The present invention relates to down-the-hole percussive rock drills and, more specifically, to a feed control for feeding rock drills in accordance with the degree of hardness of the strata through which a hole is being bored.

In the down-the-hole percussive rock drill apparatus, it is essential to apply the proper force or pressure on the drill steel string and the down-the-hole rock drill head in such a manner as to avoid excessive bit wear or bit damage, while at the same time the bit on the apparatus must be prevented from projecting too far and impeding the flow of pressurized fluid through the rotary head. The opposite end of the porting is in communication with the rotary head feed motor via a "message" line. The spindle driver and the spindle to which the drill steel is connected coat to control flow of pressurized fluid through the porting and hence to the feed motor.

The manual feed control circuit includes a manually operated selector valve disposed and accessible at an operator's station, such as the cab of the drill rig, and connected to the main fluid supply line to receive pressurized fluid from the latter. The manual control circuit also has a secondary fluid supply line for supplying fluid to the feed motor for one direction of rotation and another secondary fluid supply line for supplying fluid to the feed motor for rotation in an opposite direction, flow of fluid from the main fluid supply line through the respective secondary fluid supply lines being controlled by the selector valve. The selector valve, while actuated to provide for alternate flow through the secondary fluid supply lines, also may be actuated to prevent flow of pressurized fluid through both secondary fluid supply lines.

The automatic feed control circuit has a two-position valve disposed in the "message" line in the operator's station where it is readily accessible by an operator. The two-position valve controls flow of pressurized fluid from the internal valve through the "message" line and hence to the feed motor and is actuated to a closed position to render the automatic control circuit inoperative when manual feed control is desired.

A throttle valve is disposed in the main fluid supply line to control the flow of pressurized fluid to the rotary drill. The invention will be more fully understood from the following detailed description thereof when considered in connection with the accompanying drawings in which:

FIG. 1 is a fragmentary, side elevational view, partly in section, showing a feed control means according to this invention.

FIG. 2 is an enlarged, fragmentary, vertical sectional view of the rotary head showing the spindle and the spindle driver and the porting therein which form part of the feed control means according to the present invention.

FIG. 3 is a sectional view taken along line 3-3 of FIG. 2.

FIG. 4 is a view in section taken along line 4-4 of FIG. 2, and

FIG. 5 is a schematic drawing of the feed control means and shows the co-relationship of the automatic feed control circuit with the manual feed control circuit.

Now referring to the drawings and particularly to FIG. 1, generally designates a down-the-hole percussive drilling rig comprising a rotary head 11 supported for linear movement on guide rails which are secured to a drill tower 12. A drill string 13, comprising one or more hollow drill steels 14, is connected at one end to the rotary head 11 and at the opposite end to a down-the-hole rock drill 15. To feed the rotary head 11, drill string 13, and the down-the-hole rock drill 15 toward and into the surface being drilled, a fluid feed motor 16 is supported by the drill tower 12 and is connected to drive an endless chain 16A which is connected to rotary head 11 by means indicated at 17.

The rotary head 11 comprises a casing 18 on which are disposed one or more fluid motors 19 which may be of the conventional vane type. As shown in FIG. 2, the fluid motor 19 is connected to drive a pinion gear 20 which meshes with a gear 21. Gear 21 is secured to a hollow spindle driver 22 which is rotatively supported in casing 18 to project from the lower portion of the casing. Spindle driver 22 comprises a lower section 22A and an
A spindle 23, having longitudinally extending splines 24, is disposed for slideable axial movement within spindle driver section 22A, the lower inner surface of the bore of spindle driver section 22A, which is provided with splines 25 which mesh with splines 24 of the spindle so as to transmit rotation of the spindle driver 22 to the spindle 23 and simultaneously allow relative longitudinal movement between spindle 23 and spindle driver 22. The inner surface of the bore of the spindle driver section 22A, above splines 25, is a smooth surface forming a piston chamber 36. The spindle 23 is provided with an enlarged portion or piston 27 adjacent the upper end thereof. Piston 27 is provided at its outer periphery with seals 28 so that a fluid tight seal is effected between the piston and the bore of spindle driver section 22A.

The upper end portion of spindle driver section 22A is supported in a recess 29 formed in the lower end portion of spindle driver section 22B. The upper end of spindle driver section 22A and the upper end of spindle 23, when the latter is in its uppermost or fully retracted position, are slightly spaced from the bottom of recess 29 to form a pressurized fluid inlet chamber 31. Pressurized fluid is supplied to chamber 31 through a tube 32 supported in spindle driver section 22B by a retaining ring. To conduct pressurized fluid from chamber 31 to the drill steels 14 and thence to down-the-hole rock drill 5 through connector 33, the spindle 23 is provided with an axial bore 35.

