

Feb. 23, 1943.

V. DAHLMAN ET AL

2,312,295

DUST RECORDER

Filed July 25, 1941

2 Sheets-Sheet 1

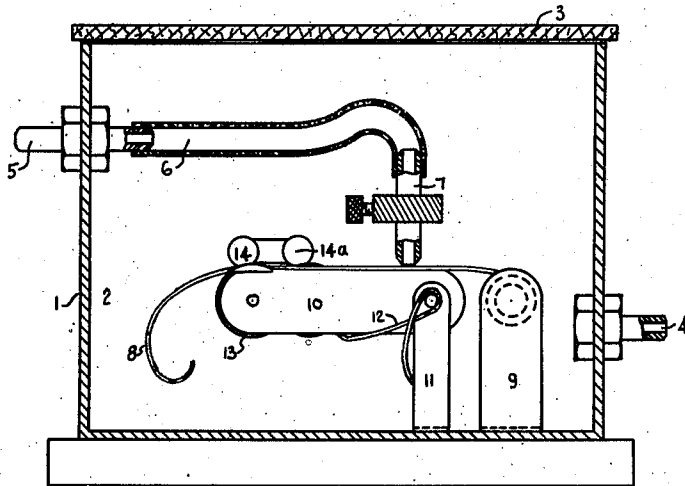


FIG. 1

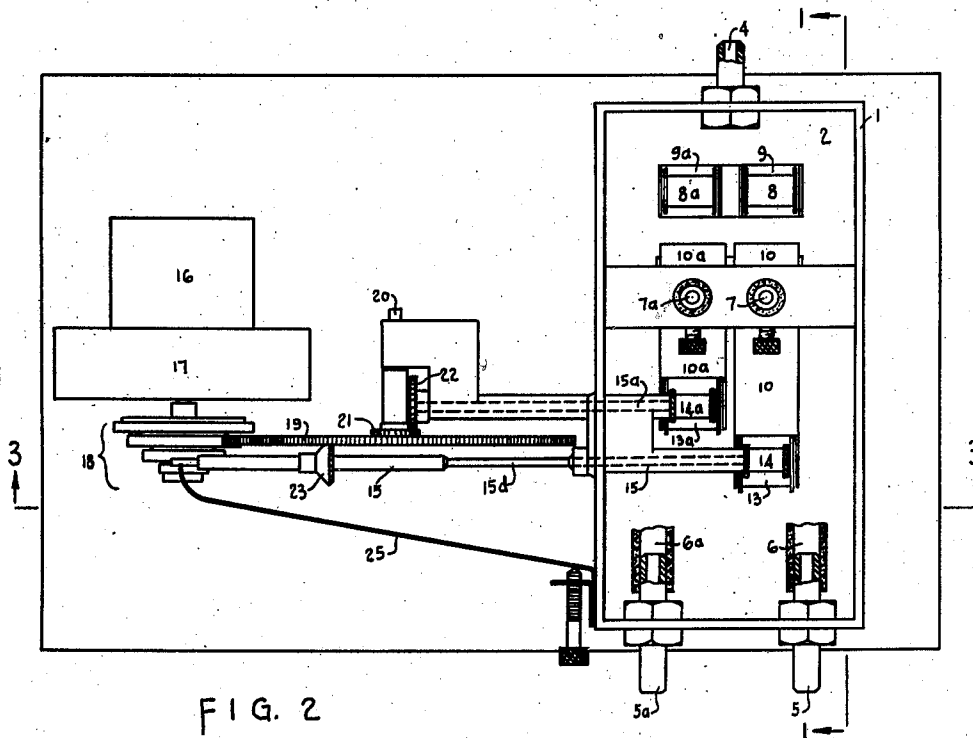


FIG. 2

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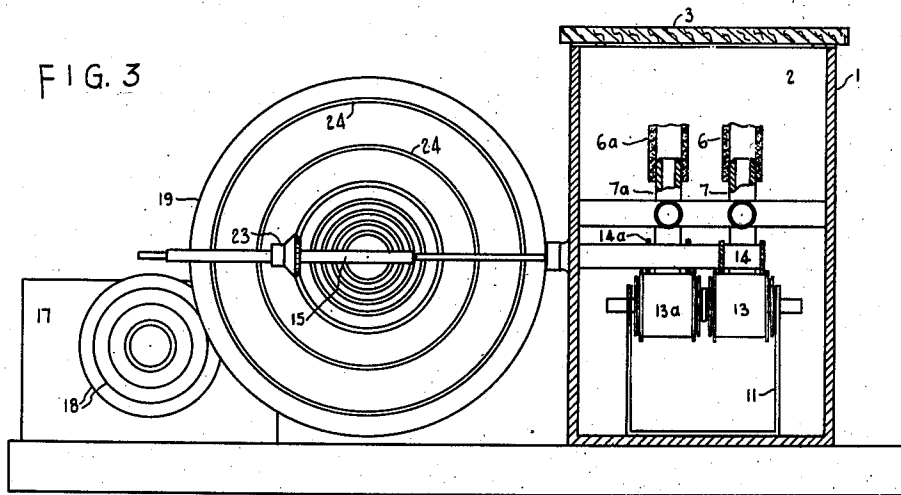
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UNITED STATES PATENT OFFICE

2,312,295

DUST RECORDER

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Application July 25, 1941, Serial No. 404,024

7 Claims. (Cl. 73—51)

To determine the dust collecting or cleaning efficiency of an air cleaner, it has been proposed to connect the air duct at opposite sides of the air cleaner to a sealed chamber through separate air sampling conduits, each terminating in a nozzle having a very small discharge opening spaced a minute distance from the face of a recording disc or target which is rotated by suitable means at a slow constant speed, say, one revolution per day. In operation, a vacuum is created within the chamber, causing a stream of air to flow through each sampling conduit and to jet against the recording target at a velocity which, due to the smallness of the discharge opening, is above the critical point of the nozzle; hence remains constant despite minor variations in the air-duct pressure. With this arrangement, all, or substantially all, of the dust contained in each stream is deposited upon the target, forming two separate tracks, the relative densities of which are accurately proportional to the efficiency of the air cleaner. Once the tracks are formed, a considerable period of time is required to evaluate the track densities accurately in terms permitting the efficiency to be determined on a percentage basis.

The present invention relates to an improved method of, and means for, measuring the dust collecting or cleaning efficiency of an air cleaner.

The principal object is to provide a novel method by which the efficiencies may be determined accurately and quickly.

Another important object is to provide an improved recorder of this general type which operates to evaluate the track densities accurately and quickly in terms permitting the efficiency to be stated on a percentage basis.

