June 22, 1965 A. G. KVELLO-AUNE ETAL 3,190,370

DRIVE AND FEED DEVICE FOR A STRING OF ROTARY DRILL STRING ELEMENTS

Filed April 17, 1962 4 Sheets-Sheet 1

Fig. 1

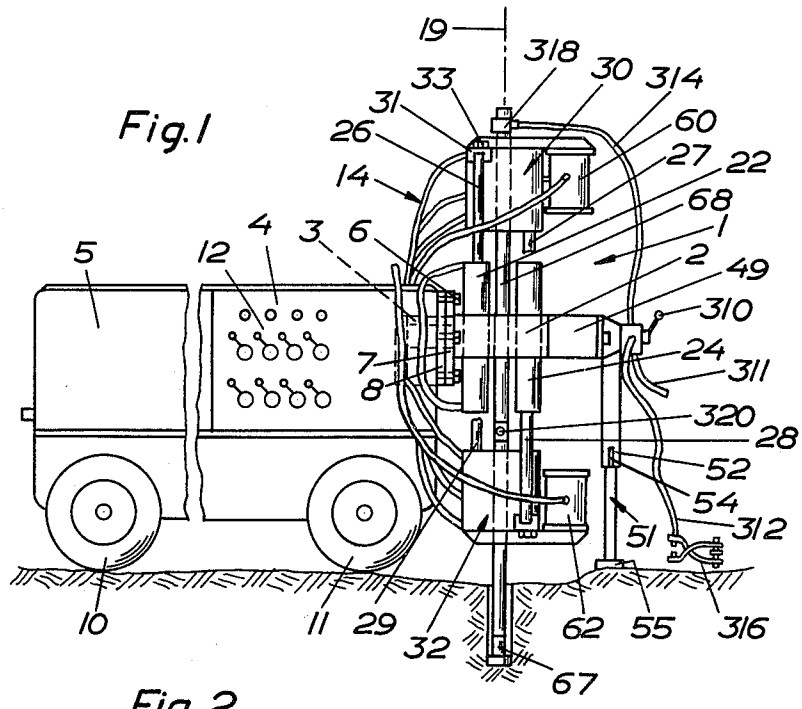
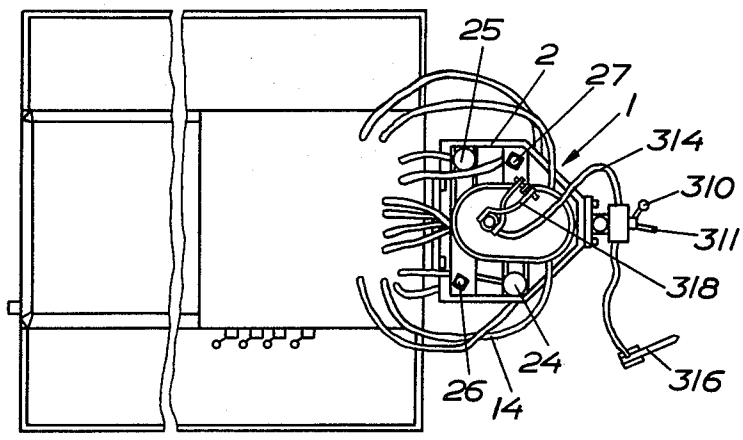


Fig. 2



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DRIVE AND FEED DEVICE FOR A STRING OF ROTARY DRILL STRING ELEMENTS

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Fig.3

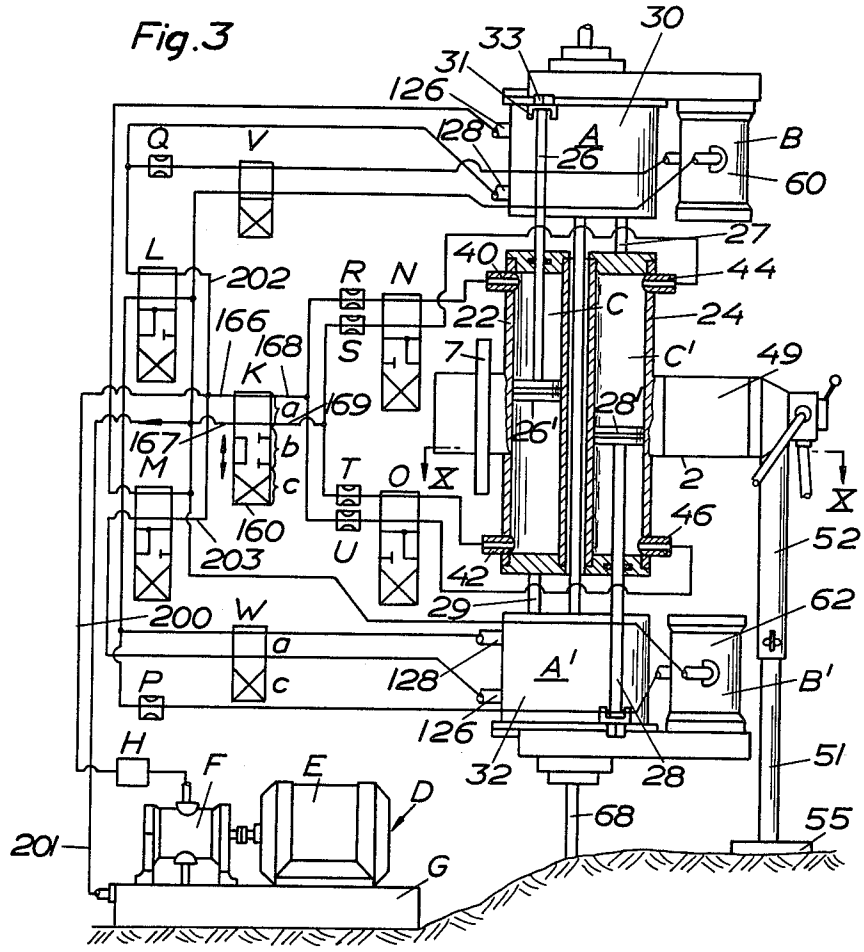
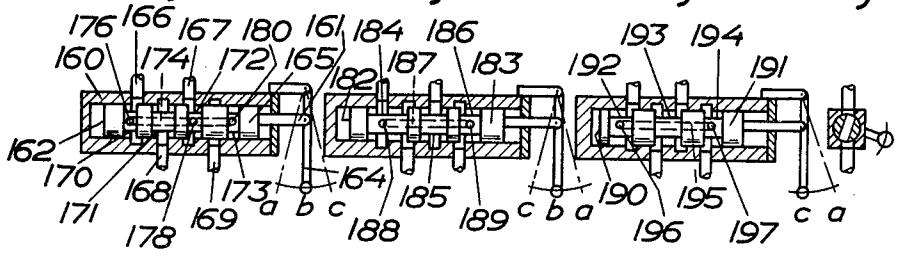