As shown in Figs. 2, 3, and 4, a passageway 34 is formed in the wall of spindle driver section 22A, which passageway, at the upper end, communicates with an inlet port 35 and at the lower end portion with an outlet port 36. Inlet port 35 communicates with piston chamber 27 when piston 27 of spindle 23 moves so that the upper surface of the piston and the piston chamber 27 are in line. Outlet port 36 communicates with an annular recess 38 formed in a ring-shaped cap 39 which is secured to casing 18 by a plurality of bolts 40 (one of which is shown in Fig. 2), the recess 38 and the outer surface of spindle driver 22 defining an outlet chamber 41. A passage 42 is provided in cap 39, which passage communicates at one end with outlet chamber 41 and at the opposite end with a pipe connection 43. As best shown in Fig. 1, a hose or pipe 44 is connected at one end to pipe connection 43 and at the opposite end communicates with fluid feed motor 16 to deliver pressurized fluid to the latter. The interstices between cap 39 and spindle driver section 22A are sealed on opposite sides of recess 38 by O-rings 45. The interstices between recess 29 of spindle driver section 22B and the outer surface of spindle driver section 22A is sealed by an O-ring 46.

Spindle 23 is dimensioned in length so that it projects beyond the lower end portion of spindle driver section 22A and at the distal end thereof is provided with a drill chuck or connector 46. Connector 46 is secured to spindle 23 by a key 47 and a bolted flange connection 48. The lower end of connector 46 is provided with a pipe threaded bore 49 in which is turned one end of the uppermost drill steel 14 (shown in Fig. 1). Bore 49 communicates with bore 33 of the spindle 23 so that pressurized fluid passes from bore 33 into the hollow drill steels 14 for communication to the down-the-hole rock drill 15.

In operation of the rotary head 11, pressurized fluid, such as compressed air, is delivered to tube 32 in rotary head 11 through branch pipe 50A, the source of pressurized fluid being preferably the same source of pressurized fluid which operates motor 19. From tube 32 the pressurized fluid is conducted to inlet chamber 31 and thence into bore 33. The pressurized fluid passes through a hollow drill steel 14 and thence into down-the-hole rock drill 15 where it performs fluidic functions to operate the hammer or piston of the down-the-hole drill 15 and cleanses the hole being drilled.

When the spindle 23 is in the operative position shown in Fig. 2, inlet port 35 in spindle driver 22 is closed off from pressurized fluid in inlet chamber 31 by piston 27 of the spindle 23 so that no pressurized fluid flows into inlet port 35, passageway 34, outlet port 36, chamber 41, passage 42, pipe connection 43, and pipe 44. Since no pressurized fluid flows through pipe 44, feed motor 16 is inoperative. If the down-the-hole drill encounters a void or a relatively soft strata of rock, the spindle 23 will move axially relative to spindle driver 22. Upon sufficient movement of spindle 23 relative to spindle driver 22 to bring piston 27 and packing 37 below inlet port 35, inlet port 35 is brought into communication with inlet chamber 31 so that pressurized fluid flows through inlet port 35, passageway 34, outlet port 36, chamber 41, passage 42, pipe connection 43, and pipe 44 to feed motor 16.

With the delivery of pressurized fluid to feed motor 16, the motor operates to drive endless chain 16A which carries the rotary head 11 in a direction toward the down-the-hole rock drill 15. Movement of the rotary head causes spindle driver 22 to move axially relative to spindle 23. When spindle driver 22 moves sufficiently to carry inlet port 35 below piston 27 and packing 37, flow of pressurized fluid into inlet port 35 is prevented. The residual pressurized fluid in the passages to feed motor 16 is sufficiently pressurized to feed motor 16 when piston 27 of spindle 23 is closed off by piston 27 of spindle 23 against the upper ends of splines 25 of the spindle driver section and in the collapsed position by abutment of the flange connection 48 against the end of spindle driver section 22A.

It is now believed readily apparent that spindle 23 and spindle driver section 22A with its inlet port 35, passageway 34, and outlet port 36 cooperate to provide, in effect, a valve disposed internally in the rotary head 11, automatically controlling operation of feed motor 16.

In Fig. 5 are shown schematically the automatic and manual feed control circuits which cooperatively function with the novel spindle and spindle driver arrangement herein described to effect either automatic or manual feed control of rotary head 11.

