

June 27, 1961

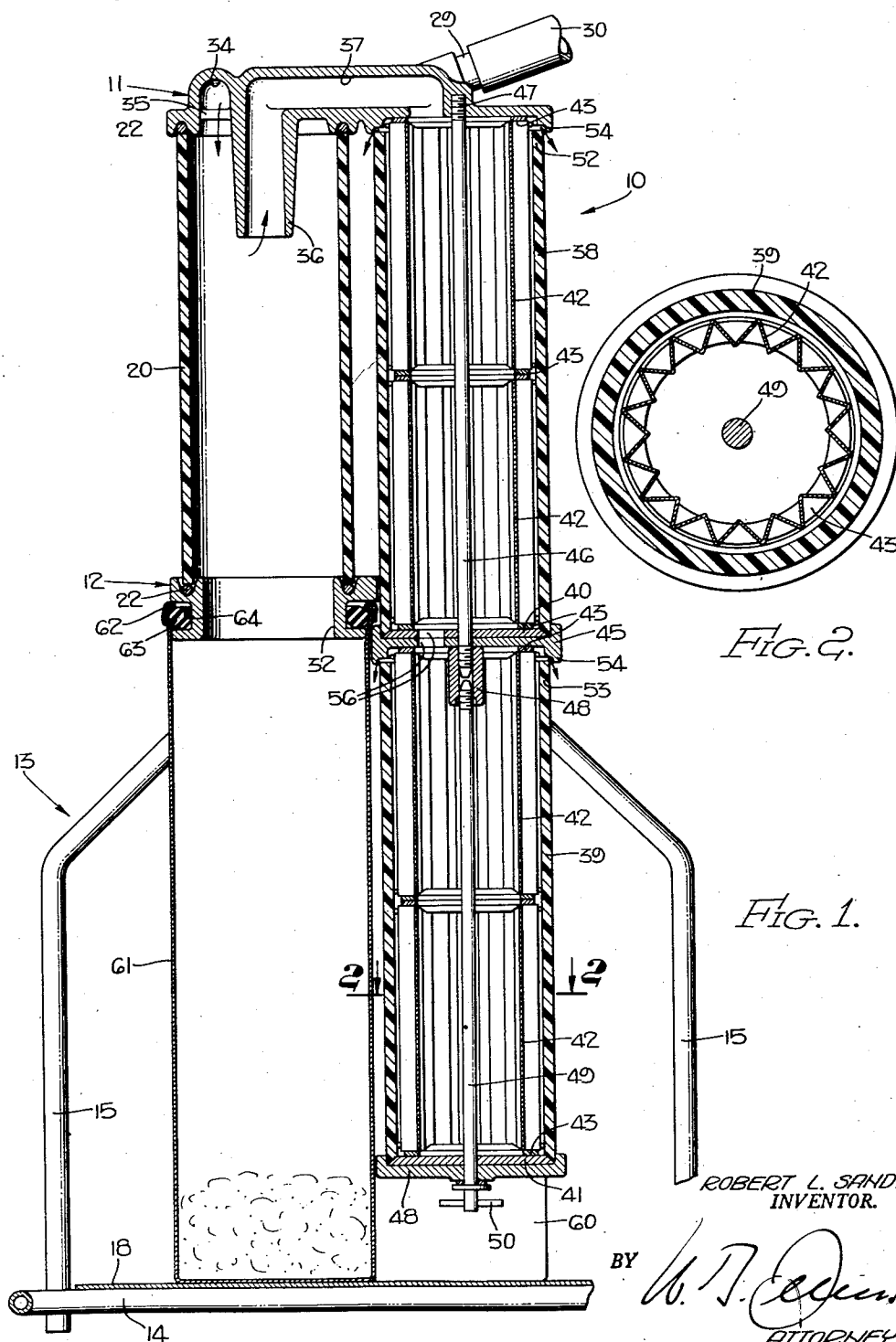
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2,990,032