Fig.4 Fig.5 Fig.6 Fig.7



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DRIVE AND FEED DEVICE FOR A STRING OF ROTARY DRILL STRING ELEMENTS

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Fig.8

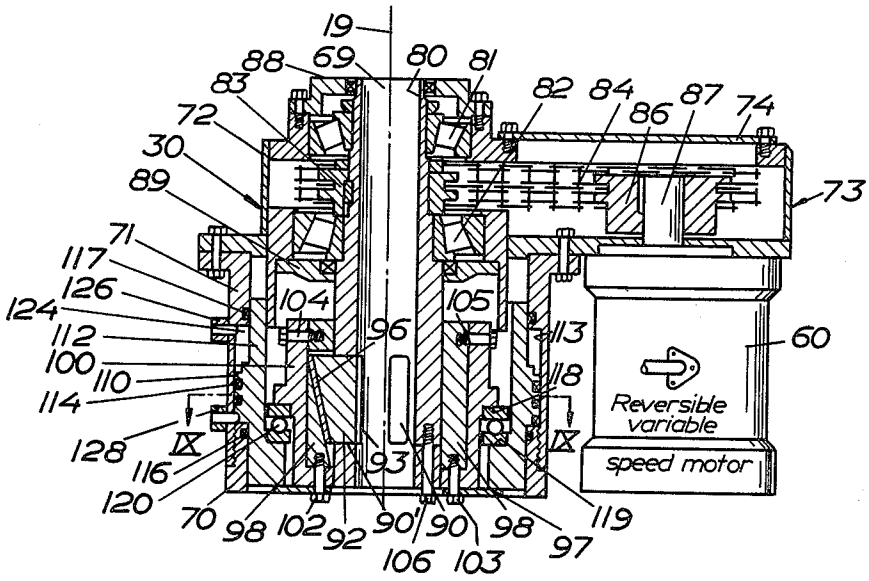


Fig.9

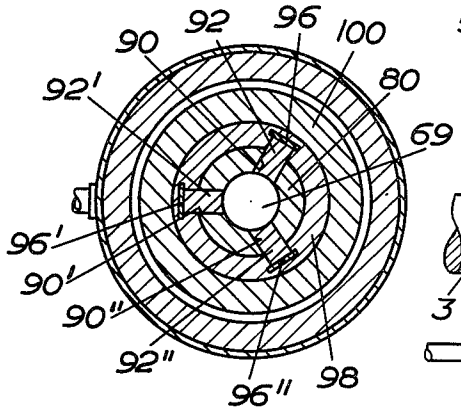
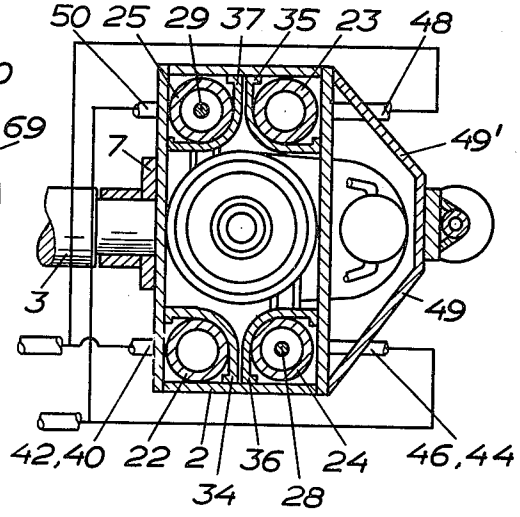