A novel form of recorder constructed in accordance with our invention and capable of carrying out either the old method or the novel method proposed herein, is illustrated in the accompanying drawings wherein:

Figure 1 is a side view corresponding to one taken along line 1—1 of Figure 2;

Figure 2 is a top plan; and

Figure 3 is an end view corresponding to one taken along line 3—3 of Figure 2.

The dust recorder illustrated in the drawings conventionally includes a vessel 1 having: a sealed chamber 2; an observation port in the form of a glass cover 3; an evacuating nipple 4 adapted for connection to a vacuum pump not shown for exhausting the interior of the vessel 1; and fore and aft nipples 5 and 5a. The outer ends of the fore and aft nipples 5 and 5a are

adapted for connection through fore and aft conduits to an operating air cleaner, that is to say, an air cleaner positioned in an air duct and operating to clean air passing through the duct, the conduits, air cleaner and air duct not being shown. The inner ends of the fore and aft nipples 5 and 5a are connected through fore and aft hoses 6 and 6a to nozzles 7 and 7a which discharge into the sealed chamber.

With this arrangement, the evacuation of the sealed chamber 2 will induce fore and aft streams of air to flow from the fore and aft sides of the air cleaner through the fore and aft conduits and jet into the chamber through the fore and aft nozzles 7 and 7a. As the degree of vacuum increases from zero, when operation is first instituted, the velocity of each discharge jet increases until the critical velocity is reached, at which further increases in the degree of vacuum will not produce any further increases in velocity. The nozzles are designed to have substantially equal critical points or velocities, while the degree of vacuum employed preferably is above that required to produce the critical velocities. Consequently, during operation, the jet velocities will remain at the same constant value despite minor variations in the air pressure at the fore and aft sides of the air cleaner.

