Abstract: An apparatus for collecting samples of drilled material. The apparatus comprises a drilled material / gas separation means such as a cyclone (11) and a sampling assembly (12) preferably comprising upper (A) and lower (B) chambers and a spreader (19) for splitting samples. The cyclone may comprise a filter arrangement (50) to prevent smaller diameter drilled materials entrained in the gas stream exiting the cyclone via gas vent (15). The spreader may comprise a rotating nozzle outlet (23) from which drilled material exiting the cyclone is delivered onto a conical surface (19a, 19b). Rotation of the nozzle outlet ensures even distribution of drilled material around the conical surface which in turn ensures that samples are delivered to the sample receptacles with maximum homogeneity.
Sample Collection Apparatus

Field of the Invention

This invention relates to a sample collection apparatus for improved sample collection.

Background

During mining exploration it is imperative that samples of the drilled material be collected in order to identify and/or assess the quality of the mineral the exploration team are attempting to locate. In light of the substantial costs associated with the establishment of a mine it is of significant importance that the samples taken are as true a representation of the drilled material as possible.

Often mining exploration is carried out in remote locations under harsh conditions. These locations are typically dry, dusty locations where the drilling process creates a significant amount of dust. Also, the ground is typically uneven and often difficult to provide a level platform from which the drilling and sampling process can take place.

Typically the process of collecting samples involves passing the drilled material removed from the drilling bore and entrained in a gaseous stream through a hydro-cyclone. As the gaseous stream circulates through the cyclone the drilled material passes from the bottom of the cyclone whilst the gaseous stream escapes from the top of the cyclone. A sample of the drilled material can then be taken from the cyclone's outlet.

Several devices have been created to improve the sample taken from the drilled material leaving the cyclone. One such device is known as a riffle splitter. This splitter takes a sample and passes it through a channel whereupon exiting the channel it is split into two different channels, with each then terminating at a
further two channels and so on depending on the size of the sample required. However, this process results in a segregation bias affecting the accuracy of the sample.

Another type of device is a cone splitter. This type of device incorporates a cone which is located adjacent the outlet of the cyclone. As the drilled material impacts upon the cone it is spread into an annulus from which the sample may be taken. This device relies on an 'hour glass' effect between the cyclones outlet and the apex of the cone and is an area prone to blockages. In order for the hour glass effect to work a large amount of drilled material needs to be collected. Another disadvantage of the cone splitter is that it must be level in order to prevent biasing of the drilled material as it falls into the annulus. If it is not level the material will tend to build up on one side. This may further be exaggerated as the majority of drilled material leaving the cyclone will always tend to exit the cyclone from one area. A further disadvantage with the cone splitter is that its construction prevents the operator to adjust the size of the sample taken.

A further device incorporates similar features to those of the cone splitter. This device has a rotating cone and a port extending through the cone through which the sample passes. This arrangement stops working as soon as wet drilling material is encountered as the port becomes blocked. In order to clear the blockage the splitter is required to be disassembled.

The devices described above also tend to be of a significant height such that the devices need to be assembled on site and removed from the rig prior to the rig being mobile. They may also require a separate transportation vehicle.

A further disadvantage of each of these devices relates to the lost drilled material which escapes as dust. The loss of such material can skew the results of the sample particularly when the mineral being sought is fine (e.g. copper oxide). Similarly if the mineral is more substantial in weight the loss of dust will result in a
higher concentration of the mineral then would be expected if the dust was also considered.

The preceding discussion of the background to the invention is intended only to facilitate an understanding of the present invention. It should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was part of the common general knowledge as at the priority date of the application.

**Disclosure of the Invention**

It is an object of the present invention to provide a sample collection apparatus capable of obtaining a more representative sample of the drilled material than some or all of the prior art.

It is also a preferred object of the invention to substantially reduce the dust created during the drilling process.

Accordingly the invention resides in a sample collection apparatus for use in extracting a sample of drilled material which is delivered to the sample collection apparatus entrained in a gaseous stream, the apparatus comprises:

- a separation means to separate the drilled material from the gaseous stream
- a sampling assembly adapted to receive the drilled material from the separation means to allow samples to be taken therefrom.

The separation means may comprise:

- a cyclone to which the drilled material entrained in a gaseous stream is delivered, the cyclone having a material outlet through which a portion of the drilled material passes from the cyclone, and a vent through which...
gaseous stream with the remaining portion of drilled material entrained therein may pass;

a filter arrangement in communication with the vent of the cyclone whereby in use the gaseous stream with the remaining portion of drilled material entrained therein passes through the filter arrangement whereupon the remaining portion of drilled material is removed from the gaseous stream before the gaseous stream is caused to pass from the sample collection apparatus.

In contrast to the prior art, the present invention enables the provision of a sample which is truly representative of the material being drilled. As the significant majority of the drilled material is removed from the gaseous stream and is made available to the sampling assembly the sample provided is not skewed by the absence of the fine particles from the sample. Furthermore, the present invention significantly reduces the dust which is produced by the drilling and collection process.

The cyclone may have an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having the vent towards its upper end and the material outlet at the lower end for the separated drilled material.

The material outlet may be associated with a spreader located below the outlet which is intended in use to distribute the drilled material into the sampling assembly.

Preferably the sampling assembly comprises an outlet chamber. The outlet chamber may comprise a receiving zone for receiving the drilled material.

The spreader may be centrally located.
The outlet chamber may have at least two closures located in spaced relation below the material outlet. The spaced closures may define an upper chamber and a lower chamber within the outlet chamber.

Preferably the closures are operable to move between an open position and a closed position. Preferably during operation, one closure does not open unless the other closure is closed. The closures may control the flow of drilled material passing through the receiving zone.

The receiving zone may be defined between the spreader and the side wall of the outlet chamber.

Preferably each closure is located to be able to extend across the receiving zone. Each closure may comprise a plurality of gate members located around the receiving zone and are movable across the receiving zone between the closed position and the open position. The gate members may slide radially between the closed and open positions.

Preferably the gate members of each respective closure are synchronised to move jointly.

Preferably the spreader comprises a conical surface located within the outlet chamber.

The conical surface may be centrally located below the material outlet.

Preferably the spreader includes a delivery chute in the form of a distribution nozzle rotatably mounted below the material outlet and between the material outlet and the conical surface, the delivery chute being caused to rotate about the central axis of the material outlet.
Preferably the delivery chute has a radial outlet, the outlet opening into the outlet chamber above the conical surface.

Preferably the conical surface is provided with a stepped portion at the location of each closure and wherein the closure members are received in the stepped portion when in the closed position.

The conical surface may be defined by a first conical portion which is located in the upper chamber and a second conical portion which is located in the lower chamber and which provides a conical extension of the first conical portion and wherein the diameter of the upper portion of the second conical portion is less than the diameter of the lower portion of the first conical portion. The undersurface at the junction of the conical portions may define a stepped portion.

Preferably a sampling inlet is provided below the lower closure for receiving a sample. There may be two sampling inlets at angularly spaced intervals.

Preferably the sampling inlet is associated with a carriage which is arranged and configured to accommodate a plurality of receptacles and to cause the receptacles to sequentially align with the sampling inlet for a sampling sequence.

Preferably the carriage comprises a carousel which is rotatable about the central axis of the receiving zone.

Preferably the outlet chamber is associated with a vibration generator which is arranged and configured to cause vibration of the outlet chamber at least when the lower closure is open. The vibration generator may be centrally located below the second conical portion.

Preferably the cyclone vent is connected to a source of negative pressure through the filter arrangement. The filter arrangement is arranged and configured to
separate fine drilled material from the gaseous stream and to cause the fine drilled material to pass to the outlet chamber.