Fig.10



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DRIVE AND FEED DEVICE FOR A STRING OF ROTARY DRILL STRING ELEMENTS

Filed April 17, 1962 4 Sheets-Sheet 4

Fig. 11

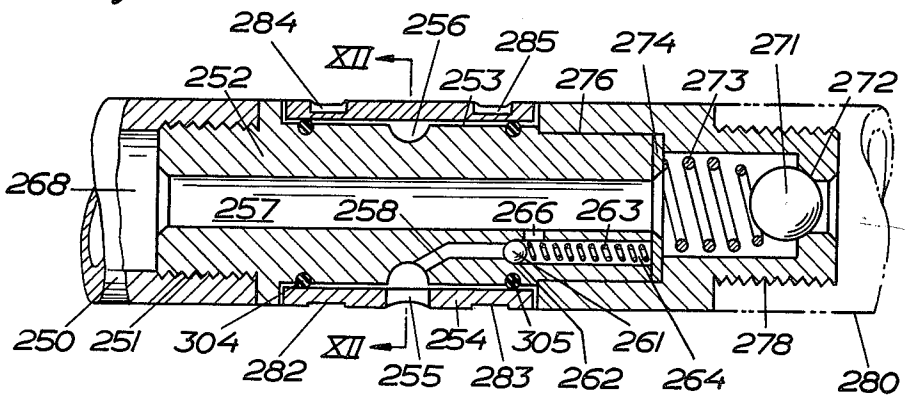


Fig. 12

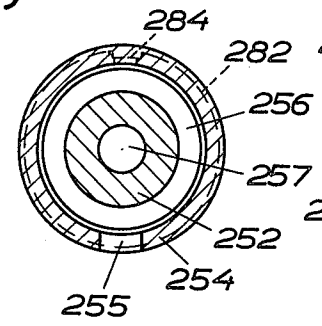


Fig. 14

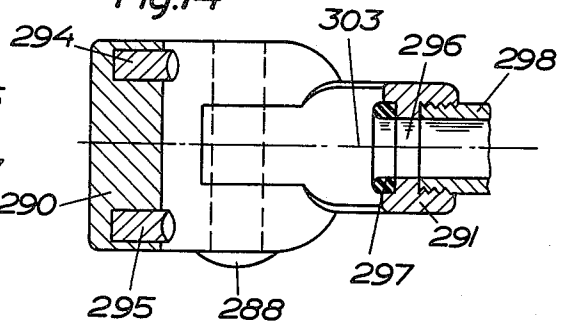
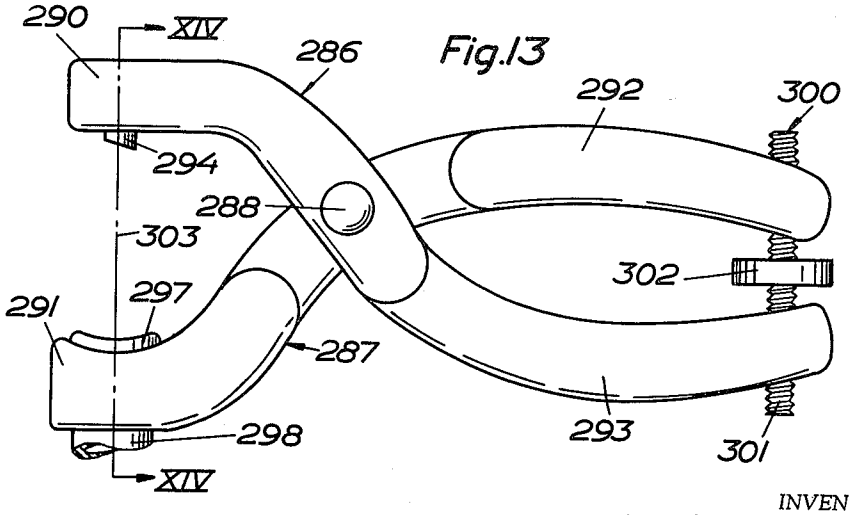


Fig. 13



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United States Patent Office 3,190,370 Patented June 22, 1965

3,190,370

DRIVE AND FEED DEVICE FOR A STRING OF ROTARY DRILL STRING ELEMENTS

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Filed Apr. 17, 1962, Ser. No. 188,044
Claims priority, application Norway, Apr. 17, 1961, 139,873
10 Claims. (Cl. 173—37)

The present invention relates generally to devices for long or deep hole drilling for investigation, for water or oil wells, for mining or for other purposes, and relates more particularly to a drive and feed device for a machine for rotary drilling, wherein the feed as well as the rotation of the drilling tool may be carried out continuously.

Applicants' copending U.S. patent application Serial No. 854,942 filed November 23, 1959, now Patent No. 3,131,776, relates to a machine for deep hole drilling comprising a frame and housing assembly supported by said frame at a point spaced from the ground, a first and a second drill chuck mechanism mounted on said housing assembly spaced along a common axis and arranged to engage a drill string element, means associated with each one of said chuck mechanisms for engaging and releasing said drill string element, means associated with the chuck mechanism for rotating the chuck mechanism, and means operable to impart first to said one chuck mechanism and then to said second chuck mechanism a motion in one direction or the other longitudinally along said axis and relative to said housing assembly for feeding or retracting the drill string, respectively.

The above mentioned machine is provided with a common prime mover mounted in the frame for rotating both chuck mechanisms, the rotary coupling between each chuck mechanism and the prime mover being provided by means of splined together hollow telescopic driving shafts. The longitudinal motion of the chuck mechanisms is performed by means of telescopic, hydraulic power cylinders. This construction permits the chuck mechanisms to be rotated and simultaneously to be fed or retracted, respectively. It also permits one chuck mechanism to be engaged with or release from the drill string during rotation.

A drawback in carrying out drilling operations with conventional deep hole or long hole drilling machines as well as with the machine according to applicants' abovementioned earlier application is, however, that various difficulties arise when additional drill string elements have to be added to the drill string. Such operations in prior machines necessitate interruption of the drilling operation.

A further drawback of similar nature occurs when the drill string has to be withdrawn from the bore hole. This drawback is especially annoying with the machine according to applicants' earlier application by which machine it is possible to undertake a continuous withdrawing of the drill string by alternately engaging and releasing the drill chucks and moving them up and down in proper way. Since it is necessary to divide the drill string into separate drill string elements or stands, for example by screwing the uppermost element from the string, the continuous withdrawing of the string has to be interrupted in order to carry out these operations.

One object of the present invention is to provide a drive and feed device for a rotatable drill string making it possible to add or to remove drill string elements such as pipes or rods in a continuous manner while the machine is performing its feeding or withdrawing operations.

A further object of the invention is to provide an improved drilling machine which is of simpler and more

rugged construction than previously known similar drilling machines and which machine is able to perform both much faster and more dependable deep drilling than hitherto has been possible.

It is a further object of the invention to provide a drilling machine which is operable to undertake drilling operations in downward as well as in horizontal or in upward direction.

Other objects and features of the invention will be more fully understood from the following detailed description of a preferred embodiment of the invention described in connection with the accompanying drawings in which:

FIG. 1 is a side view partially broken apart of a drilling machine according to the invention together with a drill string partially in the ground.

FIG. 2 is a top view of the machine in FIG. 1.

FIG. 3 is a diagrammatic view illustrating the pressure fluid control system of the machine.

FIGS. 4–7 are enlarged sectional views illustrating the valves employed in the pressure fluid system.

FIG. 8 is an enlarged vertical detailed sectional view of a chuck and chuck housing according to the invention.

FIG. 9 is a sectional view on line IX—IX in FIG. 8.

FIG. 10 is a sectional view on line X—X in FIG. 3, illustrating the work cylinder and fluid conduit arrangement.

FIG. 11 is an axial sectional view of the flushing medium supply swivel device on a preferred type of drill string element used with the machine according to the invention.

FIG. 12 is a cross-sectional view on line XII—XII in FIG. 11.

FIG. 13 is a side view of a coupling device for the supply hose for the flushing medium which may be employed in connection with the swivel device shown in FIG. 11, and

FIG. 14 is a sectional view on line XIV—XIV in FIG. 13.