SEPARATOR FOR USE WITH ROCK DRILLS

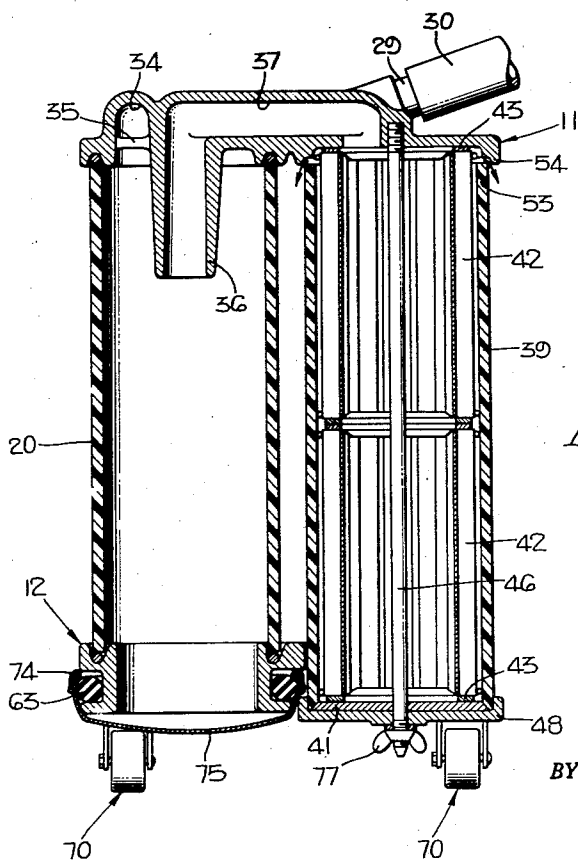
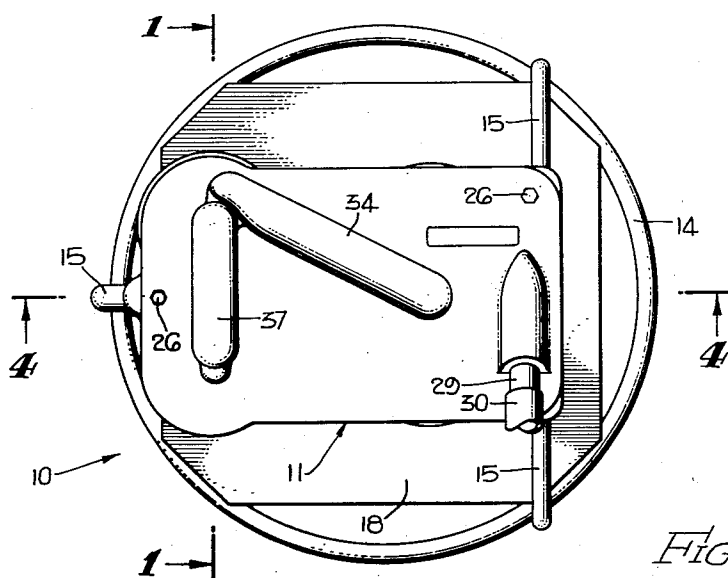
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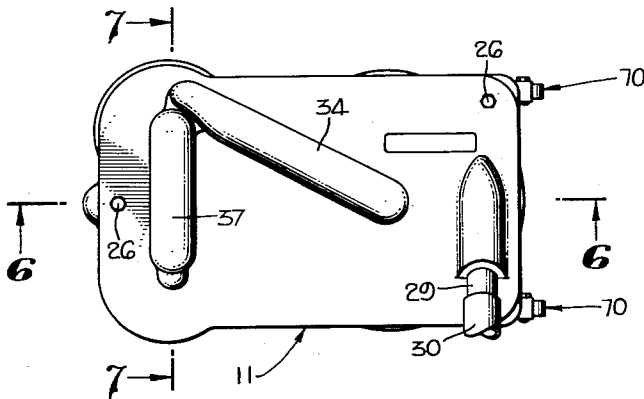


FIG. 5.