Preferably the source of negative air pressure comprises an exhaust fan having a flow rate greater than the flow rate generated by the gaseous stream from the vent.

Preferably the filter arrangement is located above the outlet chamber.

Preferably the filter arrangement comprises an annular filter chamber which is coaxial with the cyclone.

The filter chamber comprises at least one filter outlet which delivers drilled material into the outlet chamber.

The filter outlet is associated with a closure means to open and close the filter outlet to allow the drilled material collected in the filter chamber to pass into the receiving zone of the outlet chamber. The closure means closes and opens the filter outlet depending on the pressure variation between the filter chamber and the outlet chamber.

In one aspect of the invention the closure means is in the form of a valve associated with each of the at least one filter outlet, in a one-to-one relationship. Preferably the valves are located below the filter elements.

In another aspect of the invention the closure means is in the form of a skirt associated with the at least one filter outlet. Preferably the skirt is flexibly resilient and forms a lower extension of the inner wall of the filter chamber and which is positioned to lie within the outlet chamber with its lower edge closely adjacent the outer wall of the outlet chamber, the lower edge being engagable with the outer
wall to define a closed state of the valve and clear of the outer wall to define an open state.

Preferably the filter chamber accommodating at least one filter cartridge element. The filter cartridge may be in the form of an upstanding tubular column. The at least one filter cartridge may be in communication at its upper end to the source of negative pressure.

Preferably there are a plurality of filter cartridge elements arranged in a circular array around the filter chamber.

Preferably the at least one filter cartridge element is associated with a pulsing generator adapted to cause periodic pulsing of the filter walls. Dust Particulate that has built up and formed a cake on the outside of the filters cartridges drop off in sheets under the shock of the pulse and falls and settles on the closure means.

The collected dust (fines) are purged into the receiving zone through the closure means with each subsequent pulse.

Preferably the pulsing generator comprises a source of high pressure gas which is caused to periodically deliver a quantity of pressurised gas into the interior of the at least one filter cartridge element sufficient to overcome the negative pressure within the filter chamber generated by the source of negative pressure.

The closure means will open on the pressure differential being varied as a result of the pulsing generated by the pulsing generator.

Preferably the closure means is caused to open on the activation of the pulsing to facilitate delivery of material from the filter chamber to the outlet chamber through the filter outlets.
The above is relevant to dry drilling. When moisture is entrained in the gaseous stream preferably a flow valve is provided between the vent and the filter chamber, wherein the flow valve is caused to close on the gaseous stream containing entrained moisture.

If wet drilling conditions are encountered, it is important to prevent moist air from entering the dust collector filters. The flow valve is built into the top of the cyclone to divert this moist air straight to atmosphere, bypassing the dust collector filters. The flow valve also acts to physically block the path to the filters. Dust will not be emitted because the air is wet so the dust will be suppressed and contained within the cyclone.

The flow valve is double acting to allow atmospheric air to also be drawn into the dust collector by the exhaust fan. Without this, the fan would suck a vacuum and could suck the dust collector and ducting flat.

A possible future addition to the system is to fit a moisture detector instrument in the clean air plenum of the dust collector for this feature to be automatic.

Preferably the source of gaseous flow bearing entrained drilled material comprises the outlet of a down hole drill string.

Accordingly the invention further resides in a sample collection apparatus for use in extracting a sample of drilled material which is delivered to the sample collection apparatus entrained in a gaseous stream, the apparatus comprises:

- a cyclone to which the drilled material entrained in a gaseous stream is delivered, the cyclone having a material outlet through which a portion of the drilled material passes from the cyclone, and a vent through which gaseous stream with the remaining portion of drilled material entrained therein may pass;
a filtering arrangement in communication with the vent of the cyclone whereby in use the gaseous stream with the remaining portion of drilled material entrained therein passes through the filter arrangement whereupon the remaining portion of drilled material is removed from the gaseous stream before the gaseous stream is caused to pass from the sample collection apparatus;

Accordingly the invention further resides in a sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, the material outlet associated with a spreader located centrally below the outlet which is intended in use to distribute the drilled material into an outlet chamber such that it is substantially evenly introduced into an receiving zone located below the material outlet, an outlet chamber having a pair of spaced closures located in spaced relation below the outlet to define an upper and lower sub-chamber, a controller associated with the closures to cause the closures to move between an open and closed position, wherein the controller causes the upper closure to be open when the lower closure is closed and the lower closure to be open when the upper closure is closed and wherein the closure ensures that one closure is not caused to open unless the other closure is closed, the controller causing the periodic opening and closing of the closures, a sampling inlet provided below the lower closure and below the receiving zone.

Preferably the spreader comprises a conical surface located within the outlet chamber and substantially centrally below the material outlet, the receiving zone being defined between the spreader and the side wall of the outlet chamber and
the closures being associated with the receiving zone to control the flow of drilled
material from the receiving zone in each sub-chamber.

Preferably the spreader includes a delivery chute rotatably mounted below the
material outlet and between the material outlet and the conical surface, the
delivery chute being caused to rotate about the central axis of the material outlet,
the delivery chute having a radial outlet, the outlet opening into outlet chamber
above the conical surface.

Preferably each closure is located to be able to extend across the receiving zone
and each closure comprises a closure members located around the receiving
zone and movable across the receiving zone to the closed position and across the
receiving zone to their open position at which they lie clear of the receiving zone.

Preferably the conical surface is provided with a stepped portion at the location of
each closure and wherein the closure members are received in the stepped
portion when in the closed position.

According to a third preferred feature of the invention the conical surface is
defined by a first conical portion which is located in the upper sub-chamber and a
second conical portion which is located in the lower sub-chamber and which
provides a conical extension of the first conical spreader and wherein the
diameter of the upper portion of the second conical portion is less than the
diameter of the lower portion of the first conical portion and the undersurface of
the conical portions define the stepped portions.

Preferably the closure members are movable radially across the receiving zone
when moving between the closed and open position.

Preferably each closure member comprises a set of gate elements which are
supported to be movable radially across the receiving zone, the gate elements
being movable jointly across the receiving zone between the open and closed
position a drive associate with the gate elements and arranged and configured to cause the joint movement.

Preferably the sampling inlet is associated with a carriage which is arranged and configures to accommodate a plurality of receptacles and to cause the receptacles to sequentially align with the sampling inlet for a sampling sequence.

Preferably the carriage comprises a carousel which is rotatable about the central axis of the receiving zone.

Preferably a plurality of sampling inlets are located below the receiving zone at angularly spaced intervals.

Preferably the outlet chamber is associated with a vibration generator which is arranged and configured to cause vibration of the outlet chamber at least when the lower closure is open.

Preferably the vent is connected to a source of negative pressure through a filter chamber which is arranged and configured to separate fine drilled material from the gaseous stream and to cause the fine drilled material to pass to the outlet chamber through a filter outlet.

Preferably the filter chamber is located above the outlet chamber.

Preferably the filter chamber comprises an annular chamber which is concentric with the cyclone.

Preferably the filter outlet comprises a set of delivery valves.

Preferably the source of negative air pressure comprises an exhaust fan having a flow rate greater than the flow rate generated by the gaseous stream from the vent.
Preferably the air filter comprises a filter chamber accommodating at least one filter element comprising an upstanding tubular column, the interior of the column being connected at its upper end to the source of negative pressure.

Preferably the filter element is associated with a pulsing generator adapted to cause periodic pulsing of the filter walls.

Preferably the pulsing generator comprises a source of high pressure gas which is caused to periodically deliver a quantity of pressurised gas into the interior of the filter element sufficient to overcome the negative pressure within the filter chamber generated by the source of negative pressure.

