding means for receiving said workpiece;
 - means for rotating said holding means connected thereto;
 - tool carrying means for reciprocally holding a finishing tool, said tool carrying means being mounted adjacent said holding means and being pivotable, in a direction preferably radial to said holding means, and a workpiece therein between a first inoperative posture to one side of said holding means and a second operative posture opposite a workpiece in said holding means;
 - biasing means connected to said tool carrying means for constantly urging said carrying means away from said holding means; and
 - reciprocable means connected to said tool carrying means for overcoming said biasing means whereby to reciprocate said finishing tool with respect to said holding means, and a workpiece therein, when said tool carrying means is in said second operative position.
5. The apparatus of claim 4 wherein the finishing tool is a grinding wheel that spins about a tool axis and said tool carrying means maintains the tool axis in a plane containing the axis of a workpiece rotating in said holding means.
6. The apparatus of claim 4 or 5 wherein said tool

carrying means includes a pivotable carriage and an arm reciprocally carried on said pivotable carriage.

7. The apparatus of claim 6 wherein said biasing means is connected between said pivotable carriage and said arm. 5
8. The apparatus of claim 6 or 7 wherein said arm is maintained radial to an axis of said annular holding means. 10
9. The apparatus of claim 6, 7 or 8 wherein both said biasing means and said reciprocable means are connected between said pivotable carriage and said arm. 15
10. The apparatus of any of claims 6 to 9 wherein the finishing tool is a grinding wheel that is mounted at an end of said arm spaced from said carriage to spin about a tool axis and the tool axis is maintained in a plane containing the axis of a workpiece rotating in said holding means. 20
11. A grinding apparatus for facing a tubular like workpiece, said apparatus comprising: 25
 - a base for mounting to a workplace floor;
 - a fixed frame upstanding adjacent said base; 30
 - an annular holding means positioned on said fixed frame, said holding means to receive and retain an end of said workpiece;
 - a carriage pivotally connected to said base adjacent said fixed frame, said carriage extending beyond said annular holding means and workpiece therein and being pivotable in a direction preferably radial of said annular holding means, between a first position angled away from said fixed frame and a second position proximate said fixed frame; 40
 - an arm extend from said carriage over said fixed frame when said carriage is in said second position, said arm being mounted for reciprocable movement on said carriage; 45
 - a tool mounted on said arm spaced from said carriage, said tool extending toward said holding means and said workpiece therein when said carriage is in said second position;
 - first reciprocable power means connected to move said arm on said carriage; and 50
 - second reciprocable power means connected to pivot said carriage between said first and second positions whereby at said first position said tool will be removed sufficiently to one side of said holding means to enable a workpiece to be withdrawn and replaced respecting said holding means. 55

12. The apparatus of claim 11 wherein said second reciprocable power means is adjustable to set said second position at a minor angle with respect to said fixed frame whereby to hold said tool at a minor angle with respect to the face of said workpiece.

13. The apparatus of claim 11 or 12 wherein said annular holding means is rotatable on said fixed frame whereby to rotate a tubular workpiece about its axis.

14. The apparatus of claim 11, 12 or 13 including compression spring means mounted between said carriage and said arm to bias the arm in one direction and wherein said first reciprocable power means is connected to move said arm in an opposite direction.

15. The apparatus of claim 14 wherein said compression spring means biases said arm in a direction away from said annular holding means and said first power means is a fluid cylinder connected between said arm and said carriage to drive said arm toward said annular holding means.

16. The apparatus of any of claims 12 to 15 wherein said second power means is a fluid cylinder connected between said carriage and said fixed frame.

17. The apparatus of claim 16 wherein said fluid cylinder is adjustable by a shim that is mountable between said power cylinder and one of said fixed frame and said carriage.

Fig. 1

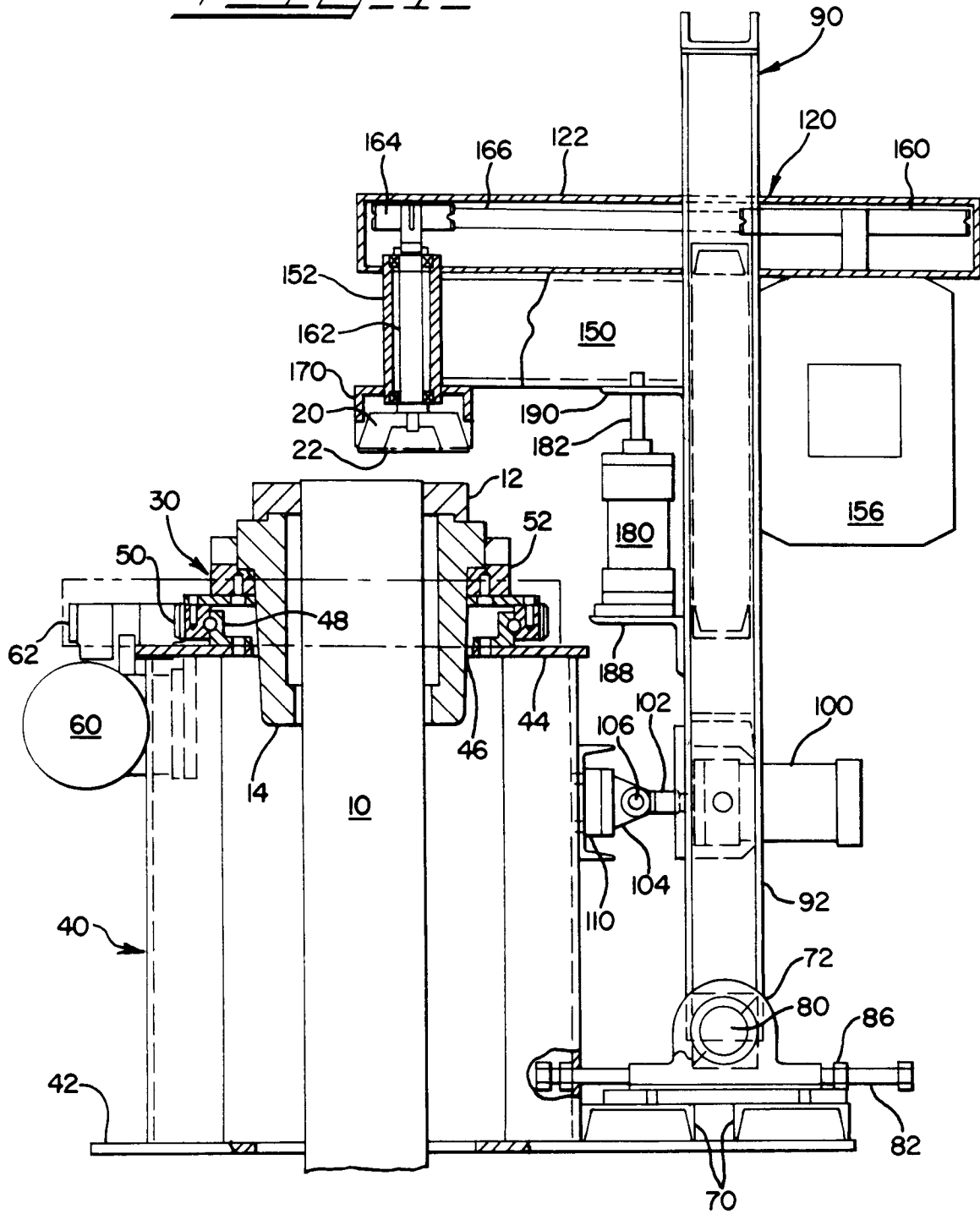


FIG. 2

