This invention relates to the art of boring and drilling, particularly to core drilling and sample taking for mineral testing and other geological tests where a bore of relatively small diameter is cut to considerable depth.

The primary object of the invention is to provide a dual system of dry sample taking, where in addition to the core, the cuttings from around the core are pneumatically conveyed to the top of the well and collected in a receptacle for visual inspection. By the use of air or gas as the compressible fluid conveyor none of the material cut is dissolved, so that the entire sample is collected. Further by the use of compressed air or gas it is possible to get dry samples of soluble formations, where it would be impossible to collect a solid sample by using water as a circulating medium, as in sample taking in potash, salt or other soluble materials.

An object of the invention is the provision of a method of drilling or boring whereby the cut material is pneumatically conveyed, as cut, away from the point of cutting and is discharged from the top of the well.

Another object is the provision of a method and apparatus for boring or drilling wherein material is removed as it is cut, by the application of pneumatic pressure acting to float the cut material from the well on a compressible fluid collecting and discharging at the well head.

A further object is the provision, in well drilling apparatus, of pneumatically controlled means for selectively regulating the weight of a drill rod upon a cutting tool carried thereby, at its point of cutting.

A still further object is the provision of a method and means for pneumatically removing material from a bore as it is cut, and for arranging the removed material in column form in transparent receptacle means approximating the dimension of the bore being cut, thus enabling visual inspection of the cuttings as work progresses.

Other objects will be apparent from the description.

In the drawings:
Figure 1 is a perspective view of the entire device with portions of the same being shown in section for greater clarity;
Figure 2 is a sectional detail showing a valve arrangement in connection with my device;
Figure 3 is a side view of the device showing the adaptation of an auxiliary device to my invention; and
Figure 4 is a detail partly in section of a two-way valve arrangement used in connection with the auxiliary device shown in Figure 3.

In the drawings, wherein like reference characters have been used throughout to designate like parts, and with particular reference to Figure 1, 10 represents the usual rotary for driving a rotating drill provided with suitable drive means (not shown), and 11 designates the usual derrick platform. Reference numeral 12 designates the usual well casing having a packed connection 13 with a rotating hollow slip sleeve 14. The slip sleeve 14 has a packed connection 17 at its upper end with a drill stem 18 concentrically arranged within the slip sleeve and clutched thereto by a clutch 16. The stem 18 is connected in the usual manner to the regular swivel block 15. The swivel block supports the drill stem from the usual derrick (not shown) in the manner common in such structures. From the lower portion of the slip sleeve 14 the smaller drill stem or pipe 18 extends, and upon the lower end of the same there is threaded or otherwise attached, a core barrel 19a which carries a drill bit 19, having toothed cutters 20. Within the core barrel 19a and the drill bit 19, which are hollow, is the usual core shell or "core catcher" 80 which is so arranged that a space 81 is provided between the inner periphery of the drill 19 and the outer periphery of the core shell 80. It will be apparent that the shell 80 extends downwardly approximately as far as do the drill teeth 20 so as to prevent the escape of any substantial amount of air from the bore into the central portion of the core shell. The shell 80 is also closed at its upper end but it is to be noted that the space 81 is continued and leads into the interior of the drill stem. This is more or less conventional in core shells of this sort and it is not my intention to limit myself to this particular form, as it may well appear that other casings for this purpose might serve equally well. While I have shown one particular type of arrangement and drill, it is conceivable that my invention is adaptable to other forms of drills, casings, core shells, drill bits, and other parts. In fact, it is not necessary that a rotary drill be used, as my invention will operate equally well with other forms of drills, such as the spudding type or any method by which material is loosened or broken away from the cutting means.

A pipe 21 is suitably connected to the casing 12 below the packed connection 13 and leads to a low pressure blower 8 which is located upon the platform 11 and which is capable of forcing a comparatively low pressure head of air, through the...
pipe 21 and into the casing 12 for a purpose to be described later. A motor M or other suitable source of power, serves to operate the blower.

