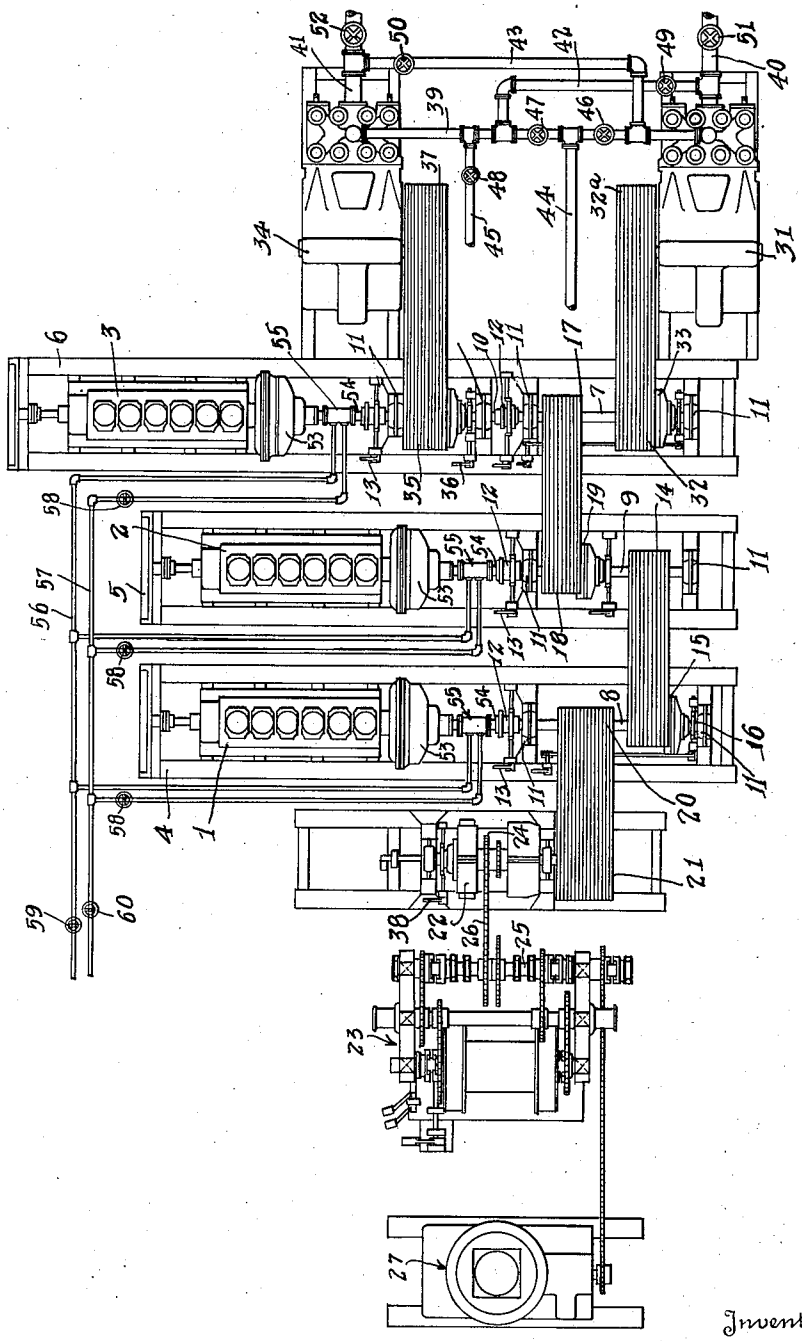
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WELL DRILLING PLANT

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WELL DRILLING PLANT

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This invention relates to improvements in apparatus for the drilling of wells, and more particularly to the power plant for driving the different mechanisms used in the rotary process of well drilling.

In the rotary process of drilling wells as now commonly employed, a number of machines are employed, each of which machines is driven and require varying amounts of power for their operation during different intervals of time. The mechanisms as commonly used include the rotary machine, the speed of drive of which is varied, and the power requirements for the driving of which are varied due to the particular drilling conditions encountered and as the depth of the well progresses and different formations are encountered.

In the rotary process of drilling wells, one or more mud, or so-called slush pumps, are employed which must be supplied with sufficient power to deliver the required amount of mud fluid. Under different conditions of operation the requirements of the mud fluid vary so that the power requirements for such a pump or pumps may vary through wide limitations.

There is also commonly employed in this process of drilling wells a mechanism known as a drawworks, which is a hoist, and the power requirements for which vary over wide ranges so that a large amount of power may be required at some interval of time to lift the drill pipe out of the hole while the rotary machine and one or more of the slush pumps are idle. The variable and fluctuating power demands have not heretofore been successfully met by conventional rig drives wherein internal combustion engines are employed. The common difficulty encountered in such internal combustion engine power plants are that they are too inflexible to meet the widely varying power demands.

