

Feb. 9, 1960

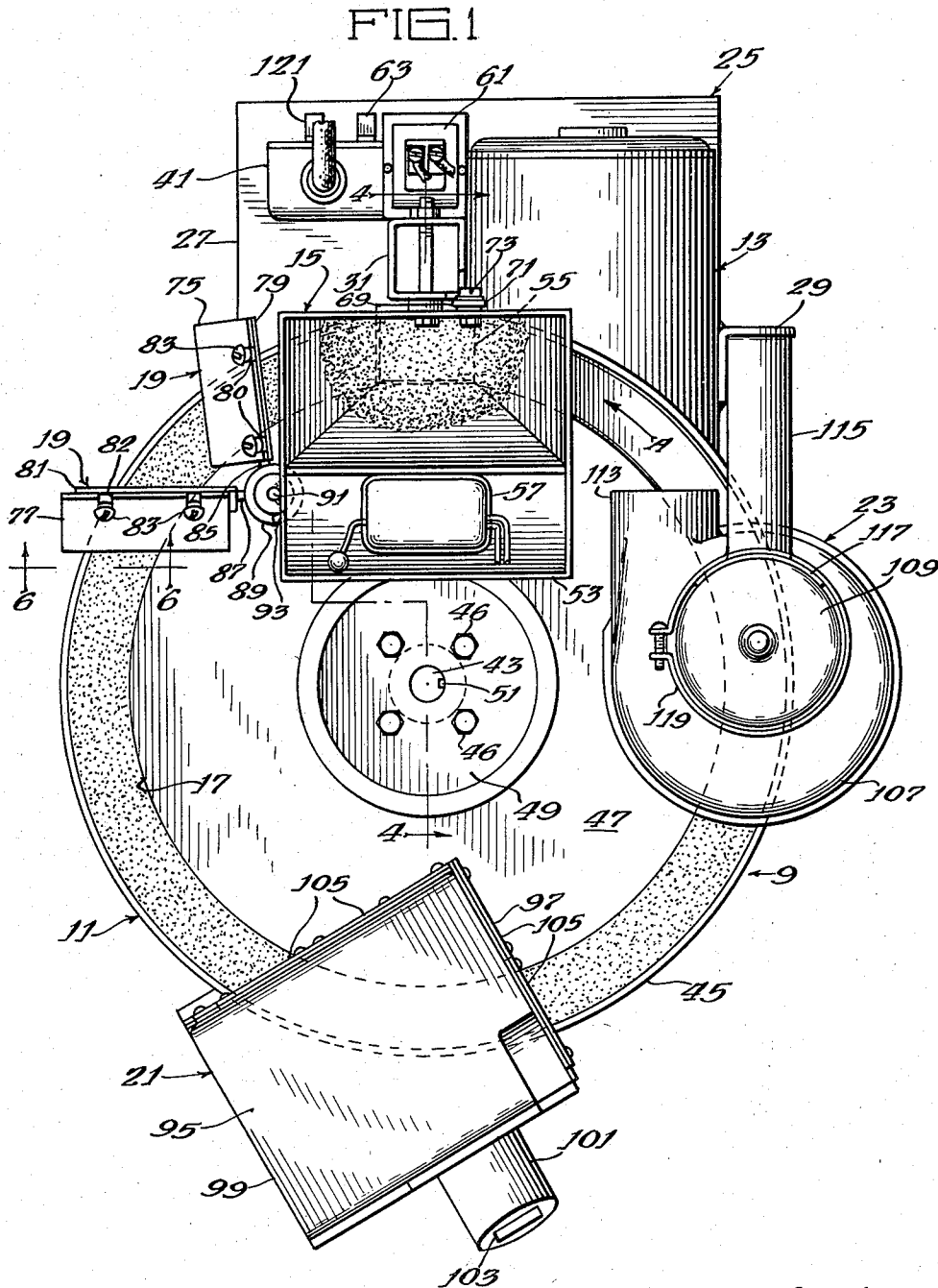
J. E. LAWVER

2,924,488

FEEDING APPARATUS FOR ANALYZER

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4 Sheets-Sheet 1



Inventor:
James E. Lawver
By: Ernest V. Haines
Attorney:

Feb. 9, 1960

J. E. LAWVER

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FEEDING APPARATUS FOR ANALYZER

