April 21, 1964 C. B. KAISER 3,129,850

POWDER CLOUD GENERATING APPARATUS

Filed May 17, 1961 3 Sheets-Sheet 1

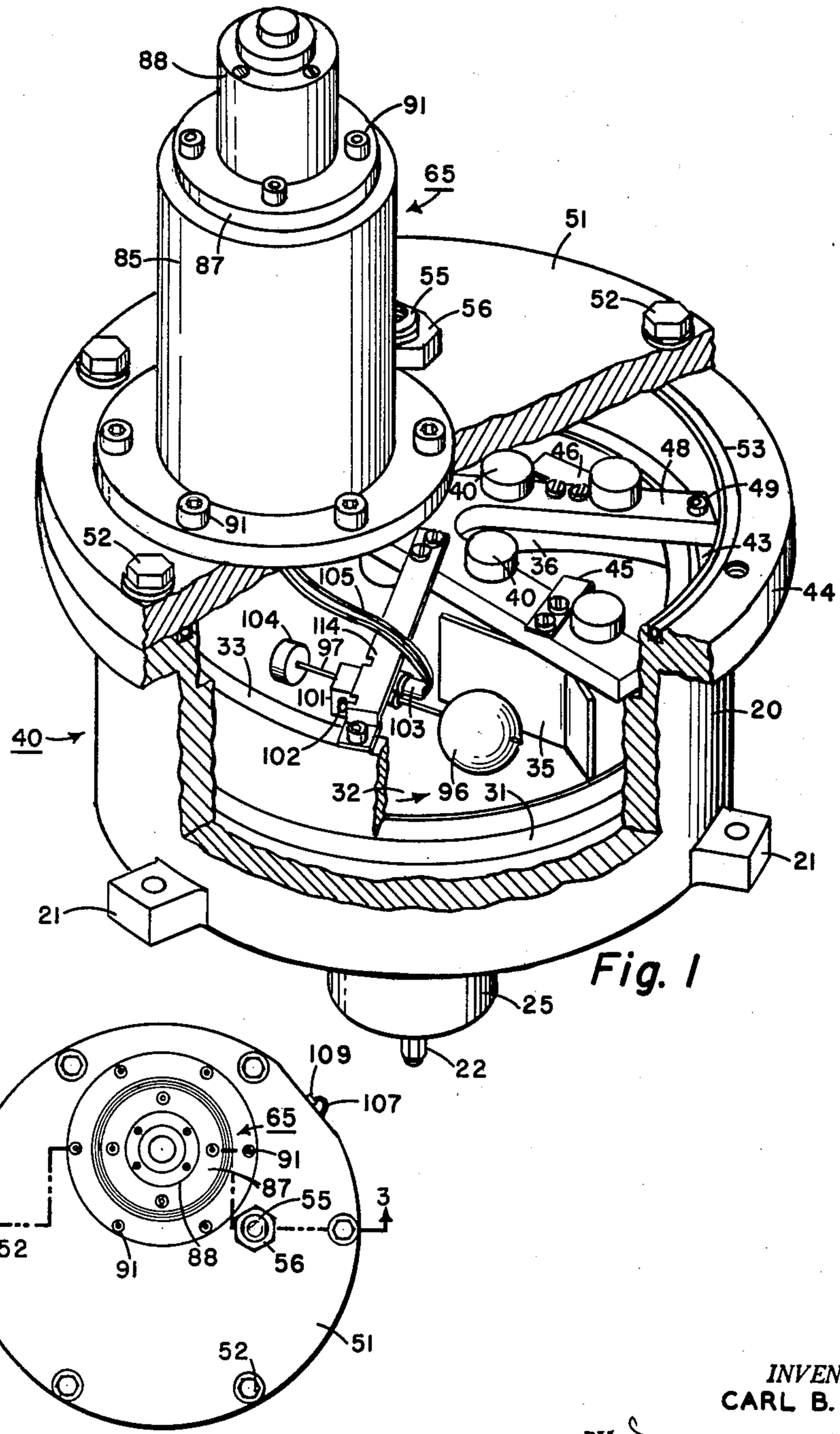

Fig. 1

Fig. 2

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POWDER CLOUD GENERATING APPARATUS