In FIGS. 1 and 2, **1** designates generally the drilling machine which comprises a supporting frame **2** rotatably journalled in a housing **4** on a horizontal shaft **3**, FIGS. 1 and 10. A wheeled vehicle for carrying the housing **4** is generally designated **5**. The supporting frame **2** may be adjusted and locked in different angular positions on the shaft **3** by means of bolts **6**, which extend through a flange **7** fixed to the frame **2** and which are screwed to a plate **8** mounted on the housing **4**. A drill string extends through the machine and comprises drill string elements **68**, for instance drill pipes, which at the lower end is provided with a drill bit **67**.

The wheeled vehicle **5** comprises in conventional manner a motor and a pressure fluid pump, not shown, for supplying pressure fluid to the drilling machine, and it comprises further two pairs of wheels **10** and **11** and a control board **12** to which are connected a number of pressure fluid hoses **14**. The hoses **14** constitute conduits for the supply and return of pressure fluid for the entire drilling machine.

The drilling machine comprises two pairs of pressure fluid cylinders **22–23** and **24–25**, hereinafter named hydraulic cylinders, each pair cooperating with a chuck housing **30**, **32**, respectively, furnished with a reversible variable speed hydraulic motor **60**, **62**. The pairs of hydraulic cylinders **22–25** are fixed in the corners of the rectangular frame **2** by means of damps **34**, **35**, **36**, **37**. Piston rods **26**, **27** extending into the cylinders **22**, **23** are fixed symmetrically in diagonally opposed positions around the drill string axis **19** at opposite sides of the upper chuck housing **30**, while piston rods **28** and **29** extending into the cylinders **24** and **25** are fixed in similar way to the lower chuck housing **32**. The position and

mounting of the cylinders appear most clearly in FIGS. 3 and 10. The piston rods carry pistons 26^1–29^1 inclusive movable in the cylinders 22–25 inclusive.

The four hydraulic cylinders 22–25 may be operated by means of pressure fluid which is supplied and returned through hoses 14 leading from the wheeled vehicle 5 to suitable fittings 40, 42 (FIG. 3) on the cylinder 22 and fittings 44 and 46 on the cylinder 24. A corresponding arrangement is, as will be understood, provided on the cylinders 23 and 25, but this is not shown in detail although the upper pipe fittings on these cylinders are indicated with reference numbers 48 and 50, respectively in FIG. 10.

Each piston rod is at one end fixed to a piston and at the opposite end to a bracket 31 on the pertaining chuck housing by means of a bolt 33.

On the extreme right end the frame 2 is provided with two arms 49 and 49^1 whereon is mounted a vertical extensible supporting leg 51, 52 the lower member 51 of which is provided with a foot plate 55 to be placed on the ground. The supporting leg 51, 52 has adjustable length and may for this purpose comprise telescopically connected pipe sections 51 and 52 which may be locked one relative to the other by means of a suitable locking device 54, so that the leg 51, 52 with its foot plate 55 may be positioned firmly against the ground before drilling is initiated.

The chuck housings 30 and 32 carry separate motors 60 and 62, respectively, and are of identical construction. The chucks 30 and 32 are coaxially supported each one by the pertaining two piston rods 26, 27 and 28, 29, respectively, in such a way that the drill pipe 68 may extend through both chuck housings.

The upper chuck 30 will be described in detail hereinafter with reference to FIGS. 8 and 9. The chuck is provided with a central through passage 69 for the drill string and the chuck housing 30 comprises cylindrical parts 70, 71 and 72, respectively, which are bolted and screwed together to form a unit. The housing is provided with extensions 73 and 74 for the support of the prime mover such as a reversible variable speed hydraulic motor 60, but other types, for instance electric or air motors may of course be used.

The chuck housing has journalled therein a tubular driving shaft 80 extending through the housing and journalled in conical roller bearings 81 and 82 of a type which can take up radial forces as well as axial forces. Between the bearings 81 and 82 is fixed on the shaft 80 a sprocket wheel 83, whereon is placed a chain 84, carried over a second sprocket wheel 86, fixed on the driving shaft 87 of the motor 60. The bearings 81 and 82 are protected against dust and the like by means of packings and detachable covers 88 and 89, respectively, secured to the chuck housing 30. The cover 88 also constitutes the end portion of the chuck housing.

In the lower portion of the chuck housing there is arranged a hydraulically actuated chuck mechanism. The driving shaft or bushing 80 is provided with three identical circumferentially spaced elongated radial apertures 90, 90^1 and 90^{11}. In these apertures are positioned radially slidable jaws 92, 92^1 and 92^{11}, the internal faces of which are furnished with grooves or corrugations at 93 in order that said jaws may be able to grasp the drill pipe firmly. The jaws are wedge-shaped and externally provided with plates 96, 96^1 and 96^{11} secured to the jaws and of greater width than the jaws, as shown in FIG. 9. The jaws together with the plates are slidable in corresponding grooves in a bushing 98, which is secured to a bushing 100 by means of bolts 102, 103, 104 and 105. For convenient assembling and disassembling the shaft 80 is divided below the jaws and assembled by means of suitable bolts 106, as shown in FIG. 8.

FIG. 8 shows the jaws in release position. When the bushing 100 is moved upwards the inclined surfaces in the bushing 98 will push the jaws radially inwards to a

position in which a drill pipe in the chuck housing is firmly engaged. The engaging and releasing motion of the chuck is produced by an annular piston 110 which is formed on a tubular piston rod 112. The piston has piston rings 114 and moves in a cylinder 113 formed in part 71 of the chuck housing. The piston rod 112 is sealed in parts 70 and 71 by sealing rings 116 and 117. Mounted on between suitable shoulders 118 and 119 on bushing 100 and a piston rod 112 is a ball bearing 120. To the lower face of bushing 100 is secured a support plate 97 by means of bolts 102 and 103. Between the chuck housing part 71 and the piston rod 112 is formed a chamber 124, which by the annual piston 110 is divided in two parts constituting working cylinder chambers, which may be supplied with pressure fluid through the pipe fittings 126 and 128.