It is therefore an object of my invention to provide a driven apparatus having a power plant of sufficient flexibility to accommodate all power requirements incident to rotary drilling operations.

Another object of my invention is to provide a power plant for rotary drilling operations in which there are independent prime movers for each of the mechanisms or machines required in such rotary drilling operations and wherein there are means provided for compounding any two or three of such engines to drive any one of the mechanisms or machines.

Another object of my invention is to provide a power plant for rotary drilling in which the drilling mechanism and the pumping mechanism may be synchronously driven by independent prime movers while a third prime mover is operable to assist in driving either or both of certain mechanism, or is available for the purpose of independently making up mud for the drilling fluid.

Another object of my invention is to provide a rotary drilling apparatus in which there is provided a plurality of prime movers and pumping mechanisms between which there is interposed a hydraulic coupling to provide for such variations in speed therebetween as are incident to series operation of such plurality of pumping mechanisms.

Another object of my invention is to provide a rotary drilling rig which includes a plurality of internal combustion engines which may be compounded for the driving of the drawworks of such drilling rig for the lifting of the drill pipe out of the hole and which includes an independent engine applicable simultaneously to operate a pump for the filling of the hole with mud fluid as the drill pipe is withdrawn.

Other objects and advantages of this invention it is believed will be apparent from the following detailed description of a preferred embodiment thereof as illustrated in the accompanying drawing.

The drawing represents a schematic plan of a rotary drilling apparatus and power plant therefor incorporating my invention.

In the preferred embodiment of my invention as illustrated in the accompanying drawing, 1, 2 and 3 indicate prime movers of the internal combustion type and may be what is commonly referred to as Diesel engines. These engines may be duplicates of each other and are, as illustrated, arranged in parallel side by side relation for compactness and for the purpose of compounding.

As illustrated, each engine may be mounted upon its own skid frame 4, 5 and 6, respectively. These skid frames may be mounted in position upon any suitable base or sub-structure commonly provided in such drilling operations and not herein illustrated. The drive shaft of each engine, 1, 2 and 3, is provided with a shaft extension 8, 9 and 10, respectively. Each of the drive shaft extensions is rotatably supported in a pair of pedestal bearings 11 carried by the respective skid frames.

In addition to the shaft extension 10 of the engine 3, the engine 3 may be coupled directly to an idler shaft 7. The idler shaft 7 is coupled to the shaft 10 in end to end relation. Flexible

couplings 12 are provided between each engine shaft and its extension shaft and between the extension shaft 10 and the idler shaft 7. These flexible couplings 12 may be of any suitable or desirable construction, but are preferred to be of the disconnecting type whereby through the instrumentality of shifter levers 13, the extension shafts may be disconnected from the engine shafts in a manner similar to that of an ordinary clutch. In this manner each engine shaft is selectively coupled to its respective extension shaft and the extension shaft 10 is selectively coupled to the idler shaft 7.

Transmission connections are provided between the respective shafts and these transmission connections may take the form of sheaves operatively connected through the medium of multiple V-belt connections.

In order to permit the operation of the prime movers 1, 2 and 3 independently or conjointly, the transmission connections include a sheave 14 which is fixed upon the extension shaft 9 and connected through the multiple V-belt connection with a sheave 15 journaled upon the extension shaft 8.

A friction clutch 16 is provided for releasably clutching the sheave 15 to the extension shaft 8. Similarly, a sheave 17 is secured to the idler shaft 7 and connected through a multiple V-belt with a sheave 18 mounted upon the extension shaft 9. A clutch 19 of any suitable or desirable construction is provided for engaging the sheave 18 with the shaft 9. It will be obvious that the coupling 12 between the extension shaft 10 and idler shaft 7 may be used to couple these shafts together. Thus depending upon the actuation of the respective couplings, the engines 1, 2 and 3 may be used independently or may be conjointly compounded together.

In addition to these selective transmission connections with at least one other engine, each of the engines 1, 2 and 3 is detachably connected to drive one of the driven connections or machines essential to the operation of the drilling rig. Thus the shaft 8 of the engine 1 is connected through the transmission illustrated as including a sheave 20 fixed upon the shaft 8 with a sheave 21 fixed upon the driven shaft of a reverse gear mechanism 22. The reverse gear mechanism 22 is interposed between the engine 1 and the drawworks 23 and is provided with a power take-off sprocket 24 which drives the drawworks drive shaft 25 through a transmission chain 26. The rotary machine 27 is, as is customary in such drilling apparatus, driven through a transmission connection from the drawworks 23.