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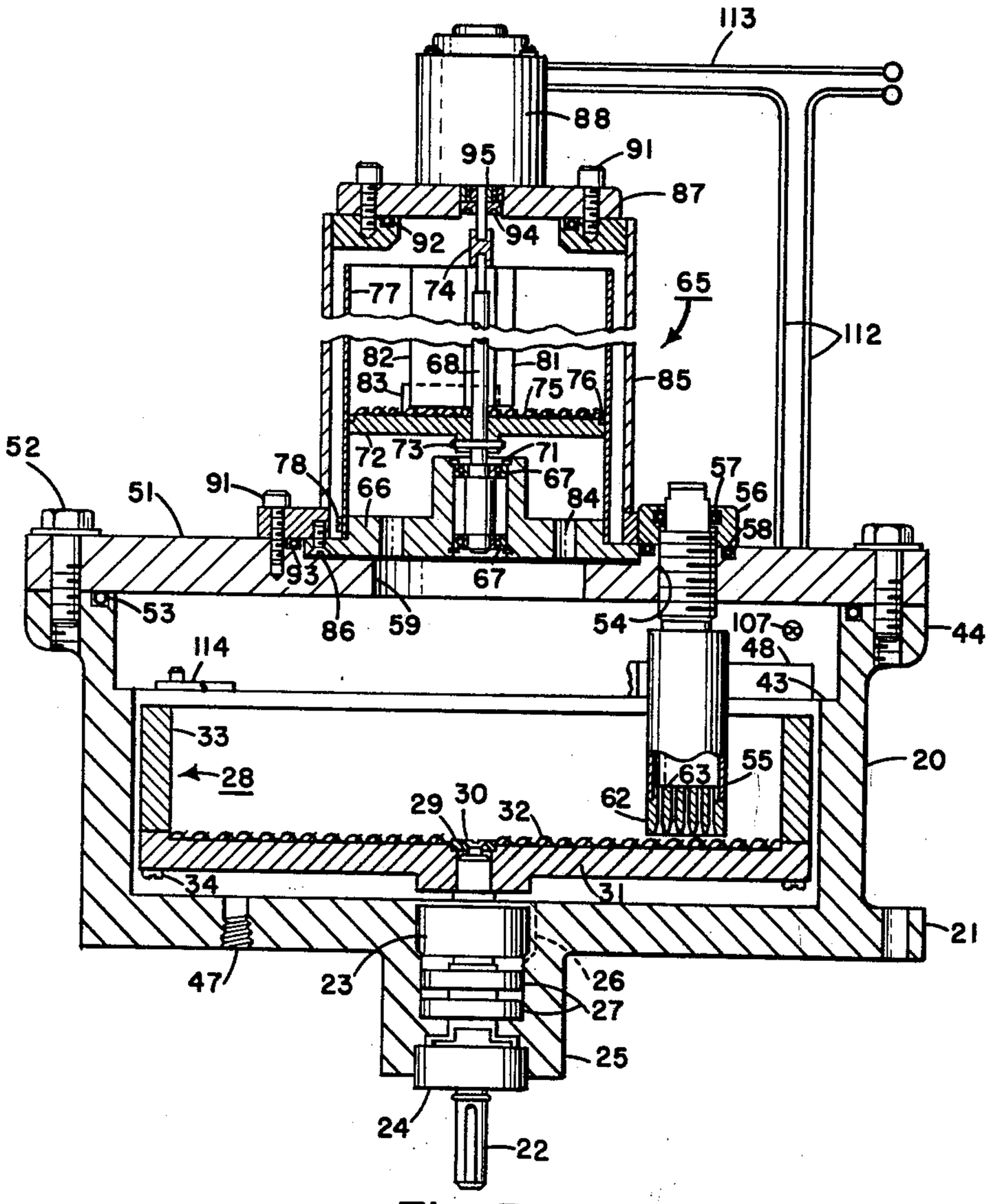

Fig. 3

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POWDER CLOUD GENERATING APPARATUS