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4 Sheets-Sheet 2

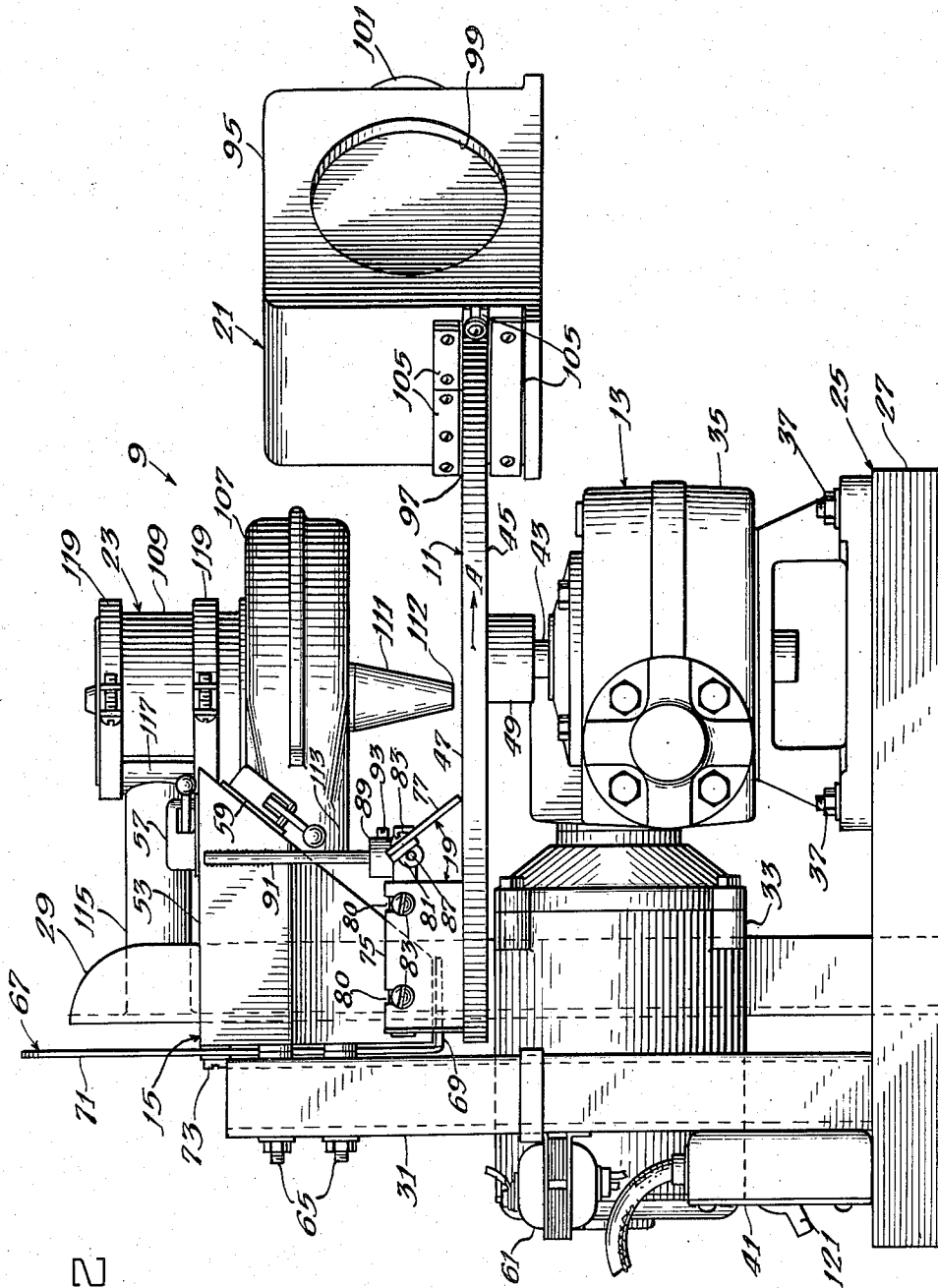


FIG. 2

Inventor:
James E. Lawver
By Ernest V. Haines
Attorney

Feb. 9, 1960

J. E. LAWVER

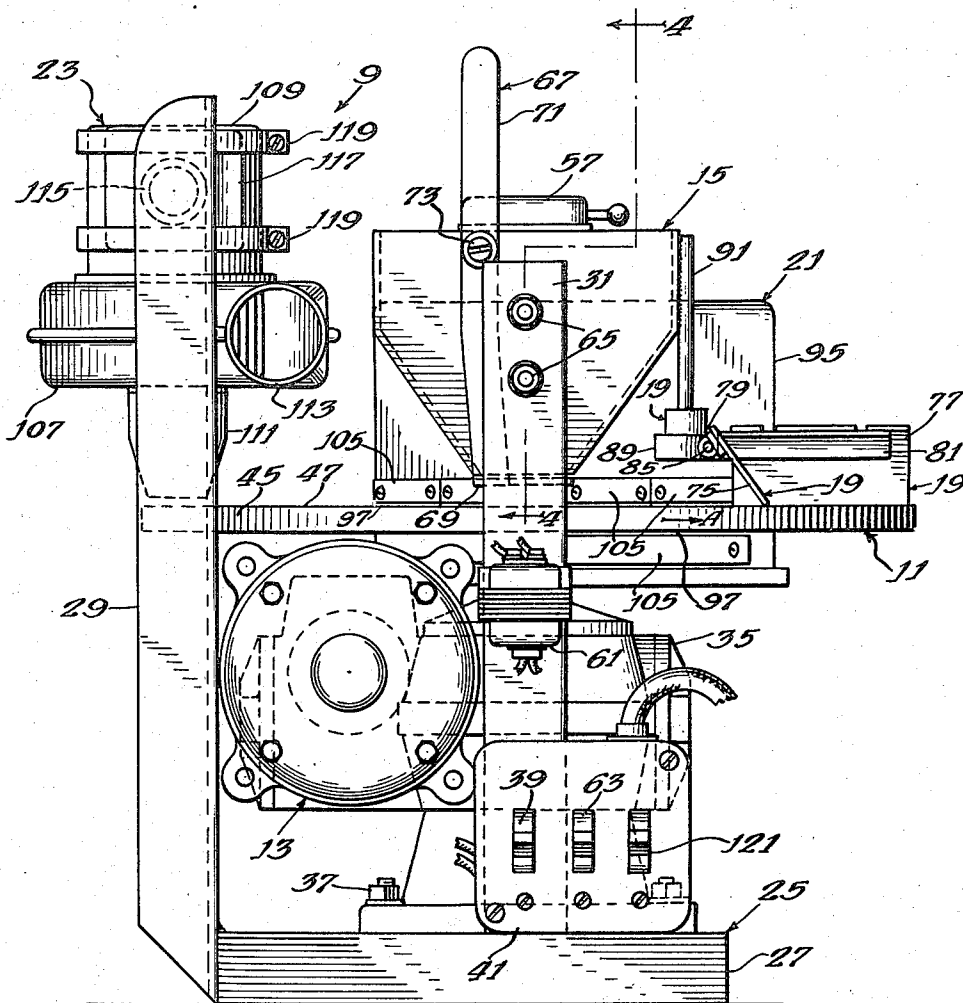
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FEEDING APPARATUS FOR ANALYZER

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4 Sheets-Sheet 3

FIG. 3



Inventor:
James E. Lawler
By: Ernest V. Haines
Attorney:

Feb. 9, 1960

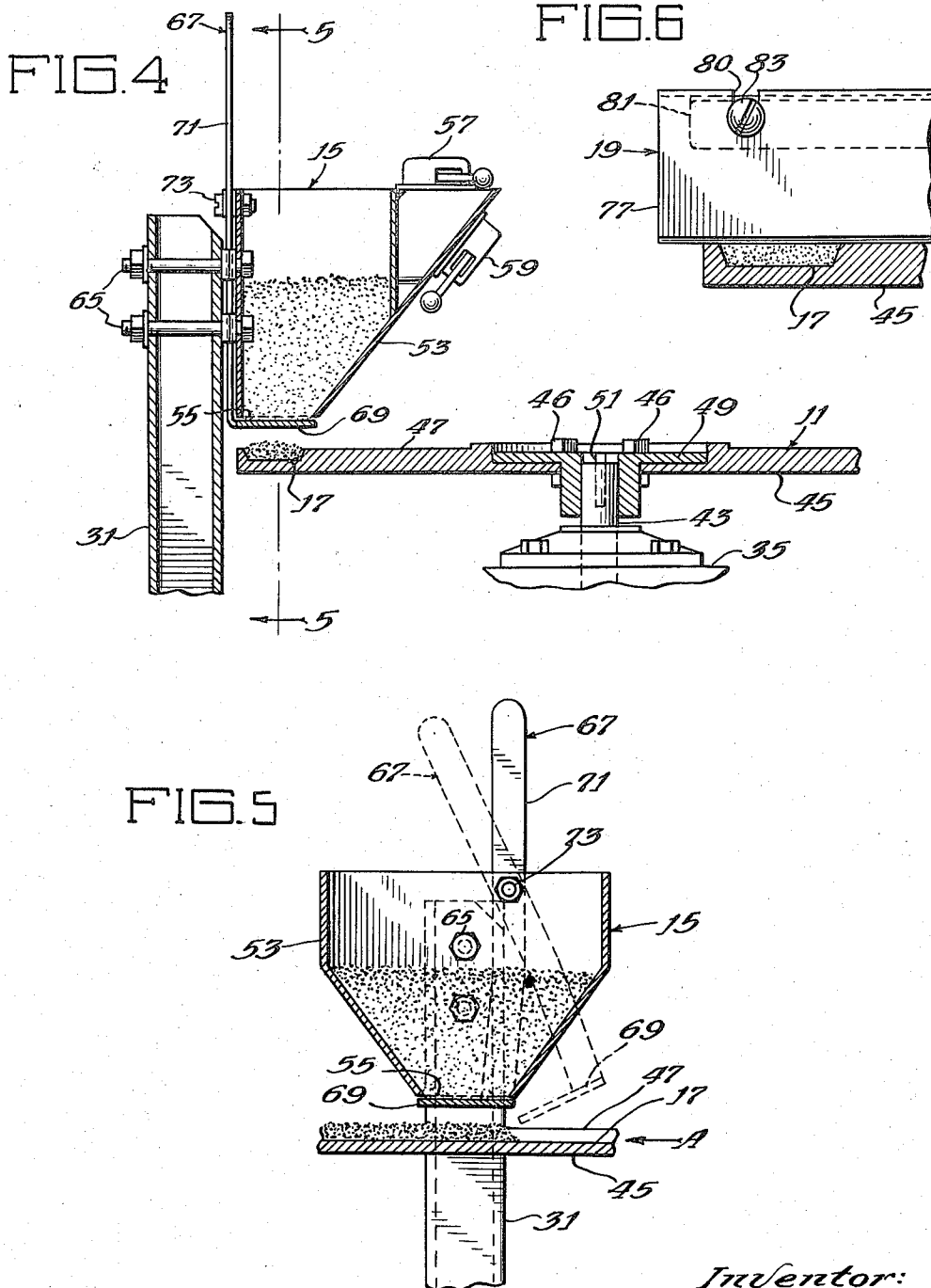
J. E. LAWVER

2,924,488

FEEDING APPARATUS FOR ANALYZER

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Inventor:
James E. Lawver
By: Ernest V. Haines
Attorney:

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FEEDING APPARATUS FOR ANALYZER

James E. Lawver, Skokie, Ill., assignor to International Minerals & Chemical Corporation, a corporation of New York

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4 Claims. (Cl. 302—36)

The present invention generally relates to a feeding apparatus for an analyzer. The invention more particularly relates to an apparatus for continuously introducing finely divided material to an X-ray apparatus so that a continuous analysis of the material may be made.

The desirability of an accurate and economical method of control for large scale chemical and metallurgical processes is self-evident. During the past few years, some industries have applied X-ray fluorescent analysis to plant control.

The earliest practical concepts of X-ray spectroscopy as an analytical tool were illustrated by Barkla (1908—1911). Barkla had found that on radiation with X-rays the different elements emitted secondary X-rays which were "characteristic" of the elements. Since that time, the method has become quite popular in industrial applications due to its accuracy, simplicity of sample preparation, and the rapidity of analysis.

The present invention, however, is not concerned with the method of or apparatus for X-ray analysis per se, but it is directed to an apparatus for introducing finely divided material to an X-ray apparatus so that an analysis of the material may be made.

Heretofore, most of the industrial applications of X-ray fluorescent analysis to plant control have been on a "batch test" basis. A continuous method of analysis and control is, however, superior to "batch testing" methods. For example, in a chemical or metallurgical process plant where moving beds of solids and streams of liquids are encountered, in order to achieve efficient automation or on-stream continuous control of the plant, a continuous method of analysis must be used. The use of X-ray analyzing apparatus in control instrumentation has proven quite effective; however, as hereinbefore set forth, in order to achieve efficient automation, a continuous method of analysis must be used. The X-ray analysis method per se is readily suitable for use in continuous control methods and the present invention is specifically directed to continuously introducing material to be analyzed to X-ray apparatus. It is, accordingly, an object of the present invention to provide a feeding apparatus for continuously introducing material to an analyzer so that a continuous analysis of the material may be made.