It will be understood, that by supplying pressure fluid to the appropriate part of chamber 124, the piston 110 and rod 112 may be moved in either axial direction, transmitting movement to the bushing 100. Simultaneously therewith the jaws are moved either radially outwards or inwards, depending on which way the bushing 100 is moving. When, for example, pressure fluid is supplied through the fitting 128, the rod 112 and piston 110 will move upwards, and such movement presses the jaws 92, 92^1, 92^{11} inwards. When pressure fluid is admitted through the fitting 126 and simultaneously vented through the fitting 128, the piston 110 and rod 112 and bushing 100 are moved downward towards the position shown in FIG. 8, causing bushing 100 and bushing 98 to pull the jaws radially outwards by their plates 96, 96^1 and 96^{11}. The plates 96, 96^1, 96^{11} then slide in the inclined grooves in the bushing 98.

Due to the actuation of the jaws by the piston 110 through the bearing 120 or the plate 97 the inward and outward radial motion of the jaws may be carried out independently of whether the chuck is rotating or not.

As indicated above the drilling machine operates by means of pressure fluid working units, more specifically two independent chuck mechanisms, two independently operable motors for rotating the chuck mechanisms, and two pairs of pressure fluid operated cylinders for feeding and retracting the chuck mechanisms.

For the sake of simplicity these pressure fluid units hereinafter will be called "hydraulic units," but it shall be understood that these units may be operated by pressure liquid as well as by gas or air under pressure, that is to say hydraulically as well as pneumatically.

The hydraulic units of the machine may be actuated by manipulation of a number of manually operable valves, whereby the drilling machine may be set to perform several different working operations.

In order to clarify the various working functions performed by the drilling machine the hydraulic system of the machine will be described in detail hereinafter.

FIG. 3 illustrates diagrammatically the different working units, the various fluid conduits and valves, and also the aggregate for supplying pressure fluid.

In the figures

A, A^1 designates the chuck devices 30, 32 of the machine.

B, B^1 are the driving motors 60, 62 of the machine, and C, C^1 the hydraulic power cylinders 22–23, 24–25, while D designates the wheeled vehicle 5, comprising a motor E, a pressure fluid pump F, a pressure fluid tank G and a governor H.

The valve system comprises two-way and multiple-way valves, each of which has several positions.

The valves K, L, M, N, O, are all four-way valves having three positions.

The valves V and W are four-way valves with two positions.

The valves P, Q, R, S, T and U are adjustable throttle valves for adjusting the fluid flow passing through said valves.

The construction of the valves is per se known. Since it is of importance, however, to understand their mode of operation in order to understand the operation of the machine, the different types of valves used are shown in detail in FIGS. 4–7. FIG. 4 shows the construction of the valve K, FIG. 5 shows the construction of the valves L, M, N, O, FIG. 6 shows the construction of the valves V and W, while FIG. 7 shows the construction of the throttle valves P, Q, R, S, T and U.

As obvious from FIG. 4, the valve K is a piston slide valve having a housing **160**, provided with a slidable piston valve member **162** which by means of a piston rod **161** and a manually operable hand lever **164** may be moved into the positions *a, b* and *c*. The housing **160** is provided with four pipe fittings **166, 167, 168** and **169**. The valve member has peripheral annular grooves **170, 171, 172, 173**, separating five annular lands **165** and the valve member has also a central internal passage **174** communicating with the grooves **170, 172** and **173** through radial openings **176, 178** and **180**. The fluid flow through this valve takes place through the valve passage **174** as well as through the annular grooves **170, 171, 172** and **173**.

It would be obvious that when the valve member **162** and lever **164** take the position *b*, the pipe fittings **166** and **167** are in communication with each other whereas passage through pipe fittings **168** and **169** is closed. In position *a* fitting **166** communicates with fitting **168** directly through groove **171** and fitting **167** then communicates with fitting **169** through passage **174** and openings **178, 180**. In position *c* fitting **166** communicates with fitting **169** through passage **174** and openings **176, 178** and fitting **167** then communicates with fitting **168** through groove **171**.

The valve shown in FIG. 5 representing the valves L, M, N, O shown in FIG. 3 is a four-way, 3-position valve very like the valve shown in FIG. 4, but here the valve member **182** has four lands **183** separated by three grooves **184, 185, 186** only and is provided with a passage **187** with openings **188, 189**. The valve shown in FIG. 6 is also a four-way valve corresponding to the valves V and W, but this valve can only take two positions. The valve member **190** of this valve has four lands **191** separated by three grooves **192, 193, 194** and a passage **195** with two openings **196, 197**.

The valve shown in FIG. 7 is a throttle valve and appears in FIG. 3 at P, Q, R, S, T and U.

The flow of fluid in different positions of all valves lettered K–W appears from the flow diagram in FIG. 3, which illustrates the flow paths for the valves in their various positions. In order to explain the particular schematic drawing method employed in this figure, the valve K, which is shown in detail in FIG. 4, is chosen as an example. In FIG. 3 the valve K takes the position *a* of FIG. 4, i.e. the position for direct flow between the conduits **166** and **168** and the conduits **167** and **169**, respectively. If the valve member **162** is then pushed upwards into the position *b*, then the conduits **166** and **167** will be interconnected whereas the conduits **168** and **169** will be closed, as shown in FIG. 4. If the valve member **162** is now pushed further upwards, then the valve is brought into the position *c*. The flow paths are now crossed as obvious from FIG. 4 so that **166** communicates with **169** and **167** with **168**. All the valves K, L, M, N, O and V, W in FIG. 3, are shown diagrammatically in analogous manner, so that all flow paths may be followed without difficulty. By this method of illustration it is believed that FIGS. 3–7 together with the above detailed description provide a clear and full illustration of the hydraulic system.

In the following will be given a short review of the function of the different valves in the pressure fluid system.

The motor E which may be an electric motor or a combustion engine drives the pressure fluid pump F which via pressure regulating device or governor H pumps pressure fluid through a conduit **200** into the hydraulic system. A conduit **201** returns pressure fluid from the system to the pressure fluid tank G. The valve K in the position *a* admits pressure fluid to the piston rod ends of the hydraulic cylinders C and C^1, while the same valve in position *b* blocks the fluid supply to the cylinders C and C^1 which are then locked, and in position *c* the flow is reversed so that pressure fluid is admitted to the opposite ends of cylinders C, C^1. During a regular drilling operation the cylinders C, C^1 are controlled by the valves N and O. The valves R, S, T and U are adjustable throttle valves by which the rate of flow is adjusted, in order to control the energy supply to the cylinders C, C^1.