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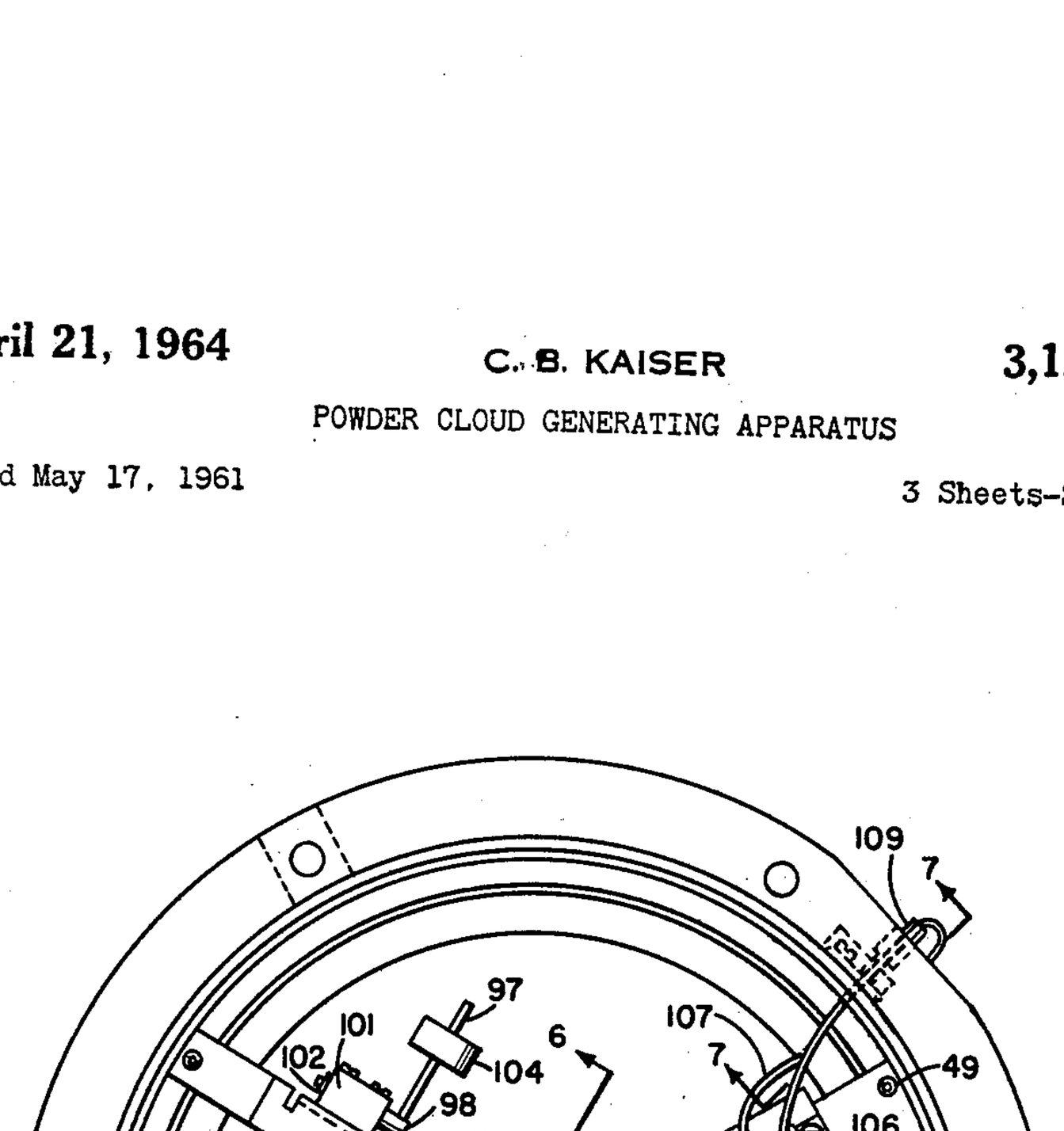