Another object of the invention is to provide a feeding apparatus for continuously introducing finely divided solid material to an X-ray apparatus for analysis, which feeding apparatus is readily adapted for use with existing X-ray analysis apparatus.

Further objects and advantages of the present invention will be apparent from the following description and accompanying drawings which illustrate one form of the invention.

In the drawings:

Figure 1 is a plan view of a feeding apparatus embodying various features of this invention;

Figure 2 is a side elevational view of the feeding apparatus shown in Figure 1;

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Figure 3 is a rear elevational view of the feeding apparatus shown in Figure 1;

Figure 4 is a fragmentary sectional view of the feeding apparatus taken along line 4—4 of Figure 3;

Figure 5 is a fragmentary sectional view taken along line 5—5 of Figure 4; and,

Figure 6 is a fragmentary sectional view of a leveling blade of the feeding apparatus taken along line 6—6 of Figure 1.

The present invention provides an apparatus for introducing divided solid materials to an X-ray apparatus so that an analysis of the material may be made. Examples of such materials are powders, crystals, granules, etc. such as occur in finely divided ores, for example, potash ore, phosphate ore, etc. The material must be relatively finely divided so that it may be readily handled in the apparatus. Large chunks would necessarily have to be ground before the material could be used in the apparatus.

The feeding apparatus includes a turntable rotatable about a substantially vertical axis and means for rotating the turntable about the vertical axis. A circular groove is provided in an upwardly facing surface of the turntable. The circular groove is concentric with the vertical axis of rotation of the turntable. The groove is provided to hold the material to be analyzed on the turntable.

The apparatus provides a delivery means for delivering material to be analyzed to the circular groove. This delivery means delivers the material to the groove as the turntable rotates, in an amount greater than needed to fill the groove. In other words, the material is supplied to the groove at a rate such that the material overfills or mounds the groove. This type of delivery means is provided to insure that the groove is filled.

The apparatus also provides means for leveling the material in the groove. In order to obtain an accurate analysis of the material, it is preferred that the material be supplied to the X-ray apparatus as a substantially level surface which has a constant elevation relative to the X-ray apparatus. Since the feeding mechanism overfills the groove in a manner such that the surface is uneven, a leveling means is preferably provided to level the material.

The apparatus also supplies a means for removing the material from the groove after it is analyzed. This removing means operates continuously as the turntable operates so that a clean portion of the groove may be presented to the delivery means for delivery of another sample to be analyzed. The use of the apparatus for analyzing granular materials makes possible continuous and rapid analysis. The use also makes possible the automatic control of various process streams which affect or are affected by the composition of the material analyzed.

An embodiment of the apparatus of the present invention is shown in the drawings and is described in the following paragraphs. While the apparatus shown is specifically adapted to delivering material to an X-ray apparatus, it will be understood that the apparatus may be used for delivering material to other types of analyzing apparatus.

As will hereinafter become apparent, the feeding apparatus 9 shown in the drawing includes, generally, a circular or disc-shaped turntable 11 positioned so as to rotate about its axis which is vertical. A means 13 is provided for rotating the turntable 11 at a predetermined constant speed and in the predetermined direction illustrated by the arrow A in Figures 1, 2 and 3. The material to be analyzed is placed in a delivery means 15 which feeds the material into a circular groove 17 in the upper surface of the turntable. After the material in the groove leaves the position under the delivery means, the material

is acted upon by a leveling means 19 which levels the material so that its upper surface is in the same plane as the upper edges of the groove 17. As the turntable continues to rotate, the material in the groove after being leveled passes through an analyzing section represented on the drawings by the X-ray analyzing section 21. After being analyzed the material must be removed from the groove so that another portion of material may be placed in the groove and to accomplish this a novel means 23 for removing the material is provided.

Referring now more particularly to the drawings, the specific feeding apparatus illustrated, embodies various of the features of the invention and, as has been pointed out, is particularly adapted to the feeding of finely divided material, such as a potash ore, to an X-ray analyzer. The illustrated apparatus has a support frame 25 which includes a heavy base platform 27 having a vertical structural support 29 which supports the means 23 for removing material from the groove 17 and a vertical structural support 31 which supports the delivery means 15.

The means 13 provided for rotating the turntable is a motor and gear head unit 13 which includes an electric motor 33 and a gear speed reducer and direction changer 35 which are drivingly interconnected. The motor and gear head unit 13 is secured to the base platform 27 by nuts and bolts 37. The motor 33 is connected to a source of electrical energy (not shown) through suitable electrical leads and switch 39 (Fig. 3) which is secured in a switch box 41. The switch box 41 is secured to the vertical structural member 31. The motor and gear head unit 13 illustrated is of the constant speed type, that is the rotational speed of the output shaft 43 is a predetermined constant. Motor and gear head units in which the speed of the output shaft is adjustable may, however, be used.