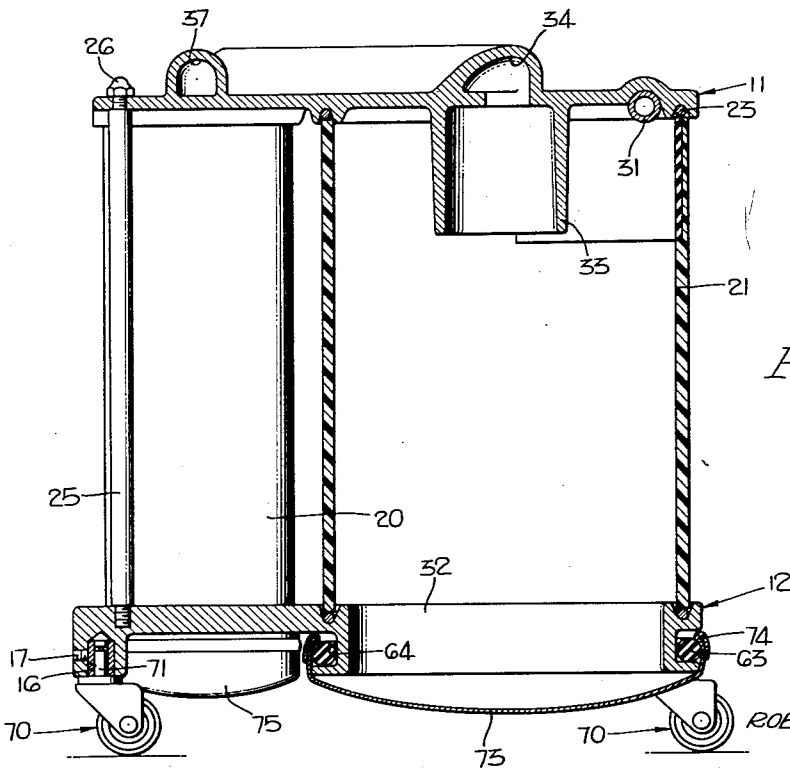


FIG. 6.

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This invention relates to foreign matter and air separators and more particularly to an improved portable separator particularly adapted for use with rock and the like types of drills to separate chips, dust and cuttings being continually conveyed thereto from the bore hole.

It has been customary practice heretofore to operate rock drills using pressurized air or water to carry away the cuttings in the annular space between the bore wall and the drill steel. Water employed as the conveying medium flows about the area of the bore creating slippery and hazardous conditions for the operator and entailing numerous other inconveniences and disadvantages well known to those experienced in this art. The use of pressurized air avoids certain of these disadvantages but contaminates the surrounding air with fine dust which collects in the eyes and lungs of workmen thereby creating a serious hazard to health and comfort.

Proposals to circumvent the disadvantages of these prior practices have involved the use of a suction air stream to carry away the cuttings and convey them to a safe area for discharge. Such areas are not always conveniently accessible and may necessitate the use of long ducts to carry the cuttings to a safe disposal point. To avoid these shortcomings it has been proposed to bubble the stream of cuttings and air through liquid to separate the cuttings before allowing the air to escape. This has been successful only to a limited degree owing to the fact that highly dangerous quantities of fine dust remain suspended in air bubbles rising through the water.

Attempts to use mechanical filtering devices to avoid these difficulties have presented further problems. Thus, it has been found that the filtering devices required to handle the large volumes of air are excessively bulky and operate at widely varying efficiencies depending upon the frequency with which the filters are serviced and cleaned. The porous walls through which the air escapes from these prior filters become clogged after a short period of use increasing the back pressure on the suction line to a point such that the chips are not removed from the bore hole and instead remain at the base of the bore and interfere with the effective and efficient operation of the drill bit.

By the present invention there is provided an improved separator device of compact lightweight construction found most satisfactory in obviating the numerous shortcomings and disadvantages of prior constructions, including those referred to above and others. This separator makes use of a plurality of cyclone type separators to remove the great bulk of cuttings and foreign matter from the suction air stream after which the substantially clean air is passed through a final filter effective in removing the remaining particles of micron size and larger before discharging the cleaned air to the atmosphere. The graduated size of the primary and secondary filters assures relatively slow velocity cyclone action in the primary chamber and the separation of the principal portion of the cuttings and particularly the heavier portions without excessive abrasive action on the walls of the primary filter chamber. The relatively smaller diameter of the secondary cyclone assures high velocity cyclone action as is desirable for the removal of the major portion of the fine particles. The very fine dust escaping separation in this chamber then passes to the final filter where it is removed as the air filters through the pores of an appropriate air-pervious filter maze.