Fig. 4

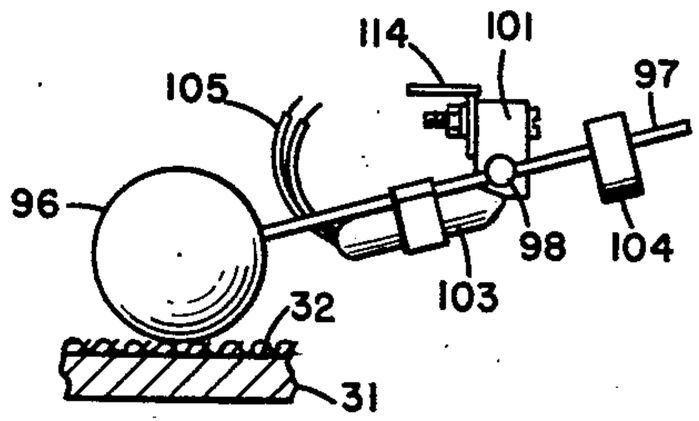

Fig. 6

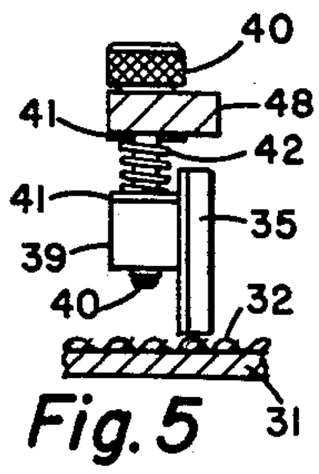

Fig. 5

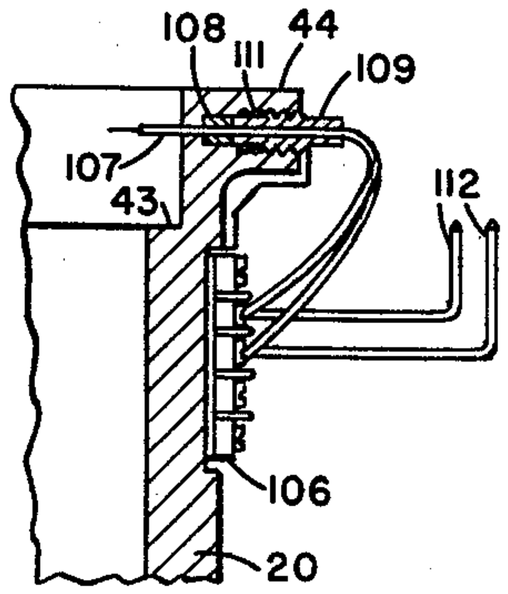

Fig. 7

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United States Patent Office

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3,129,850
POWDER CLOUD GENERATING APPARATUS

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Filed May 17, 1961, Ser. No. 110,805
3 Claims. (Cl. 222—67)

This invention relates to the field of xerography and, particularly, to an improved powder cloud generator for use in the development of xerographically produced images. More specifically, the invention relates to improvements in powder cloud generators of the type disclosed in Huber Patent 2,935,234, issued May 3, 1960, and in copending Huber application Serial No. 19,845, now Patent 3,094,248, filed April 4, 1960.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them to thereby create an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material, such as electroscopic powder, which is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic image is usually transferred to a support surface to which it may be fixed by any suitable means.

For continuous tone images, development is usually effected by means of a method of development called powder cloud development. In this technique of development, a dispersion of electrically charged powder particles in an aeriform fluid is directed to the surface bearing the electrostatic latent image and the powder particles are drawn from the aeriform fluid dispersion to form a powder image on the plate. This form of development is disclosed and described in Carlson Patent 2,221,776, wherein a rotating paddle wheel or propeller is used to stir up powder in a chamber, thereby creating a cloud of particles for presentation to the electrostatic latent image.

Generally, in powder cloud generating apparatus there is included a powder source, means to create a cloud of powder in aeriform fluid, means to convey the cloud to a surface carrying an electrostatic latent image and means to electrostatically charge the powder before it reaches the photoconductive surface carrying the electrostatic latent image. Such devices, which include one or a number of the above elements, and which are used to take powder from a source whether it be a mound of powder or whether it be in other shapes or forms, and convert the powder to an aerosol of powder and aeriform fluid, it is herein and generally in the art referred to as a powder cloud generator, as described in the above-referred Huber disclosures.

An object in the art of xerography, as in any art concerned with image reproduction, is that of uniformly developing high quality copy. Means for obtaining this object, while using powder cloud development, is through the uniform and constant presentation to the electrostatic latent image on the photoconductive surface of a powder cloud of fine developing powder particles uniformly and densely dispersed throughout the medium of an aeriform fluid.

In the early art device, of the type described, the amount of time during which a powder cloud generator could be operated at a given dispensing rate is dependent on the amount or charge of powder deposited on the support of the powder cloud generator. When the charge of powder was dispensed, the unit had to be depressurized before a new charge of powder could be inserted in the powder cloud generator.

Although the operation time of these early prior art devices could be extended within apparent limits by increasing the amount of powder in the charge, this mode of operation placed limits on the operating efficiency and dependability of the unit, that is, the dispensing rate of the unit would be effected by variation in the quantity of powder placed in the charge to be dispensed.

In the above-referred to Huber application, Serial No. 19,845, there is disclosed a powder cloud generator having a powder dispenser formed as an integral unit thereon for continuously supplying the powder cloud generator element with a continuous charge of powder particles to be metered. In this type of apparatus the output of the powder dispenser must be adjusted to approximately correspond to the amount of powder delivered from the powder cloud generator. Otherwise, if the dispensing rate is too low, the powder supply in the generator will be depleted or if the dispensing rate is too great, an excessive charge of powder will build up in the generator to adversely effect the powder density of the aerosol created by the powder cloud generator.