The turntable 11 illustrated includes a circular disc member 45 which has a substantially flat upper surface 47. The central portion of the disc member 45 is bolted by nuts and bolts 46 to a flanged fitting 49 and the flanged fitting in turn is mounted on the output shaft 43 through a key and slot connection 51. It is important that the sample of material to be analyzed be delivered to the analyzing section 21 of the X-ray apparatus (not shown) in a manner that the elevation of the upper surface of the sample be substantially constant relative to the analyzing section. This is readily accomplished in the illustrated apparatus by mounting the turntable 11 on the output shaft 43 carefully so that the plane of the upper surface 47 of the turntable is perpendicular to the vertical axis of rotation of the output shaft 43.

The circular disc member 45 of the turntable 11 has the circular groove 17 in the upper surface 47. As is illustrated in Figures 4 and 6, the cross section of the groove, taken cross-wise to the groove, is an inverted isosceles trapezoid. This cross-sectional configuration of the groove is preferred since it has been found that when the material is in such a groove the surface may readily be leveled or smoothened. The circular groove is concentric with the axis of rotation of the turntable and is positioned adjacent to the outer periphery. It is to be understood that the groove 17 may have configurations other than that illustrated in the drawings. The depth of the groove, however, should be at least twice the average particle size of the material to be analyzed. If the groove is of less depth, difficulty is often experienced in leveling the material and in analyzing the material.

The material to be analyzed is delivered to the groove 17 by the delivery means 15, which is peripherally spaced from the analyzing section 21. The delivery means 15 includes an open-topped hopper 53. A supply of the material to be analyzed may be placed in the hopper 53, or the material may be supplied continuously to the hopper which then acts somewhat as a surge bin. In some instances the delivery means provided may deliver material to be analyzed directly to the groove 17; however, it

is preferred to provide a hopper to insure relatively uniform flow of material into the groove.

The lower section of the sides of the hopper slope inwardly toward an opening 55 in the bottom of the hopper. The opening 55 is positioned directly above the groove 17. The opening is of a sufficient size to overfill the groove 17 as the turntable rotates. In order to insure a relatively uniform flow of material through the hopper 53 and out of the opening 55 into the groove 17, it is preferable that the hopper 53 be vibrated. In the illustrated embodiment, two vibrators 57 and 59 are provided. These vibrators are firmly attached to the hopper. The vibrators illustrated are electrically operated and they are accordingly connected to a suitable source of electrical energy (not shown). The vibrators illustrated operate at a relatively low voltage as compared to the voltage necessary to operate the motor 33. Since a common source of electrical energy is usually used, a step-down transformer 61 is provided in the circuit so as to supply a lower voltage to the vibrators. The transformer 61 is attached to the vertical structural member 31. The hopper 53 is also secured to this vertical structural member 31 by nuts and bolts 65. An electrical switch 63 in the switch box 41 is in the electrical circuit to the transformer.

A bottom closing member 67 is provided on the hopper 53 so as to stop the flow of material out of the hopper 53 through the opening 55 when desired. The bottom closing member includes a substantially square plate 69 which is somewhat larger than the opening 55 so as to be capable of closing the opening 55 when it is positioned against the opening as is indicated by the solid lines in Figure 5. The plate 69 is attached to an elongated lever 71 which is pivotally mounted on a bolt 73 secured in a side of the hopper 53. The lever 71 may be pivoted about the bolt 73 so as to attain the position indicated by the dotted lines in Figure 5, in which position the plate 69 is removed from the opening 55 so that material in the hopper 53 may flow out of the opening.

As is illustrated in Figures 4 and 5, the delivery means 15 overfills the groove. It is important, however, that the upper surface of the material in the groove be substantially smooth and level and there is, therefore, provided the leveling means 19 overlying the groove and mounted intermediate the delivery means 15 and the analyzing section 21 for accomplishing this. The leveling means 19 provides a leveling edge and as illustrated includes a pair of adjustable wiping blades or knives 75 and 77. Each of these blades, 75 and 77, is mounted on a bracket 79 and 81 respectively. The upper edge of each of the blades, 75 and 77, has a pair of slots, 80 and 82 respectively, therein and screws 83 in these slots hold the blade securely to the respective bracket. The slots 80 and 82 permit the blades to be adjusted up or down so as to be engageable with material in the groove to achieve the desired smoothening effect on the top surface of the material in the groove. Each of the brackets, 79 and 81, is mounted on a short rod, 85 and 87 respectively, which extends horizontally and radially from a hub 89. Each of the brackets 79 and 81 and the respective rods, 85 and 87, is pivotally adjustable about the longitudinal axis of each respective rod so as to permit the adjustment of the slope of the blades 75 and 77.