2

Another feature of the invention is the simplicity of the construction characterized by the use of two main plate members held separated by the tubular housings of the several separators. This main sub-assembly is supported vertically and spaced above the supporting surface to provide access to the dirt collectors at the bottom of each tubular housing. All passages for the air undergoing cleaning are formed in the top plate. A further feature of the construction permits the main sub-assembly to be converted from small to large capacity operation by the simple expedient of replacing roller supports for this assembly with an auxiliary stand of sufficient height to permit use of large capacity collecting bags and a supplemental final filter unit.

Another feature is the provision of a highly effective automatic visual indicator to appraise the operator when the separator is in need of servicing. This indication is provided by a visible film of dust collecting adjacent the outlet of the final filter and easily wiped away as an incident to the servicing of the separator, this film collecting only when the filter is in need of servicing.

Accordingly, it is a primary object of the invention to provide an improved separator particularly adapted for use in separating chips, cuttings and dust produced in drilling rock, concrete and the like hard substances.

Another object of the invention is the provision of an improved portable separator for use with rock drills and which is highly effective in separating both large and minute particles of rock over a protracted period of use without substantial increase in back pressure or decrease in operating efficiency.

Another object of the invention is the provision of a simple, compact, lightweight, portable separator readily convertible from small to large capacity without change in the essential parts of the separator proper.

Another object of this invention is the provision of a dust and air separator utilizing a plurality of cyclone separators connected in series with a final filter with the size of the cyclones varying in size in accordance with the size of particles remaining to be filtered as the air stream approaches the final filter.

Another object of the invention is the provision of a dust and air separator employing a plurality of cyclones and a final filter held assembled between end plates one of which is effective to convey dust-laden air through the cyclones and final filters in series flow and the other of which is arranged to support detachable dirt collecting air-pervious member.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawings to which they relate.

Referring now to the drawings in which preferred embodiments of the invention are illustrated:

FIGURE 1 is a vertical sectional view taken along line 1—1 on FIGURE 3 through one preferred embodiment of the invention;

FIGURE 2 is a cross-sectional view taken along line 2—2 on FIGURE 1 showing features of the final separator;

FIGURE 3 is a top plan view of the separator;

FIGURE 4 is a vertical sectional view taken along line 4—4 on FIGURE 3;

FIGURE 5 is a top plan view of the separator converted for use as a small capacity separator wherein the lower supporting base shown in FIGURES 1 and 4 is replaced with castoring rollers;

FIGURE 6 is a vertical sectional view taken along line 6—6 on FIGURE 5; and

FIGURE 7 is a further vertical sectional view taken along line 7—7 on FIGURE 5.

Referring more particularly to FIGURES 1 to 4, there

is shown a preferred embodiment of the separator designated generally 10. This separator comprises an upper plate 11, a lower plate 12 and a supporting stand 13. As here shown, stand 13 includes a tubular ring 14 welded or otherwise secured to the lower ends of three vertically disposed supporting legs 15, the upper ends of these legs fitting into sockets 16 of plate 12 and secured in place therein, as by set screws 17. A platform 18 of sheet metal is brazed, welded or otherwise secured in place across ring 14 and provides a support for the cuttings collector bags as will be more fully explained presently.

Plates 11 and 12 are held separated by a pair of tubular housing or cyclone chambers 20, 21, as is best shown in FIGURES 1 and 4. These housings are preferably formed of transparent plastic material and their opposite ends are held sealingly engaged with O-ring gaskets 22, 23 seated in annular channels formed in plates 11 and 12, these components being held securely together by spacer bolts 25. The lower ends of bolts 25 have threaded engagement with plate 12 and their upper ends project through plate 11 and are held assembled thereto by cap screws 26. The upper interior side walls of housings 20, 21 may be provided with suitable protective guards 27 (FIGURE 4) of rubber or other abrasion resistant material in the areas opposite the inlet end of the dirt-laden stream in order that rock cuttings present in this stream will not cut through housings 20, 21.

As is made clear by FIGURES 1, 3 and 4, top plate 11 is here shown cast from metal or other suitable material and is provided with an inlet fitting 29 to which a flexible hose 30 may be connected for delivery to the separator of a stream of air laden with rock cuttings. Fitting 29 is connected at its inner discharge end with a tube 31 (FIGURE 4) discharging tangentially into the upper rim portion of larger cyclone housing 21. Accordingly, it will be understood that the incoming stream of cuttings and air swirls downwardly casting the cuttings centrifugally against the wall where they fall by gravity through opening 32 in plate 12. The low velocity swirling air axially of housing 21 flows upwardly into the tubular outlet 33 and into a transfer passage 34 formed in plate 11 and discharging through outlet 35 tangentially into the upper rim portion of the secondary cyclone separator formed in major part by housing 20. A considerably increased centrifugal force is here effective to cause the very fine suspended particles which escaped the first cyclone to be cast against the wall and drift spirally down through opening 32, thence to be encrusted against the walls of bag 61 which is air permeable. The remainder of the air carrying minute particles of from 1 to 5 microns, which cannot be separated centrifugally, passes upwardly through tubular outlet 36 into a transfer passage 37 opening downwardly into the top of the final separator formed by housing members 38, 39 (FIGURE 1).

The cup-shaped final separator housings 38, 39 are preferably formed of opaque plastic material and each has a closure plate 40, 41 fused or otherwise secured across its lower end. Each housing 38, 39 encloses one or more disposable final filter cartridges 42, there being a pair of these cartridges in each of the housings shown in FIGURE 1. A suitable type of final filter consists of an accordion-pleated tube of porous filter paper designed for separating out particles as small as one or two microns. The paper may and preferably is of the plastic-coated type and the pleats will be understood as being as close together as possible to provide a maximum exposed area of filter surface. Gasket rings 43 at the opposite ends of the filter cartridges avoid leakage across the ends of the filter cartridges but are spaced sufficiently from the interior side walls of housing 38, 39 to permit the filtered air to escape therealong.

The means for detachably securing the final filter housing and cartridges to the separator are here shown as comprising a coupling ring 45 having oppositely facing flanges serving to locate the adjacent ends of housing 38, 39 in the manner made clear by FIGURE 1. A through bolt

46 threaded at its opposite ends mates at one end with a threaded bore 47 in plate 11 and is provided with a double-ended threaded nut 48 at its lower end serving to hold coupling 45 and the upper housing 38 to plate 11. Supplemental housing 39 is provided at its lower end with a cap 48' having a central opening receiving a second through bolt 49 having a threaded connection with nut 48 at its upper end and provided at its lower end with a thumb screw 50.

It is pointed out in particular that in assembling final filter sections 38, 39 to the separator, care is exercised to so adjust through bolts 46 and 49 that the upper ends 52, 53, respectively, of housings 38 and 39 are spaced from the adjacent surfaces of plate 11 and of coupling 45 respectively, to provide a narrow annular outlet from each housing. The downturned lips 54 provided on plate 11 and on coupling 45 act to direct the discharging air downwardly along the side of the housing although some of the air will rise and flow across the surfaces of lips 54. Any traces of fine dust carried in this discharging air will form a film deposit on the adjacent surfaces thereby providing an indicator readily visible to the operator and indicative of the need for servicing the separator. This film is easily wiped away after servicing has been completed in order that the next inefficient condition of the separator may be readily detected in the same manner, it being pointed out that the dust film is deposited only when the filters are dirty and in need of servicing.

Attention is called to FIGURE 1 and the provision therein of aligned openings 56, 56 in bottom 40 of housing 38 and in the corresponding portion of coupling member 45. These openings permit air to flow downwardly into the supplemental final filter chamber 39. After the air is filtered by passing through filter air cartridges 42, it flows upwardly and issues through the same narrow annular air discharge port provided between the upper end of housing 39 and lip 54 on coupling 45 as was described above in connection with the upper filter housing. It will be understood that the width of the air outlet opening for both housings 38, 39 may be varied by adjustment of the corresponding through bolts 46 and 49 associated with each.