Preferably the valves are caused to open on the activation of the pulsing to facilitate delivery of material from the filter chamber to the outlet chamber.

Preferably the filter outlet is controlled by a valve which is sensitive to the differential pressure between the filter chamber and the outlet chamber wherein the valve will open on the pressure differential being varied as a result of the pulsing generated by the pulsing generator.

Preferably a plurality of filter elements arranged in a circular array around the filter chamber.

Preferably the valves are located below the filter elements in a one-to-one relationship.

Preferably the valve is defined by a flexibly resilient skirt which forms a lower extension of the inner wall of the filter chamber and which is positioned to lie within the outlet chamber with its lower edge closely adjacent the outer wall of the outlet chamber, the lower edge being engagable with the outer wall to define a closed state of the valve and clear of the outer wall to define and open state.
Preferably a flow valve is provided between the vent and the filter chamber, wherein the flow valve is caused to close on the gaseous stream containing entrained moisture.

Preferably the source of gaseous flow bearing entrained drilled material comprises the outlet of a down hole drill string.

Accordingly the invention further resides in a sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, the material outlet associated with a spreader located centrally below the outlet which is intended in use to distribute the drilled material into an outlet chamber such that it is substantially evenly introduced into outlet chamber below the material outlet, the outlet chamber having a receiving zone, the spreader comprising a conical surface located within the outlet chamber and substantially centrally below the material outlet, the receiving zone being defined between the spreader and the side wall of the outlet chamber and wherein the spreader further includes a delivery chute rotatably mounted below the material outlet and between the material outlet and the conical surface, the delivery chute being caused to rotate about the central axis of the material outlet, the delivery chute having a radial outlet, the radial outlet opening into outlet chamber above the conical surface, the outlet chamber having an outlet, a sampling inlet provided at the outlet.

Preferably the outlet chamber has a pair of spaced closures located in spaced relation below the outlet to define an upper and lower sub-chamber, and the closures being associated with the receiving zone to control the flow of drilled material from the receiving zone in each sub-chamber a controller associated with the closures to cause the closures to move between an open and closed position, wherein the controller causes the upper closure to be open when the lower
closure is closed and the lower closure to be open when the upper closure is closed and wherein the closure ensures that one closure is not caused to open unless the other closure is closed, the controller causing the periodic opening and closing of the closures,

Preferably each closure is located to be able to extend across the receiving zone and each closure comprises a closure members located around the receiving zone and movable across the receiving zone to the closed position and across the receiving zone to their open position at which they lie clear of the receiving zone.

Preferably the conical surface is provided with a stepped portion at the location of each closure and wherein the closure members are received in the stepped portion when in the closed position. According to a third preferred feature of the invention the conical surface is defined by a first conical portion which is located in the upper sub-chamber and a second conical portion which is located in the lower sub-chamber and which provides a conical extension of the first conical spreader and wherein the diameter of the upper portion of the second conical portion is less than the diameter of the lower portion of the first conical portion and the undersurface of the conical portions define the stepped portions.

Preferably the closure members are movable radially across the receiving zone when moving between the closed and open position.

Preferably each closure member comprises a set of gate elements which are supported to be movable radially across the receiving zone, the gate elements being movable jointly across the receiving zone between the open and closed position a drive associate with the gate elements and arranged and configured to cause the joint movement.

Preferably the sampling inlet is associated with a carriage which is arranged and configures to accommodate a plurality of receptacles and to cause the receptacles to sequentially align with the sampling inlet for a sampling sequence.
Preferably the carriage comprises a carousel which is rotatable about the central axis of the receiving zone.

Preferably a plurality of sampling inlets are located below the receiving zone at angularly spaced intervals.

5 Preferably the outlet chamber is associated with a vibration generator which is arranged and configured to cause vibration of the outlet chamber at least when the lower closure is open.

Preferably the vent is connected to a source of negative pressure through a filter chamber which is arranged and configured to separate fine drilled material from the gaseous stream and to cause the fine drilled material to pass to the outlet chamber through a filter outlet.

10 Preferably the filter chamber is located above the outlet chamber.

Preferably the filter chamber comprises an annular chamber which is concentric with the cyclone.

15 Preferably the filter outlet comprises a set of delivery valves.

Preferably the source of negative air pressure comprises an exhaust fan having a flow rate greater than the flow rate generated by the gaseous stream from the vent.

Preferably the air filter comprises a filter chamber accommodating at least one filter element comprising an upstanding tubular column, the interior of the column being connected at its upper end to the source of negative pressure.

20 Preferably the filter element is associated with a pulsing generator adapted to cause periodic pulsing of the filter walls.
Preferably the pulsing generator comprises a source of high pressure gas which is caused to periodically deliver a quantity of pressurised gas into the interior of the filter element sufficient to overcome the negative pressure within the filter chamber generated by the source of negative pressure.

5 Preferably the valves are caused to open on the activation of the pulsing to facilitate delivery of material from the filter chamber to the outlet chamber.

Preferably the filter outlet is controlled by a valve which is sensitive to the differential pressure between the filter chamber and the outlet chamber wherein the valve will open on the pressure differential being varied as a result of the pulsing generated by the pulsing generator.

Preferably a plurality of filter elements arranged in a circular array around the filter chamber.

Preferably the valves are located below the filter elements in a one-to-one relationship.

15 Preferably the valve is defined by a flexibly resilient skirt which forms a lower extension of the inner wall of the filter chamber and which is positioned to lie within the outlet chamber with its lower edge closely adjacent the outer wall of the outlet chamber, the lower edge being engagable with the outer wall to define a closed state of the valve and clear of the outer wall to define and open state.

20 Preferably a flow valve is provided between the vent and the filter chamber, wherein the flow valve is caused to close on the gaseous stream containing entrained moisture.

Preferably the source of gaseous flow bearing entrained drilled material comprises the outlet of a down hole drill string.
Accordingly the invention further resides in a sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, wherein the vent is connected to a source of negative pressure through a filter chamber which is arranged and configured to separate fine drilled material from the gaseous stream flowing from the vent and to cause the fine drilled material to pass to the material outlet chamber through a filter outlet.

Preferably the filter chamber is located above the outlet chamber.

Preferably the filter chamber comprises an annular chamber which is concentric with the cyclone.

Preferably the filter outlet comprises a set of delivery valves.

Preferably the source of negative air pressure comprises an exhaust fan having a flow rate greater than the flow rate generated by the gaseous stream from the vent.

Preferably the air filter comprises a filter chamber accommodating at least one filter element comprising an upstanding tubular column, the interior of the column being connected at its upper end to the source of negative pressure.

Preferably the filter element is associated with a pulsing generator adapted to cause periodic pulsing of the filter walls.

Preferably the pulsing generator comprises a source of high pressure gas which is caused to periodically deliver a quantity of pressurised gas into the interior of
the filter element sufficient to overcome the negative pressure within the filter chamber generated by the source of negative pressure.

Preferably the valves are caused to open on the activation of the pulsing to facilitate delivery of material from the filter chamber to the outlet chamber.

5 Preferably the filter outlet is controlled by a valve which is sensitive to the differential pressure between the filter chamber and the outlet chamber wherein the valve will open on the pressure differential being varied as a result of the pulsing generated by the pulsing generator.

Preferably a plurality of filter elements arranged in a circular array around the filter chamber.

10 Preferably the valves are located below the filter elements in a one-to-one relationship.

Preferably the valve is defined by a flexibly resilient skirt which forms a lower extension of the inner wall of the filter chamber and which is positioned to lie within the outlet chamber with its lower edge closely adjacent the outer wall of the outlet chamber, the lower edge being engagable with the outer wall to define a closed state of the valve and clear of the outer wall to define and open state.

