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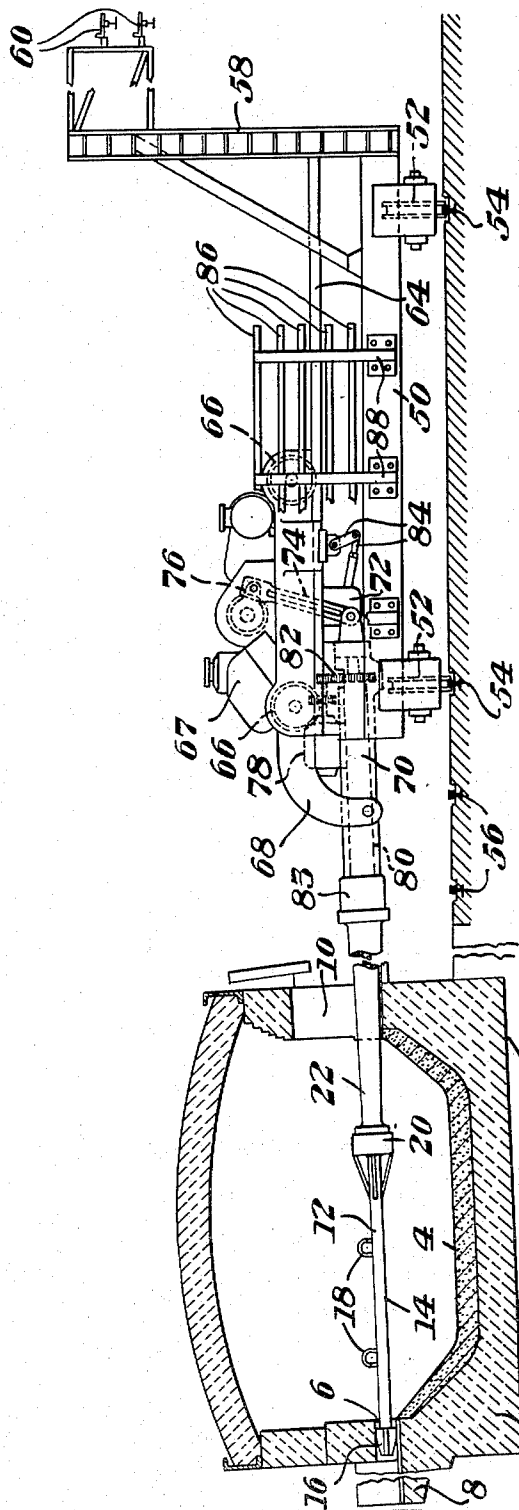
S. W. KEMOCK
TAPPING HOLE REAMER

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2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

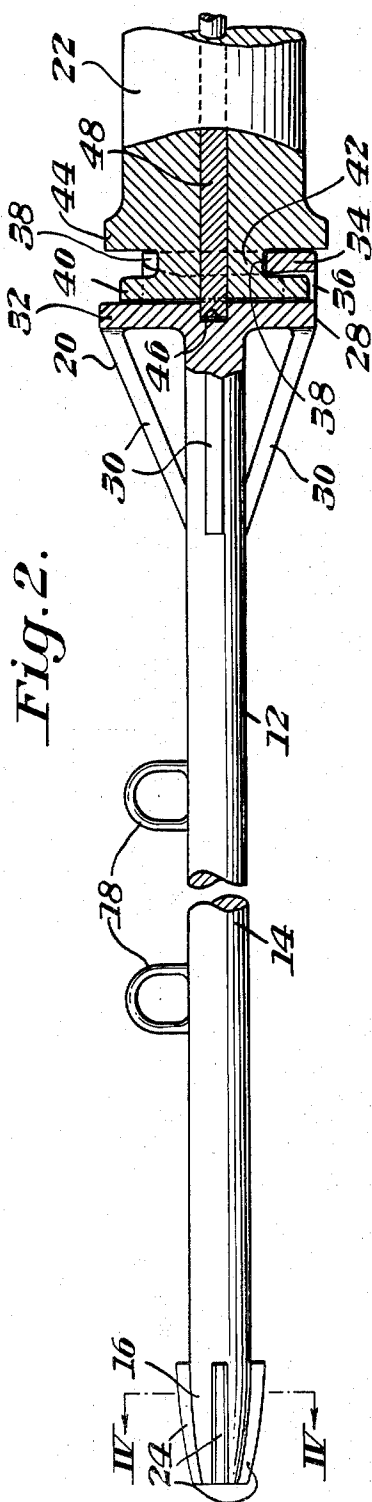
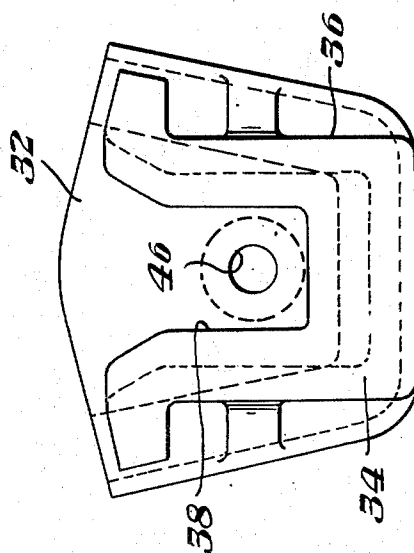
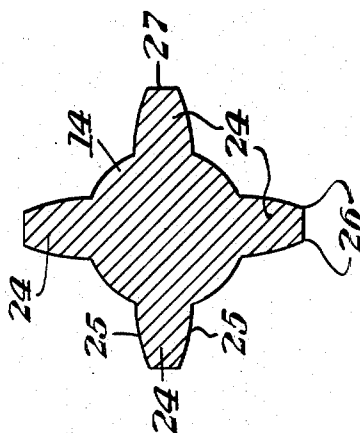