It is therefore, an object of this invention to improve powder cloud generators so that a uniform and dense dispersion of powder particles in an aeriform fluid can be created by controlling the level of the powder charge in the powder cloud generator.

Another object of this invention is to improve powder cloud generators whereby the charge of powder in the generator is automatically controlled and replenished.

For a better understanding of this invention, together with further objects thereof, reference is had to the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a powder cloud generator with parts of the casing and cover broken away to show the arrangement of an automatic level control device;

FIG. 2 is a top view of the powder cloud generator;

FIG. 3 is a cross-sectional view of the powder cloud generator taken along line **3—3** of FIG. 2;

FIG. 4 is a top view of the powder cloud generator with the cover plate and toner dispenser removed;

FIG. 5 is a sectional view taken along line **5—5** of FIG. 4 to show the mounting arrangement of the meter blades;

FIG. 6 is a sectional view taken along line **6—6** of FIG. 4 to show the mounting of the automatic level control device; and,

FIG. 7 is a sectional view taken along line **7—7** of FIG. 4.

A preferred embodiment of the powder cloud generator as shown in FIGS. 1 through 4, inclusive, consists of a flanged, cup-shaped body or casing **20** having mounting lugs **21** formed integrally therewith for supporting the unit on a structural element of the xerographic machine, not shown, and an air inlet opening **47** for connection to a source of aeriform fluid under pressure. A shaft **22**, by means of which the unit may be driven by a suitable drive mechanism, not shown, is journaled in double sealed bearings **23** and **24** mounted in the bored hub **25** of the casing. Since the interior of the casing will in operation be pressurized, a groove **26** is formed to extend along the bored wall of the hub to permit equalization of pressure on both sides of the top bearing **23**, suitable oil seals **27** being positioned in the bored opening of the hub between the bearings **23** and **24** to effectively seal this opening in the casing.

A cup-shaped powder carrier element **28** is rotatably

mounted in the casing 20 by means of the shaft 22. The powder carrier element 28 consists of a backing plate 31 secured against a shoulder of the shaft 22 by means of washer 29 and screw fastener 30. A skin or support 32 having numerous interstices in the surface thereof for carrying a powder particle is suitably secured to the backing plate, as by gluing. Suitable materials from which the support 32 may be fabricated are fully described in Hayford et al. Patent 2,862,646, issued December 2, 1958. Shell 33, fastened by screws 34 to the backing plate, is used to retain powder on the support surface.

First and second meter blades or scrapers 35 and 36, respectively, are adjustably positioned over the support 32 for metering powder across the surface of the powder support and first and second brushes 37 and 38, respectively, are spring mounted against the support to agitate powder particles deposited on the surface thereof. Two meter blades or scrapers are preferably used to insure more uniform and equal metering of a thin layer of powder to the surface of the support. As shown in FIG. 5, the meter blades or scrapers are adjustably positioned over the support by means of internally threaded blocks 39 secured as by soldering to the meter blades to receive the threaded end of the adjustment screws 40. By rotating the adjustment screws 40, the meter blades 35 and 36 can be adjustably positioned relative to the surface of the support, and the meter blades are maintained in this position by springs 42 encircling the adjustment screws 40 between washers 41 butting against the blocks 39 and the yoke 48 which is suitably apertured to receive the adjustment screws 40.

The yoke 48 which is Y-shaped is secured by cap screws 49 to the shoulder 43 formed in the body or casing 20.

Brushes 37 and 38 are rotatably secured to brush carriers 45 and 46, respectively, made of spring steel. The brush carriers are suitably connected to yoke 48 as by screws 34.

The open end of the casing or body 20 is closed by means of a cover plate 51 held in position by bolts 52 passing through suitable apertures in the cover plate and threaded into the flange 44 of the casing. An airtight seal is obtained by means of an O-ring gasket 53 positioned in a suitable annular recess formed in the upper face of the flange. The cover plate 51, thus secured to the body or casing 20 forms with the casing a housing which is capable of withstanding high internal aeriform fluid pressures and within which the powder carrier element rotates.

High pressure aeriform fluid is admitted into the housing by means of an inlet opening 47 adapted to be connected to a source of pressurized aeriform fluid, such as a compressor.