The conduits **202** and **203** supply pressure fluid from conduit **200** to the valves L and M, which control the chucks A, A^1 as well as the motors B and B^1. The valves L, M, N, O, are arranged and coupled in such a way that the machine may undertake continuous drilling operations when the valves are put into proper positions. For instance, in position *a* of the valves, as shown, the chuck A engages and rotates the drill string and simultaneously the chuck A is fed downwards by the cylinder C and the chuck A^1 is disengaged and does not rotate but is pressed upwards by the cylinder C^1.

When chuck A has substantially completed its maximum downward stroke the valves L, M, N, and O are moved into the intermediate position *b*. In this position, which may be called the transition position, the chuck A^1 discontinues its upward motion and instead acts to move downwards and is brought into engagement with the drill string and put into rotation in the same direction as the upper chuck A, in other words, both chucks, A, A^1 will work in parallel, i.e. rotate the drill string and feed the same downwards. After a short time the valves L, M, N, and O are simultaneously moved into the lower position *c*.

In this position the chuck A disengages the drill string, stops rotation and is pressed upwards to the upper position. By following a sequence of operations including repositioning the valves L, M, N, and O in the sequence *a-b-c-b-a-b-c-b* the machine will undertake a continuous drilling operation. It is possible, if desired, to join the manual control handles on the valves L, M, N, and O so that the entire change of operation and reversion of the machine may be carried out with a single manual movement, and as further will be understood, it is possible to utilize an automatic timing device, such that the entire drilling operation may proceed automatically.

When the insertion of the first drill rod or pipe in the machine is carried out both chucks are opened which is produced by moving valves L, M and W to *c* position. Valve K should be in *a* position. A drill string element may then be inserted through both chuck housings. The valve W, which controls the flow to the lower chuck, is thereupon put into *a* position, whereby the drill pipe is being grasped. Thereafter the valves L, M, N, O, are put into *b* position, whereupon the above described working cycle may proceed.

The operational speed and the power employed may be adjusted by means of the throttle valves Q, P, R, S, T and U, all of which are of similar construction and are shown in cross section in FIG. 7.

When the drill string by the machine has been advanced into the ground so far that only the chuck A^1 is able to engage the drill string, then the chuck A is moved upwards in open position. Another drill string element is now inserted manually or by means of conventional hoist, not shown, through the chuck A. Thereafter the valves L, M, N, and O are put into the *b* position so that both chucks A, A^1 operate in parallel as described above. During such operation the throttle valve Q is opened further causing the rotational speed of the chuck A to increase. This results in the new drill rod or pipe being screwed on to the top end of the drill string which is held and rotated

by the chuck A^1, so that drilling may proceed without interruption.

By means of the machine according to the invention it is possible to perform continuous withdrawing or extraction of the drill string. Simultaneously the drill string may be divided into its separate drill string elements or stands which are screwed off one after the other. Such operations necessitate that the working cycle above described for the connection of a drill string element is reversed. This reversed working cycle will now be described.

The valve K is put into *c* position. The supply and return of the pressure fluid is thereby reversed at the right side of the valve K. As a result the cylinders C, C^1 operate reversely to the mode of operation during drilling. The valves L, M, N, and O are now put into *a* position after which the valves Q and P are closed, so that rotation of the motors B, B^1 is discontinued. The chuck A^1 in this position is disengaged from the drill string. Simultaneously the chuck A engages the uppermost drill string element and the upper chuck A will then be moved upwards, thereby lifting and withdrawing the drill string.

The valves L, M, N, and O are now moved to *b* position so that the chucks will operate in parallel upwards, and if then the valves L, M, N, O are moved to *c* position the chuck A^1 will continue to withdraw the drill string simultaneously as the chuck A return to lower position.

Thereupon the valve V is put into *c* position, whereby the rotational direction of the motor B is reversed. The valve P is kept closed preventing the chuck A^1 from rotating. As soon as the joint between two adjacent drill string elements has been moved to *a* position between the chucks being in the upper half of the distance between the chucks adjacent the chuck A, the valves L, M, N and O are put into *b* position and the throttle valve Q is opened so that motor B starts to rotate in reversed direction. The drill rods will not be screwed from each other by means of the upper chuck A, provided that the valves R and S are fully opened simultaneously with the valves T and U being partly closed, so that the upper chuck is being lifted faster than the lower chuck. Hereby the uppermost drill string element is screwed off and lifted upwards from the adjacent lower drill string element.

In this position the rotation of the chuck A is interrupted by closing valve Q and by putting valves L, M, N, and O in *c* position so that the upper drill pipe or stand is disengaged and may be lifted out of the machine manually or by means of a conventional hoist, not shown, by the operator and put aside.

For the continuous withdrawing and extraction of the drill string it is necessary to operate the valves L, M, N, and O, and further also the valve Q in order to carry out the unscrewing of the upper drill string element.

During most drilling it is necessary to supply flushing medium to the hollow drill string and the bore hole in order to flush and cool the drill bit and to carry away the drill cuttings and slurry. Air or water or a combination thereof or other compositions may be used as flushing medium.

In order to fully utilize the advantages inherent in the drilling machine according to the invention, it is preferred to provide a flushing medium supply device whereby flushing medium may be supplied to the drill string continuously, and this is obtained by employing the device disclosed in a copending U.S. patent application filed by A. G. Kvello-Aune on April 12, 1962, Serial No. 187,071.

Due to the importance of said flushing medium supply device for the full understanding the present invention said device is here described in detail with reference to FIGS. 11, 12, 13 and 14.

In FIG. 11 **250** is a drill pipe element furnished with internal screw threads **251**, to which is screwed a housing **252**, the outer diameter of which is equal to the outer diameter of tthe drill pipe except for an annular recess **253**. In the recess **253** is located a swival bushing **254**, having a wall thickness somewhat smaller than the depth of the recess **253**, so that the outer diameter of the bushing **254** substantially corresponds to the outer diameter of the drill pipe **250**. The swivel bushing **254** is provided with a radial aperture **255** therethrough, which leads into a peripheral annular groove **256** in the housing **252**.