Fig. 2.



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UNITED STATES PATENT OFFICE

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TAPPING HOLE REAMER

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1 Claim. (Cl. 266—42)

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This invention relates to apparatus for reaming the tapping hole or other similar opening in the wall of a furnace.

The invention has among its objects the provision of a reamer adapted to be mounted on and operated by apparatus conventionally used in the operation of furnaces.

A further object of the invention is the provision of a reamer operable from the inside of the furnace, thereby reaming the tap hole or similar furnace opening without injury to the furnace lining.

These and further objects of the invention will be made apparent in the following description.

Metallurgical furnaces, such as electric furnaces, open hearth furnaces and the like are provided with tap holes or similar openings which are in contact either continuously or intermittently with the molten bath of the metal melted in the furnace. Such holes, which extend through the firebrick or other refractory lining of the furnace and out through the metal shell thereof, thus tend to become constricted or closed after a period of use by an accumulation of metal and slag in the hole. When the hole has been substantially constricted, it must be enlarged to its original size to permit the pouring of metal from the furnace. It has been the practice heretofore to ream the tap hole by using long bars inserted in the opening from the pouring side of the furnace to pry loose or otherwise remove the deposited metal and slag from the hole. Since the force exerted by such bars is in an inward direction, it tends to break or dislodge the refractory bricks of the furnace lining in the vicinity of the hole. Injury to the bricks also resulted from the use of rotary tools advanced from the pouring side of the furnace, which have occasionally been tried, since here again the force exerted was in an inward direction.

My invention overcomes such difficulties and provides a convenient and easily operated apparatus which may be used without injury to the furnace lining, since it approaches the tap hole or similar opening from a position initially within the furnace with a rotary cutting action and since the relatively small force it exerts axially of the hole in the furnace lining tends to thrust the lining against the supporting shell of the furnace. My improved reaming apparatus will be more fully understood by reference to the accompanying drawings, in which:

Figure 1 is a cross-section through a furnace showing a side elevation of the reaming apparatus mounted on a furnace charging machine;

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Figure 2 is an enlarged view in side elevation of the reamer and the charging machine ram, with parts in section;

Figure 3 is an end elevation of the reamer showing the means by which it is connected to the supporting and operating mechanism; and

Figure 4 is a cross section of the cutting head of the reamer taken along the line IV—IV in Figure 2.