The cover plate 51 is provided with a threaded opening 54 adapted to receive an externally threaded hollow cylinder 55 adjustably secured by lock nut 56. The cover plate, the hollow cylinder and the lock nut coact with each other and with annular gaskets 57 and 58 held in suitable annular recesses in the lock nut and cover plate, respectively, to form an airtight seal. The upper portion of the cylinder 55 is adapted to be secured to a discharge conduit (not shown) for transporting the powder cloud to a xerographic plate or other area of utilization. A pickup tube 62 having a large number of output orifices 63 formed therein is secured as by soldering to the bottom portion of the hollow cylinder 55.

In the prior art devices, in order to operate for a reasonable period of time, it was necessary to place a large mass of powder on the support in front of meter blade 35. This was done before the unit was pressurized in preparation for operation. It is apparent that either the amount of developer powder placed in front of the meter blade 35 would depend on the amount of continuous use desired of the powder cloud generator, or stated in another manner, the length of time during which the powder cloud generator could be continuously operated would depend on the amount of powder that could be placed on the support in front of the first meter blade. Various other factors influencing the length of time during which the dispenser could be continuously operated are the size or area of the support, the shape and size of the first meter blade, that is meter blade 35, and its spacing above the support.

To operate this type of powder cloud generator for any extended period of time would require a substantially large charge of powder to be initially placed on the surface of the support. This not only overloads the support surface but the larger the mass or weight of powder placed thereon, the greater the variation in the density or compactness of the powder mass which adversely effects the amount of powder actually metered by the meter blade for a given setting. In the above-referred to copending Huber application, Serial No. 19,845, there is disclosed a powder cloud generator having a powder dispenser formed integral therewith to continually feed additional powder to the powder carrier element. In this device, it is necessary to set the dispensing rate of the powder dispenser so that, at all time, it dispenses a quantity of powder at least equal to or greater than the amount of powder dispersed in the aeriform fluid discharged from the generator. Stated in other words, the output of the powder dispenser must at all times be equal to or greater than the output of the powder cloud generator to prevent a loss of charge in the powder generator, which would, of course, effect development.

To permit continued operation of the powder cloud generator, the powder cloud generator of the invention includes a powder dispenser to feed additional powder to the powder carrier element, the powder dispenser being operated so as to replenish only the powder which has actually been used as opposed to the concept of continuously feeding powder to the powder cloud generator.

To feed additional powder onto the support of the powder carrier element and to control the amount of powder particles fed thereon, as only to replenish the powder which has been used, a powder dispenser, generally designated 65 is mounted onto cover plate 51 over the opening 59 formed therein.

The powder dispenser 65 consists of a flanged bearing bracket 66 adapted to fit within the counterbored portion of the cover plate forming opening 59. The flanged bearing bracket is bored to receive bearings 67 rotatably supporting a shaft 68, the bearings being retained in the bearing bracket by means of retaining rings 71 positioned in suitable annular grooves formed in the bored section of the flanged bearing bracket. Shaft 68 supports for rotation, therewith, a dispensing platform 72 secured thereon by means of a taper pin 73, and at its upper end the shaft is provided with a squared key portion adapted to engage a drive coupling 74.

Dispensing platform 72 preferably made circular in form, has its upper surface faced, preferably with a powder support 75 similar to support 32, the powder support being retained in position on the top of the dispensing platform by means of a hoop 76, the powder support being clamped between the hoop and the stepped peripheral portion of the dispensing platform.

Open ended dispenser cylinder or hopper 77 enclosing the dispensing platform is secured at its bottom end by screws 78 to the outer hub portion of the bearing bracket, the inside diameter of this cylinder being sufficiently large to permit the dispensing platform to rotate freely therein. The dispenser cylinder or hopper 77 and the dispensing platform 72 with the powder support fastened thereon, forms a reservoir for a supply of powder particles to be dispensed to the powder carrier element 28.

Within the dispenser cylinder or hopper 77 there is suitably mounted, a metering blade 81 and a dispensing blade 82. The bottom edge of the metering blade 81 is positioned sufficiently above the surface of the dispensing

support, for example, 1/64" to 1/32", to permit the desired quantity of powder carried by the rotating powder support to pass under this metering blade. The lower edge of dispensing blade **82** is positioned as close as possible to the dispensing support, without, of course, being in contact therewith with sufficient force to tear the powder support, whereby the dispensing blade acts as a scraper to force the powder from the dispensing support as it is rotated therebeneath over the peripheral edge of the dispensing support through an opening or powder outlet **83** formed in the side wall of the cylinder **77** opposite the powder support and adjacent these blades from whence it will fall through suitable apertures **84** formed in the bearing brackets onto the support of the powder carrier element. Suitable means may be provided to permit adjustment of these blades with respect to the dispensing support.