In accordance with our invention, the fore and aft jets are respectively directed against separate fast and slow targets 8 and 8a moving at speeds adjusted so that the tracks produced on both targets will be of the same density. By adjusting the speed of the slow target to bring the density of the aft track within a range in which the eye is capable of quickly detecting slight differences in shade, we have found that the speed of the fast target may be quickly adjusted to a value at which the shade of its fore track matches the shade of the aft track and that, when the tracks are matched in this way, the ratio R of the slow to the fast target speeds is an accurate indication of the inefficiency of the air cleaner. The efficiency in per cent may be determined by the following formula: 100 minus 100 times R. For example with a ratio of 1 to 20, the efficiency is equal to 95%.

The fast and slow targets 8 and 8a are in the form of narrow strips of paper tape supplied from suitable rolls. The roll for the fast target 8 is rotationally mounted upon a stand 9 from which the tape is continuously drawn in a path extending horizontally across the fore jet where it is minutely spaced from the discharge end of the fore nozzle 7. The tape is supported for

movement along this path by means of an arm 10, having secured and free ends. The secured end is pivotally mounted upon a stand 11, while the free end is resiliently urged upwardly by means of a spring 12 which is suitably anchored to the stand 11 and arranged appropriately to engage the arm 10. The spring 12 functions to press an idling roller 13, which is rotationally carried by the free end of the arm 10, into yielding engagement with a drive roller 14. The drive roller is mounted upon a drive shaft 15 which projects out of the vessel 1 through a wall thereof. In this way, when the tape is inserted between the drive and idling rollers, appropriate rotation of the drive roller pulls the tape from the supply roll across the jet, thereby causing the fore track to be formed on the tape. The tape discharges from the roller into the adjacent space of the sealed vessel 1.

The slow target 8a is similarly arranged; hence it is associated with a supply stand 9a, arm 10a, supporting stand 11 (common to both targets), a spring corresponding to spring 12, idling roller 13a, drive roller 14a and drive shaft 15a, the latter likewise projecting out of the vessel 1.

The drive shafts 15 and 15a may be driven by any suitable adjustable speed means. In the arrangement shown, a motor 16 operates, through the gear reducer 17 and stepped wheels 18, to drive a disc 19. The motor reducer and stepped wheels are adjustably mounted as a unit to permit any one of the stepped wheels 18 to be placed in peripheral engagement with the periphery of the disc 19. In this way, the disc may be driven at any of a corresponding number of different constant speeds.

The shaft 20, upon which disc 19 is mounted, carries a small gear 21 which meshes with a similar gear 22 on drive shaft 15a to drive the slow target 8a. The fast target 8 is driven through the engagement, with the face of the disc 19, of a knurled roller 23 mounted on drive shaft 15 for axial movement along the shaft and rotational movement with the shaft.

If desired, the face of the disc 19 may be provided with a series of radially spaced grooves 24 dimensioned to provide definite speed ratios between the drive shafts 15 and 15a. For example, the innermost groove could be made of the same diameter as the gear 21 providing a 1 to 1 ratio while the outermost groove might be made of a size providing a 20 to 1 ratio. With grooves of this character, it would not be necessary to measure the speed of either shaft since the speed ratio would be instantly known from the particular groove employed. Where grooves or the like are employed, the drive shaft 15 should be made flexible in order to facilitate the transfer of knurled roller 23 from one groove to another. This is easily accomplished by reducing the diameter of shaft 15 as indicated at 15d although various other well-known equivalent means may be employed. Since shaft 15 is flexible, its projecting end is engaged by spring 25 which functions to urge the shaft laterally toward the disc, thus pressing the roller 23 firmly against the disc.