The hub 89 is mounted on a lower portion of a rod 91 which depends from and is secured to the hopper 53. The hub and its attachments are adjustable up and down on the rod 91. A set screw 93 (Fig. 2) extends through the hub 89 to the rod 91 so as to lock the hub in position on the rod. In the illustrated embodiment, two leveling blades are illustrated. It is to be understood, however, that one or more may be used. The number of leveling blades used depends to some extent upon the physical characteristics of the material in the groove 17. The blades 75 and 77 are adjusted so that they are slightly touching the upper surface 47 of the turntable 11 (Fig. 6).

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The material in the groove 17 after being leveled by the leveling means 19 is carried around on the turntable 11 which is disposed to pass the material in the groove through the X-ray analyzing section 21 in which the material is analyzed. In the drawings only the so-called "dog house" 95 of the X-ray apparatus is shown. In the drawing the "dog house" 95 is shown unsupported, that is, it is resting on the turntable 11; however, in actual use the "dog house" 95 is not resting on the turntable but it is supported by the rest of the X-ray apparatus (not shown) to be positioned at a predetermined elevation for cooperation with the turntable. The "dog house" is illustrated so that its position relative to the turntable may be more easily understood. In operation, with the "dog house" 95 supported on the X-ray apparatus, the turntable passes through an opening 97 in the sides of the "dog house."

The "dog house" 95 also has a circular opening 99 which accommodates the X-ray tube (not illustrated) of the X-ray apparatus. In a side of the "dog house" adjacent to the wall in which the opening 99 is positioned, a neck 101 with an opening 103 (Fig. 1) is attached. This neck and opening are adapted to fit the collimator of the X-ray apparatus. In operation, the "dog house" 95 is often filled with an inert gas such as helium or hydrogen and in order to prevent the gas from rapidly escaping through the opening 97 through which the turntable passes, adjustable scrapers 105 are positioned and screwed on the "dog house" about the opening 97 and these are adjusted so that they are in sliding contact with the turntable 11, thereby reducing any opening between the "dog house" and the turntable to a minimum. As hereinbefore stated, the design of the "dog house" or any of the remainder of the X-ray apparatus forms no part of the present invention and the "dog house" is illustrated merely to show its position relative to the other members of the feeding apparatus 9.

After the material in the groove 17 is analyzed, it is removed from the groove by the means 23. The novel means 23 illustrated is mounted intermediate the analyzing section 21 and the delivery means 15, and includes a centrifugal blower 107 which is driven by an electric motor 109. The blower 107 has a depending suction nozzle 111 connected thereto and the lower end 112 (Fig. 2) of the suction nozzle terminates adjacent to turntable 11 and directly above the groove 17. In operation, as the turntable revolves and carries the material in the groove under the suction nozzle, the material is sucked up out of the groove through the suction nozzle 111 and is blown out through the discharge nozzle 113 thereby thoroughly cleaning out the groove 17. The groove is therefore prepared for another filling as it passes beneath the delivery means 15.

A horizontal support member 115 extends from an upper portion of the vertical support 29 and is welded thereto. The other end of the horizontal support member 115 is attached to a convex formed plate member 117 into which the motor 109 is nested. In order to hold the motor 109 securely to the plate member 117, a pair of ring clamps 119 is provided. The motor 109 is connected to a suitable source of electrical energy (not shown) in a conventional manner and a switch 121 in the switch box 41 is provided in the circuit.

In one commercial embodiment of the apparatus which has been described, the turntable 11 had a diameter of 24 inches. The motor 33 was of one-eighth horsepower and rotated the turntable at 1¼ r.p.m. The blower motor 109 was ¼ horsepower. Using this apparatus, a continuous analysis of material was made using X-ray fluorescent apparatus for analysis. The use of this apparatus therefore makes a continuous control method possible.

The description of the invention utilized specific reference to certain apparatus details; however, it is to be understood that such details are illustrative only and are not by way of limitation. Other modifications and equiv-

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alents of the invention will be apparent to those skilled in the art from the foregoing description.