To permit only powder metered by metering blade **81** to be dispensed from the powder outlet, the dispensing blade and the metering blade extend to the top of the dispenser cylinder, as shown.

The above-described elements of the powder dispenser are enclosed within a dispenser housing **85** and secured thereto by screws **86** passing through suitable apertures in the flanged portion of the bearing to be threadingly engaged in the flanged bottom end of the dispenser housing.

The dispenser housing is closed at its upper end by means of a closure plate **87** which also supports a dispenser drive motor **88**. The closure plate is secured to the dispenser housing by means of cap screws **91** and this assembly is made airtight by an O-ring gasket **92** placed in a suitable annular groove formed in the top of the dispenser housing. Cap screws **91** passing through the flanged end of the dispenser housing secure this assembly to the cover plate in position over the opening **59** therein, an O-ring gasket **93** being positioned in a suitable annular groove formed in the cover plate so that as the dispenser housing is secured to the cover plate the O-ring gasket is compressed to form an airtight seal.

The drive shaft of the dispenser drive motor **88** extends through a suitable opening in the closure plate to engage the coupling **74** connected to the top of the shaft **68**. The drive motor is suitably secured to the closure plate and is effectively sealed thereon by means of the seal **94** positioned in the aperture formed in the closure plate and encircling the drive shaft of the motor below the bearing **95**.

To measure the quantity of powder discharged from the powder dispenser there is provided a level sensing element adapted to ride on the powder retained in front of the metering blade **35** as determined by the direction of rotation. In the embodiment shown, the powder level sensing element consists of a suitable float, such as a ping pong ball **96**, connected to one end of a lever **97** secured intermediate its ends to a pivot pin **98** journaled in a bearing block **101** suitable secured to bracket **114** fastened at opposite ends to the shoulder **43** of casing **20** and to the yoke **48**. The pivot pin is secured in the bearing block by means of retaining ring **102** positioned in a suitable groove formed in the reduced end of the pivot pin. To effect a substantially balanced equilibrium of the lever arm a counterweight **104** is adjustably positioned on the opposite end of the lever arm from the float ball. Mounted on the lever arm is a conventional mercury switch **103**, such as for example, a model 9S417B2 Minneapolis Honeywell Mercury Switch.

The conductor leads **105** from the mercury switch are connected to one end of a terminal strip **106**. Permanent conductor wires **107** extend from the terminal strip through a suitable aperture in the casing **20** to be connected to a second terminal strip **106** positioned exteriorly of the casing. To maintain an airtight seal the permanent conductor wires **107** extend through a compression fitting **108** positioned in the aperture **111** of the casing **20** and adapted to be compressed by screw **109**.

With this arrangement, the powder cloud generator may be disassembled or the mercury switch replaced without the necessity of dismantling the conductive leads passing through the wall of the casing **20**. Suitable conductors **112** and **113**, as shown schematically in FIG. 3, connect the motor to a source of power, via the second terminal strip **105** to the mercury switch **103** whereby the operation of the motor is controlled by the mercury switch.

In the operation of the powder cloud generator of the invention, after a supply of developer powder is placed in the hopper **77** and on the powder carrier element **28**, the closure plate **87** is secured in position and the inlet duct **47** is connected to a source of pressurized aeriform fluid. As the shaft **22** is rotated by a suitable drive source, the powder carrier element **28** is rotated in the direction indicated by the arrow in FIG. 1, beneath the metering blades **35** and **36**. As the powder carrier element is rotated a small quantity of powder carried on the support surface **32** thereof, is permitted to pass under the meter blade **35** while the remainder of the supply of powder is retained against the face of this meter blade. The powder passing beneath meter blade **35** is then remetered as it passes under meter blade **36** before it is picked up by the stream of compressed aeriform fluid as it flows beneath the pick-up tube.

As the support **32**, carried by the backing plate **31**, rotates under the meter blade **35** the pile of powder originally placed thereon will tend to lift the level sensing element or ball **96** up so that the mercury switch is tilted and maintained in an open position. When the level sensing element or ball drops, as the pile of powder in front of the meter blade **35** diminishes, the mercury switch is tilted sufficiently to close its contact to energize the motor **88** to effect operation of the toner dispenser to cause more powder to be added in front of the meter blade **35** which, of course, will cause the level sensing element or ball **96** to rise once again to open the contact to the motor, thus stopping the feeding of powder from the toner dispenser to the powder carrier element.