Preferably a flow valve is provided between the vent and the filter chamber, wherein the flow valve is caused to close on the gaseous stream containing entrained moisture.

According to a preferred feature of the invention, the material outlet is associated with a spreader located centrally below the outlet which is intended in use to distribute the drilled material into an outlet chamber such that it is substantially evenly introduced into an receiving zone located below the material outlet, an outlet chamber having a pair of spaced closures located in spaced relation below
the outlet to define an upper and lower sub-chamber, a controller associated with
the closures to cause the closures to move between an open and closed position,
wherein the controller causes the upper closure to be open when the lower closure is closed and the lower closure to be open when the upper closure is closed and wherein the closure ensures that one closure is not caused to open unless the other closure is closed, the controller causing the periodic opening and closing of the closures, a sampling inlet provided below the lower closure and below the receiving zone.

Preferably the spreader comprises a conical surface located within the outlet chamber and substantially centrally below the material outlet, the receiving zone being defined between the spreader and the side wall of the outlet chamber and the closures being associated with the receiving zone to control the flow of drilled material from the receiving zone in each sub-chamber.

Preferably the spreader includes a delivery chute rotatably mounted below the material outlet and between the material outlet and the conical surface, the delivery chute being caused to rotate about the central axis of the material outlet, the delivery chute having a radial outlet, the outlet opening into outlet chamber above the conical surface.

Preferably each closure is located to be able to extend across the receiving zone and each closure comprises a closure members located around the receiving zone and movable across the receiving zone to the closed position and across the receiving zone to their open position at which they lie clear of the receiving zone.

Preferably the conical surface is provided with a stepped portion at the location of each closure and wherein the closure members are received in the stepped portion when in the closed position. According to a third preferred feature of the invention the conical surface is defined by a first conical portion which is located in the upper sub-chamber and a second conical portion which is located in the lower sub-chamber and which provides a conical extension of the first conical spreader
and wherein the diameter of the upper portion of the second conical portion is less than the diameter of the lower portion of the first conical portion and the undersurface of the conical portions define the stepped portions.

Preferably the closure members are movable radially across the receiving zone when moving between the closed and open position.

Preferably each closure member comprises a set of gate elements which are supported to be movable radially across the receiving zone, the gate elements being movable jointly across the receiving zone between the open and closed position a drive associate with the gate elements and arranged and configured to cause the joint movement.

Preferably the sampling inlet is associated with a carriage which is arranged and configures to accommodate a plurality of receptacles and to cause the receptacles to sequentially align with the sampling inlet for a sampling sequence.

Preferably the carriage comprises a carousel which is rotatable about the central axis of the receiving zone.

Preferably a plurality of sampling inlets are located below the receiving zone at angularly spaced intervals.

Preferably the outlet chamber is associated with a vibration generator which is arranged and configured to cause vibration of the outlet chamber at least when the lower closure is open.

Preferably the source of gaseous flow bearing entrained drilled material comprises the outlet of a down hole drill string.
Brief Description of the Drawings

The invention will be better understood by reference to the following description of several specific embodiments thereof as shown in the accompanying drawings in which:

Figure 1 is a schematic sectional illustration of an apparatus for Sample Collection Apparatus according to a first embodiment;

Figure 2 illustrates the flow through the apparatus of figure 1 during normal operation;

Figure 3 illustrates the flow through the apparatus of figure 1, minus the collection assembly, when wet drilling conditions are encountered;

Figure 4 illustrates the flow through the apparatus of figure 1, minus the collection assembly, during a stage of the collection process whereby a pulse of compressed air passes therethrough;

Figure 5 illustrates the operation of a sealing curtain located in the filter assembly of the apparatus;

Figure 6 is a schematic sectional side elevation of an outlet chamber of figure 1 showing the apparatus at the pre-start stage;

Figure 7 is a view similar to figure 6 showing the initial period of material collection passing to the second closure, whereby the first chamber is open and the second chamber is closed;

Figure 8 is a view similar to figure 6 showing both closures closed;
Figure 9 is a view similar to figure 6 showing the upper closure closed and the lower closure open allowing the material to be sampled whilst the material continues to be collected in the upper chamber;

Figure 10 is a view similar to figure 6 showing the upper closure and the lower closure closed;

Figure 11 is a view similar to figure 6 showing the final stage of operational sequence whereby the upper chamber is opened and the material is collected in the closed second chamber;

Figure 12 is a view similar to figure 6 showing an end of interval sequence whereby an injection of compressed air enters the system to clean the filters, and the filter bags are rotated ready for sampling the next interval;

Figure 13 is a plan view of a closure according to the first embodiment when in the closed position;

Figure 14 is a plan view of a closure according to the embodiment when in the open position;

Figure 15 is a schematic sectional illustration of the cyclone and filter chamber according to a second embodiment when being utilised under dry drilling conditions;

Figure 16 is a view similar to figure 15 when being utilised under wet drilling conditions;

Figure 17 is a schematic sectional side elevation of outlet chamber of the second embodiment showing the upper closure open and the lower closure closed;
Figure 8 is a schematic sectional side elevation of outlet chamber of the second embodiment showing the top closure open and the lower closure closed and during the initial period of material collection;

Figure 19 is a schematic side elevation of outlet chamber of the second embodiment showing both closures closed;

Figure 20 is a schematic sectional side elevation of outlet chamber of the second embodiment showing the upper closure closed and the lower closure open; and

Figure 21 is a schematic sectional elevation of the outlet chamber of the second embodiment at the end of sampling sequence.

In the drawings like structures are referred to by like numerals throughout the several views. The drawings shown are not necessarily to scale, with emphasis instead generally being placed upon illustrating the principles of the present invention.

**Detailed Description of Specific Embodiments**

A particular application of the invention relates to an apparatus which collects a sample which more accurately represents the constituents of the drilled material. In the embodiments discussed below the apparatus is associated with a drill string utilising a reverse circulation down hole hammer. It is usual practice during a drilling operation to collect samples representative of the ground traversed by the drill string. Whilst the below discussion of two embodiments is directed to such an application, it is to be understood that the invention also has applications in other industries where it is necessary to obtain a sample. Such industries may include mine processing plant sampling, grain sampling, soil sampling, oil sands sampling, mineral sands sampling. These applications are also considered to be within the scope of this invention.
As mentioned, each of the embodiments are directed to a Sample Collection Apparatus for use during drilling exploration. In use the apparatus is associated with a drill rig utilising a reverse circulation down hole hammer where the stream of exhaust air and the entrained drilled material in the form of cuttings is received to be sampled.

In accordance with established practice a sampling sequence extends for the period of time as determined on site depending upon the ground being drilled and the drilling task. Typically the number of sequences is governed by the interval which is to be drilled. These are typically 1m, 2m or 3m in length.

In the below embodiments the sample collection apparatus comprises a separation means 10 to separate the drilled material from the gaseous stream which is delivered to the apparatus, and a sampling assembly 12 adapted to receive the drilled material from the separation means 10. The sampling assembly 12 enables samples to be taken from the drilled material received therein.

The separation means comprises a cyclone 11 to which the drilled material entrained in a gaseous stream is delivered. The cyclone has a material outlet 17 through which a portion of the drilled material passes from the cyclone 11, and a vent 15 through which gaseous stream with the remaining portion of drilled material entrained therein passes.