Above the swivel block 15, instead of the usual gooseneck, I have provided a T-joint 22 having arms 22a and 22b and also a valve 23 in the arm 22b and a second valve 24 in the other arm 22a. A suitable conduit 25 leads from the arm 22a into the intake 26a of a centrifugal gravity separator 26 which is suitably supported, as at 31, at one side of the platform 11. The separator 26 may have a window 27 on one side wall thereof and is provided on its top wall with an air exhaust 28 which is fitted with a funnel-like outlet 29 for the cuttings or samples which are discharged therefrom into a relatively tall and narrow receptacle 30 which has a dimension approximating that of the bore being cut by the drill and which is formed of transparent material. In practice it may be advisable to use an impervious walled receptacle of similar size and shape, but in that event windows would be provided so that the various strata could be observed as they are deposited.

In operation, the drill is rotated in the usual manner and the valve 23 in the arm 22b of the T-joint 22 is closed. The valve 24 in the opposite arm is operated and the motor M and low pressure blower B are started. Air under comparatively low pressure is pumped into the casing 12 by way of the pipe 25. By reason of the packed connection between the casing 12 and the slip sleeve 14 and the packed connection between the sleeve 14 and the inner tube or drill stem 16, the air is forced in a downward direction as indicated by the arrows. The air at this pressure is blown into the bottom of the drill 21 and up through the bottom of the drill 19. The velocity of the air is so great that it carries orri...
carry pistons 56 on their free ends. The pistons 56 work in twin pneumatic cylinders 54 by means of air from the high pressure tank 32. A conduit 57 leads from one of the connections 54 on the high pressure tank 32 to a pressure reducing valve 58. A pipe 59a leads from the valve 58 and connects with a pipe 59 by means of a $\tau$-joint 58b. Two way valves 56 on either side of the $\tau$-joint 58b, regulate the air supply to the cylinders 54. A pipe 59a leads from the valve 61 and is provided with branches 62 and 63 each of which leads to the upper portion of one of the cylinders 54. In like manner, a pipe 59b leads from the valve 60 and supplies air to the lower portions of the cylinders 54 by means of branches 64 and 65. The valves 60 and 61 are also provided with exhaust ports 68 and 69 respectively.

The operation of the device is as follows:

When the valves are in the position shown in Figure 4, air following the direction of the arrows, passes through the valve 61 and into the upper portions of the cylinders 54. This forces the pistons downwardly and, of course, carries with it the yokes 61, collar 69, slip sleeve 64, drill stem 54, and, of course, these last described parts are designed to engage the surface to be cut with enough pressure to overcome the hardness of the material. Air in the lower portions of the cylinders is exhausted through the branches 66 and 67 of the pipe 59b and escapes through the exhaust port 68 of the valve 61 which is open when the valve is in the position shown.

It frequently happens, however, that it becomes desirable to reverse this operation just described. This occurs when the condition is true that the advancing of the drill bit is preceded by going to a shallower section, or in some instances, the softening of the material (due to the heating of the material) when the drill stem is moving through the material and is heating the material. When this occurs, it is only necessary to reverse the position of the valves 60 and 61. Then, when the former is opened and latter closed, air is forced into the lower portions of the cylinders 54 and they tend to raise the pistons, yokes, collar, slip sleeve, and drill string and relieve the weight upon the drill bit. It is apparent that these last described operations may go on without interrupting the sample taking for, I contemplate providing a high pressure tank 32 capable of taking care of both the back blowing and the weight relieving operation at once should an occasion arise when both must be carried on at the same time. For instance, in back blowing, it is desirable to raise the drill string slightly before the valve 23 is opened.

It will, thus, be seen that I have provided a device which is capable of a high degree of performance and which, at the same time is simple in construction and efficient and economical in operation.

While I have described and shown what now appears to be the preferred form of my invention, it is to be understood that I do not limit myself to the precise expression shown and described. It is my belief that my device is susceptible of other expressions and, modifications thereof and other embodiments without departure from the spirit of the invention and scope of the appended claims.

Having thus described the invention, what is claimed is:

1. The method of drilling a well which comprises the advancing of a drill-bit into the formation, forcing a stream of air downwardly to the bit and upwardly to the surface to remove the cuttings from the well, separating the cuttings from the stream of air and depositing them into a transparent receptacle thereby enabling visual inspection as drilling proceeds.

2. The method of drilling a well which comprises the advancing of a drill-bit into the formation on the lower end of a hollow drill stem, forcing a stream of air downwardly outside the drill-bit and bit and upwardly to the surface, within the drill stem to remove the cuttings from the well, separating the stream of air, discharging them into a transparent receptacle, thereby enabling visual inspection as drilling proceeds.