As the dispensing platform **72** is rotated upon operation of the motor **88**, a small quantity of powder carried by the dispensing platform on the surface thereof is permitted to pass under metering blade **81**. This powder, which has thus been metered by metering blade **81**, is then scraped by dispensing blade **82** to the periphery of the support surface to fall therefrom through the powder outlet **83** in the walls of the hopper from whence it will fall by gravity onto the powder carrier element in front of meter blade **35**.

With this arrangement of elements there is provided a device by means of which a substantial uniform quantity of powder can be maintained on the powder carrier element to effect substantially uniform density in the powder cloud generated by the device.

While there has been shown and described the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. A powder cloud generator including an enclosure, a powder carrier means rotatably journaled in said enclosure, at least one metering blade connected to said enclosure in closely spaced relation above said powder carrier means for metering a quantity of a powder thereon, an inlet duct in said enclosure adapted to be connected to a source of compressed aeriform fluid, an output means connected to said enclosure with one end of said output means positioned in closely spaced relation above said powder carrier means, the opposite end of

said output means being connectable to a discharge conduit, a powder inlet duct in said enclosure positioned above said powder carrier means in front of said metering blade with respect to the direction of rotation of said powder carrier means, a powder dispenser connected to said enclosure and positioned over said powder inlet duct for feeding powder through said powder inlet duct onto said powder carrier means, drive means connected to said powder dispenser for driving said powder dispenser, a switch positioned within said enclosure and operatively connected to said drive means for controlling the operation of said drive means, a lever pivotally mounted within said enclosure and positioned above said powder carrier means in front of said metering blade, a level sensing means connected to one end of said lever and positioned in front of said metering means and operatively connected to said switch, said level sensing means being adapted to ride on a pile of powder retained by said metering blade on said powder carrier means to effect the opening and closing of said switch as said level sensing means is moved by changes in the amount of powder retained on said powder carrier element by said metering means.

2. A powder cloud generator including an enclosure, a powder carrier means, including a support and a shaft, rotatably journaled in said enclosure with said support positioned for rotation in a horizontal plane in the bottom portion of said enclosure, and said shaft extending from said enclosure for connection to a suitable drive means; at least one metering means connected to said enclosure and positioned therein in closely spaced relation above said support for metering a quantity of a powder on said support as it is rotated beneath said metering means, an inlet duct in said enclosure adapted to be connected to a source of compressed aeriform fluid, an output means positioned in closely spaced relation above said support, the opposite end of said output means being connectable to a discharge conduit, a powder inlet duct in said enclosure positioned above said support and located in front of said metering means with respect to the direction of rotation of said support, a powder dispenser connected to said enclosure over said powder inlet duct for feeding powder through said inlet duct onto said support, drive means connected to said powder dispenser for driving said powder dispenser, a lever pivotally secured within said enclosure above said support, a mercury switch mounted on said lever and operatively connected to said drive means for controlling the operation of said drive means, a level sensing means secured to one end of said lever in position in front of said metering means, said

level sensing means being adapted to ride on a pile of powder retained by said metering means on said support to effect the opening and closing of said mercury switch and therefore the operation of said powder dispenser by said drive means in relation to the amount of powder on said support in front of said metering means.

3. A powder cloud generator including an enclosure, a powder carrier means, including a support and a shaft, rotatably journaled in the bottom portion of said enclosure with said support positioned for rotation in a horizontal plane, and said shaft extending from said enclosure for connection to a suitable drive means; metering means connected to said enclosure and positioned therein in closely spaced relation above said support for metering a quantity of a powder on said support as it is rotated beneath said metering means, an inlet duct in said enclosure adapted to be connected to a source of compressed aeriform fluid, an output means connected to said enclosure with one end of said output means positioned in closely spaced relation above said support, the opposite end of said output means being connectable to a discharge conduit, a powder inlet duct in said enclosure positioned above said support and positioned in front of said metering means with respect to the direction of rotation of said support, a powder dispenser connected to said enclosure and positioned over said powder inlet duct for feeding powder through said powder inlet duct onto said support, drive means connected to said powder dispenser for driving said powder dispenser, a lever pivotably secured above said support, a switch operatively connected to said lever for controlling the operation of said drive means, a level sensing means connected to one end of said lever in front of said metering means, whereby as said support rotates under said metering means a small quantity of powder on said support passes under said metering means while the remaining powder is retained against the metering means to cause the level sensing means to ride up onto the top of the pile of powder retained by said metering means on said support to effect movement of said lever to actuate said switch to control the operation of said drive means in relation to the amount of powder on said support in front of said metering means.

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