Referring now to FIGURES 1 and 4, it will be seen that the means for collecting and removing the cuttings separating in cyclone separators 20, 21 comprise a large bag 60 and a considerably smaller bag 61, the larger bag 60 being connected with primary cyclone 21 and the smaller bag 61 being connected to secondary cyclone 20. The detachable filter bag connection for the filter bags includes a seam enclosing a drawstring 62, 62 by which the inlet ends of these bags may be snugly compressed against a resilient gasket ring 63 seated in an annular groove 64 formed in tubular projections in the lower surface of plate 12. As will be apparent from FIGURES 1 and 4, the tensioning of drawstrings 62 compresses gasket 63 downwardly as the drawstring constricts the top of the collection bags between the upper side of the gaskets and the upper side walls of channel 64.

The larger collector bag 60 is preferably formed of heavy canvas so woven as to pass air without permitting the passage of fine dust particles. The secondary filter collection bag 61 is preferably formed of flannelette type fabric in order to filter out particles of finer dust carried into the secondary cyclone. It is found in practice that by properly correlating the diameters of the primary and secondary cyclones and by the proper selection of the fabric materials for the collector bags 60, 61, that as high as 98 percent of the rock cuttings separate out in the two cyclones leaving as little as 0.5 percent of the cuttings in the form of very fine dust to be separated in the final separator. In fact, normally 98 percent of the cuttings separate out in the primary cyclone, and 1.5 percent separate out in the secondary cyclone.

5

The described separator is particularly suitable for use with heavy duty drills operating for prolonged periods. For smaller scale operations, the large capacity provided by the described embodiment is unnecessary. These two widely varying needs are met in a highly satisfactory manner by the present invention without need for scaling down the various components of the separator or in making other substantial changes in the separator. Instead, the widely varying needs are met by utilizing the identical components described above, it merely being necessary to replace the tubular stand 13 shown in FIGURES 1 and 4 with the auxiliary supporting wheels 70, 70; substituting smaller collector bags 60, 61 and omitting the supplemental final filter unit 38. Accordingly, the same reference characters used in the first described embodiment have been retained for the small capacity assembly illustrated in FIGURES 5, 6 and 7.

The auxiliary roller supports 70 are here shown as comprising castoring rollers having their shanks 71 seated in sockets 16 and secured in place by set screws 17. The small capacity cuttings collector bag for the primary cyclone 21 comprises a shallow cup-shaped cap 73 of air pervious material having its upturned rim edges formed with a seam enclosing a drawstring 74 which can be tightened about the upper rim of gasket 63 to form an airtight seal similar to the first described embodiment. Likewise, the lower end of secondary cyclone housing 20 is closed by a similar small capacity cup-shaped receptacle 75 of air pervious material likewise provided at its upturned rim with a drawstring 74 by which it may be detachably secured in fluid-tight manner over gasket ring 63.

The final separator utilizes the lower section 39 of the final filter described in the first embodiment, the upper or supplemental separator section 38 being detached along with its filter unit and coupler ring 45. Housing 39 and end cap 48' are held in position on through rods 46 by means of a thumb screw 77, care being taken to adjust this nut to leave a narrow annular outlet between the upper end 53 of the separator housing and lip 54 of plate 11. It is pointed out that lips 54 include several low height radial ribs or the like projecting inwardly therefrom and serving to prevent the upper rim edges of housings 38, 39 from being assembled in a manner closing off the air escape outlets from the final filters.

From the foregoing it will be readily apparent that the described convertible separator may be quickly converted from a small to a large capacity unit by the simple expedient of substituting stand 13 for roller supports 70, by substituting the proper size chip collector bag and by adding, wherever desirable, an additional and supplemental final filter cartridge.

While the particular convertible portable air and dirt separator herein shown and disclosed in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims.

I claim:

1. A unitary portable air-and-cuttings separator assembly for use with pneumatically operated rock drills and adapted to be carried about by an operator comprising a pair of vertically spaced plates, rigid spacer means holding said plates spaced apart, means for supporting the lower one of said plates in spaced relation to the floor or the like supporting surface, said spacer means including a plurality of readily removable tubular members positioned between said plates and sealed thereto except that one end of one of said tubular members is spaced from the juxtaposed surface of the adjacent one of said spaced plates to provide an outlet opening for a portion only

6

of the dirty air entering said portable separator, a plurality of said tubular members opening at their lower ends into removable air-pervious cuttings collectors secured to the under side of the lower one of said plates and through which a major portion of the filtered air escapes, and another one of said tubular members enclosing a disposable air-pervious fine dust filter having its exterior in communication with said outlet opening to the ambient air, the upper one of said plates having passage means confined thereto for delivering air laden with dust and cuttings tangentially and successively into said tubular members and finally into the tubular member enclosing said disposable filter.