The reaming apparatus of the present invention is, as above stated, capable of use with various types of furnaces having openings therein which must periodically be cleaned and restored to their original size. Among furnaces of this type are electric furnaces, both arc and induction, and open hearth furnaces. For purposes of illustrating the invention, the reaming apparatus is shown in connection with an electric arc furnace. In Figure 1, such furnace, there designated 2, is shown somewhat schematically in cross section and without the electrodes, which project through the roof thereof. The furnace shown is of the tilting type, having a hearth 4 for containing the bath of molten metal and a tapping hole 6 located somewhat above the slag line of the furnace when the furnace is in horizontal operating position. The hole 6 is normally closed during the melting and refining operation by means of a refractory brick or with a loose refractory material which can be poked out by use of a rod from the outside of the furnace before pouring. When the furnace charge is ready to be poured, the furnace is tilted to lower the tapping hole, whereupon molten metal flows through the hole into pouring spout 8 from which it passes to a ladle (not shown).

The furnace is initially charged through a door 10 which is located in the wall of the furnace diagonally opposite the tapping hole. The furnace 2 is shown in Figure 1 as having had the tapping hole thereof reamed by my improved reamer after the metal has been poured from the hearth thereof and the furnace tilted sufficiently to bring the axis of the tapping hole at least substantially into line with the shank 14 of the reamer designated generally by the reference character 12, held in operative position by the supporting operating means subsequently to be described. Reamer 12 is provided with tapered radial blades 24 formed on a forward cutting head 16 having a maximum effective diameter at the rear end thereof substantially equal to the original size of the tapping hole. In operation, the reamer is thrust through the charging door and into the tapping hole from the inside of the

furnace. On rotation, it cuts away the deposited metal and slag from the tapping hole and restores it to its original size.

The reamer shank has lifting eyes 18 for the reception of a sling to facilitate suspension by a crane, and is provided at the rear end thereof with a head 20 adapted to be detachably mounted on the forward end of a supporting and operating means, such as the ram 22 of a furnace charging machine. The construction of the reamer is more fully shown in Figures 2, 3 and 4. As shown in Figures 2 and 4, the cutting head of the reamer is in this instance provided with four substantially radially extending cutting blades 24 tapered at the forward ends thereof to permit their ready entry into the tapping hole and to allow the gradual enlargement of the hole as the reamer travels therethrough. The cutting head is made of a hard, heat-resisting alloy so that it may operate at elevated temperatures, since the tapping hole is reamed while the furnace is hot. Blades 24, in the modification illustrated, have somewhat rounded side faces 25, the bases of which are thicker than the outer edges thereof, and flat outer edges 27. Corners 26, formed by the intersections between the sides and the outer edges of the blades, are made sufficiently sharp to insure the efficient cutting away of the deposits from the sides of the tapping hole. Sufficient space is provided between adjacent blades to accommodate the dislodged deposits without jamming the tool. The rounded symmetrical side faces 25 of the blades have been found to be effective in preventing any tendency of such material to become attached to the cutting head regardless of the direction in which the reamer is rotated.

The head 20 at the rear end of the shank of the reamer is shown in Figures 2 and 3. It consists essentially of a transverse plate 32 welded or otherwise attached to the rear end of shank 14 and suitably braced therefrom by radial webs 30. A yoke 34 has a flange 35 welded to plate 32. This provides a socket open at one side for accommodating a flange 40 on the charging machine ram 22. The flange 40 of the ram 22 is received in the space between the plate 32 and yoke 34, as shown, the relationship of the parts being such that shoulder 44 on the charging machine ram 22 fits snugly against the outer surface of the yoke 34. The reamer is locked in place on the end of the ram by means of the blind hole 45 in plate 32, into which the end of locking rod 48, axially slidable in ram 22, may be advanced.

In Figure 1 the reamer is shown supported and operated by a furnace charging machine. Operation of the reamer by such device offers the greatest advantages, since furnaces of the types indicated are conventionally provided with such machine. It is to be understood, however, that other supporting and operating apparatus for the reamer may be employed, provided such device supports the reamer rigidly and accurately, has means for advancing it into and through the tapping hole from the inside of the furnace, and provides means for rotating the reamer during such advance. The overall length of the reamer is preferably somewhat greater than one-half the width of the furnace.

The charging machine shown in Figure 1 consists of a large base frame or bridge 50 mounted on wheels 52 for travel on rails 54 in front of the furnace and extending transversely of the line from the tapping hole centrally through the door 10. Bridge 50 may be traversed on tracks 54 by

means of an electric motor or motors, not shown, which receive power from rails 60 through collector shoes located on the upright structure 58 at the rear end of the bridge. Located on bridge 50 transverse to its direction of movement are rails 64 upon which a frame or trolley travels by means of wheels 66, an electric motor, not shown, driving such wheels through gearing indicated generally at 67. The trolley is provided at the front end thereof with a downwardly extending fork 68 to which is pivoted a cylindrical sleeve 70, whereby the sleeve may be rotated about the pivot in limited amounts, to carry the forward end of the sleeve above and below the horizontal.

Attached to the rear end of the sleeve 70 is a casing 72, the rear end of which is provided with a clevis to which link 74 is attached, the upper end of said link being connected to the crank pin of crank 76 which may be rotated at slow speed by a motor, not shown, whereby the forward end of the sleeve 70 may be either elevated or depressed. Carried upon casing 72 is a ram twist motor 78, which is connected to a shaft 80 within the sleeve 70 by means of gearing indicated generally at 82, whereby the shaft 80 may be rotated intermittently or continuously, as desired, in either direction. Ram 22 is removably attached to the forward end of shaft 80, at the forward terminus of sleeve 70, by means of the coupling means shown generally at 83. Linkage 84 attached to the rear end of casing 72 provides for the reciprocation of locking rod 48, whereby the reamer connecting means may be locked to or unlocked from the forward end of the ram 22. Power is supplied to the various motors on trolley 62, and the control circuits for such motors are completed, by means of rails 86 supported on the bridge by means of vertical supports 88, and collector shoes on the trolley in contact with the rails.

A charging machine of the type above described is well adapted for operation of the reamer and obvious advantages result from utilizing such existing equipment and an operator skilled in its control for supporting the reamer, for presenting it to the tapping hole, and for operating upon the same.

The reamer of the present invention may be utilized in the reaming of a furnace tapping hole in the following manner:

After the furnace melt has been poured, the furnace, if it is of the tilting electric arc type, may be tilted if necessary to bring the tapping hole into proper alignment. The reamer 12, disconnected from the charging machine, is then positioned by means of an overhead crane or other auxiliary lifting means or by means of the end of ram 22 engaging a sling between eyes 18, so that the forward end extends partially into the furnace through door 10 and the rear connecting end is supported on a stool or blocking in front of the furnace at the proper height. Before the start of the reaming operation the cars on rails 56 for carrying charging boxes are moved out of a position in front of the furnace door. The charging machine is then operated to bring it into alignment with the furnace door, and to advance the ram toward the furnace sufficiently to allow connection to be made between the forward end of the ram and the reamer connecting means 20. After the reamer has been attached and secured in place by the locking rod, the operator then advances trolley of the charging machine to thrust the forward end of the cutting head 16 into the inner end of the tapping hole.

Ram twist motor 78 is then actuated, preferably quite slowly, at least at first. The turning of the reamer may be effected in either direction since the cutting blades thereof are symmetrical. In some instances, it may be preferred to give the reamer a rocking motion, that is, to rotate it a few revolutions in one direction and then to reverse its direction of rotation. Usually, however, it is sufficient to allow the reamer to rotate slowly in one direction while slowly racking the trolley forward, so as to thrust it gradually deeper into the tapping hole and thus finally to cause the cutting head to travel through the tapping hole and to clear it throughout its length.

Use of my improved reamer has resulted in a marked increase in the total life of the furnace lining, and a reduction in the number of repairs which must be made thereto, particularly in the vicinity of the tapping hole, during its life. The reamer is simple and rugged, and when used in conjunction with existing apparatus, such as the charging machine, it requires only a small amount of time to ream the tapping hole to restore it to its original size.

Having thus fully described the invention and its manner of operation, I desire to claim as new the following.

I claim:

Apparatus for reaming the tap hole of a melting furnace having a refractory lining, a charging door in the front wall and a tap hole in the rear wall, said apparatus comprising a charging machine outside of the front of the melting furnace and having a ram, means for advancing and

retracting the ram through the furnace charging door and means for rotating the ram, and a tap hole reamer having means at one end for detachably securing the same to the ram of the charging machine to be advanced and retracted through the furnace charging door and rotated by the ram and having a cutting head at the other end, the tap hole reamer being of such length that, on advancing the ram through the furnace door with the reamer attached thereto, the cutting head of the reamer is fed through the tap hole from the interior of the furnace outwardly and rotated for reaming deposited metal and slag from the tap hole without injuring the furnace refractory lining.

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