Between the groove **256** and an axial central passage **257** in the housing **252** is a conduit **258** in which is located a one-way valve comprising a ball **261** which is kept biased against a seat **262** by a spring **263** in a spring chamber **264**. The portion of the passage **258** connect to the passage **257** is indicated at **266**.

The passage **257** communicates to the left in FIG. 11 with the cavity **268** in the drill pipe. To the right the passage **257** is closed by a one-way valve comprising a ball **271** which is biased against a seat **272** by a spring **273**. The spring **273** is arranged concentrically in the housing **252**, bearing against a suitable shoulder formed by a washer **274**. The one-way valve **271** permits flow to the left in FIG. 11 only.

In order to be able to assemble the bushing **254** in the recess **253**, and further for locating the one-way valves **261**, **271**, the housing **252** is preferably made in two parts fitted together at **276**. These parts may be pressed, screwed or joined together in any other suitable way. To the right in FIG. 11 the housing **252** is provided with external threads **278** for screwing on the next drill pipe **280**, indicated in chain dotted lines.

The swivel bushing **254** and adjoining parts appear also from FIG. 12, which is a cross section on line XII—XII in FIG. 11.

The swivel bushing **254** is at each end provided with an external peripheral groove **282**, **283**, which at a point diametrically opposed to the aperture **255** are provided with small recesses **284** and **285**, respectively. The grooves **282** and **283** are used as guides in connection with a coupling device for the flushing medium fluid supply hose, which will be described hereinafter.

FIGS. 13 and 14 show a coupling device for the flushing medium hose which is employed in order to admit flushing medium through the aperture **255** while the drill string rotates. The device comprises two substantially S-shaped levers **286** and **287** which are pivotally connected to each other by means of a rivet **288**. The lever elements **286**, **287** form a pliers-like device having jaws **290**, **291**, and shanks **292**, **293**, respectively. The jaws are formed for encircling the swivel bushing **254** on the drill pipe.

Internally on jaw **290** are provided two lugs **294** and **295** which are spaced apart and formed to fit the grooves **282** and **283** of the swivel bushing **254**.

The jaw **291** is provided with a bore **296**, the axis **303** of which points half-way between the lugs **294** and **295**. The face of the jaw **291** has a packing **297** of rubber or plastic provided around the bore **296**, while the supply hose for the flushing medium is coupled to the outer part of the bore by means of a threaded nipple **298**.

The shanks **292**, **293** of the levers **286**, **287** are provided with a spanner **300**, comprising a left and right hand threaded screw **301** engaging threads provided in dice in the arms **292** and **293** and provided with a wheel **302** which, when rotated moves the lever elements **286** and **287** relative to each other.

In FIGS. 1 and 2 are indicated the flushing medium supply devices at **316** and **318**. **310** designates a three-way valve which may be mounted on the frame **2**. **311** designates a supply hose for the flushing medium while **312** and **314** designate the hoses to the supply devices **316** and **318**, respectively, both being of the type which is shown in detail in FIGS. 13 and 14.

Suppose now that during drilling operation a further drill pipe has been connected to the drill string. This drill pipe has to be of the type shown in FIG. 11. Flushing medium may now be admitted into this drill pipe by mounting the device **316** (or **318**) on the drill pipe as

above described so that the lugs 294 and 295 enter the grooves 282 and 293. The bushing 254 rotates together with the drill pipe until the lugs 294 and 295 engage the recesses 284 and 285, whereafter the bushing is stopped and the device 316 or 318 is firmly clamped in place by turning the wheel 302 and pressing the packing 297 to seal around the aperture 255. Thereupon the supply of flushing medium may be turned on, for example by means of the valve 310. The flushing medium will now flow from the supply hose through the aperture 255, the groove 256, passage 258, over one-way valve 261, and opening 266 to the passage 257 and into the cavity 268 of the drill string. The one-way valve 271 prevent flushing medium from flowing in the opposite direction, i.e. out of the drill string. In order to prevent leakage of flushing medium between the swivel bushing 254 and the housing 252 suitable packing rings 304 and 305, for example rubber rings, may be provided.

When the drill string has been fed down to the position illustrated in FIG. 1, the idle device 316 is connected to the swivel bushing between the chucks at 320. Thereafter the flushing medium supply is changed from the device 318 to the device 316 by means of the valve 310, whereafter the device 318 is disconnected from its swivel bushing which moves through chuck 30 until it comes out below chuck 30. The swivel bushing coming out below chuck 30 is now clamped in device 318 and valve 310 is changed back to supply flushing medium to swivel bushing 318 while device 316 may be disconnected. A further drill pipe having a housing 252 at the top end is connected to the drill string, as previously described, and the idle device 316 is connected to the swivel bushing at the top of said drill pipe, whereafter the flushing medium is switched to the device 316 and device 318 is removed. It will be understood, that in this way one device 316 or 318 is always connected to the drill string and flushing medium is consequently supplied continuously during drilling and assemblying of additional drill string elements or stands to the drill string.

The embodiment of the invention above described and illustrated in the drawings should only be considered as an example and the invention may be modified in several different ways within the scope of the following claims. For example, in lieu of hydraulic maneuvering of the chuck there may be employed pneumatic operation and analogously the feeding and the rotation of the chucks may be provided by means of pneumatic working units.

What we claim is:

1. In an apparatus of the character described for rotating, feeding and retracting a string of rotary drill string elements to and from a working surface while simultaneously adding or taking away individual elements from said string and having a frame and a source of pressure fluid, the combination which comprises two axially aligned and spaced apart fluid pressure actuated drill chucks rotatably disposed on said frame, power extensible and retractable means disposed on said frame adjacent each of said chucks and connected to said source of pressure fluid for moving said chucks axially of said drill string and independently of each other selectively for feeding and engaging and disengaging said drill string, first power driving means connected to one of said chucks and in flow communication with said source of pressure fluid for rotating said chuck and said drill string disposed therein, second power driving means connected to the other of said chucks and in flow communication with said source of pressure fluid for rotating said chuck and said drill string disposed therein, at least one of said power driving means being operable at various speeds greater and less than the speed of the other and said power driving means being operable selectively simultaneously and independently of each other, and control means in said source of pressure fluid for controlling the supply thereof to each of said chucks and said power expansible and retractable means and each of said power driving means for the operation thereof selectively simultaneously or independently of each other as desired.

2. Apparatus as recited in claim 1 and including a chuck housing for each of said chucks with fluid pressure piston and cylinder means disposed therein for operating said chuck for engaging and disengaging said drill string extending therethrough.

3. Apparatus as recited in claim 2 in which said first and second power driving means are reversible variable speed air motors disposed on the housing of each said chuck and in driving connection with the said pertaining chuck.

4. In an apparatus of the character described for rotating, feeding and retracting a string of rotary drill string elements to and from a working surface while simultaneously adding or taking away individual elements from said string and having a mobile substructure with a motor-driven pressure fluid pump, and a frame disposed on said substructure, the combination which comprises two axially aligned and spaced apart fluid pressure actuated drill chucks rotatably disposed on said frame, power extensible and retractable means disposed on said frame adjacent said chucks and connected to said pressure fluid pump for moving said chucks axially of said drill string and independently of each other, first variable speed power driving means connected to one of said chucks and in flow communication with said pump for rotating said chuck and said drill string disposed therein, second variable speed power driving means connected to the other of said chucks and in flow communication with said pressure fluid pump for rotating said chucks and said drill string disposed therein, said two power driving means being operable selectively simultaneously and independently of each other, pressure fluid conduits connecting said pump to each of said chucks and said power feeding and power retracting means and said power driving means, and control valve means disposed on said substructure between said pump and each or said chucks and said power feeding and power retracting means and said power driving means for controlling the supply of pressure fluid thereto.

5. Apparatus as described in claim 4 and including a shaft fixedly disposed on said mobile substructure with said frame rotatably disposed on said shaft.

6. In an appartus of the character described for rotating, feeding and retracting a string of rotary drill string elements to and from a working surface while simultaneously adding or taking away individual elements from said string and having a frame and a source of pressure fluid, the combination which comprises a first drill chuck housing disposed on said frame and having a fluid pressure actuated drill chuck disposed therein, a second drill chuck housing disposed on said frame and being axially aligned and spaced from said first housing and having a fluid pressure actuated chuck disposed therein, a first pair of power cylinders disposed on said frame and in flow communication with said source of pressure fluid with one end thereof connected to said first chuck housing, said chuck housing forming a yoke between said pair of cylinders with said power cylinders forming a power linkage between said chuck housing and said frame, a second pair of power cylinders disposed on said frame and in flow communication with said source of pressure fluid with one end thereof connected to said second chuck housing, said housing forming a yoke between said pair of cylinders and said cylinders forming a power linkage between said frame and said second housing, said pairs of power cylinders forming means for moving said housings with said chucks disposed therein axially of said drill string and independently of each other, first reversible variable speed power driving means disposed in said first housing in flow communication with said source of pressure fluid and in driving connection with said chuck disposed therein for rotating said chuck and said drill string disposed therein, second reversible variable speed power driving means disposed on said second housing in flow communi-

cation with said source of pressure fluid and in driving connection with said chuck disposed therein for rotating said chuck and said drill string disposed therein, said power driving means being operable selectively simultaneously and independently of each other, and control means in said source of pressure fluid for controlling the supply thereof to each of said chucks and said power cylinders and said power driving means for the operation thereof selectively simultaneously or independently of each other as desired.

7. A device according to claim 6, in which each power cylinder comprises a cylinder housing fixed to the frame, a double acting piston movable in said cylinder housing, a piston rod connecting said piston to the pertaining chuck housing, means for supplying pressure fluid to cylinder chambers formed in the cylinder housing on both sides of the piston, and means for the escape of fluid from said cylinder chambers.

8. A device according to claim 6, in which each pair of power cylinders is disposed in a plane substantially through the drill string centre line.

9. In an apparatus of the character described for rotating, feeding and retracting a string of rotary drill string elements to and from a working surface while simultaneously adding or taking away individual elements from said string and having a wheeled substructure with a motor-driven pressure fluid pump disposed thereon for providing a source of pressure fluid, a shaft fixedly disposed on said substructure, and a frame rotatably disposed on said shaft, the combination which comprises a first drill chuck housing disposed on said frame having a pressure fluid actuated drill chuck disposed therein, a second drill chuck housing disposed on said frame and being axially aligned and spaced from said first housing and having a pressure fluid actuated chuck disposed therein, first power cylinder means disposed on said frame with one end thereof connected to said first chuck housing and forming a power linkage between said chuck housing and said frame, second power cylinder means disposed on said frame with one end thereof connected to said second chuck housing and forming a power linkage between said frame and said second housing, said power cylinder means moving said housings with said chucks disposed therein axially of said drill string and independently of each other, first reversible variable speed power driving means disposed in said first housing and in

driving connection with said chuck disposed therein for rotating said chuck and said drill string disposed therein, second reversible variable speed power driving means disposed on said second housing and in driving connection with said chuck disposed therein for rotating said chuck and said drill string disposed therein, pressure fluid conduits connecting said pump to each of said chucks and said power cylindere and said power driving means, and separate control valve means in said pressure fluid lines for controlling the supply of pressure fluid to aech of said chucks and said power cylinders and said power driving means for the operation thereof selectively simultaneously and independently of each other whereby each said chucks can engage and rotate at various speeds in either direction and feed or retract said drill string simultaneously with the other said chuck or independently thereof as desired.

10. Drive and feed device for a string of rotary drill string elements comprising a frame, a first drill chuck rotatably mounted and carried on said frame and operable independently to engage and to disengage said drill string, a second drill chuck rotatably mounted and carried on said frame axially aligned and spaced from said first drill chuck and operable independently thereof to engage and to disengage said drill string, means for power feeding and for power retracting at least one of said chuck forming a power linkage between said one chuck and the frame, an independently rotatable tubular shaft in each chuck forming a passage for a drill string and couplings between the drill string elements, radial openings in said shaft, chuck jaws operable through said openings to engage a drill string extending through said shaft, power driving means for rotating said shafts selectively simultaneously and independently at different speeds for drilling, and power cylinder means in said drill chucks adjacent said jaws for movement thereof in and out of said radial openings for engaging or disengaging drill string elements.

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