In operation, with the fore and aft nozzles 7 and 7a connected to the air duct at the fore and aft sides of the air cleaner and with the interior of vessel 1 vacuated through its connection with a vacuum pump, the motor 16 is started and the speed of the slow target 8a adjusted through the connection between the stepped wheels 18 and the disc 19 to a constant value at

which the aft track produced on the slow target 8a is neither too light nor too dark, but, on the contrary, of an intermediate shade, where slight differences in shading can be distinguished by the eye. When an aft track of suitable density is thus established upon the slow target 8a, the fast target may be adjusted, by properly positioning the knurled roller 23, to a speed at which the density or shade of the fore track produced on the fast target 8 matches the density of the aft track on target 8a. When a "color" match is thus made, the ratio of slow to fast speeds can be readily determined from the groove from which the knurled roller engages. With this ratio known, the efficiency can be quickly calculated. In this way, we have found it possible to obtain accurate measurements of efficiency in relatively short intervals of time.

It will be appreciated that if the recorder shown is set at a 1 to 1 ratio, it may be operated to carry out the old method of determining efficiency by ascertaining the relative densities of the fore and aft tracks. This may be useful occasionally to obtain a check determination of the efficiency.

Having described our invention, we claim:

1. In a method of measuring the efficiency of an operating air cleaner in an air duct, the steps of: removing separate streams of air from the duct at the fore and aft sides of the cleaner; jetting the streams at predetermined rates upon separate moving targets to form fore and aft tracks; adjusting the relative speeds of the targets to values at which the tracks formed are of substantially equal density; and determining the relative speeds of the fore and aft targets whereby the air cleaner efficiency may be determined.

2. In a method of measuring the efficiency of an operating air cleaner in an air duct the steps of: removing separate streams of air from the duct at the fore and aft sides of the cleaner; jetting the streams at substantially equal critical velocities upon separate moving targets to form fore and aft tracks; adjusting the relative speeds of the targets to values at which the tracks formed are of substantially equal density, and determining the relative speeds of the fore and aft targets whereby the air cleaner efficiency may be determined.

3. In a method of measuring the efficiency of an operating air cleaner in an air duct the steps of: removing separate streams of air from the duct at the fore and aft sides of the cleaner; jetting the air at substantially equal critical velocities upon separate moving targets to deposit substantially all of the dust contained in said streams upon said targets and thereby form fore and aft tracks; adjusting the relative speeds of the targets to values at which the tracks formed are of substantially equal density, and determining the relative speeds of the fore and aft targets whereby the air cleaner efficiency may be determined.

4. In a method of measuring the efficiency of an operating air cleaner in an air duct the steps of: removing separate streams of air from the duct at the fore and aft sides of the cleaner, jetting the air at substantially equal critical velocities upon separate moving targets to form fore and aft tracks; adjusting the speed of the aft target to the value at which the aft track is of an intermediate shade having color-matching quality; adjusting the speed of the other target to a value at which the density of the

fore track is substantially equal to that of the aft track, and determining the relative speeds of the fore and aft targets whereby the air cleaner efficiency may be determined.

5. A dust recorder of the type having a sealed chamber adapted for connection to an air duct at the fore and aft sides of an operating air cleaner through fore and aft sampling conduits terminating in nozzles having similar critical velocity characteristics, wherein the evacuation of the chamber causes fore and aft streams of air to jet at substantially equal critical velocities from the nozzles into the chamber comprising: fore and aft targets arranged for movement across the fore and aft jets respectively; means for moving said targets whereby fore and aft dust tracks are formed thereon; and means for adjusting the relative speeds of said targets to values at which the fore and aft tracks are of equal densities.

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6. The recorder of claim 5 wherein the adjusting means includes means for indicating a series of predetermined target-speed ratios.

7. The recorder of claim 5 wherein the adjusting means includes: a disc connected to rotate in accordance with the speed of one target, the disc having a series of concentric grooves on one face representing a series of known ratios between the linear speeds of the grooved portions of the disc and the speed of said one target; and a roller connected to drive the other target, the roller being adjustably mounted for movement along the face of the disc to place its periphery into driven engagement with one groove or another of said disc.

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