Having now fully described and illustrated the invention, what is desired to be secured and claimed by Letters Patent is set forth in the appended claims.

I claim:

1. In apparatus for delivering divided solid material for analysis the combination of means for mounting analyzing apparatus at a predetermined elevation for analyzing divided solid material passed through an analysis station, a turntable rotatable about a substantially vertical axis and having a peripheral portion of said turntable extending through said analysis station, means for rotating said turntable about said vertical axis in a predetermined direction, said turntable having an upwardly facing surface with an annular groove formed therein concentric with said vertical axis and disposed to pass through said analysis station as said turntable rotates, material delivery means having an outlet disposed above said groove and peripherally spaced from said analysis station to discharge a flow of divided solid material into said groove in an amount greater than that needed to fill said groove, leveling means mounted intermediate said analysis station and said outlet and providing a leveling edge overlying said groove and engageable with material in said groove to produce a substantially level upper surface at a predetermined elevation relative to said mounting means, and material removal means mounted intermediate said outlet and said analysis station to withdraw material from the groove after passing through said analysis station and prepare the groove for introduction of further divided solid material from said outlet as said turntable rotates.

2. In apparatus for delivering divided solid material for analysis the combination of means for mounting analyzing apparatus at a predetermined elevation for analyzing divided solid material passed through an analysis station, a turntable rotatable about a substantially vertical axis and having a peripheral portion of said turntable extending through said analysis station, means for rotating said turntable about said vertical axis in a predetermined direction and at a substantially constant speed, said turntable having an upwardly facing surface with an annular groove formed therein concentric with said vertical axis and disposed to pass through said analysis station as said turntable rotates, material delivery means having an outlet disposed above said groove and peripherally spaced from said analysis station to continuously discharge a flow of divided solid material into said groove in an amount greater than that needed to fill said groove, leveling means mounted intermediate said analysis station and said outlet and providing a leveling edge overlying said groove and engageable with material in said groove to produce a substantially level upper surface at a predetermined elevation relative to said mounting means, and material removal means mounted intermediate said outlet and said analysis station to continuously withdraw material from the groove after passing through said analysis station and prepare the groove for introduction of further divided solid material from said outlet as said turntable rotates.

3. In apparatus for delivering divided solid material for analysis the combination of means for mounting analyzing apparatus at a predetermined elevation for analyzing divided solid material passed through an analysis station, a turntable rotatable about a substantially vertical axis and having a peripheral portion of said turntable extending through said analysis station, means for rotating said turntable about said vertical axis in a predetermined direction and at a substantially constant speed, said turntable having an upwardly facing surface with an annular groove formed therein concentric with said vertical axis and disposed to pass through said analysis station as said turntable rotates, a hopper having an outlet disposed above said groove and peripherally

spaced from said analysis station to continuously discharge a flow of divided solid material into said groove in an amount greater than that needed to fill said groove, at least one scraper blade mounted intermediate said analysis station and said outlet and providing a leveling edge overlying said groove and engageable with material in said groove to produce a substantially level upper surface at a predetermined elevation relative to said mounting means, and vacuum means mounted intermediate said outlet and said analysis station to continuously withdraw material from the groove after passing through said analysis station and prepare the groove for introduction of further divided solid material from said outlet as said turntable rotates.

4. In apparatus for delivering divided solid material for analysis the combination of means for mounting analyzing apparatus at a predetermined elevation for analyzing divided solid material passed through an analysis station, a turntable rotatable about a substantially vertical axis and having a peripheral portion of said turntable extending through said analysis station, means for rotating said turntable about said vertical axis in a predetermined direction and at a substantially constant speed, said turntable having an upwardly facing surface with an annular groove formed therein concentric with said vertical axis and disposed to pass through said analysis station as said turntable rotates, said groove

having an inverted isosceles trapezoid cross section and having a depth of at least twice the average particle size of the material to be analyzed, a vibrating hopper having an outlet disposed above said groove and peripherally spaced from said analysis station to continuously discharge a flow of divided solid material into said groove in an amount greater than that needed to fill said groove, at least one scraper blade mounted intermediate said analysis station and said outlet and providing a leveling edge overlying said groove and engageable with material in said groove to produce a substantially level upper surface at a predetermined elevation relative to said mounting means, and an electric motor driven suction means mounted intermediate said outlet and said analysis station to continuously withdraw material from the groove after passing through said analysis station and prepare the groove for introduction of further divided solid material from said outlet as said turntable rotates.

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