June 22, 1965 J. D. DRAPER 3,190,629

BLAST FURNACE TAPPING RIG

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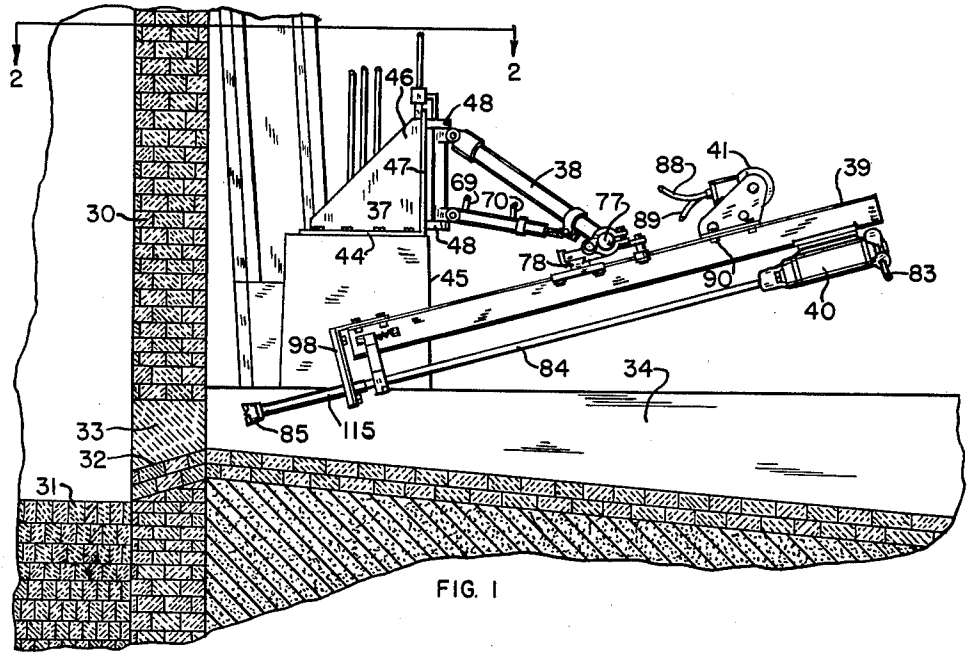