The separation means also comprises a filter arrangement 50 in communication with the vent 15 of the cyclone 11. In use the gaseous stream with the remaining portion of drilled material entrained therein passes through the filter arrangement whereupon the remaining portion of drilled material is removed from the gaseous stream before the gaseous stream is caused to pass from the sample collection apparatus. The filter arrangement in the embodiments discussed below is located in an annulus filter chamber surrounding the cyclone.
The pathway through which the entrained drilled material passes is treated to minimise the potential for the material to stick and build up. For instance, internal surfaces may be painted, covered in ceramic tiles, and/or lined with polyurethane.

The first embodiment as shown at Figures; 1 to 12 comprises the cyclone 11 having an inlet 13 which is intended to be connected to the exhaust of the drill string (not shown). The central vent 15 of the cyclone 11 is located at its upper end while the lower end of the cyclone is provided with the material outlet 17.

The material outlet 17 is associated with a spreader 19. The spreader includes, in part, a distribution nozzle 21 which is located below the material outlet 17 and which is provided with a generally downwardly inclined but radially directed nozzle outlet 23 for depositing the drilled material flowing from the cyclone 11 into an outlet chamber 24 defined below the material outlet 17. The distribution nozzle 21 is caused to rotate such that the drilled material being delivered from the nozzle outlet 23 will be received substantially uniformly into a receiving zone 22 within the outlet chamber 24.

The spreader 19 further includes a conical surface which is defined by an upper conical member 19a and a lower conical member 19b where the conical members 19a, 19b are coaxial and are located below the distribution nozzle 21 such that material flowing from the nozzle outlet 23 will be delivered onto the conical surface.

As the drilled material leaving the cyclone 11 tends to leave from the same location, the use of the rotating distribution nozzle 21 provides for an even distribution of the drilled material around the respective conical member 19a, 19b.

The outlet chamber 24 comprises an upper chamber A and a lower chamber B defined by a pair of closures comprising a first closure 25 which defines the lower end of the upper chamber A and a second closure 27 which defines the lower end of the lower chamber B.
The first conical member 19a is located within the upper chamber A and the second conical member 19b is located within the lower chamber B. The diameter of the upper end of the second conical member 19b is less than the diameter of the lower end of the first conical member 19a to define an inward step 29 between the upper and lower portions 19a and 19b.

The first closure 25 is intended to be movable across a first annulus 26 defined between the outer wall 33 of the upper chamber A of the outlet chamber 24 and the underside of the first conical member 19a into the inward step 29 in the conical surface. The second closure 27 is intended to be moveable across a second annulus 28 defined between the outer wall 33 of the lower chamber B of the outlet chamber 24 and underneath the step defined by the lower edge of the second conical member 19b of the conical surface.

The distribution nozzle 21 delivers the drilled material into the outlet chamber 24 and the flow of the drilled material therethrough is controlled by the opening and closing of the first and second closures 25, 27.

As shown in Figures 13 and 14 each of the first and second closures 25, 27 comprise a set of gate members 31 of a generally frusto-triangular plate configuration and which are moveable across the respective annulus 26, 28.

Each gate member 31 is associated with a fluid operated cylinder 35 which is adapted to be able to cause the joint movement of each of the gates 31 between a closed position as shown at Figure 13 and the open position as shown at Figure 14. The gates 31 are configured such that when they are in the closed position they abuttingly engage with each other to cooperatively close the respective annulus 26, 28.

The mounting of the gates 31 within the external wall 33 of the outlet chamber 24 is such that there is substantially no loss of air pressure from the outlet chamber 24 though the mountings. This also serves in ensuring that when the
gates 31 are withdrawn to the open position that all of the material on their upper surfaces is scraped off the gates 31 to pass from the outlet chamber. This may also be enhanced with the use of scrapers. Located at the point through which each gate 31 moves as it exits and enters the outlet chamber 24.

The second closure 27 is associated with a pair of sampling cutters 37 located therebelow. The cutters 37 extend across the second annulus 28 for a portion of the angular extent of the annulus 28, so as to be arranged to deliver the collected sample into a sample receptacle 39 whilst the remainder of the drilled material is delivered from the device through a central deposition outlet 41.

According to the embodiment the sampling cutters 37 are associated with a carousel 42 at its lower extent which supports a circular array of sample receptacles 39 whereby for each interval drilled a receptacle is located below the sampling cutter 37 and on completion of the interval the carousel 42 is caused to rotate to introduce an empty sampling receptacle 39 below each cutter and enable the filled sampling receptacle to be removed. In an alternative embodiment the carousel 42 may be caused to rotate to provide an empty sampling receptacle 39 at the end of each sequence.

The upper and lower closures 25, 27 are associated with a controller, such as a PLC, which causes the respective closures to be moveable between the open and closed position whereby the opening of one closure cannot be affected until the other closure has been fully closed. This is required in order to prevent undue air flow from the cyclone 11 through the outlet chamber. The controller causes the multiple periodic opening and closing of the closures 25 and 27 throughout the sampling sequence, as will be described below.

In addition the outlet chamber 24 is associated with a pneumatic vibrator 43. The vibrator is located under the conical member 19b in a relatively central position. This provides for an even vibration throughout the apparatus and ensures the sampling arrangement is vibrated from the inside out.
The operation of the sampling assembly is represented in figures 6 to 12. As represented at the pre-start position shown in figure 6, upon commencement of a sampling sequence the first closure 25 is maintained open while the second closure 27 is closed.

On activation of the drill string the first closure remains open for a predetermined time, whilst the second closure remains closed, as shown at Figure 7. During this stage drilled material passes from the material outlet 17 of the cyclone 11, through the distribution nozzle 21 to be deposited into the outlet chamber 24 and collect on the gates 31 of the second closure 27.

At the predetermined time, the controller causes the cyclic periodic opening and closing of the closures 25 and 27. According to the next step in the sequence the first closure 25 is caused to close while the second closure 27 remains closed, as represented at Figure 8. This ensures the lower chamber B is sealed from the cyclone 11 before the second closure 27 is opened.

Once the first closure 25 is fully closed, the second closure 27 will open as shown at Figure 9. There may be a period of delay between the closing of the first closure 25 and the opening of the second closure 27. As drilled material continues to exit the cyclone 11, the drilled material will collect on the gates 31 of the first closure 25, which are in the closed position. As the second closure 27 opens, the drilled material previously collecting upon the second enclosure 27 now passes through the material outlet 41 with a sample of the drilled material being delivered to the respective sampling receptacles 39 via the cutters 37. Typically two sample are simultaneously taken in order to have a duplicate sample for future referral.

To facilitate clearance of the material from the lower chamber B the vibrator 43 is activated to cause vibration of the walls 33 of the lower chamber B.
At the conclusion of the sampling sequence as represented in figures 10 and 11, the second closure 27 is first closed before the first closure 25 is opened. This now completes one sequence. The operator continues to operate the apparatus, continuing to place a sample into the receptacles 39.

At the end of the interval the operator activates the end of interval sequence. As shown in figure 11 this causes the carousel to be indexed such that an empty receptacle is below each cutter, and the vibrator is switched on to dislodge any material. The end of interval sequence also causes the filtering arrangement to be cleaned, as shown in figure 4 and which will be described below.

As noted in figure 11, as the end of interval sequence is being performed the drilling of the next interval has commenced whereby the drilled material accumulates on the second closure 27.

The filter arrangement provides a means of extracting and collecting the fines which are entrained in the gas being exhausted from the vent 15 of the cyclone 11. In the past such fines have not been collected for channelling into the outer chamber 24. The operation of the filter arrangement is best shown in figures 2, 3 and 4.