The idler shaft 7 is normally driven by the engine 2 and the transmission connection provided for this drive includes a sheave 18 which is journaled upon the extension shaft 9 and is adapted to be releasably clutched thereto through the medium of a clutch 19. Through a suitable transmission connection such as the multiple V-belt illustrated, the drive from the engine 2 is transmitted to a sheave 17 fixed to the idler shaft 7.

In order to drive the slush pump 31 directly from the engine 2, a sheave 32 is journaled upon the idler shaft 7 and is adapted to be releasably clutched through the medium of a clutch 33. A transmission connection, which may be of the multiple V-belt type, connects the sheave 32 with a sheave 32a secured to the driven shaft of the slush pump 31.

In the same manner, the slush pump 34 may be directly driven from the engine 3 through the medium of a sheave 35 journaled upon the extension shaft 10 and adapted to be releasably clutched thereto through the medium of a clutch 36. A transmission connection, illustrated as of the multiple V-belt type, extends from the sheave 35 to a sheave 37 fixed to the driven shaft of the slush pump 34.

It will be apparent that the slush pumps 31 and 34 may be disconnected from their respective driving engines 2 and 3 by moving the clutches which may be of the friction type 19 and 36 to their disengaged position. It will also be apparent that the engine 1 can be disengaged from its driven mechanism, that is, the reverse gear 22, by shifting the reverse gear actuating lever 38 to its neutral position, at which position the power take-off sprocket 24 is not driven and the reverse gear 22 idles and does not transmit power.

The slush pumps 31 and 34 are operatively associated together so that they may be driven independently or in series or in parallel, depending upon the conditions of operation desired or required during the rotary drilling of the well. For example, it may be desired to operate the pump 34 only. In order to connect the pumps so as to permit of such individual operation, a header 39 is provided, which header 39 is connected with the outlets from each of the pumps 31 and 34. The inlets 40 and 41 of the pumps 31 and 34 are respectively connected to conduits 42 and 43, which conduits are connected into the header conduit 39. A single discharge conduit 44 is provided which leads to the customary hydraulic swivel (not illustrated) usually employed in a rotary drilling rig.

A second discharge conduit 45 is provided leading from the header conduit 39 which extends outward to the point where mud is mixed for entry into the intakes 40 or 41 of the pumps 31 and 34, respectively. The header conduit 39 is provided with valves 46 and 47, respectively. The auxiliary discharge conduit 45 is provided with a valve 48; the conduit 42 is provided with a valve 49; the conduit 43 is provided with a valve 50; the intake conduits 40 and 41 are provided with intake valves 51 and 52, respectively.

When only one pump, for example the pump 31, is desired to be operated, the clutches 19 and 33 are engaged. The valve 48 is normally maintained closed except in the mixing of mud, and for the following examples, may be considered to be maintained closed at all times.

In operating the single pump 31 to provide the mud fluid for the drilling operations, the valves 49, 47 and 50 are closed. The pump 31 then draws the mud fluid through the intake 40 by the intake valve 51 which is open and discharges the same through the valve 46 to the discharge line 44. If it is desired to operate the slush pump 34 alone, the clutch 33 may be disengaged and the clutch 36 engaged. During this operation the valves 52 and 47 are open and the valves 50, 46 and 49 are closed. Mud is then drawn through the intake 41 and discharged by the valve 47 and through the discharge conduit 44.

In order to operate the two pumps 31 and 34 in parallel, both the engines 2 and 3 may be utilized and the clutches 19, 33 and 36 are closed, and all valves with the exception of valves 49 and 50 are open, then both pumps discharge into the discharge pipe 44.

In order to operate the pumps 31 and 34 in series, either pump may be utilized for low pressure or high pressure service as desired. For example, the pump 31 may be used for low pressure service and the pump 34 for high pressure service, in which case the valves 49, 46 and 52 are closed and all other valves remain open. Mud fluid then enters the intake 40 and is discharged by the pump 31 through the conduit 43 by the valve 50 into the intake 41 of the pump 34 and is discharged by the pump 34 through the header conduit 39 by the valve 47 and into the discharge conduit 44.

In the equivalent operation, when the pump 34 is used for low pressure service and the pump 31 for high pressure service, the engines remain coupled to the pumps for driving the same as heretofore described, and in this case the valves 51, 50 and 47 are closed and all other valves remain open. In this case the operation is that the mud fluid is taken in through the intake 41 of the pump 34, discharged through the header conduit 39 through the conduit 42 by the valve 49 into the intake 40 of the pump 31 and is discharged from the pump 31 by the valve 46 into the discharge conduit 44.

The pumps 31 and 34 are, as is common in such drilling rig, of the positive displacement type and in operating these pumps in series, it is required that the output from the low pressure pump be equal to the input to the high pressure pump.