FIG. 1

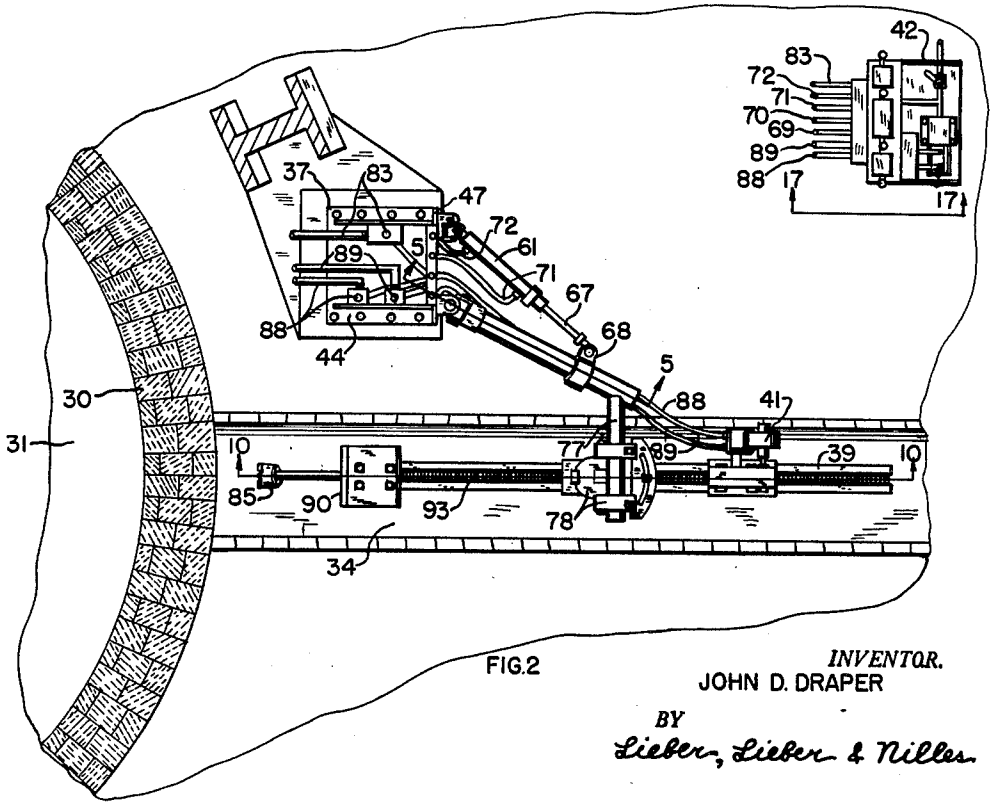


FIG.2

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BLAST FURNACE TAPPING RIG

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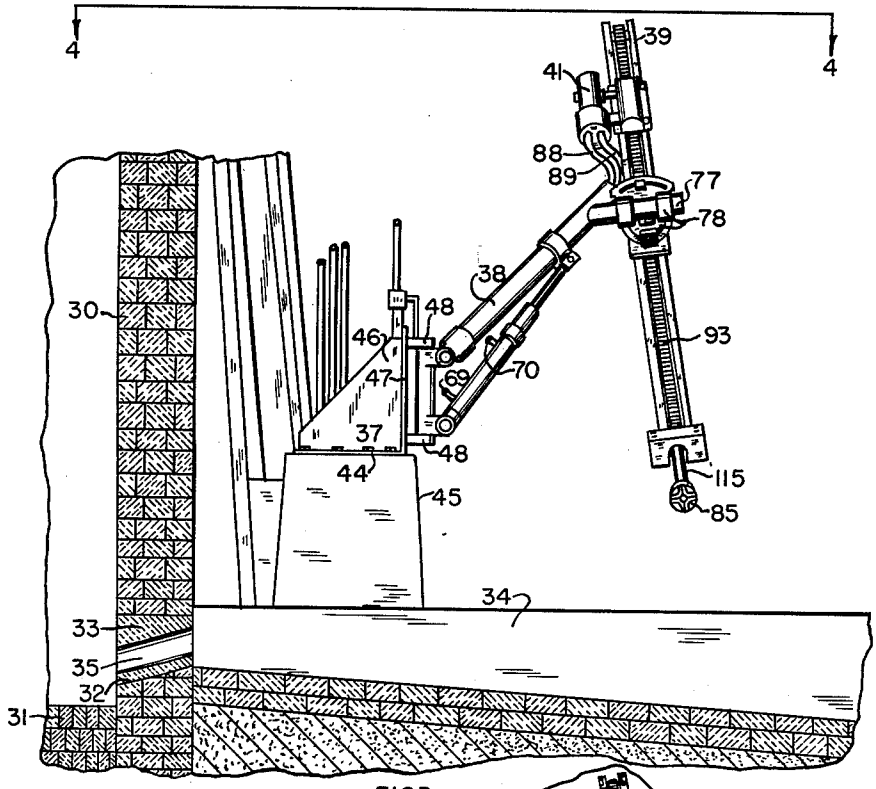


FIG.3

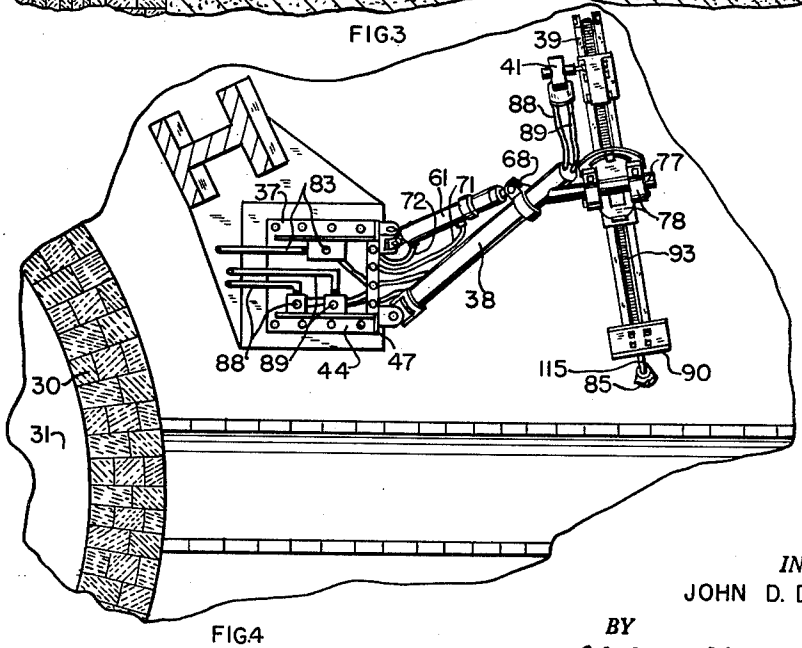


FIG.4

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BLAST FURNACE TAPPING RIG

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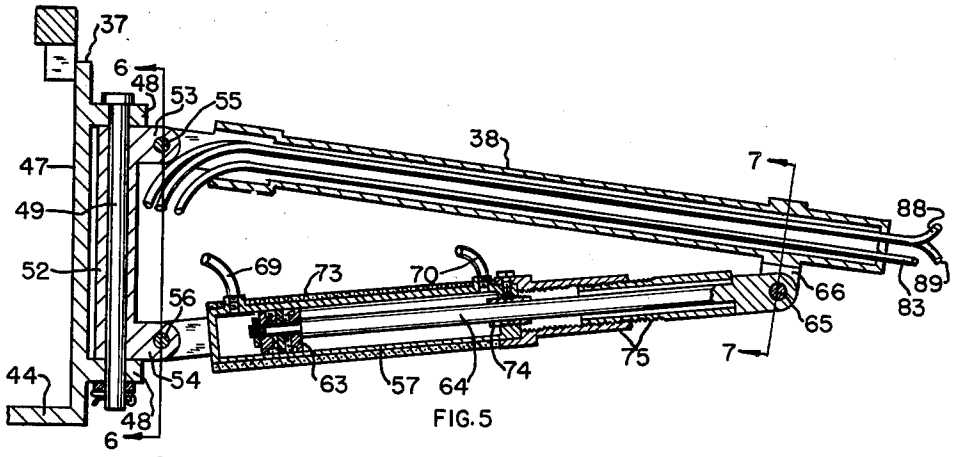


