This invention relates to the art of earth boring and more particularly to a method of cleaning oil well drilling fluids. The application is a continuation-in-part of our copending application Serial No. 112,761, filed November 25, 1938.

As is well known in the art, a fluid is pumped down the drill stem of a rotary drilling rig, passes through holes in the bit, washes over the cutting faces of the bit, and rises to the surface through the annular space surrounding the drill stem, this annular space approximating the amount by which the diameter of the bit exceeds the diameter of the drill stem. The principal functions of the drilling fluid in this use are to seal the walls of the open hole, to lubricate the bit, to carry the cuttings from the bit to a point outside the hole, to prevent the settling of cuttings and the consequent seizure of the bit, and to supply a static head sufficient to overcome pressures encountered during boring which would blow the fluid from the bore.

In the present art there are a number of difficulties in accomplishing all these functions. Many of these have been pointed out in our copending application Serial No. 112,761. A difficulty which causes great expense due to wear of the equipment is that of being unable to separate the abrasive material from the drilling fluid. This abrasive material ordinarily is in the form of fine sand. This causes excessive wear of the drill stem, the drill bit and of pumps. In average drilling the sand content may vary greatly. A sand content of 1% to 3% by weight of mud is the maximum desirable amount. It is seldom that a concentration as low as this can be obtained.

Having the foregoing in mind, an object of this invention is to provide a novel method of cleaning the drilling fluid of abrasive material. One form of treatment of oil well drilling fluid in accordance with the practice of our invention is shown in the accompanying drawing. A is the suction pit; B, the mud pump; C, the flexible hose connecting pump B with the drill stem; D is the drill stem; E is the drill bit; F is the bore made; G is the surface casing; H is a vibrating screen; J, a settling pit; K is a filter; L is a centrifuge; M is a refuse pit; N is a swivel connecting C with D; and P is the rotary table of drilling rig O. A description of the operation of the illustrated apparatus follows: Drilling mud is picked up from suction pit A by pump B and is forced through the line and flexible hose C through swivel N and downwardly through drill stem D. The mud passes through holes in the bit E and proceeds upwardly through the hole F, surface casing G, and proceeds from the outlet of G to the vibrating screen H. The screen removes considerable amounts of shale and larger particles. The mud proceeds from H to settling pit J. In this pit there is further dropping or separation of cuttings by gravity. From J the mud may be pumped through the centrifuge L, which contains the customary pumping means. During this period the valve between L and K is closed and the valve between L and A is opened. The centrifuge separates the abrasive material from the mud and ejects the cleaned mud through the line from L to A; and ejects the waste abrasive material through the line to refuse pit M simultaneously. This type of operation is more successful with a brine drilling fluid, due to the fact that there is no gelling action by the natural mud drilled in a brine solution. Thus the for-
large amount of solid matter. The only way in which the mud is cleaned is by dilution and by the action of the settling pit, and often by the vibrating screen. However, if a mud is continually cleaned as drilling progresses the total amount of solid material that must be removed is comparatively small. For example, a ten-inch hole being drilled at a rate of 100 feet per day gives only 275 pounds of solid material per hour. A filter for removing this amount of material at this rate is a requirement easily met. The filter may be of the Swedish type or may be a rotary type. With a rotary type filter, a screen having openings smaller than the particle size of the sand which is to be removed may be used as the filter, in combination with a cleaning knife which removes the cake at each revolution of the screen.

Several ways of operating this invention have been disclosed, but these disclosures are not intended as limitations on the use of any combination of equipment specifically described. For example, there may be a varying number of pits, there may or may not be a vibrating screen, a filter may be used alone with fresh water or brine mud, the centrifuge may be used alone, or the centrifuge and filter may be used in combination with each other.

The advantages in the use of this method of cleaning mud are that maintenance of drilling and pumping equipment is greatly decreased, and that where soluble weighting materials are used the weighted solution may be recovered completely.

Having thus described the invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination with a rotary drilling apparatus for oil and gas wells, an exit conduit from the drill hole to a screen for removing large solid particles, a settling pit, a conduit between said screen and said settling pit, a centrifuge for removing smaller solid particles not removable by the screen, a conduit between said settling pit and said centrifuge, a filter adapted to remove substantially all of the liquid from the solid materials, a conduit between said filter and the settling pit, a conduit between said filter and the centrifuge, a suction pit, a conduit between said suction pit and said filter, another conduit between said suction pit and said centrifuge, and a conduit including pumping means between said suction pit and the drilling apparatus for recycling the cleaned drilling fluid.

2. In the art of drilling oil and gas wells, the method of treating a mud-laden drilling fluid containing a weighting agent as it comes from a drilling hole which comprises the steps of passing the same through a screen to remove shale and large particles, sending the screen-passed fluid to a settling tank, and combining the fluid therein to permit cuttings to separate by gravity, removing the separated cuttings to a refuse pit, and adding the remaining fluid to the settling tank to a centrifuge, centrifuging the drilling fluid in the centrifuge in separate sand-like abrasive material, removing said separated abrasive material from the centrifuge to the refuse pit, passing the cleaned mud from the centrifuge to a suction pit, sending the mixed cuttings and abrasive material from the refuse pit to a filter and filtering the same, and passing the filtrate from said filter to the suction pit to join the cleaned mud from the centrifuge, and reusing the cleaned fluid mixture in the drilling system.

3. In the art of drilling oil and gas wells, the method of treating a mud-laden drilling fluid containing a weighting agent to remove undesirable solids and abrasive materials accumulated in a drilling hole and to recondition the same which comprises the steps of centrifuging the fluid, passing the cleaned centrifuged mud to a receptacle, filtering the separated abrasive material from the centrifuge by a filter and combining the filtrate from the filter with the cleaned mud in the receptacle, and recirculating the mixture to the drilling hole.

4. In the art of drilling oil and gas wells, the method of reconditioning a mud-laden drilling fluid containing a weighting agent as it comes from a drilling hole which comprises the steps of separating undesirable large solids and cuttings, centrifuging the remaining mud-laden drilling fluid, filtering the cleaned mud coming from the centrifuge, mixing the aforesaid large particles and cuttings with the separated abrasive material from the centrifuge, filtering the cuttings and abrasive mixture and combining the filtrate therefrom with the filtered mud originally cleaned by the centrifuge, and recirculating the mixture for reuse.