In the case of the first embodiment and as shown at Figure 2 the vent 15 of the cyclone 11 is connected to the filtering arrangement which is in turn connected to an exhaust fan 51. The exhaust fan 51 functions to generate negative pressure at the air outlet 15 thus causing the gaseous stream and entrained drilled material to be drawn from the cyclone 11 into the filtering arrangement.

The filtering arrangement comprises an annular filter chamber 53 which surrounds the cyclone 11 where the vent 15 is connected into the annular chamber 53 by a duct 55. The filter chamber 53 accommodates a plurality of air filter cartridges 57 in the form of tubular filter elements and which are disposed to be generally upright within the annular chamber 53. The upper end of each air filter cartridges
57 opens into a plenum 63 at the upper end of the filter chamber 53 which in turn is connected to the exhaust fan 51. The air filter cartridges 57 are arranged in an annular array within the filter chamber 53.

The lower end of the air filter chamber 53 is provided with a circumferential skirt 71 which defines the lower wall of the filter chamber 53 and depends downwardly from the inner wall of the filter chamber 53 into the outlet chamber 24 such that its lower edge 73 is closely adjacent the outer wall 33 of the upper chamber A of the outlet chamber 24, as best shown in figure 5. When the air pressure within the upper chamber A is greater than the air pressure within the filter chamber 53 the lower edge 73 of the skirt 71 is forced into sealing engagement with the side wall 33 of the upper chamber A. When the air pressure within the filter chamber 53 is greater than the air pressure within the outlet chamber 24 the lower edge 73 will move out of sealing engagement with the outer wall 33 of the outlet chamber to permit any fines contained in the filter chamber 53 to be deposited into the outlet chamber 24. The annular skirt can be formed of a suitably flexibly resilient material and may be associated with axial ribs or the like to maintain its integrity.

As the gaseous stream passes through the filter chamber 53 any fines entrained in the stream are deposited on the air filter cartridges 57. In order to dislodge the fines from the exterior of the filter cartridges 57 the filter chamber 53 is subjected to a pulsing action.

Referring to figure 4, the pulsing is affected by introducing into the interior of each filter cartridge 57 a short flow of high air pressure. The supply of the high pressure air is sufficient to also raise the air pressure within the filter chamber 53, causing the skirt 71 to open. In this regard the interior of each filter cartridge 57 is associated with an air nozzle 62 and a second controller connected to a source 61 of compressed air. The second controller periodically introduces into the interior of each filter cartridge 57 a burst of compressed air, causing the walls of the filter cartridge 57 to vibrate causing dislodgement of the collected fines therefrom, and which fall into the lower end of the filter chamber 53. The introduction of the
compressed air will generate a pressure within the filter chamber 53 which overcomes the negative pressure created by the exhaust fan 51, causing the skirt 71 to open to allow the fines collected in the annular filter chamber 53 to flow into the outlet chamber 24.

5 The high pressure air may be injected into the filter chamber 53 by a series of pulses or one long blast.

In the event of the drill encountering water the flow of air from the vent 15 to the filter chamber 53 can be closed by a control valve 65 as shown in Figure 3. As this occurs the duct 55 is open to atmosphere to allow the filter arrangement to continue to draw air therethrough. This will help to draw the filter cartridges in the event the become wet prior to the control valve 65 being activated. It also enables the exhaust fan 51 to continue to operate. Upon activation of the control valve 65 the closures 25, 27 move to an open state. The control valve 65 may work automatically upon sensing moisture within the drilled material.

15 According to a second embodiment of the invention as shown at Figure 15 the skirt 71 which is provided at the lower end of the filter chamber 53 of the first embodiment are replaced with a circumferential array of valves 59 which are adapted to open into the upper end of the outlet chamber 24. The valves 59 comprise one way lip valves which will open and close in response to a predetermined pressure differential to either side of the valve whereby on the air pressure within the outlet chamber 24 being greater than that in the filter chamber 53 the valves will be held closed and on the air pressure in the filter chamber being greater than the air pressure in the outlet chamber 24 the valves will open to deliver the precipitated fines into the outlet chamber.

25 According to another alternative the carousel of the first embodiment which carries the sample receptacles is replaced by an magazine associated with each sampling cutter which carries a set of receptacles and is capable of being indexed past the respective sampling cutter.
The present invention is not to be limited in scope by any of the specific embodiments described herein. These embodiments are intended for the purpose of exemplification only. Functionally equivalent products, materials and methods are clearly within the scope of the invention as described herein.

The advantages of the present invention include:

- Improved sample - increased sample representivity;

- Collection of fines otherwise lost to atmosphere or a dust collector;

- Enables better dust control;

- Small in height allowing it to be integral with the rig making it easier to transport;

- Large apertures and passageways, minimising the likelihood of blockages;

- Easily adjustable to change size of sample;

- Operator is able to regularly monitor sampled material as each sequence is shorter than conventional sampling techniques;

- Improved operation of sample collection increases safety as well as reducing man hours;

- Sample represents a cross section of the interval;

- Susceptibility of a bias result when the outer chamber is not level is largely negated;

- Operation possible when not level (e.g. when drilling on a hill side);
• Allows for a larger cyclone resulting in less wear as the material vortex is at a lower velocity;

• Operates under negative pressure - if improper seal material will not be blown out;

Sample may be released regularly as do not need to wait for build up of material to collect, which could lead to blockages.

Sample collection apparatus traditionally use a cyclone for collection of material for sampling. The fines of less than 10 microns are unable to be collected by a mechanical collector such as a cyclone and are lost to atmosphere or a separate dust collector as emission. The present apparatus captures 100% of the material entering it for sampling making the sample vastly more representative.

The sampling assembly is designed to receive both coarse and fine particulate from the Cyclone/Filter arrangement, evenly distribute it around the conical surface and periodically release it over two horizontal cutters to take a sample of the total collected amount. The width of these cutters are variable to take a larger of smaller percentage of sample and there may be two or more samples taken at once. Below the cutters is a small chute to guide the split sample into a bag or container and this is on a multiple station carousel that automatically indexes to a fresh bag/container at the end of each drilled interval at the push of a button.

As the material entering the sampling assembly is subject to pressurised air (positive pressure drilling air, negative pressure exhaust fan air and positive pressure pulse cleaning compressed air), it is not possible to simply split the exiting collected material directly because the volatile air surrounding the sample would adversely influence the way the material entered the cutters (blow or suck) which would bias the sample and create dust.
It is for this reason that a "double dump" closure arrangement has been designed where no two sets of closures being open at the same time. This allows the material to be split purely under gravity.

One or more pneumatic or electric vibrators may be incorporated in the various stages of the sequence to assist flow. Their introduction will also be controlled by the PLC to come on at the various relevant stages of the dumping sequence.

The Distribution Nozzle ensures all the material collected by the cyclone is evenly distributed around the receiving zone where the material will be dumped from over the splitting cutters. It has the potential to be rotated at a relatively high speed to spread the collected material out so the natural variation in ore grade becomes more evenly distributed. This combined with the fines that are being released periodically via the closure means add the otherwise lost fines into the mix. This essentially acts to evenly mix up the interval prior to splitting to ensure a representative sample is taken. All other sampling systems rely on the splitter itself to "mix" the sample which is rarely achieved, be it a Riffle Splitter, Cone Splitter, Vezin Splitter.

By achieving a good, even mix in the receiving zone, it is critical to ensure that this material is dumped evenly over the sample cutters.