FIG. 5

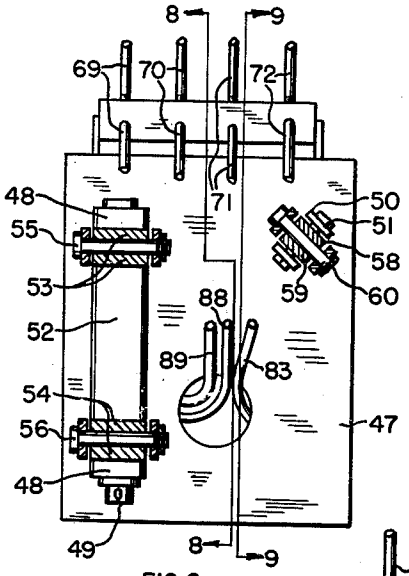


FIG. 6

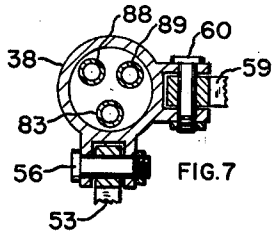


FIG. 7

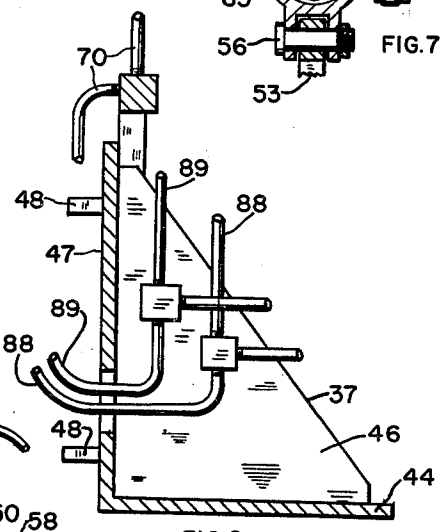


FIG. 8

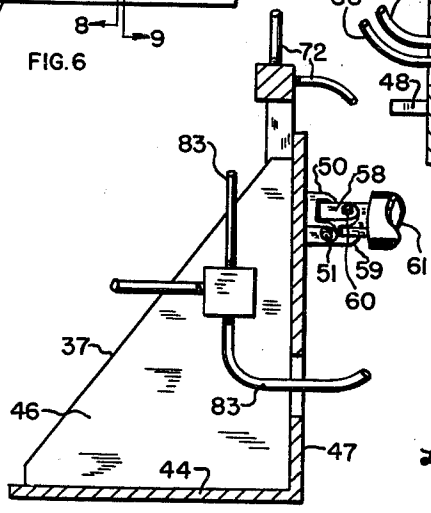


FIG. 9

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BLAST FURNACE TAPPING RIG

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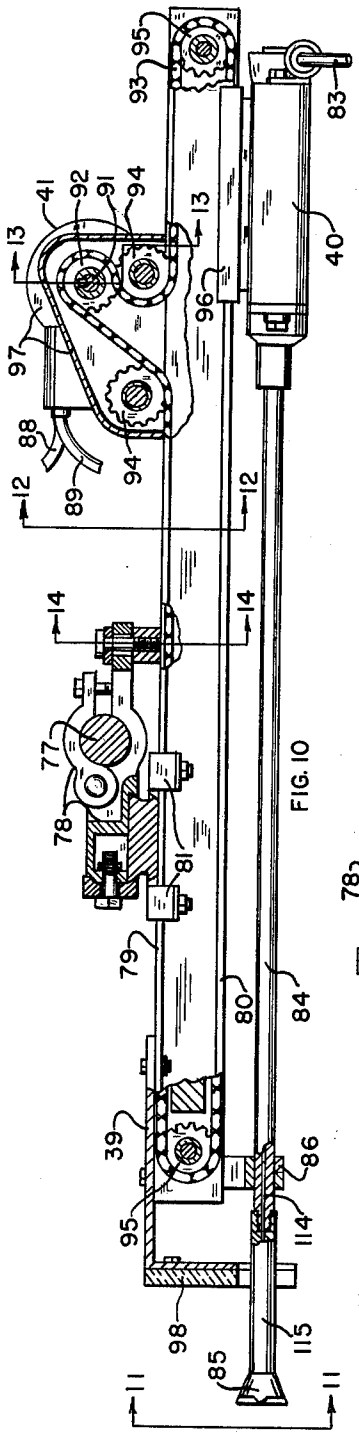