Considerable difficulty has heretofore been experienced in endeavoring to control the speeds of the two pumps so that this requirement may be met. In my present invention this difficulty is overcome by providing two separate engines and further by providing a hydraulic coupling 53 between each engine and its flexible coupling 12 whereby the engine shaft is connected to its respective extension shaft. The hydraulic coupling 53 may be of any suitable or desirable construction but is as herein illustrated of the type specifically set forth and disclosed in the copending application of Merton T. Archer and Ernest L. Durrell, Serial No. 215,192, filed June 22, 1938, Patent No. 2,164,173, granted June 27, 1939, to which application reference is specifically made for the construction and operation of this hydraulic coupling. These hydraulic couplings 53 are of such construction and mode of operation that minor variations and speed of the output shafts 54 thereof can be readily absorbed without materially affecting the speed of the driving engine. This permits the engines to be driven or operated at substantially constant speed while driving the pumps 31 and 34 in series operation and any necessary difference in speed of operation of the pumps 31 and 34 may be absorbed by the slip of these hydraulic couplings.

The use of these couplings 53 also permits the power plant embodying my invention to be operated so that it does not "pick up the load," i. e., the output shaft 54 does not begin to run until the speed of the engine is increased above idling speed. Therefore each engine can be allowed to idle without turning its extension shaft until such time as its power is required, at which time the engine automatically picks up the load upon increase in speed.

In order that the working fluid within the hydraulic couplings may not become overheated in service, means are preferably provided for circulating a cooling liquid such, for example, as water to and from each hydraulic coupling 53. In order to accomplish this, a manifold 55 is provided for each coupling mounted upon each output shaft 54 between the hydraulic coupling 53 and the coupling 12. These manifolds 55 direct the cooling liquid from the respective supply pipes 56 to the hydraulic couplings 53 through a passage formed within the shaft 54. The discharge fluid returns to the manifold 55 through another passage within the shaft 54 and is carried away through a discharge conduit 57.

Individual valves 58 may be provided on the individual discharge conduits and master valves 59 and 60 may be provided for the conduits 56 and 57 as illustrated. The internal construction of the manifolds 55, the shafts 54 thereof, and the hydraulic coupling 53, is disclosed in the copending application as hereabove referred to and is not per se claimed herein.

It will be obvious from the foregoing that through the instrumentality of my invention a power plant for rotary drilling apparatus is provided which provides independent and individual prime movers for drilling mechanism and each pumping mechanism. It also provides the power plants which may be combined so that any two or three of the engines are available to drive any one of the mechanisms, either the drilling machine, or either of the pumps.

It will also be evident that the drilling mechanism and the pumping mechanism may be separately operated by independent prime movers with one of them available for mud mixing and make-up. It will be further obvious that any two engines may be compounded to operate the drawworks while the third engine is available to operate a mud pump for circulating the mud fluid or for filling the casing with mud as the drill pipe is withdrawn. It will be further obvious that the drilling mechanism may be operated with one engine while the other engines may be compounded to operate one mechanism or may operate two mechanisms in series or in parallel and that the series operation of the mud or slush pumps is facilitated through the use of the hydraulic couplings as hereinabove set forth.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a rotary drilling apparatus, the combination of a pair of pumping mechanisms of the positive displacement type operatively connected for series operation, means to drive one of said pumping mechanisms, a prime mover, a power take-off shaft adapted to drive the other pumping mechanism; a hydraulic coupling operatively interposed between the prime mover and the power take-off shaft and adapted to transmit power to the latter, the slip of said hydraulic coupling acting to absorb variations in speed between the prime mover and the pumping mechanism driven thereby which are incident to series operation of the pumping mechanisms.

2. In a rotary drilling apparatus, the combination of a plurality of pumping mechanisms of the positive displacement type operatively connected for series operation, means to drive said pumping mechanisms including a separate engine for each, power transmission connections between each pumping mechanism and its respective engine including a hydraulic coupling, the slip of said hydraulic coupling acting to absorb variations in speed between each engine and its

pumping mechanism which are occasioned by series operation of the pumping mechanism.

3. In a rotary drilling apparatus, the combination of a plurality of pumping mechanisms of the positive displacement type operatively connected for series operation, means to drive said pumping mechanisms including a separate engine for each, power transmission connections between each pumping mechanism and its respective engine including a hydraulic coupling, the slip of said hydraulic coupling acting to absorb variations in speed between each engine and its pumping mechanism which are occasioned by series operation of the pumping mechanisms, and power transmission connections between two of said engines, including releasable clutch means, whereby the combined power of both engines may be available to drive either of their respective pumping mechanisms.

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