This present invention has larger internal apertures than any known prior art because the collection annulus is further from the centreline than other devices so the splitting aperture is wider for the same splitting percentage, and the device is substantially physically smaller in height and weight than any other known prior art. In addition, as a result of the design it may be possible to split far larger sample interval volumes down into more manageable samples for testing in other applications because of the wider apertures associated with this system.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to
imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.
Claim

The Claims Defining the Invention are as follows:

1. A sample collection apparatus for use in extracting a sample of drilled material which is delivered to the sample collection apparatus entrained in a gaseous stream, the apparatus comprises:

   a separation means to separate the drilled material from the gaseous stream

   a sampling assembly adapted to receive the drilled material from the separation means to allow samples to be taken therefrom.

2. The sample collection apparatus according to claim 1 wherein the separation means comprises:

   a cyclone to which the drilled material entrained in a gaseous stream is delivered, the cyclone having a material outlet through which a portion of the drilled material passes from the cyclone, and a vent through which gaseous stream with the remaining portion of drilled material entrained therein pass;

   a filter arrangement in communication with the vent of the cyclone whereby in use the gaseous stream with the remaining portion of drilled material entrained therein passes through the filter arrangement whereupon the remaining portion of drilled material is removed from the gaseous stream before the gaseous stream is caused to pass from the sample collection apparatus.

3. The sample collection apparatus according to claim 2 wherein the cyclone has an inlet connected to a source of gaseous flow bearing entrained drilled
material, the cyclone having the vent towards its upper end and the material outlet at the lower end for the separated drilled material.

4. The sample collection apparatus according to claim 2 or 3 wherein the material outlet is associated with a spreader located below the outlet which is intended in use to distribute the drilled material into the sampling assembly.

5. The sample collection apparatus accordingly to claim 1, 2, 3 or 4 wherein the sampling assembly comprises an outlet chamber.

6. The sample collection apparatus according to claim 5 wherein the outlet chamber comprises a receiving zone for receiving the drilled material.

7. The sample collection apparatus according to claim 5 or 6 wherein the outlet chamber has at least two closures located in spaced relation below the material outlet.

8. The sample collection apparatus according to claim 7 wherein the spaced closures define an upper chamber and a lower chamber within the outlet chamber.

9. The sample collection apparatus accordingly to claim 7 or 8 wherein the closures are operable to move between an open position and a closed position to control the flow of drilled material passing through the receiving zone.

10. The sample collection apparatus accordingly to claim 6, 7, 8 or 9 wherein the receiving zone is defined between the spreader and the side wall of the outlet chamber.
11. The sample collection apparatus accordingly to any one of claims 7 to 10 wherein each closure is located to be able to extend across the receiving zone.

12. The sample collection apparatus accordingly to any one of claims 7 to 11 wherein each closure comprises a plurality of gate members located around the receiving zone and which are movable across the receiving zone between the closed position and the open position.

13. The sample collection apparatus accordingly to claim 12 wherein the gate members of each respective closure are synchronised to move jointly.

14. The sample collection apparatus accordingly to any one of claims 4 to 13 wherein the spreader comprises a conical surface located within the outlet chamber.

15. The sample collection apparatus accordingly to claim 14 wherein the conical surface is centrally located below the material outlet.

16. The sample collection apparatus accordingly to claim 14 or 15 wherein the spreader includes a delivery chute rotatably mounted below the material outlet and between the material outlet and the conical surface, the delivery chute being caused to rotate about the central axis of the material outlet.

17. The sample collection apparatus accordingly to claim 16 wherein the delivery chute has a radial outlet, the outlet opening into the outlet chamber above the conical surface.

18. The sample collection apparatus accordingly to any one of claims 14 to 17 wherein the conical surface is provided with a stepped portion at the location of each closure and wherein the closure members are received in the stepped portion when in the closed position.
19. The sample collection apparatus accordingly to any one of claims 14 to 18 wherein the conical surface is defined by a first conical portion which is located in the upper chamber and a second conical portion which is located in the lower chamber and which provides a conical extension of the first conical portion and wherein the diameter of the upper portion of the second conical portion is less than the diameter of the lower portion of the first conical portion.

20. The sample collection apparatus accordingly to any one of claims 7 to 19 wherein a sampling inlet is provided below the lower closure for receiving a sample.

21. The sample collection apparatus accordingly to claim 20 wherein the sampling inlet is associated with a carriage which is arranged and configured to accommodate a plurality of receptacles and to cause the receptacles to sequentially align with the sampling inlet for a sampling sequence.

22. The sample collection apparatus accordingly to any one of claims 7 to 21 wherein the outlet chamber is associated with a vibration generator which is arranged and configured to cause vibration of the outlet chamber at least when the lower closure is open.

23. The sample collection apparatus accordingly to any one of claims 2 to 22 wherein the cyclone vent is connected to a source of negative pressure through the filter arrangement.

24. The sample collection apparatus accordingly to claim 23 wherein the source of negative air pressure comprises an exhaust fan having a flow rate greater than the flow rate generated by the gaseous stream from the vent.

25. The sample collection apparatus accordingly to any one of claims 5 to 24 wherein the filter arrangement is located above the outlet chamber.
26. The sample collection apparatus accordingly to any one of claims 2 to 24 wherein the filter arrangement comprises an annular filter chamber which is coaxial with the cyclone.

27. The sample collection apparatus accordingly to claim 26 wherein the filter chamber comprises at least one filter outlet which delivers drilled material into the outlet chamber.

28. The sample collection apparatus accordingly to claim 27 wherein the filter outlet is associated with a closure means to open and close the filter outlet to allow the drilled material collected in the filter chamber to pass into the receiving zone of the outlet chamber based on the pressure variation between the filter chamber and the outlet chamber.

29. The sample collection apparatus accordingly to claim 28 wherein the closure means is in the form of a valve associated with each of the at least one filter outlet, in a one-to-one relationship, the valves being located below the filter elements.

30. The sample collection apparatus accordingly to claim 28 wherein the closure means is in the form of a skirt associated with the at least one filter outlet.

31. The sample collection apparatus accordingly to claim 30 wherein the skirt is flexibly resilient and forms a lower extension of the inner wall of the filter chamber and which is positioned to lie within the outlet chamber with its lower edge closely adjacent the outer wall of the outlet chamber, the lower edge being engagable with the outer wall to define a closed state of the valve and clear of the outer wall to define an open state.

32. The sample collection apparatus accordingly to any one of claims 26 to 31 wherein the filter chamber accommodates at least one filter cartridge element.
33. The sample collection apparatus accordingly to claim 32 wherein the filter cartridge is in the form of an upstanding tubular column, the at least one filter cartridge being in communication at its upper end to the source of negative pressure.

34. The sample collection apparatus accordingly to claim 32 or 33 wherein there are a plurality of filter cartridge elements arranged in a circular array around the filter chamber.

35. The sample collection apparatus accordingly to claim 32, 33 or 34 wherein the at least one filter cartridge element is associated with a pulsing generator adapted to cause periodic pulsing of the filter walls.

36. The sample collection apparatus accordingly to claim 35 wherein the pulsing generator comprises a source of high pressure gas which is caused to periodically deliver a quantity of pressurised gas into the interior of the at least one filter cartridge element sufficient to overcome the negative pressure within the filter chamber generated by the source of negative pressure.

37. The sample collection apparatus accordingly to claim 35 or 36 wherein the closure means is caused to open on the activation of the pulsing to facilitate delivery of material from the filter chamber to the outlet chamber through the filter outlets.

38. The sample collection apparatus accordingly to any one of claims 26 to 38 wherein a flow valve is provided between the vent and the filter chamber, wherein the flow valve is caused to close on the gaseous stream when containing entrained moisture.