FIG. 10

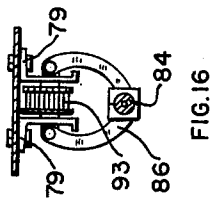


FIG. 16

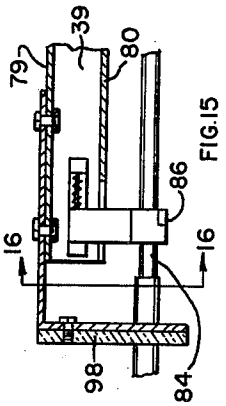


FIG. 15

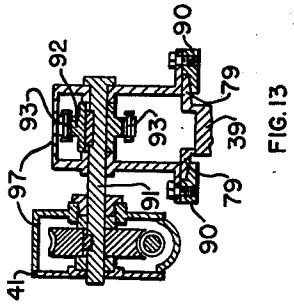


FIG. 13

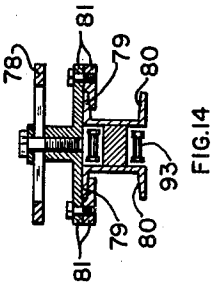


FIG. 14

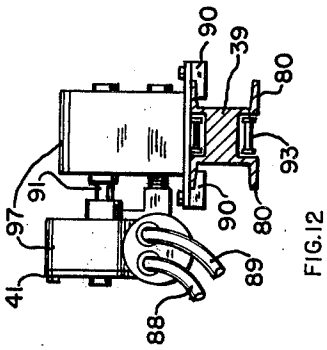


FIG. 12

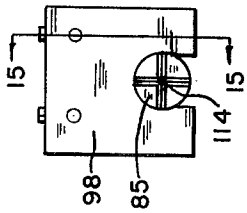


FIG. 11

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BLAST FURNACE TAPPING RIG

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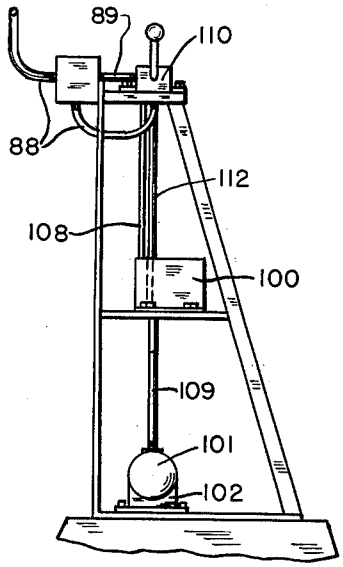


FIG. 17

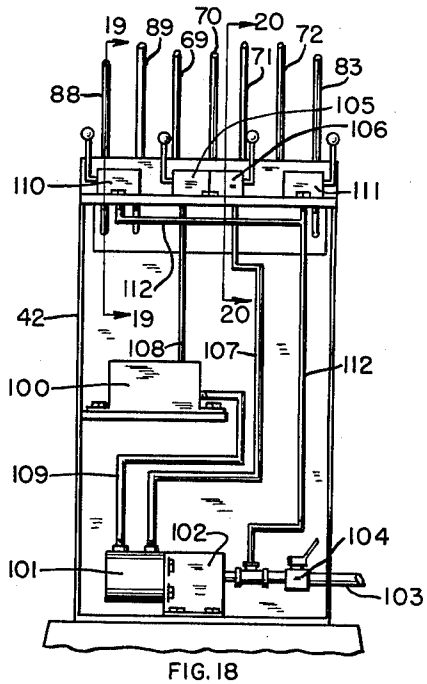


FIG. 18

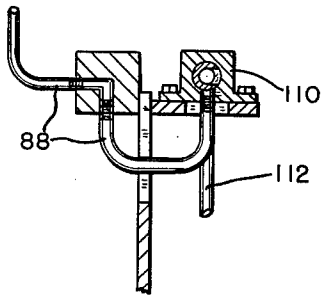


FIG. 19

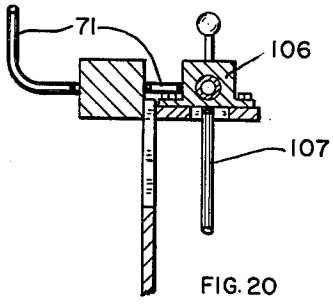


FIG. 20

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United States Patent Office

3,190,629

Patented June 22, 1965

3,190,629

BLAST FURNACE TAPPING RIG

John D. Draper, Milwaukee, Wis., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

Filed Dec. 16, 1960, Ser. No. 76,405

6 Claims. (Cl. 266—42)

The present invention relates generally to improvements in the art of manufacturing iron, and relates more particularly to the provision of an improved device and method for periodically tapping a blast furnace.

A primary object of the invention is to provide an improved remotely controllable and automatically positionable pneumatic drilling rig for forming the tap hole in the iron notch of a blast furnace for the release of molten iron therefrom in a safe and expeditious manner.

In the operation of blast furnaces for producing iron, the molten iron is periodically tapped or released from the bottom of the furnace through an opening or tap hole provided in the furnace wall and extending through what is commonly referred to in the industry as the iron notch. The molten iron released through the opening in the iron notch is conveyed away from the furnace and to the cast house by way of a trench lined with firebrick or the like and commonly called the iron runner. The iron notch customarily extends through the furnace wall at a downward angle of approximately 25° more or less with respect to the horizontal, and the iron runner extends to a point immediately under the high discharge side of the iron notch.

After a charge has been withdrawn from the furnace, the tap hole extending through the iron notch is plugged with a mixture called mud. This plugging is accomplished with the aid of a device referred to as a mud gun which is adapted to inject a charge of the plugging material or mud into the tap hole at the completion of a tapping. When a subsequent charge of molten iron is to be withdrawn from the furnace, it becomes necessary to reopen the tap hole as by drilling through the mud. At the interior of the tap hole, the plugging mix or mud becomes extremely hard and hot, and this point is customarily referred to in the steel industry as the skull which must also be penetrated.

It has heretofore been common practice in the industry to tap the mud plug in the iron notch of a blast furnace by a two-step hand operation in which a rotary drill is used for the initial step. In some instances, means have been provided to help support the weight of the drill and to aid in guiding it at a proper angle coinciding with the desired tap hole angle, and two men are ordinarily required in this hand drilling operation in order to provide sufficient feeding thrust to drill the tap hole plugging material. The hole is thus drilled to the so-called skull, at which point the plugging mix is too hard and hot to be drilled through with a rotary bit by a hand operation, and even if it were possible to penetrate the skull by the hand drilling operation, it would be extremely hazardous. Accordingly, for this second stage, an oxygen lance pipe is used to burn through the skull and complete the tap hole to start the molten metal flowing through the iron notch and into the iron run.

It is thus apparent that the personnel required in the vicinity of the iron notch for the initial drilling and subsequent skull burning operation are exposed to very hazardous working conditions, and serious accidents have not been at all uncommon in the past. Furthermore, in order to permit hand drilling of the tap hole, concessions have heretofore been made with regard to the materials used in the mud mixes, and softer and less effective plugging materials than desired have necessarily been utilized despite the general awareness of steel mill operating personnel that better control could be accomplished through use of harder available mixes which cannot, however, be drilled through by hand. In this regard, the less effective softer mixes used for the hand drilling method are caused to erode badly by action of the molten iron running through the tap hole, thereby enlarging the tap hole to such an extent that the charge runs too fast to handle and often also resulting in the undesirable ejection of other materials such as coke from the furnace before the hole can be plugged.

In addition to the foregoing, positioning of the drill by the hand method is subject to human error and results in frequent inaccuracies both in properly locating the tap hole and in directing or guiding the drill in its operation. Thus, there is no assurance that the skull will be penetrated at exactly the same point on each tapping operation so as to keep the thickness thereof at a minimum, and damage around the iron notch is likely to result from poorly directed holes. Also, the rate of feed of the drill in the hand method is variable since it is a matter of judgment by the operators, and the bit consequently is subject to undesriable clogging with the tapping operation being slow and tedious.

Recently, efforts have been made to introduce automation to the industry through the use of remotely controlled rotary drills for the iron notch tapping operation. These rotary drills are electrically operated and mechanically positioned by remote control so as to eliminate need for operating personnel in the iron notch vicinity, thus reducing the hazards attendant the tapping operation. Separate geared motors are provided, one for feeding the drill bit forwardly at a fixed rate and another for thereafter more quickly retacting the bit and drill rod from the hole. Rotation of the drill is effected by still another geared reduction motor, and provision is made for raising the drill, after retraction from the hole, to an elevated position above the iron notch and the iron run. These rotary drills are operated and controlled completely by electricity.

While these electric rotary drills have helped in reducing or minimizing the hazardous conditions existing heretofore, operators of these devices are nevertheless exposed to the inherent dangers of electricity, especially in view of the close proximity of the wiring and the electric motors to the extreme heat of the molten iron following each tapping operation. Also, these rotary rigs are objectionably complicated and expensive to manufacture as well as to install, maintain and operate, and due to their necessary driving components, the complete rigs are heavy and bulky. Furthermore, adjustments for positioning these rotary drills for tapping are relatively complicated and still subject to human error, and the rotating type drill bits are still subject to clogging and side or lateral thrust which may cause enlargement of or improperly directed holes. In addition, these bits are rela-

tively expensive to replace and must be periodically resharpened.

It is therefore an important object of the present invention to provide an improved remote controlled automatically operable and positionable percussion type drilling device and method for tapping blast furnaces which obviates the above mentioned disadvantages and objections attendant other known devices and methods.

Another object of this invention is to provide an improved method of tappping a blast furnace, which comprises, positively positioning a percussion type drill with the bit thereof adjacent the iron notch of the furnace and in fixed axial alignment with the hold to be tapped, commencing the percussive operation of the drill bit from a remote control station, advancing the drill bit forwardly from the same remote control station along its fixed axial path until the tap is completed, and then retracting the drill bit completely from the tap hole along the same fixed axial path and from the same remote control station while continuing its operation.

Another object of my invention is to provide an improved blast furnace tapping rig comprising, a percussion drill, means for supporting the drill in the vicinity of the iron notch of the furnace and for positively positioning the same with its bit adjacent the iron notch and in fixed axial alignment with the hole to be tapped, means controlled from a station remote from the iron notch for commencing percussive operation of the drill bit, means controlled from the same remote station for advancing the drill bit forwardly along its fixed path and completely through the iron notch, and means likewise controlled from the same remote station for completely retracting the drill bit from the tap hole along the same fixed path.

Still another object of my prevent invention is to provide improved means for tapping the iron notch of a blast furnace with maximum safety and efficiency with the aid of a positively positionable pneumatic percussion drill controlled completely from a protected common remote station in a simple manner by a single operator.

Another object of this invention is to provide an improved pneumatic percussion drill for tapping blast furnaces which positively and accurately locates the tap hole and drills entirely through the plug, including the skull, along a straight and definite path without side thrust, thereby eliminating need for lancing through the skull by a separate operation while also minimizing skull build-up and damage around the notch caused by off-directional holes.

An additional object of the invention is to provide an improved blast furnace tapping rig which has excellent penetrating power applied in a straight axial path at a fixed rate of feed by means of an expendanble percussive type drill bit continuously cooled during its forward drilling advancement as well as during retraction thereof from the drilled hole by means of its actuating medium to thereby eliminate clogging and minimize damage and shut-downs for repair or replacement of parts.

A further object of the present invention is to provide an improved remotely controlled hydraulically positionable and pneumatically actuated drilling rig for tapping the iron notch of blast furnaces in which the drill is automatically positionable at a predetermined angle for the drilling operation and is adapted to be retracted and swung to a position at a side of the iron runner and out of the path of the molten iron charge upon completion of the tapping operation, with the need for expensive electric motors and consequent use of electricity being entirely eliminated.

These and other objects and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings wherein like reference characters designate the same or similar parts in the several views.

FIG. 1 is a fragmentary vertical section through the iron notch portion and the iron runner of a typical blast furnace showing one of my improved rigs with the drill positioned for the commencement of a tapping operation;

FIG. 2 is a fragmentary horizontal section through the furnace wall above the iron notch and iron runner and showing the rig and its control station from the top with the drill again positioned for the start of a tapping operation;

FIG. 3 is a view similar to FIG. 1 but showing the improved rig with the drill retracted and swung to inactive position at one side of the iron runner;

FIG. 4 is a view similar to FIG. 2 but with the drill in inactive position as in FIG. 3;

FIG. 5 is a somewhat enlarged fragmentary section through the mounting bracket, main drill carrying arm and swing cylinder therefor taken along the line 5—5 of FIG. 2;

FIG. 6 is a likewise enlarged section through the bracket hinges taken along the line 6—6 of FIG. 5;

FIG. 7 is another enlarged section transversely through the main arm and its pivotal connection with the swing cylinder taken along the line 7—7 of FIG. 5;

FIG. 8 is a similarly enlarged section through the mounting bracket taken along the irregular line 8—8 of FIG. 6;

FIG. 9 is another enlarged section through the mounting bracket taken along the line 9—9 of FIG. 6;

FIG. 10 is an enlarged part-sectional view of the drill and its feed and guide arm and associated mechanism, the sections having been taken along the line 10—10 of FIG. 2;

FIG. 11 is a view looking at the bit end of the drill as indicated at 11—11 of FIG. 10;

FIG. 12 is a secition through the feed leg taken along the line 12—12 of FIG. 10;

FIG. 13 is a fragmentary section through the feed drive gear mechanism taken along the line 13—13 of FIG. 10;

FIG. 14 is another section through the feed leg at one of its points of attachment to the main swing arm taken along the line 14—14 of FIG. 10;

FIG. 15 is a fragmentary longitudinal section through the forward end of the feed leg taken along the line 15—15 of FIG. 11;

FIG. 16 is still another section through the feed leg and drill steel taken along the line 16—16 of FIG. 15;

FIG. 17 is an enlarged side view of the control station looking at it in the direction indicated at 17—17 in FIG. 2;

FIG. 18 is another view looking into the control station from the rear;

FIG. 19 is a further enlarged fragmentary section through one of the air lines taken along the line 19—19 of FIG. 18; and

FIG. 20 is an enlarged fragmentary section through another one of the air lines at the control station taken along the line 20—20 of FIG. 18.

Referring to FIGS. 1 to 4 of the drawings, the side wall of the typical blast furnace illustrated diagrammatically therein is designated by the reference numeral 30 with the bottom thereof being designated by the numeral 31. The iron notch 32 is formed in the side wall 30 near the bottom 31 and extends downwardly into and through the side wall at an angle of approximately twenty to twenty-five degrees. As shown in FIG. 1, the iron notch 32 is plugged with a mud mix to contain the iron in the furnace until it is desired to withdraw a charge, the plug being identified by the numeral 33. Located immediately below the iron notch 32 exteriorly of the furnace and extending therefrom to the cast house is the iron run or runner 34. In order to release a charge of molten iron from the furnace, it is necessary to drill or otherwise break through the mud plug 33 of the iron notch as shown at 35 in FIG. 3, and to minimize skull buildup and possible damage in the area of the iron notch, it is highly desirable to accurately locate and always maintain the same angle and position of the tap hole 35. The im-

proved rig and method accomplishes the accurate formation of the tap hole through the iron notch by percussive drilling controlled entirely from a remote locality or station.

In accordance with my improved method of tapping the blast furnace, a percussion type drill is initially positioned and positively supported with the bit of the drill adjacent to the iron notch 32 of the furnace and in fixed axial alignment with the hole to be tapped. With the drill thus positively positioned and supported, percussive operation of the drill bit is commenced by feeding air under pressure to the drill from a remote locality or central control station. Thereafter, the drill bit is advanced forwardly along its fixed axial path by means of pneumatic pressure fluid fed and controlled from the same remote control station, and this advancement of the drill bit is continued until the tap is completed. Upon completion of the tap by the advancement of the drill bit through the mud plug 33 and the iron skull covering the interior thereof, the drill bit is immediately pneumatically retracted completely from the tap hole along the same fixed axial path by pneumatic fluid under pressure fed and controlled from the same remote control station, and during this retraction of the drill bit, the pneumatic operation of the drill is continued until the bit has been completely retracted from the hole. Subsequently, the drill is swung upwardly and laterally away from and out of the plane of the tap hole 35 also by means of hydraulic fluid under pressure which is likewise fed and controlled from the same remote control station from which the other operations are controlled. Finally, after the drill has been swung out of the path of the molten iron released through the tap hole, the flow of operating fluid to the drill may be completely stopped until it is time for the next tapping operation which may be accomplished in the same series of steps as herein described.

The improved blast furnace tapping rig for performing the method thus described comprises, in general, a mounting base 37 fixedly positioned at one side of the iron notch 32 and iron runner 34, a hydraulically movable positioning arm 38 secured at one end to the base 37 for swinging movement relative thereto, a drill-carrying arm and feed shell 39 secured to the other end of the swing arm 38, a pneumatically operable percussive drill 40 carried by the arm 39 and movable longitudinally thereof for axial advancement and retraction of the drill bit, air motor drive means 41 also carried by the arm 39 for feeding the drill forwardly toward the work and for thereafter retracting the same, and a remote control console 42 located a safe distance from the iron notch vicinity and containing hydraulic controls for positioning the arm and air controls for the air motor and pneumatic drill.

The mounting base 37 includes a horizontal base plate 44 firmly secured in a suitable manner to a reinforced and fixed pedestal 45, the base plate having a pair of laterally spaced rigid brackets 46 projecting upwardly therefrom and having a vertical face plate 47 rigidly secured thereto. The plate 47, in turn, has a pair of vertically alined and spaced lugs 48 rigidly projecting from the face thereof and supporting a vertical pivot shaft 49, and a pair of angularly disposed lugs 50 spaced laterally of the lugs 48 and rigidly projecting from the face of the plate 47 for supporting an inclined pivot shaft or pin 51. Swingably mounted on the pivot shaft 49 is a swivel support or swing bracket 52 which has a pair of vertically spaced outwardly projecting lugs 53, 54, the upper lug 53 of which has the rear end of the swing arm or boom 38 pivotally mounted thereon by means of a pivot pin 55 and the lower lug 54 of which has the rear end of a hydraulic power cylinder 57 mounted thereon by means of a pivot pin 56. The angularly disposed pivot shaft 51, in turn, has a swivel support 58 swingably mounted thereon, and this support 58 has a lug 59 to which the rear end of a second hydraulic power cylinder 61 is pivotally mounted by means of a pivot pin 60. Thus, the hydraulic cylinders 57, 61 are both swingable vertically and horizontally with respect to the base mounting 37.

The hydraulic power cylinder 57 has the usual piston 63 therein with the piston rod 64 extending outwardly through the end of the cylinder remote from the swivel bracket 52, and the outer end of the piston rod 64 is pivotally mounted by means of a pivot pin 65 between a pair of spaced lugs 66 depending from the swing end of the arm or boom 38. The hydraulic power cylinder 61 likewise contains a piston, and the piston rod 67 thereof extends from the end of the cylinder 61 and is pivotally mounted between a pair of spaced lugs 68 projecting laterally from the swing end of the arm or boom 38. To actuate the piston 63 and its rod 64 to thereby raise and lower the swing arm 38 about its pivot 55, hydraulic fluid under pressure is conducted to and from the cylinder 57 on opposite sides of the piston 63 by way of conduits 69, 70; and the arm or boom 38 is swung horizontally about the pivot shaft 49 by the cylinder 61 and piston rod 67 actuated by hydraulic fluid under pressure conducted to and from the opposite ends of the cylinder 61 by way of conduits 71, 72. The hydraulic pistons as well as the cylinder end heads embody the usual packings and seals, and each of the cylinders 57, 61 are preferably covered with a suitable insulating and protective sheath 73 (see FIG. 5). Also, to provide for automatic positive positioning of the drill 40 by its swing arm or boom 38, each of the hydraulic cylinders are provided with adjustable built-in positioning or locating stops 74, 75, likewise shown in FIG. 5, to limit movement of the respective pistons and rods in both directions.

The outer swinging end of the arm or boom 38 has a rigid tubular portion 77 extending angularly therefrom, and the drill-carrying and guide arm of the feed shell assembly is mounted thereon by means of a saddle clamp 78 adapted to firmly grip the tubular portion 77 in adjusted position. The arm 39 of the feed shell assembly has upper and lower lateral flanges 79, 80 respectively, and the saddle clamp 78 is, in turn, firmly secured in adjusted position to the upper flanges 79 by means of clamps 81. The drill 40 is of conventional construction embodying a fluid actuated hammer motor receiving actuating fluid through conduit 83 for percussively actuating a drill steel 84 carrying a drill bit 85 at its forward end, and the drill is slidably guided on the lower lateral flanges 80 of the arm 39 for movement longitudinally therealong while the forward end of the drill steel 84 rearwardly of the bit 85 is supported and guided by a centralizing bracket 86 secured to the arm 39. The pneumatic feed motor 41 carried by the guide arm 39 is of conventional construction, receiving actuating fluid by way of conduits 88, 89, and is secured to the upper flanges 79 of the arm as by means of clamps 90. Keyed to the shaft 91 of the motor 41 is a sprocket gear 92 driving a feed chain 93 about idler gears 94, 95, the latter of which are carried at opposite ends of the arm 39, and the feed chain 93 is, in turn, suitably connected to the drill carriage 96 to move the drill toward and away from the work. As shown in FIGS. 10 and 12, the air motor and its drive mechanism is preferably enclosed in a casing 97, and the drill steel 84 and its front centralizer 86 is protected by a heat resistant shield 98 extending transversely thereacross.

Referring now to the operating controls, the remotely located control console 42 as shown in FIGS. 17 to 20 includes a hydraulic reservoir or tank 100, an air motor driven hydraulic pump 101, an air motor 102, a main air line 103 supplying operating air to the air motor 102, and a manually controlled main shut-off valve 104 in the air line 103. In addition to the main shut-off valve 104, the control station or console 42 embodies two manually controllable valves 105, 106 connected to the pump 101 by pressure line 107 for supplying hydraulic operating fluid to the lift cylinder 57 and swing cylinder

61 respectively, the valves 105, 106 also being connected to tank 100 by a conduit 108 for returning hydraulic fluid thereto. Also, a pair of manually controllable valves 110, 111 are provided in the console 42, these valves being connected to the compressed air supply line 103 by way of a conduit 112 and 112' for supplying pneumatic operating fluid to the pneumatic feed motor 41 and the drill 40 respectively. As customary, an air strainer, not shown, is also interposed in the compressed air supply line, and this may also be conveniently located in the control console. The several valves may be of any suitable commercially available type capable of performing the desired functions and separately actuated by levers conveniently extending above the console 42, and it is of course understood that the pump 101 is connected to tank 100 by means of a conduit 109.

With the drill positioned as shown in FIGS. 1 and 2, operating fluid may be supplied to the drill motor via conduit 83 by actuating the valve 111 by means of its lever, and the drill steel 84 and bit 85 will thereupon be caused to rapidly reciprocate, compressed air being simultaneously fed to the bit 85 through passageway 114 extending centrally through the drill steel to flush cuttings from the drilled hole. With the drill being percussively operated, the valve 110 is actuated by means of its lever to deliver pneumatic operating fluid to the air motor 41 by way of conduit 88 to thereby drive the chain 93 of the feed shell and advance the drill 40 toward the iron notch, and as the drill 40 is advanced by the air motor 41, the reciprocating bit 85 is caused to drill in a straight path axially through the mud plug 33 and the skull formed interiorly thereof. As soon as the tap is completed and the molten iron begins to flow from the hole 35 thus formed, the feed motor 41 is reversed by actuation of the four-way valve 110 to conduct fluid pressure through the conduit 89 to the motor, the feeding of pressure air to the drill 40 by way of conduit 83 being permitted to continue during such withdrawal so as to maintain the drill steel and bit as cool as possible.

After the bit 85 has been completely withdrawn from the hole 35, the drill may be swung to the position shown in FIGS. 3 and 4 by actuating the four-way hydraulic valve 105 to supply hydraulic pressure fluid to the rear of the piston 63 in the lift cylinder 57 by way of conduit 69 and thereby swing the boom 38 upwardly and raise the drill carrying and feed arm 39. At the same time, the drill and its carrying arm 39 may be swung laterally to one side of the iron runner 34 by actuating the four-way hydraulic valve 106 to admit pressure fluid to the forward end of the piston in the swing cylinder 61 and thereby swing the boom 38 in a horizontal plane away from the iron runner; and with the drill thus swung upwardly and laterally to inactive position, the percussive operation thereof may be stopped by actuating the valve 111 to closed position. In order to again position the drill as shown in FIGS. 1 and 2 for the start of a drilling operation, it is only necessary to actuate the hydraulic valve 106 in a reverse direction to supply pressure fluid to the rear side of the piston in the cylinder 61 to swing the boom 38 laterally toward the iron runner while also actuating the hydraulic valve 105 in a reverse direction to supply fluid pressure to the front of the piston 63 in the cylinder 57 and thereby cause the boom 38 to be swung downwardly. By reason of the limit stops provided on both the swing cylinder 61 and lift cylinder 57 which limit the movement of their respective pistons and piston rods, the proper positioning of the drill carrying and feed arm 39 is automatically and accurately accomplished.

From the foregoing detailed description, it is believed obvious that the present invention provides an improved method and rig for tapping blast furnaces which eliminates need for personnel in the vicinity of the iron notch and iron runner during the tapping operation, thus minimizing hazards formerly prevailing in the industry. With all of the control operations being effectively accomplished from a single remote control station or console by means of a pneumatic percussion drill which is automatically positionable, the entire tapping operation may be performed by a single operator thus reducing overhead, and each successive tapping operation may be accomplished with the highest degree of accuracy and minimum damage to the iron notch of the furnace. As previously indicated, the major portion of the drill steel 84 is protected by a forwardly positioned protective shield 98 and the lift and swing cylinders 57, 61 respectively are covered with a protective sheath with all of the various air and hydraulic conduits being likewise wrapped with a protective insulating cover. The bit 85 is, of course, subjected to an extreme amount of abuse, and these bits are expendable and may be readily removed from the drill steel 84 and replaced as necessary. In addition, the high heat to which the forward unprotected end of the drill steel 84 is subjected during operation causes relatively rapid erosion thereof, and replacement and maintenance costs may be minimized by forming the drill steel or rod 84 of two sections connected by a suitable threaded coupling or adapter 115 as shown in FIG. 10.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. A blast furnace tapping rig comprising, a pneumatically operable percussion drill, a drill carrier member supporting said drill for axial movement to and from extended and retracted positions, means including a swingable arm for supporting said carrier member and said drill in the vicinity of the iron notch of the furnace for swinging movement from a position above and laterally of the iron notch to a position in which the drill bit is adjacent the iron notch and in fixed axial alignment with the hole to be tapped when the drill is in its retracted position, a control station located within viewing distance of the furnace remote from the iron notch vicinity, means controlled from said station for effecting swinging movement of said carrier member and said drill from one of its said positions to the other of its said positions, means at said station for also feeding operating fluid to said drill to control the percussive operation thereof, a fluid motor fixedly mounted on said carrier member rearwardly of said swingable supporting arm, a chain connection between said motor and said drill for moving said drill axially along said carrier member to and from its extended and retracted positions, and means at said station for feeding pressure fluid to said motor to control the movement of said drill in both directions.

2. A blast furnace tapping rig according to claim 1, wherein the means for supporting the carrier member and drill for swinging movement comprises a base fixedly positioned laterally of the iron notch and having a pair of laterally spaced vertical pivots, an arm having one end secured to one of said pivots for swinging movement both vertically and horizontally and having the other end secured to the drill carrier member, and a pair of hydraulic ram units both secured at one end to the arm and each secured at the other end to one of the pivots.

3. A blast furnace tapping rig according to claim 1, wherein means are provided for positively guiding the drill rod and bit along a fixed path, and a protective shield is additionally mounted on the carrier adjacent to and in advance of the guide means.

4. A blast furnace tapping rig according to claim 2, wherein means is provided for positively limiting extension of the ram units to thereby automatically fix the extent of movement of the carrier member and drill.

5. A blast furnace tapping rig according to claim 3, wherein the drill rod is formed in two sections detach-

ably coupled together in axial alignment rearwardly of the protective shield.

6. A blast furnace tapping rig according to claim 1, wherein the percussive operation of the drill may be continued until the drill is entirely withdrawn from the iron notch.

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