2. A unitary portable separator assembly as defined in claim 1 characterized in that the tubular member and cuttings collector to which the cuttings are delivered is larger in diameter and in area than the second one of said members and cuttings collector.

3. A unitary portable separator assembly as defined in claim 1 characterized in that the upper one of said rigid spacer means comprises a unitary rigid plate overlying and secured to the upper ends of each of said tubular members, said last-mentioned plate having a tube projecting downwardly centrally into at least two of said tubular members, the upper ends of said tubes including passages formed in said rigid plate for conveying air and cuttings out of one tubular member and delivering the same tangentially into the top rim portion of an adjacent one of said tubular members.

4. A unitary portable air and cuttings separator assembly for use with rock drills and adapted to be carried by an operator, said separator comprising an upright frame supporting a plurality of cyclone separator chambers and a filter type final separator chamber, said cyclones being of substantially different capacities and connected in series with one another and with said final separator, said cyclones including an upper imperforate cylindrical section and a lower tubular collector section each formed by a readily detachable air-pervious bag through which a major portion of the filtered air escapes, said final separator including a disposable filter capable of removing very fine residue particles from the air not escaping through said air-pervious bags, said final separator including a tubular enclosure supported with one end spaced from a juxtaposed cooperating surface of said final separator to provide a narrow outlet for the clean air, and means for circulating cuttings-laden air successively through said cyclones and through said final separator, said narrow outlet from said final separator being shaped to direct the discharging air across the exterior of the adjacent surfaces whereby fine dust discharging with said air collects on said adjacent surfaces and provides a readily observed visual indicator of the need for servicing and removing collected cuttings from said separator.

5. A unitary portable separator assembly as defined in claim 4 characterized in that said upright frame includes provision at the lower end thereof selectively to seat supporting rollers and a relatively tall stand, said stand having a platform spaced below the lower end of said frame and providing space for large capacity collecting bags for cuttings in lieu of small capacity collecting bags usable when said separator is supported by said rollers.

6. A unitary portable dirt separator assembly for use with rock drills and the like and adapted to be carried about by an operator, comprising a plurality of tubular chambers providing a large capacity primary cyclone and at least one smaller capacity cyclone separator and a final separator all formed by vertically-extending tubular housings compactly arranged in side-by-side relation, a common unitary one-piece connecting plate for the upper ends of said housings having passage means formed directly in said one-piece plate for conducting dirt-laden air through said primary, secondary and final separators in series, a one-piece base plate means interconnecting the lower ends of said tubular housings provided with air-pervious means

7

opening axially into the lower ends of said housings for collecting and removing cuttings separating in each of said housings and including means for holding each detachably connected to the under side of said one-piece base plate, and means for supporting said separator from said base plate with said cuttings collecting means spaced above and out of contact with the floor.

7. A portable dirt separator assembly as defined in claim 6 characterized in the provision of an outwardly opening channel surrounding the lower end of said primary and secondary cyclones, a resilient gasket ring seated in said channel, said separable means for collecting dirt comprising a bag having its inlet end telescoped snugly over said gasket ring and having drawstring means for compressing said bag inlet in a manner to compress said gasket into said channel.

8. A portable dirt separator assembly as defined in claim 6 characterized in that said final separator includes at least one narrow annular outlet at one end thereof through which clean air escapes after passing through said final separator.

9. A portable dirt separator assembly as defined in claim 6 characterized in that the outer tubular housing of said final separator comprises a relatively narrow but tall cup-shaped member housing readily removable pleated filter means, said cup-shaped member being held detachably assembled to said common plate at the top of said separator by threaded means extending longitudi-

8

nally through said final separator and accessible from the lower end thereof.

10. A portable separator assembly as defined in claim 4 characterized in that the first cyclone cylinder is made of a translucent plastic material whereby the stream of chips, cuttings, and dust are readily visible by the operator from his remote operating station as an indicator of performance of the entire rock drill cuttings removal system.

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