39. The sample collection apparatus accordingly to any one of the preceding claims wherein the source of gaseous flow bearing entrained drilled material comprises the outlet of a down hole drill string.
40. A sample collection apparatus for use in extracting a sample of drilled material which is delivered to the sample collection apparatus entrained in a gaseous stream, the apparatus comprises:

a cyclone to which the drilled material entrained in a gaseous stream is delivered, the cyclone having a material outlet through which a portion of the drilled material passes from the cyclone, and a vent through which gaseous stream with the remaining portion of drilled material entrained therein pass;

a filtering arrangement in communication with the vent of the cyclone whereby in use the gaseous stream with the remaining portion of drilled material entrained therein passes through the filter arrangement whereupon the remaining portion of drilled material is removed from the gaseous stream before the gaseous stream is caused to pass from the sample collection apparatus;

a sampling assembly adapted to receive the drilled material from the cyclone and filtering arrangement to allow samples to be taken therefrom.

41. A sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, the material outlet associated with a spreader located centrally below the outlet which is intended in use to distribute the drilled material into an outlet chamber such that it is substantially evenly introduced into an receiving zone located below the material outlet, an outlet chamber having a pair of spaced closures located in spaced relation below the outlet to define an upper and lower sub-chamber, a controller associated with the closures to cause the closures to move between an open and closed
position, wherein the controller causes the upper closure to be open when the lower closure is closed and the lower closure to be open when the upper closure is closed and wherein the closure ensures that one closure is not caused to open unless the other closure is closed, the controller causing the periodic opening and closing of the closures, a sampling inlet provided below the lower closure and below the receiving zone.

42. A sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, the material outlet associated with a spreader located centrally below the outlet which is intended in use to distribute the drilled material into an outlet chamber such that it is substantially evenly introduced into outlet chamber below the material outlet, the outlet chamber having a receiving zone, the spreader comprising a conical surface located within the outlet chamber and substantially centrally below the material outlet, the receiving zone being defined between the spreader and the side wall of the outlet chamber and wherein the spreader further includes a delivery chute rotatably mounted below the material outlet and between the material outlet and the conical surface, the delivery chute being caused to rotate about the central axis of the material outlet, the delivery chute having a radial outlet, the radial outlet opening into outlet chamber above the conical surface, the outlet chamber having an outlet, a sampling inlet provided at the outlet.

43. A sample collection apparatus for use with a drilled material entrained in a gaseous stream, the sample collection apparatus comprising a cyclone having an inlet connected to a source of gaseous flow bearing entrained drilled material, the cyclone having a vent towards its upper end intended in use to permit the escape of gas and a material outlet at the lower end for the separated drilled material, wherein the vent is connected to a source of
negative pressure through a filter chamber which is arranged and configured to separate fine drilled material from the gaseous stream flowing from the vent and to cause the fine drilled material to pass to the material outlet chamber through a filter outlet.
INTERNATIONAL SEARCH REPORT

International application No.
PCT /AU20 10/00 1245

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
E21B 49/02 (2006.01) B01D 50/00 (2006.01) GOIN 1/18 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI & EPODOC - IPC & EC: GOIN 1/1-, E21B 49/1-, B04C 3/1-, B04C 4/1-, B01D 50/1-, B01D 45/1- & keywords (drill, bore, core, ore, rock, spreader, splitter, divider, distributor, cyclonic, vortex, centrifugal, filter and like terms)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>FR 2237670 A (LARSSON et al.) 14 February 1975 See Figs. 1-3 and pages 1 and 4</td>
<td>1-3, 5, 6, 23-27, 32-36, 39, 40, 43</td>
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<td>Y</td>
<td>A s above A U 2005205832 A 1 (UDR-KL PTY LTD) 23 March 2006 See page 2 lines 6-1, page 4 lines 31-33, Fig. 1</td>
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<td>Y</td>
<td>A s above A U 200010013 B 2 (DRILLING PROJECT SERVICES AUSTRALIA PTY LTD) 7 February 2002 See Fig. 1, page 1 line 34 to page 2 line 8, page 8 lines 25-34</td>
<td>1, 5, 6, 39</td>
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<td>A</td>
<td>U S 4946650 A (RÖTHELE) 7 August 1990 See Fig. 2</td>
<td>16, 17, 42</td>
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[ ] Further documents are listed in the continuation of Box C [ ] See patent family annex

| "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "K" | document member of the same patent family |

Date of the actual completion of the international search 21 December 2010

Date of mailing of the international search report 05 JAN 2011

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustralia.gov.au
Facsimile No. +61 2 6283 7999

Authorized officer
RHYS MUNZEL
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No: +61 3 9935 9623

Form PCT/ISA/210 (second sheet) (July 2009)
# DOCUMENTS CONSIDERED TO BE RELEVANT

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| A         | US 4388087 A (TIPTON) 14 June 1983  
See Figs. 1-4                                                                                                      | 2                     |
| A         | US 4332301 A (JONELL) 1 June 1982                                                                                           |                       |
| A         | Derwent Abstract Accession No. 1978-H8061 A[40], Class S03, SU 568862 A1 (SURVEY METHOD TECH) 15 August 1977  
See whole abstract                                                    | 16, 17, 42            |
**INTERNATIONAL SEARCH REPORT**

International application No.
PCT /AU20 10/00 1245

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<td>2. [ ] Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:</td>
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<td>3. [ ] Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)</td>
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<th>Box No. III</th>
<th>Observations where unity of invention is lacking (Continuation of item 3 of first sheet)</th>
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<td></td>
<td>This International Searching Authority found multiple inventions in this international application, as follows:</td>
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<td>as reasoned in the Supplemental Box.</td>
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<td></td>
<td>1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.</td>
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<td></td>
<td>2. [ ] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.</td>
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<tr>
<td></td>
<td>3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:</td>
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<tr>
<td></td>
<td>4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:</td>
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</table>

**Remark on Protest**

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

Form PCT/ISA/2 10 (continuation of first sheet (2)) (July 2009)
Continuation of Box No: III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are three different inventions as follows:

- Claims 2-4, 7-38, 40 and 43 relate to a sample collection apparatus comprising a separation means and a sampling assembly wherein the separation means comprises a cyclone and a filter arrangement in communication with the vent of the cyclone to remove entrained particles. It is considered that the defined relationship between the filter and cyclone comprises a first distinguishing feature.

- Claim 41 relates to a sample collection apparatus comprising a separation means and a sampling assembly wherein the sampling assembly comprises an outlet chamber having at least two closures located in spaced relation below the material outlet. It is considered that the outlet chamber having at least two closures as defined comprises a second distinguishing feature.

- Claim 42 relates to a sample collection apparatus comprising a separation means and a sampling assembly wherein the sampling assembly comprises a spreader that further comprises a delivery chute rotatably mounted below the material outlet and the conical surface. It is considered that the rotatably mounted delivery chute comprises a third distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

The only feature common to all of the claims is a sample collection apparatus comprising a separation means and a sampling assembly. However this concept is not novel in the light of the admitted common general knowledge discussed at pages 1 and 2 of the specification where it is disclosed that the process of collecting samples involves passing the drilled material entrained in a gaseous stream through a hydrocyclone (i.e. a separation means) to remove gas and thereafter pass the drilled material though a cone splitter (i.e. a sampling assembly) located at the outlet of the cyclone. I thus consider that the subject matter of claims 1, 5, 6 and 39 is known from the admitted common general knowledge. For completeness I further note that the subject matter of claims 1, 5, 6 and 39 is disclosed in:

AU 2000 10013 B2 (DRILLING PROJECT SERVICES AUSTRALIA PTY LTD) 7 February 2002 (at pages 1 and 2)

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention a posteriori.

It is considered that search and examination for the second invention will require no more than negligible additional search and examination effort over that for the first invention, and therefore an additional search fee is not warranted.
This Annex lists the known "A" pplication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX