Jan. 19, 1932. F. F. STELZ 1,841,556

APPARATUS FOR SEPARATING SOLIDS FROM GASES

Filed July 17, 1928 2 Sheets-Sheet 1

Fig. 1.

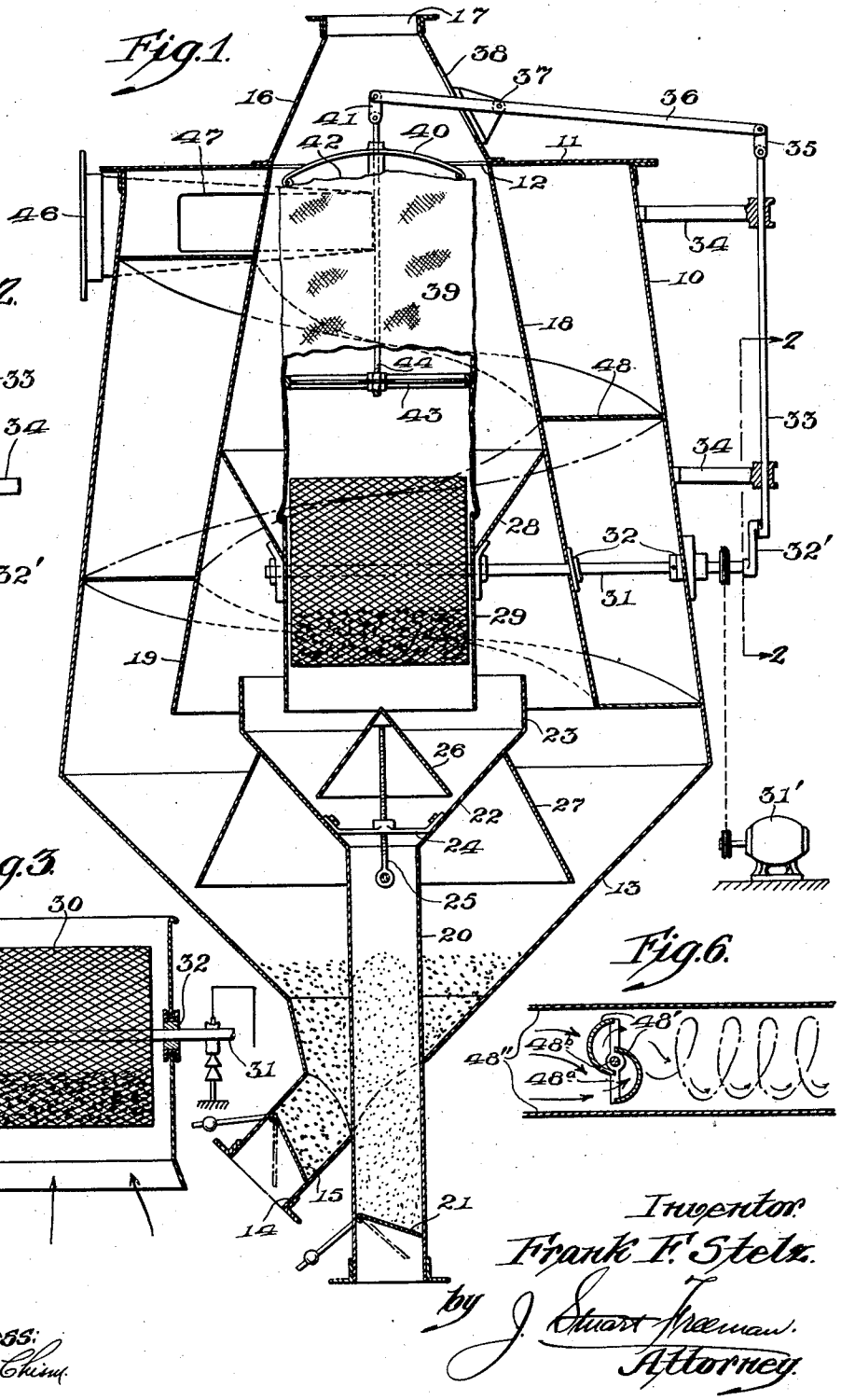


Fig. 2.

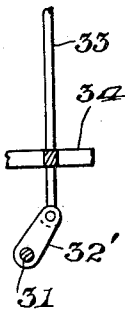


Fig. 3.

Fig. 6.

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Fig. 4.

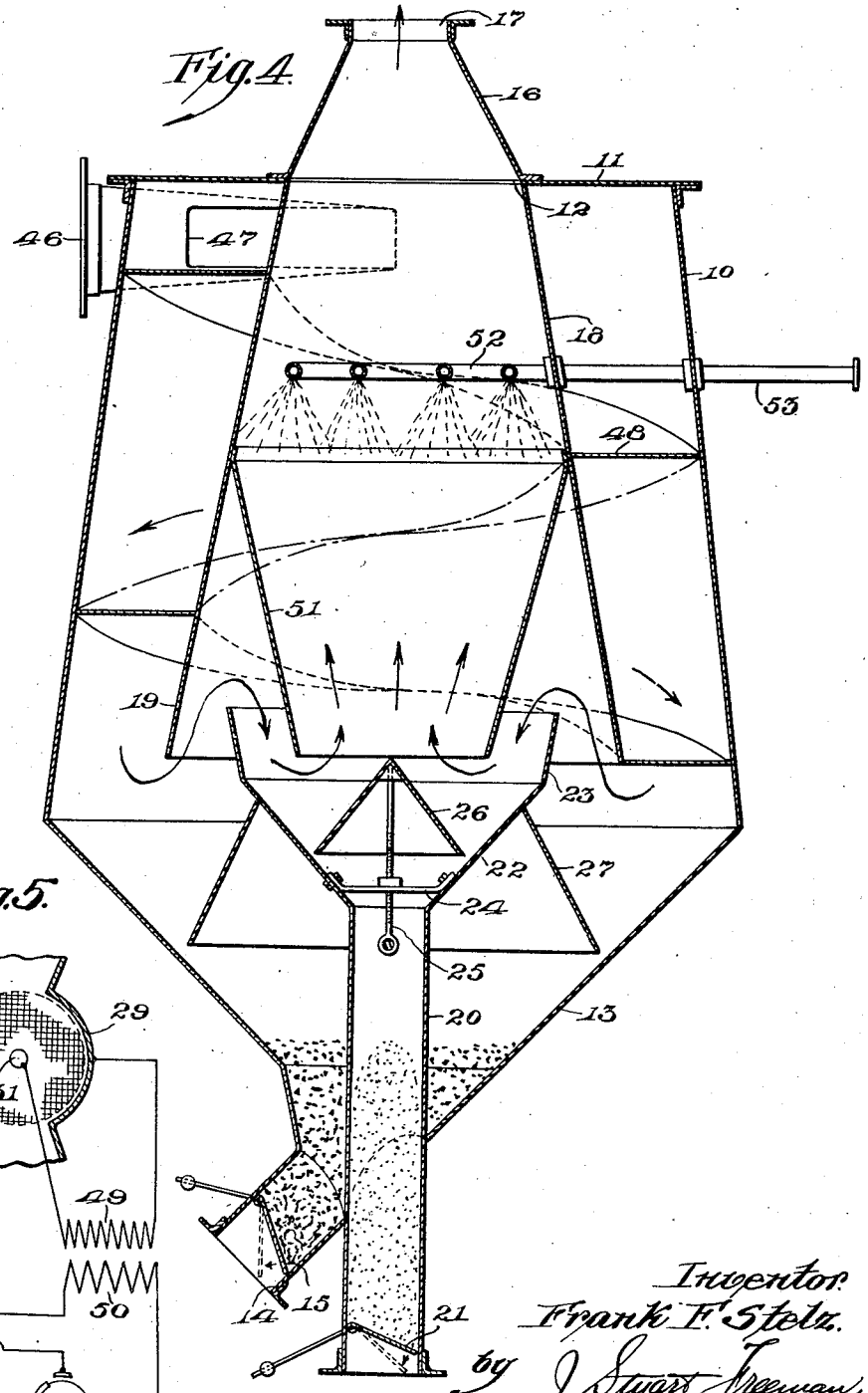


Fig. 5.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR SEPARATING SOLIDS FROM GASES

Application filed July 17, 1928. Serial No. 293,450.

The object of the invention is to provide apparatus for carrying out an improved method of separating solid particles from any type of gas such for instance as the gases which are given off from blast furnaces, cement making plants, chemical apparatus, et cetera, and which carry with them large quantities of valuable materials that would otherwise be lost, but which upon being reclaimed, provide by-products of sufficient quantity and value to materially add to the profits of a given industry.

Another object is more specifically to provide a static separator comprising a circuitous path providing spaced cavities or areas in which the solid particles carried by the gas fall and from which they can be withdrawn as desired, the first of such cavities receiving particles of relatively large size or mesh, while the last of such cavities in a series receives the most finely divided particles, whence the spent gases pass from the device.

A further object is to provide in connection with such static separator a mechanical means for still further purifying the gas by separating therefrom dust particles which would otherwise be carried off with the current of gases discharged from the device, said means comprising a rotatable element having an outer surface formed of relatively fine wire mesh or the like and in cross section being spherical, cylindrical, elliptical, or the like, together with solid particles contained within said rotatable means, such as short sections of tubes or similar articles which constantly change their position as said means rotates and which cooperate to form a heterogeneous mass in which the air channels constantly change in shape, direction and cross section.

Still another object is to provide in combination with the foregoing an embodiment of the invention in which a secondary mechanical separating means is employed, the same comprising a hollow fibrous member which receives the gases passing from the rotatable mechanical separator and through which the gases pass as the finest dust particles are strained therefrom, said fibrous member being preferably so mounted as to permit its being shaken or joggled in any suitable manner as for instance by and in accordance with the same motive power which rotates said mechanical separating means.

A still further object is to mount the rotatable means in insulated relation in respect to the surrounding parts of the device in order that said means and preferably metallic contents can be electrically charged with a relatively high voltage and of the opposite polarity to a charge imposed upon the surrounding elements, so that particles of dust of certain character in particular are electrified by well-known principles and are more completely precipitated by the gases passing through said means, thus providing an electrical separating means.

With these and other objects in mind the present invention comprises further details of construction and operation which are fully brought out in the following description when read in conjunction with the accompanying drawings in which Fig. 1 is a vertical diametrical section through one embodiment of the invention; Fig. 2 is a fragmentary section on the line 2—2 of Fig. 1; Fig. 3 is a detail elevation of the rotatable mechanical separator means; Fig. 4 is a sectional view similar to Fig. 1, but showing a modified embodiment of the invention; Fig. 5 is a diagrammatic view which when considered in conjunction with Fig. 3 is intended to illustrate the method of effecting an electrical precipitation of dust particles as adjunct to the mechanical separation also employed in the invention; and Fig. 6 is a diagrammatic section illustrating an air circulating means which may be placed in as many and different positions as desired, to rotate or impart a rolling motion to the air currents.

Referring to Figs. 1, 2, 3 and 5, of the drawings, the major portion of the device embodies preferably a sheet metal structure and comprises an upwardly tapering conical section 10 closed upwardly by means of a top 11 in which is positioned a central aperture 12 and which at its lower end is closed by a downwardly tapering conical section 13, having a laterally directed discharge out-

let 14 which may be normally closed by any suitable means such the flapper valve 15.

Rising from the periphery of the aperture 12 in the top 11 is a conical dome 16, having a discharge outlet 17, while depending from the periphery of said aperture is a tubular section 18, which preferably increases in cross section downwardly in substantial conformity with the sides of the outer or first-named section 10, and terminates preferably above the level of the plane of union between the oppositely direction conical sections 10 and 13. Extending from a point outside of and upwardly through the lower portion of the depending conical section 13 is a preferably axially positioned discharge tube 20, which may be closed by any suitable type of valve 21. The upper or innermost end of said tube leads from a conical section 22 increasing in cross section upwardly and terminating in a substantially cylindrical section 23, which enters the lower portion of, but is in spaced relation with respect to, the lower portion of the tubular section 18.

The lower portion of the conical section 22 is spanned by a bracket or spider 24 of any desired shape and through which extends an adjustable rod 25, to the upper free end of which is secured a preferably conical member 26, which at its lower periphery terminates in spaced relation with the surrounding conical section 22 by which it is preferably entirely surrounded. From the outer surface of said last-named conical section 22 there also extends the downwardly diverging sides of a conical skirt 27, which terminates in spaced relation with the adjacent walls of the depending conical section 13 of the outer casing by which it is preferably substantially entirely surrounded.

The interior of the tubular member 18 is preferably provided with a downwardly tapering conical flange 28, which terminates substantially adjacent to the outer surface of a casing 29, which latter is supported in any suitable manner and may extend from a point from within said conical flange downwardly to a point within the cylindrical flange 23 above the cone 26. Within this casing there is rotatably mounted a mechanical separator unit 30 carried by a shaft 31 in bearings 32, which preferably insulate said shaft and surrounding unit electrically from adjacent portions of the device for a purpose hereinafter described, and said shaft being driven by any suitable source of motive power 31'.

The shaft is journaled in any suitable manner through the tubular member 18 and outer casing 10 and is provided with a crank or offset 32', to which is connected a rod 33 suitably supported by brackets 34 so as to reciprocate upwarly and downwardly alternately, and at its upper end is connected through a link 35 with a rocker arm 36, pivotally mounted at 37 and extending through an elongated aperture 38 in one side of the dome 16.

Within the tubular section 18 a hollow strainer element 39, preferably of fibrous material or other suitable porous fabric, is connected at its lower edge portion to the upper edge portion of the casing 29 and is suspended from a spreader 40 which, and through a link 41, is connected to and supported by the inner end of the rocker arm 36. The strainer element 39 is closed at its top 42, and at a position intermediate of its ends is provided with a secondary supporting spreader element or spider 43, connected by a rod 44 to said first-named spreader 40.

When this construction rotation of shaft 31 and the offset 32' carried thereby causes the rod 34 to rise with the result that the inner end of the rocker arm 36 is lowered, thereby lowering the strainer element 39. As the free end of the offset 32' passes the highest point in its circular path, the rod 34 moves abruptly downwardly, with the result that the spreader elements 40 and 43, together with the strainer element 39 are suddenly jerked upwardly. This alternate reciprocation of the strainer element is repeated with each revolution of the shaft 31 and the mechanical separator element 30.

Within said separator element 30, which primarily comprises an outer casing of metallic mesh of suitable gauge, there is positioned a quantity of small articles, such as short lengths of tubing of the proper size to retard the flow of gases diametrically therethrough, yet sufficiently open to provide extremely tortuous paths, both through and around such articles. However, it is not to be considered that only articles of tubular nature can be used, as various other types can be employed instead, the principal characteristic being that with the continued rotation of the separator element 30, the interior structure of the body containing the contents thereof is constantly altered, and furthermore results in such a jarring or jolting of said articles, both individually and collectively, as to cause particles of dust, extracted by them from the gas passing therethrough, to be precipitated towards the bottom of and through the metallic gauze which comprises the outer surface of said separator element.

In the operation of this device, dust-laden gases of any character whatsoever are admitted into the device through a tubular connection 46, which connects with an aperture 47 in one side of the upper portion of the outer casing section 10, said gases thereby entering said section substantially tangentially thereto and being conducted to the bottom thereof between said section 10 and the centrally positioned tubular member 18 by means of a spiral partition 48, which terminates adjacent to the lower free end portion

of said tubular member and delivers dust-laden gases into the upper portion of the depending conical section 13. At this point, the largest and heaviest particles drop by gravity between the inwardly positioned conical section 27 and surrounding section 13 towards the outlet 14, whence by manipulation of the valve 15 they may be discharged whenever and into whatever receptacle may be desired.

From the point last-mentioned, the gases continue in a radially inwardly and upwardly directed course within the tube 18, where they are prevented from continuing farther upwardly by the conical member 28, which deflects them against the casing 29 and downwardly into the cylindrical section 23 and conical section 22, where a certain proportion of the particles remaining in the gas drop between said last-named section and cone 26, whence they drop into the discharge tube 20 and are withdrawn whenever desired by a manipulation of the valve 21 into receptacles of any suitable character. The gases from this point contain only dust particles of relatively much smaller mesh and are carried upwardly through the rotatable mechanical separator element 30, where additional dust particles are extracted from the gases and are precipitated as hereinbefore described upon the cone 26 and thence fall by gravity into the tube 20.

The gases thereafter pass upwardly and through the porous structure of the fabric of which the strainer element 39 is composed and outwardly through the discharge opening 17. However, the last of the remaining particles of dust of verifying mesh within the gases within said separator element are caught thereby and, as they precipitate upon the inner surfaces of the walls thereof, are shaken downwardly by the joggling motion hereinbefore described upon the rotatable element 30, whence they too drop by gravity towards and into the discharge tube 20.

Referring to Fig. 5 specifically, the shaft 31 and the casing 29, electrically separated by the insulated bearings 32, are shown diagrammatically as being connected with leads from the secondary winding 49 of a transformer which also includes the primary winding 50, and which together represent any suitable source of high-voltage electric current. When such a current is used, the finely divided particles carried by the gases passing through the separator element become positively and negatively electrified, and this condition increases the precipitation of such particles especially when they are of certain types. It is to be understood, too, that this electrical charging of the rotatable separator can be employed in conjunction with the mechanical operation thereof, or may be discontinued at any time without in the slightest affecting such mechanical operation and the precipitation caused thereby, and if desired the electrical separating means can be positioned upon the top of the static and mechanical separators in order to supplement without interfering with the operation of the latter.

Still greater efficiency can be obtained by causing a rolling, rotation, or swirling, of the dust laden gases as they progress through any portion of their path in the separator. Such motion, which preferably takes place about the longitudinal axis of motion, also develops centrifugal force which materially contributes towards throwing the solid particles out of and free from the gas. This highly desirable rotation of the gases can be effected by means of oppositely disposed, partially overlapping and suitably spaced cups, semi-cylinders, or the like 48′, extending transversely of the conduit 48″, and preferably rotatably supported in any suitable manner by one or more yokes 48^a carried by a pin or shaft 48^b, as shown in Fig. 6.

Referring now to Fig. 4, parts similar to those found in Fig. 1 are similarly designated by corresponding numerals. However, in this construction the rotatable and superimposed oscillatable separator elements are absent, and the device broadly comprises a static separator consisting of a circuitous path through which the dust laden gases pass downwardly between the outer section 10 and the tube 18, with or without the interposition of the air-rotating elements 48′, thence upwardly over and downwardly within the flange 23, and finally upwardly and radially inwardly over the cone 26. In this construction, the flange 28 and casing 29 as two separate elements are eliminated, and instead there is substituted a single depending conical element 51, which extends from a point within the flange 23 upwardly towards and is secured at its periphery to the inner wall of the tube 18, so that gases which have deposited their dust particles in the respectively conical and tubular bins 13 and 20 are free to leave the separator through the discharge dome 16 without further hindrance, unless the electrical separating means is superimposed thereupon. This form of the device is particularly efficient under certain conditions, but will not extract from gases the most finely divided particles of dust which of certain chemical elements are so valuable, and may be of such relatively low specific gravity as to permit the drafts of gas to carry them through the device, unless screened by such means as hereinbefore described. However, particularly in the case of hot gases, a water sprinkler may be installed within the tube 18 and comprise any suitably arranged set of pipes 52, connected by an inlet pipe 53 with any accessible source of supply (not shown), the cooling of gases being especially desirable when they are emitted from blast fur-

naces or comprise other forms of gases of combustion. Also, it is obvious that in this construction the sprinkler system can be removed and replaced by a mechanical separator of any desired form such as the rotatable or agitated types above described.

Furthermore, with relation to the device as illustrated in Fig. 1, instead of the single rotatable separator element, there may be a series of such elements of the same or different shapes and in which case their size likewise may vary as for instance, decreasing in cross section or volume respectively as they progress upwardly or downwardly and at the same time varying as to the size of mesh if desired. In fact, this invention anticipates the broad features necessary to carry out the general result hereinbefore described and without limiting such invention to such minor details as are disclosed herein for certain embodiments thereof.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:—

1. A dust extractor, comprising an outer casing, an inner shell comprising a discharge conduit and communicating at its lower end with said casing, a tortuous path for gases between the walls of said casing and said shell, a receptacle adapted to receive relatively large dust particles falling from gases passing through said path, a rotary filter disposed in said conduit, a reciprocatory filter also disposed in said conduit beyond said first filter, and operative to extract relatively fine material which may have passed such first filter, common means to actuate both of said first means, and a second receptacle adapted to catch such particles as may fall from said filters.

2. A dust extractor, comprising an outer casing, an inner shell comprising a discharge conduit and communicating at its lower end with said casing, a tortuous path for gases between the walls of said casing and said shell, means within said path to impart a circular or rolling motion to the gases, a receptacle adapted to receive relatively large dust particles falling from gases passing through said path, a rotary filter disposed in said conduit, a reciprocatory filter also disposed in said conduit beyond said first filter, and operative to extract relatively fine material which may have passed such first filter, common means to actuate both of said first means and a second receptacle adapted to catch such particles as may fall from said filters.

3. A dust extractor, comprising a casing having a channel for gases, a rotatable perforated unit within said channel through which gases may pass and operative to separate dust particles from gases passing therethrough, an adjacent reciprocatory strainer operative to receive dust-laden gases and separate finer dust particles from such gases after having passed through and had their coarser particles removed by said unit, and common means to rotate said unit and to agitate said strainer to cause dust collecting thereupon to loosen and fall therefrom.

4. A dust extractor, comprising a casing having a channel for gases, a rotatable perforated member therein, a strainer obstructing said channel, a source of power, and mechanism connected therewith and operative to rotate said member and reciprocate said strainer simultaneously.

In testimony whereof I have affixed my signature.

FRANK F. STELZ.