As shown in Fig. 5, pressurized fluid, such as compressed air, is supplied through line 51 from a suitable source, such as an air compressor (not shown), to a four-way valve 52 and a main supply line 50. Assuming that four-way valve 52 is positioned by an operator for automatic feed control of rotary head 11, two-way valve 53 in feed motor inlet pipe 44 is in the open position, and throttle valve 54 in main supply line 50 is open. Pressurized fluid flows from line 51 through main supply line 50 and branch pipe 89A to rotary head 11 to effect simultaneous rotation of the down-the-hole rock drill and its operation as hereinbefore described.

When pressurized fluid is supplied to pipe 44 by movement of spindle 23 so as to expose inlet port 35, pressurized fluid is conducted to feed motor 16. To sense the presence of pressurized fluid in pipe 44, a sensing line 55 is provided, which line communicates at one end with pipe 44 and at the opposite end with a pilot operated exhaust valve 56 which is connected, by pipe 47, to motor 16.

When pressurized fluid is present in pipe 44, the sensing line conducts a portion of such fluid to valve 56,
which fluid causes valve 56 to open and thereby communicate line 57 with atmosphere. Communication of line 57 with atmosphere permits feed motor 16 to operate and feed rotary head 11 in a direction toward the down-the-hole rock drill 15. When rotary head 11 is moved sufficiently relative to spindle 23 to close inlet port 35 so that no pressurized fluid is delivered to pipe 44, the feed motor 16 ceases to operate.

The manual feed control circuit includes four-way valve 52 which is connected to feed motor 16 by two secondary supply lines 58 and 59. Line 58 is connected to pipe 44 to communicate with motor 16, while line 59 is connected with line 57 to communicate with feed motor 16. To sense fluid pressure in line 59, a sensing line 60 is connected at one end to line 59 and at the opposite end to a pilot operated exhaust valve 61, similar to valve 56. Valve 61 is connected through line 62 with pipe 44.

In operation of the manual feed control circuit, four-way valve 52 is positioned by an operator so as to bring line 51 into communication with either line 58 or line 59, depending upon which direction it is desired to operate feed motor 16 and hence feed rotary head 11. If it is desired to feed rotary head 11 in a direction toward the down-the-hole drill 15, the four-way valve is adjusted to provide for flow of pressurized fluid from line 51 into line 58 and pipe 44. The pressure in pipe 44, as in the automatic feed control operation, is sensed by pressure in line 55, which pressure actuates valve 56 so as to communicate line 57 with atmosphere and thereby permit the feed motor 16 to operate by pressurized fluid delivered thereto through pipe 44. To prevent backflow of pressurized fluid in pipe 44, a check valve 63 is provided in pipe 44. During normal operation of feed motor 16, two-way valve 52 in pipe 44 is closed to prevent the automatic control system from overriding the manual control.

If it is desired to elevate rotary head 11, as, for example, where penetration of the down-the-hole drill has reached the point where an additional drill steel must be joined to the drill string and the rotary head and the latter must be moved to the top of tower 12, four-way valve 52 is positioned so as to communicate line 51 with secondary supply line 59. With the four-way valve 52 in this position, pressurized fluid flows through line 59 and line 57 into feed motor 16 to rotation of the latter in a direction to cause the rotary head to be carried upwardly on tower 12. The flow of pressurized fluid in line 59 is sensed by line 60, the pressure in line 60 effecting the actuation of valve 61 which permits exhaust pressure fluid to flow to atmosphere from feed motor 16 through pipe 44 and line 62.

It is believed and evident from the foregoing description that a novel feed control means has been provided for a down-the-hole rock drill rig, which means provides a relatively simple internal automatic valve in the feed motor inlet line and has a relatively long operating life and no adverse effect on the fluid feed motor. It is a feed control means having an automatic circuit and a manual control circuit interconnected so as to provide quick and easy switching from one circuit to the other at an operating station, such as the cab of the drill rig.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the arrangement of parts without departing from the scope and spirit of the invention as the same will now be understood by those skilled in the art.

We claim:
1. A feed control apparatus in combination with a down-the-hole rock drill comprising
   (a) a drill rig,
   (b) a drill,
   (c) a rotary head having
   (1) a rotating mechanism movable longitudinally on said rig to support said drill for longitudinal movement,
   (2) a spindle driven by said rotary head and rotated by said mechanism,
   (3) a longitudinally movable drill rotating spindle slidably supported in said spindle driven for relative longitudinal movement with respect to the latter and connected to rotate therewith,
   (4) said spindle and spindle driven defining a pressurized fluid inlet chamber communicating with a source of pressurized fluid to receive pressurized fluid therefrom,
   (d) pressurized fluid operated control means for moving said rotary head longitudinally on said rig,
   (e) said spindle driven having passage means communicating with said inlet chamber and said motor means to convey pressurized fluid from the inlet chamber to said motor means and effect operation of the latter to move said rotary head, and
   (f) means carried by said spindle for controlling communication of said passage means with said inlet chamber so that flow of pressurized fluid to said motor means is controlled in response to a predetermined relative longitudinal movement between the spindle and spindle driven.
2. The apparatus of claim 1 wherein said means carried by the spindle is a piston portion on said spindle slidably engaging the spindle driver in a fluid tight manner.
3. A feed control apparatus in combination with a down-the-hole rock drill comprising
   (a) a drill tower,
   (b) a rotary head slidably supported for linear movement on said drill tower,
   (c) fluid motor means drivenly connected to said rotary head to provide for linear movement of said rotary head on said drill tower,
   (d) a source of pressurized fluid,
   (e) said rotary head having
      (1) a spindle driver supported for rotation by said rotary head,
      (2) a rotary drive mechanism disposed in said rotary head and drivenly connected to said spindle driver to rotate the latter,
      (3) a spindle telescopically receivable in said spindle driver and connected for conjoined rotation with the said spindle driver,
      (4) said spindle and spindle driven defining therebetween a pressurized fluid inlet chamber communicating with said source of pressurized fluid to receive such fluid from the latter,
      (5) said spindle having a passageway therein communicating with said inlet chamber,
      (f) a down-the-hole drill connected to said spindle to be rotated and linearly moved by the latter and connected to communicate with said passageway and receive pressurized fluid from said passageway in said spindle,
      (g) pressurized fluid operated motor means for moving said rotary head linearly on said drill tower,
      (h) passage means in said spindle driven communicating with said inlet chamber and said motor means to convey a portion of the pressurized fluid from the inlet chamber to said motor means and thereby effect operation of the latter to linearly move said rotary head, and
      (i) valve means carried by said spindle and cooperating with said passage means in said spindle driven to interrupt communication between the passage means and said inlet chamber when the spindle is in a retracted position to prevent flow of pressurized fluid to said motor means and to communicate the passage means with the inlet chamber upon a predetermined extension of the spindle with respect to
the spindle driver to allow flow of pressurized fluid to said motor means and thereby operate said motor to linearly move said rotary head and spindle driver relative to said spindle.

4. A feed control apparatus in combination with a drill rig comprising
(a) a rotary head supported for linear movement on a drill tower,
(b) said rotary head having a spindle driver,
(c) a pressurized fluid operated rotary motor connected to said spindle driver to rotate the latter,
(d) a spindle slidably disposed within said spindle driver and spline connected to the latter for conjoined rotation therewith and to allow limited linear movement relative to the spindle driver,
(e) said spindle and spindle driver defining within the spindle driver a pressurized fluid inlet chamber,
(f) a source of pressurized fluid communicating with said rotary head to deliver pressurized fluid to said fluid operated rotary motor to operate the latter and said inlet chamber,
(g) a down-the-hole drill connected to said spindle for conjoined rotation and linear movement with the latter,
(h) a passage means in said spindle communicating with said inlet chamber to receive pressurized fluid from the latter and with the down-the-hole rock drill to pass pressurized fluid to the latter,
(i) a fluid operated feed motor connected to said rotary head to linearly move said rotary head on said drill tower,
(j) conduit means partially extending in said spindle driver communicating with said feed motor and said inlet chamber to conduct pressurized fluid from the latter to the feed motor, and
(k) valve means carried by said spindle for movement with the latter and cooperating with said spindle driver to interrupt communication between the

5. The apparatus of claim 4 wherein said source of pressurized fluid is in constant communication with said rotary head through a throttle valve.

6. The apparatus of claim 4 wherein an on-off valve is disposed in said conduit means to render said valve means inoperative to control operation of said feed motor.

7. The apparatus of claim 4 wherein said apparatus is provided with a pilot-actuated exhaust valve connected to said feed motor and a pressure sensing line connected to said conduit means to sense the pressure in the latter and connected to said exhaust valve to effect the actuation of said exhaust valve to an open position and thereby permit said feed motor to operate.

8. The apparatus of claim 4 wherein said apparatus is provided with a pilot-actuated exhaust valve means in communication with said motor to receive exhaust fluid from the latter, pressure sensing means communicating with said conduit means to sense the pressure in the latter and communicating with said exhaust valve means to effect the actuation of said exhaust valve to an open position and thereby permit said feed motor to operate, and a manual means in said conduit means for controlling the direction of operation of said feed motor to effect linear movement of the rotary head on said drill tower in a direction toward or away from the down-the-hole drill.

No references cited.