3. A well drilling apparatus in combination, comprising a hollow drill stem, a drill-bit on the end thereof, means for operating said drill stem and bit, means for forcing a stream of air into the well downwardly to the bit and upwardly to the surface to remove the cuttings from the well, a separator connected to the discharge outlet for separating the cuttings from the stream of air and a transparent receptacle into which the cuttings are discharged from the separator.

4. A well drilling apparatus in combination, comprising a hollow drill stem, a drill bit on the end thereof, means for operating said drill stem and bit, means for forcing a stream of air downwardly outside of said drill stem to the bit and upwardly within the hollow drill stem to the surface to remove the cuttings from the well, a separator connected to the discharge outlet for separating the cuttings from the stream of air and a transparent receptacle into which the cuttings are discharged from the separator.

5. A geological sample taking apparatus in combination, comprising a hollow drill stem, a drill bit on the end thereof with a core barrel attached inside and concentrically with the hollow drill stem by means of any suitable swivel, means for operating said drill stem and bit, means for forcing a stream of air into the well downwardly to the bit and upwardly to the surface to remove the cuttings from the well, a separator connected with the discharge outlet for separating the cuttings from the stream of air, means for inspecting the contents of the separator while in operation, and a transparent receptacle into which the cuttings are discharged from the separator.

6. A geological sample taking apparatus in combination, comprising a hollow drill stem, a core bit attached thereto, a core barrel of smaller diameter than the internal diameter of the drill stem, attached inside of and concentrically with the hollow drill stem by means of a suitable swivel, means for operating said drill stem and bit, means for forcing a stream of air into the well downwardly to the bit and upwardly through the opening between the external wall of the core barrel and the internal wall of the hollow drill stem to the surface to remove the cuttings from the well, a separator connected with the discharge outlet for separating the cuttings from the stream of air, means of inspecting contents of separator while in operation, and a receptacle into which the cuttings are discharged.

7. A well drilling apparatus, comprising a hollow drill-stem, a drill bit on the end thereof, means for operating said drill stem and bit, means for forcing a stream of air downwardly outside of said drill stem to the bit and upwardly within the hollow drill stem to remove the cuttings from the well, a separator connected to the discharge outlet for separating the cuttings from the stream of air and a transparent receptacle into which the cuttings are discharged.
tings from the well, and discharge same at any desired point.

8. A well drilling apparatus in combination, comprising a hollow tube, means for lowering the said tube into the well bore, means for lowering a drilling tool through said tube with a drill bit thereon and means for operating said drilling tool independently of said tube, means for lowering said tube in the well as drilling proceeds to keep the lower end of same near the drilling tool, and means for forcing stream of air into the well downwardly outside of the hollow tube to the lower end thereof, and upwardly through the hollow tube to the surface to remove the cuttings from the well.

9. A geological sample taking apparatus in combination for taking two samples simultaneously, comprising a hollow drill stem and bit with core barrel attached inside concentrically with the hollow drill stem, means for operating said drill stem and bit, means for forcing a stream of air into the well downwardly to the bit and upwardly through the hollow drill stem to the surface to remove the cuttings from the well, a separator connected with the discharge outlet for separating out the cuttings from the stream of air, and means for inspecting the cuttings while the core is being taken, and pneumatic sustaining means to regulate the weight on said coring tool while drilling.

10. A geological sample taking apparatus in combination, comprising a hollow drill stem and bit, a core barrel attached thereto, means to operate said drill stem and coring tool, means for forcing air under pressure down the outside of said drill stem to the bit, and back through said drill stem and bit to the surface to remove the cuttings from the well, a separator connected to the discharge outlet to separate the cuttings from the air stream, means for inspecting the cuttings while in operation, and a receptacle into which the cuttings are discharged from the separator and means for temporarily reversing the air stream downwardly through the drill rod.

11. The pneumatic method of taking two geological samples simultaneously in a core drilling operation: Comprises advancing a core drill into the formation, forcing a stream of air downwardly outside of the drill stem to the bit and upwardly within the drill stem to remove the cuttings from the well, separating the cuttings from the stream of air, discharging them into a transparent receptacle, thus enabling visual inspection, as drilling proceeds, giving an index to the core being taken.

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